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# THE Poona Agricultural College Magazine

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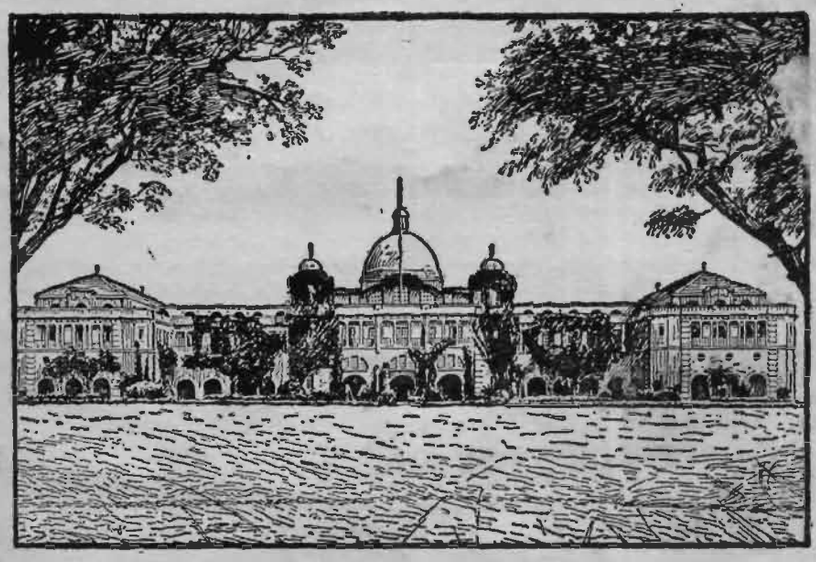

Lead me from the unreal to the real!
Lead from darkness to light!

—*Upanishad.*

I want India to recognize that she has a soul that cannot perish, and that can rise triumphant above any physical weakness and defy the physical combination of a whole world.

—*Mahatma Gandhi.*

"Grow more food" was not a bad cry during the war. It is a greater necessity now.

—*Mahatma Gandhi.*

THE POONA
# AGRICULTURAL COLLEGE MAGAZINE.

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THE POONA

AGRICULTURAL COLLEGE MAGAZINE

VOL. XL ] JUNE, 1949 [ No. 1

# Editorial

Our deepest sympathy goes to the cultivators of the famine affected area of Gujarat. Nature has spent her wrath in its fullness and has shed very little rain on certain areas in Gujarat and Saurashtra–especially the coastal strip of these regions, the agriculturists of which are hard hit. An unprecedented scarcity of water, food and fodder for cattle has been felt in this tract The Government and other agencies have done their best by providing al possible facilities to relieve the distress. Food, water and fodder have been conveyed to the affected areas. Boring operations have been carried out on a considerable scale and large scale pumping from available sources of water supply has been taken on hand to raise fodder and mitigate the effect of famine. We sympathise deeply with the cultivators of this region who have not only suffered by loosing the year's crop but have lost some of thier cattle wealth. There are signs of an early mansoon this year and we hope that the rains will be plentiful in this tract and afford much needed relief.

* * * *

What with famines in some areas and excess of rainfall in other parts of the province, the crop yields of the year 1948–49 have been low. Our province, as is well known, is a deficit area as regards food supply. Last year's results should open our eyes and it becomes all the more imperative to adopt all measures to raise more food and attain self sufficiency. As a matter of fact self sufficiency in food supply should not be our goal. We should grow food in excess to enable us to tide over years of insufficiency. Prime Minister Pandit Jawaharlal Nehru has sometime ago announced that the food drive should be treated as a war measure and all steps should be taken to stop the import of food from foreign countries in 1951. The Government of Bombay have started this drive in right earnest. The Hon. Minister for agriculture Shri. M. P. Patil, is going round the province and conducting food conferences at all district centres with a view to adopt the necessary measures for intensifying food production. The drive for tractor ploughing, manuring, better seed supply is getting on space and suitable large scale irrigation schemes are taking shape. Other provinces are getting ahead with their land reclama-

tion and tractor ploughing schemes with a view to get more area under crop. It is to be hoped that the measures planned will relieve the food scarcity in the country.

* * * *

The Government of Bombay have recently started a scheme for bettering the milk supply of Bombay. For this purpose a milk colony has been opened at Aarey about 20 miles north of Bombay. The colony is a self contained unit comprising farms, grazing areas, milk sheds and arrangements have been made for water supply, veterinary service, milk handling, Electricity and transport facilities have been provided. It is a complete and ideal dairy unit, which will utilise the surrounding area to grow its own fodder requirements. It will prepare and handle clean and sanitary milk. The milk will be pasturised before selling. The aim is to cheapen the cost of milk, to rear the animals properly and to provide stabling accommodation for 15,000 milch cattle. Calving facilties and arrangements to rear the calves properly will be provided. The opening ceremony of the colony was performed by Dr. Rajendraparsad, President of the Constituent Assembly, a few months ago. It is expected that the colony will be one of the ideal self contained units for milk handling in the East.

* * * *

It would be interesting to await the results of the scheme for crop insurance for the province of Madras, prepared by Shri. B. Natarajan, Economic Adviser to the Government. It is true that the Indian agriculturist has to face many risks by way of famine, pests, diseases, inclement weather etc. It is also well known that the several Governments have to give land revenue remissions to the cultivators in famine and scarcity tracts periodically. The relief, when given, is delayed and none too generous.

The scheme envisages an insurance confined to a certain percentage of the yield of a crop and proposes to confine it to staple crops in the first instance. The premium may be paid in cash or in kind. Licenced warehouses would be established to store the grain, thus relieving Government of the responsiblity of storing the grain. The scheme not only eliminates the necessity of giving revenue remissions but also guarantees for a yield of 75% of the normal and, thus will save Government a considerable expenditure on famine relief. The scheme which certainly is meant for the benefit of agriculture. the basic industry in our country, deserves full encouragement.

* * * *

It is well known that there is a great dearth of manure in our country. The supply will be still shorter when the demand for manure will increase due to the increase in irrigated areas, when the large and small scale irrigation schemes begin to operate fully. To make up the manure requirements for the development of agriculture, it is essential that all possible sources of manure supply should be utilised to the maximum extent and there should be no waste in this respect. The Government of Bombay are to be congratulated

for the legislation, they proposes to enact to compel all the municipalities in the province to convert the town refuse, rubbish and night soil into compost. The scheme deserves the utmost support from the public. If Government could enact legislation to prevent the burning of cow-dung as fuel, they would be adding yet another boon to the development of agriculture.

* * * *

India has suffered a great loss by the passing away of Mrs. Sarojini Naidu, one of our greatest poetess. A veteran congress leader, an early worker in the cause of advancement of women, President of the Indian National Congress for 1925 and lastly Governor of the United Provinces, she had an extraordinary and varied career that any woman could claim any where in the world. Those who have heard her would remember her as a born orator. Her silver voice and poetic expression won for her the title of "Nightingale of India."

She had a crowded and ever active life and served the country in many different spheres. She carried peace, goodwill, tolerance and warm humane qualities with a full sense of values She has left her mark on the people of free India and especially of the United Provinces. Though physically not amongst the people of India she will continue to inspire them for a long time to come. May her soul rest in peace.

* * * *

The death of Prof. Birbal Sahani is a matter of greatest regret to the Indian scientific world. He was the head of the Department of Botany, Lucknow University and Dean of the Faculty of Science and was a great teacher and one of the foremost scientists of India. He was an eminent botanist and attained world distinctions in botany and geology. His loss in the field of science will be difficult to fill.

* * * *

The Dharwar Forest College was recently declared open by Honourable Shri M. P. Patil, Minister of Forest and Agriculture. We welcome the sister college which some years ago functioned along with this college and wish it all success.

* * * *

Once again a large batch of young agricultural graduates have passed through the portals of this institution. This year for the last time the college has trained graduates of the Uuiversity of Bombay and for the first occasion turned out a fair number of Poona University graduates. Our congratulations to all those who have passed and we wish them a bright career.

The college opened on the 16 th May for the new session. The rush for the admission is relatively less compared to the past few years. In any case a good number of freshers have selected the profession of agriculture and are slowly getting into their stride and are fitting themselves to the hard work

as this institution. They appear to have realised the importance of work and are busy absorbing the spirit and atmosphere of the college. We wish them a successful three years stay at the college.

* * * *

We congratulate Shri. S. P. Dhamale and Shri. P. S. Pandya, both old alumni of our college on their return after a successful career of studies in U. S. A. Shri. Dhamale worked under Dr. J. L. Lush of Iowa State College and obtained the M. S. degree in animal breeding. Shri. Pandya obaitned the M. S. degree in Plant Genetics at Texas, where he specialised in cotton.

* * * *

Mr. G. I. Patel a graduate of this college, who had joined the University of California for Plant Genetics (fruit breeding) have been awarded a graduate fellowship amounting to $ 1200 for studies in viticulture and exemption from tuition fees ($ 300 per year). We congratulate Mr. Patel for his excellent work.

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# Cost of Cultivation of Sugarcane and Gul Manufacture

BY

J. P. MIRIKAR, B. Sc. (Agri.) Hons. *

## I. Introductory.

Sugarcane is aptly known as the king of all the cultivated crops, requiring the maximum expenditure per acre. In the pre-war period the cost of cultivation and gul manufacture was Rs. 400/- per acre. Since the last war, the cost is rising every year and recently it has reached a high peak of Rs. 1400/- per acre, due mainly to enormous increase in the prices of manures. Also with the removal of control on gul, its princes are going down and with abnormally high costs and low prices the business is on the verge of collapse. The cultivator himself has now-a-days become rather uncertain and, therefore, pessimistic about the future of this business. Therefore, in order to know, where the sugarcane grower stands, in this spiral of high costs and low prices, an attempt is made in this article to arrive at the cost incurred by him to produce a *palla* (240 lbs.) of gul, the unit for sale in the Deccan markets.

* Agricultural Officer I/C ( Government Farm, Kopergaon, Dist. :—Ahmednagar )

## II. Material and Methods.

With the above end in view an inquiry was made into the costs on Godawari Canals area in the Ahmednagar district. The cane cultivation having been mostly standardised in recent years, the costs are more or less similar (with minor local variations) on all canals and, therefore, the data put up here, is equally representative of all the canals in the Bombay Deccan.

The method of calculating costs included investigations into sub-heads as (1) Preparatory tillage (2) Manures and manuring (3) Seed and sowing (4) Irrigation cess and watering (5) Intercultivation (6) Harvesting and gul-boiling (7) Marketing (8) Interest on current expenses (9) Interest and depreciation on capital investment (10) Land rent (11)Supervision charges.

The inquiry covered cane grown on canals, engine lifts and mhot lifts, rahat lifts being dropped out as they are negligible. It is observed, that the cost varies when crushing of cane is done on power crusher or bullock cursher and on the fact whether the crushing equipment is owned or taken on hire. Therefore, a separate inquiry was made into each. Thus the different costs according to circumstances, that were gone into are—(1) cane on canal (a) with own power cursher (b) with hired power crusher (c) with own bullock crusher (d) with hired bullock crusher; these four items are commonly met with in the canal areas. (2) Cane on power lift with own power crusher—the only item found along with power lifts. (3) Cane under mhot irrigation (a) with own bullock crusher (b) with hired bullock crusher (c) with hired power crusher; these three items are commonly met with on well irrigation with mhot. These cover almost all the circumstances under which cane is grown.

Apart from above circumstantial variations, the cost varies also with the time of planting, whether the crop is a ratoon or a plant crop and whether manure is added. The October planting of cane and 300 lbs. N (ratio of Sulphate to Cake 1:5 N) under canals and power lift and 200 lbs. N (ratio of Sulphate to Cake 1:4 N) on wells is adopted as a base for the data. The items for which the cultivator generally does not pay in hard cash, are included in the total costs, to arrive at a correct acedemical figure, but to make the data more realistic, these items are separately accounted for, and the actual figure of costs is also found out side by side.

## III. Cost of cultivation and manufacture.

In cane farming two types of costs are generally incurred viz. (1) capital expenditure (2) current expenditure. Capital expenses generally includes cost on cane crushing equipment or erection of a power lift or the construction of a new well. No other expenditure is generally incurred as the rest of the equipment (i. e. plough, ridger etc.) is easily available at negligible hire of Re. 1 per acre. The capital costs on bullocks is highly

variable and hence hire charges of bullocks is taken in current expense. Current expense includes costs on various items referred to above, the interest on capital ( which has to be paid by all farmers each year ) and the depreciation on capital necessary for renewals and current repairs.

The capital required for purchase and erection of a complete power crushing plant with a capacity of nearly 110 acres ( cane ) a season is Rs. 24,000 at present. Smaller plants are uneconomic and even if a person has less than 110 acres of his own, he fits such large plants to reduce overhead charges and hires it out during the season, when he can spare it. For a complete bullock crusher equipment, an investment of Rs. 2200 is necessary and this can crush maximum of 15 acres in a season. In case of power lift the engine is used for the duel purpose of pumping water and crushing cane, hence this requires Rs. 1500 only as capital for a planting programme of 50 acres. For mhot irrigation, construction of a new well in dry tract costs Rs. 3,500 at present. It can irrigate 8 acres on an average. All these costs are based on current prices, as otherwise, their depreciation if calculated on pre-war rates, will not be able to meet the expenses on repairs or renewals, which have necessarily to be done at present rates.

The current expense, as said above, includes all sub-heads detailed below. All these items are standardised on Deccan canals and contractors at fixed rates are easily available. All these costs are on acre basis and all unnecessary details generally known, are omitted, to cutshort the matter. These are available with the author and will be gladly supplied on request.

(1) *Preparatory tillage*:—

Includes charges from ploughing to repairs to the ridges and comes to Rs. 60 bullock labour charged at hired rates.

(2) *Manures and manuring* :—

Includes expenses on purchase of Basal manure, top dressing and cost of application. On canals and power lifts generally, 15 cart-loads of Farm Yard Manure is used ( green manuring being very rare ) and 300 lbs. N is given as a top dressing with 50 lbs. N from sulphate of amonia, 150 lbs. N from Ground nut cake and 100 lbs. N from caster cake. The present rates per Re. are—1·5 lbs. N of amonium sulphate, 3/4 lb. N of Ground nut cake and ½ lb. N of Caster cake and Rs. 5 per cart-load ( 1000 lbs. ) of F. Y. M. In addition, Rs. 10 are required for application. All this cost comes to *Rs. 540*. On wells, generally 15 carts of F. Y. M. and 200 lbs. N as top dressing ( with 50 N from amonium sulphate, 100 N from ground nut cake, 50 N from caster cake ) is given and at above rates it comes to *Rs. 353*. The remarkable feature is high prices of manure, as compared to pre-war, which was—6 lbs. N per Re. for amonium sulphate, 5 lbs. N per Re. for groundnut cake and 4 lbs. N per Re. for caster cake. The caster cake gives better gul and, therefore, though costly has become common.

(3) *Seed and sowing* :—

Generally own seed is used. But for correct costing its price is included here. Ready made sets cost Rs. 12 per 1000 ( when gul price is Rs. 12 a md. ) and an acre takes Rs. 120. In addition actual planting takes Rs. 3 and total cost is Rs. 123 only.

(4) *Water cess and cost of watering* :—

For canals, water cess ( in block area ) is Rs. 60 for first 12 months, Rs. 20 further upto crushing and Rs. 20 for actual watering for 14 months i. e. Rs. 100 only. For engine lifts the cess is Rs. 30 and actual cost of watering Rs. 200 for the life of the crop i. e. Rs. 230 only. For mhot lifts there is no water cess in dry areas surrounding canals ( taken for study here ) but actual watering takes Rs. 288.

(5) *Inter-cultivation* :—

Includes weeding, hoeing, *tagarni* and earthing up and comes to Rs. 62 in all.

(6) *Harvesting and gul manufacture* :—

Circumstances mentioned above, lead to four different rates for accounting in this case—(a) On own power crusher (b) On hired power crusher (c) On own bullock crusher (d) On hired bullock crusher.

(a) *On own power crusher* ( i ) Cane on canals :—Harvesting and carting to gurhal Rs. 100 ; crushing and boiling ( yield 40 tons cane ) Rs. 128, total Rs. 228.

(b) *On hired power crusher* ( i ) Cane on canals :—Harvesting and carting to gurhal Rs. 100 ( same tonnage ) ; manufacturing cost Rs. 320 ; total Rs. 420. ( ii ) Cane under mhot :—Harvesting ( yield 30 tons cane ) Rs. 60 ; carting 5 miles Rs. 75 ; crushing Rs. 220 ; total Rs. 355.

(c) *On own bullock crusher* ( i ) Cane on canals :—Harvesting (40 tons cane) carting, crushing, total Rs. 324. (ii) Cane under mhot :—Harvesting (yield 30 tons cane) carting, crushing ; total Rs. 232.

(d) *On hired bullock crusher* :—(i) Cane on canals :—Harvesting carting, crushing, boiling ; total Rs. 430. (ii) Cane under mhot lift :—Harvesting, carting, crushing, boiling ; total cost Rs. 298.

(7) *Marketing charges* :—

Includes carting up to market (5 miles for canal cane and 15 miles for mhot lift cane), *hamali*, *mapai* commission, rebate and gift cess etc. The cane on canal requires Rs. 42 under this head, and cane on well irrigation Rs. 58.

(8) *Interest on current expenditure* :—

Nearly 98 p. c. of the cultivators have to borrow money from *sawkars* (*adtya*). Advances for current expenditure are required till the time of crushing and once the crushing starts, its expenses are met from daily sale of gul. The variations in the conditions of growing cane referred to above, also affect this and different amounts are required as advance up-to crushing viz. cane on canal Rs. 885, cane on pump lift Rs. 1015, cane on mhot lift Rs. 877 and @ 9 p. c. average interest rate, the inrerest comes to Rs. 77, 91 and 76 respectively.

(9) *Interest on capital expenditure* :—

This includes interest proper and depreciation kept aside for renewals and current repairs of machinery etc. Here also varying conditions mentioned above bring in four different costs for accounting :—(a) For a complete power crushing plant Rs. 24000 are required as capital as stated earlier and @ 9 p. c. the interest comes to Rs. 2160 per year and with 12 years life for engine and crusher and 5 years life for accessories, the annual depreciation comes to Rs. 2400 which totals Rs. 4560. With its capacity to crush 110 acres a season the interest and depreciation works out to Rs. 41-8-0 per acre per year (say Rs. 42). (b) For a bullock crusher the capital required is Rs. 2200, as said before, and @ 9 p. c., the interest is Rs. 198 and with 10 years life for crusher and 5 years for accessories, the depreciation comes Rs. 330, which totals Rs. 528. With its capacity at 15 acres per season the interest and depreciation works out to Rs. 35 per acre per year. (c) For an engine lift the net capital required is Rs. 1500, only and its interest and depreciation at above rates is Rs. 285 and since 50 acres can be irrigated on such a plant the cost is Rs. 5-8 per acre per year. (d) For a well, in these days Rs 3500 are required for digging and building the same. At 9 p. c. rate interest is Rs. 315 and with 40 years life depreciation is Rs. 87 per year which totals to Rs. 402 per year. It has a capacity to irrigate 4 acres perennial and 4 acres seasonal and therefore the interest and depreciation work out to Rs. 50 per acre per year.

(10) *Rent of the land*:—

This is too varying a factor since pre-war rentals still in force are at Rs. 10 and now they are anything from Rs. 25 to Rs. 50 per acre. Therefore the average rent of Rs. 20 per acre per season is taken into account.

(11) *Supervision charges*:—

This is also controversial. Only persons owning large cane area maintain managers. Also with many crops to look to, the manager's pay is to be divided on crops according to value of each crop. In cane farming 80 p. c. is return from cane crop, out of all crops grown on canals. Generally with minimum area of 75 acres, a grower keeps a manager at Rs. 100, P. M. and at 80 p. c. rate as above the manager's pay for cane is Rs. 80, P. M. for 75 acres i. e. Rs. 12 per acre per year. This is applicable only to large growers on canals with own power crushers. It is out of question for small areas.

**Economics**

| Variation | Total Acedemic cost | | | Total cost in cash | | |
|---|---|---|---|---|---|---|
| | P. A. Cost | P. A. Income | P. Palla Cost | Per acre cost | Per acre income | Per palla cost |
| *Canal Cane* | Rs. | Pallas gul | Rs. | Rs. | Pallas gul | Rs. |
| Own power crusher | 1306 | 40 | 32·65 | 1186 | 40 | 29·65 |
| Hired power crusher | 1444 | 40 | 36·10 | 1239 | 40 | 30·97 |
| Own bullock crusher | 1393 | 40 | 34·82 | 1188 | 40 | 29·70 |
| Hired bullock crusher | 1454 | 40 | 36·35 | 1249 | 40 | 31·22 |
| *Power Lift* | | | | | | |
| Sugarcane own power crusher | 1455 | 40 | 36·37 | 1335 | 40 | 33·37 |
| *Mhot Lift* | | | | | | |
| Cane | | | | | | |
| own bullock | 1357 | 30 | 45·23 | 1032 | 30 | 34·40 |
| Hired bullock | 1388 | 30 | 46·26 | 1063 | 30 | 35·43 |
| „ power „ | 1445 | 30 | 48·16 | 1120 | 30 | 37·33 |

The income is based on a cane to gul ratio of 11 p. c. on average. On wells, due to so many factors, the yields are always less.

## IV. Conclusion

The above figures speak for themselves and need no criticism. The business of growing sugarcane under well irrigation is not going to pay as much as that on canal or power lifts. On the other hand it is in a loss. It is worth nothing, that, even with high prices of manures, the business is a paying proposition under canal with an average price of Rs. 35 a palla current at present. With high sugar prices, there will be a demand for gul which is not going to reduce its price any further below Rs. 35 (current at present) and since this is the marginal price for the grower, he need not be afraid of a collapse in the business, at the same time he should not expect higher profits at present.

How the grower can increase his profit even under these circumstances is a difficult question and beyond the scope of the present article. However, the consideration of this problem is very urgent and needs immediate attention of all concerned.

## Total cost per acre ( Abstract )

*Figures in brackets are costs not incurred in cash.*

| Item of cultivation. | Cane on canal. | | | | On power lift. | On wells. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Power crusher | | Bullock crusher | | Power crusher | Bullock crusher | | Power crusher | |
| | Own | Hired | Own | Hired | Own | Own | Hired | Own | Hired |
| 1. Preparatory tillage. | Rs. 60 | Rs. 60 | Rs. 60 | Rs. 60 | Rs. 60 | Rs. 60<br>(20) | Rs. 60<br>(20) | | Rs. 60<br>(20) |
| 2. Manure and manuring. | 540 | 540<br>(75) | 540<br>(75) | 540<br>(75) | 540 | 353<br>(75) | 353<br>(75) | | 353<br>(75) |
| 3. Seed and sowing. | 123<br>(120) | 123<br>(120) | 123<br>(120) | 123<br>(120) | 123<br>(20) | 123<br>(120) | 123<br>(120) | | 123<br>(120) |
| 4. Irrigation cess and watering. | 100 | 100<br>(10) | 100<br>(10) | 100<br>(10) | 230 | 288<br>(40) | 288<br>(40) | | 288<br>(40) |
| 5. Inter-cultivation. | 62 | 62 | 62 | 62 | 62 | 62 | 62 | | 62 |
| 6. Harvesting and gul boiling. | 228 | 420 | 334 | 430 | 228 | 232 | 298 | | 355 |
| 7. Marketing. | 42 | 42 | 42 | 42 | 42 | 58 | 58 | | 58 |
| 8. Interest on current expenditure. | 77 | 77 | 77 | 77 | 91 | 76 | 76 | | 76 |
| 9. Interest on capital expenditure. | 42 | | 35 | | 47 | 85<br>(50) | 50<br>(50) | | 50<br>(50) |
| 10. Land rent. | 20 | 20 | 20 | 20 | 20 | 20<br>(20) | 20<br>(20) | | 20<br>(20) |
| 11. Supervision. | 12 | | | | 12 | | | | |
| Total | 1306 | 1444 | 1393 | 1454 | 1455 | 1357 | 1388 | | 1445 |
| Total cash expenditure | 1186 | 1239 | 1188 | 1249 | 1335 | 1032 | 1063 | | 1120 |

# Food Problem and Pest Control

BY

H. L. KULKARNI., M. Sc. (Agri.)*

A vigourous campaign to increase food supplies by putting more land under the plough and by increasing the out-turn per acre is carried out in all the provinces of India with a view to make the country self sufficient in as short a time as possible, An increase in total cropped area will solve the problem in part, but it is also equally necessary to take steps to save the crops from the severe depredations caused by insect pests in the fields, and efficient protection of grains during storage is very essential. It is estimated that by efficient protection of plants against insect pests, diseases and animals we can increase the total production by about 10 percent.

*Damage by insect injury.*

The average figures for 1945-46 indicate that a total area of 181 lakh acres was under cereals in Bombay Province. (i) Deccan wingless grasshoppers-(*Colemania sphenareoides*), (ii) Jowar stem borers (*Chilo Zonellus Sw*), (iii) Katra hairy caterpillers (*Amsacta moorei*), (iv) Paddy grasshoppers (*Hieroglyphus banian*), (v) Kane flies (*Pachydiplosis oryzae*), (vi) Paddy blue beetles (*Leptispa pygmoea*), (vii) Crabs and ocassionally (viii) Paddy case worm (*Nymphula depunctalis*), and (ix) Paddy army worms (*Spodoptera mauritia*) form the chief pests of cereals. Even with an average of 2 % damage an annual loss of about Rs. 23,80.000 may be incurred due to the damage by Deccan wingless grasshoppers. In years of bad infestations the losses may still mount higher. Similiarly, with an average of 5 % damage by Katra hairy caterpillers a loss of about Rs. 7,00,000 may be incurred. Khapra (*Trogoderma granaria*), (ii) Rice moth (*Corcyra cephalonica St.*), (iii) Pulse beetles (*Bruchus analis*), (iv) Rice weevil (*Sitophilus oryzae*), (v) Grain moth (*Rhizopertha dominica*), etc, are a serious menace to the stored grains in the godowns. At various stages in the journey, the food has to be stored and storage plays an important part in food economy. At present there is a considerable waste of food. Quite a bit of it is eaten by insects and rats. It is estimated that roughly about two and a half crores of rupees worth of grains are damaged by store pests annually. Improved storage facilities are therefore very badly needed.

*Vegetables* :—

The present acreage under vegetables excluding potatoes is about 1,00,000 acres. Of this, about 13,000 acres is cultivated under sweet potatoes.

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The sweet potatoes weevil (*Cylas formicarius*) is the major pest of this crop both in the fields as well as in the storage. (ii) Aphids (*Siphanocoryne indobrassicae*) on cruciferous vegetables, *Macrosiphum pisi*, Kalt. on peas, *Aphis* gossypi, Glover. etc are the chief pests on most of our winter vegetables. Besides, mustard sawflies (*Athalia proxima*), Pumpkin beetles (*Aulacophora Spp*), diamondback moth (*Plutell maculipennis*), Jassids (*Empoasca Spp*), thrips etc, comprise additional enemies of the vegetable growers in this province. It is difficult to estimate the additional yield on account of the control of these notorious pests. The pre-war acrage under potatoes in this province averaged to about 20,000 aeres per year. Cut worm (*Agrotis ypsilon*) is considered to be a major pest in the fields. Probably, the most serious pest of potatoes is the tuber moth (*Gnorimoschema operculella Zell*). Though the actual amount of damage may be greater, we may certainly estimate the losses at 10 % of all tubers stored for more than three months.

*Fruit crops* :—

The acrage under fruit crops in the province is about 85,000 acres. Mangohoppers (*Idiocerus Spp*) (ii) grapevine beetles (*Scelodonta strigicollis*), (iii) beetlevine bug (*Disphinctus maesarum*) (iv) Red ants on citrus (*Oecophylla smargadina*) (v) citrus scale insects (vi) mango stem borers (*Batocera rubus*), (vii) fruit flies (*Chaetodacus Spp.*) (viii) Anar fruit caterpillers (*Virachola isocrates*) (ix) Citrus mites (x) citrus fruit sucking moths (*Ophiderus Spp*), etc., are the chief pests of fruit trees in our province.

Artificial control methods for most of the crop pests have been discovered. Besides experimental trials with D. D. T., Gammexane, Hexyclan, Pyrodusts and Pyrocolloids and other new allied insecticides are as well in hand. Encouraging results have been noticed in the control of mango hoppers by dusting with 10 % D. D. T. and sulbhur in equal proportions. Similarly, the control operations against Deccan wingless grasshoppers and paddy grasshoppers by dusting with 7–10 % Hexyclan and 5 % Hexyclan respectively, have yielded very satisfactory results under the D. D. T. scheme. Further trials with these new insecticides against other important economic pests are taken up to work out their efficacies as compared to standard insecticides.

### Organisation of plant protection and some of its limitations

It is possible to increase by several million tons the food output of the province. This can be had as a result of controlling only a small number of major pests of annual occurance in this province. The main problem that confronts the field entomologists is that a large farming community, because of their want of familiarity with modern methods of pests control, does not necessarily appreciate the measures advocated by the experts. However actual field demonstrations have been very useful. Realising this, therefore, the government is now favouring the actual carrying out of plant protection

on the farms of cultivators. Such measures have much impressed our farmers on the whole. Thus during 1947, 1,50,000 acres of paddy in Dharwar and Belgaum districts were treated with 5% Hexyclan dust and the grass hopper pest was brought under complete control. The insecticides, machinery, as well as technical advice was provided by the Government to popularise the control operations.

The success of Government campaign for the control of crop pests much depends upon the size of block to be treated, and the execution of the work in as short a time as possible. Often the fields may be separated by wide patches of fallow lands, or patches of fields grown under different crops.

Availability of water supply is another important factor in deciding the form in which the insecticide is required to be uesed. The use of spray amounts to the handling of large quantities of water and the use of more complicated machinery. However, spray treatments are sometimes found more economical as the insecticide adheres better and has a bettar residual effect than the dust which is very likely to be blown away by high winds or washed away by rains.

The cost of treatment is another limitation in the execution of the plant protection service, because the control cost must be low enough to allow the application to be profitable.

Besides, quick transport facilities are very essential to conduct the pest control work before the insects gain an upper hand.

To be successful, quick dispersal of information about the incidence of the pest must take place so that the technical staff can be switched on to work without loss of time.

**Machinery and equipment.**

Crop protection could be successfully carried out if the control operations are taken up over a larger area. Many difficulties may stand in the way of such an undertaking. Of these, smallness of holding chiefiy hinders the success to a large extent. The use of power machinery for dusting or spraying cannot be a practicable measure under exisisting conditions on account of small individual holdings and patchy cultivation of crops. A tractor equipped with spraying device, for instance, cannot be taken accross irrigation channels or high bunds. Therefore, spraying eduipment for field and garden work consists of compressed air sprayers, knapsace sprayers, bucket pumps, barrel and tank pumps. The capacities of individual pressure sprayers generally ranges from $1\frac{1}{4}$ to 4 gallons. In compressed air sprayers the air pressure fluctuates widely which is not the case with knapsack sprayers.

Dusting outfits in practice include bellows type of dusters, hand dusters operated by a blower-fan and power dusters. The bellows type of dusters are winning favour because young trees and low lying crops can be conveniently treated by them. Crank type of dusters have been very popular since they are efficient and are high geared. The prewar pearless dustguns have been wholly replaced by Root hand-dusters of the crank type. The power dusters are found suitable to treat the godowns against storepests only.

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# A Note on the Preparation of Superphosphate from Bone Meal.

BY

M. M. KIBE.*

The manurial value of any phosphatic fertiliser depends upon its contents of water-soluble phosphoric acid, and the higher the soluble phosphate the greater is its manurial value. Bone meal, which has long been in use as a fertiliser, contains on an average 20 per cent phosphoric acid, most of which is present in the insoluble form as tricalcic phosphate (i. e. Ca3 (PO4)2), in combination with a certain amount of calcium carbonate (CaCO3). When added to the soil, bone meal undergoes decomposition and liberates the phosphoric acid in a soluble form. The change from the insoluble to soluble form is mainly brought about by the production of carbonic acid (H2CO3) in the soil, as a result of the combination of water and carbon-dioxide pro-

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duced by bacterial action and the respiration of roots. However this change is comparatively very slow resulting in the slow availability of phosphoric acid of the bone meal to the plants. The availability of phosphorus in the bone meal can be increased by turning it into superphosphate by the action of sulphuric acid. With a view to working out a suitable method for the preparation of superphosphate from bone meal, some experiments were conducted, a short account of the preliminary findings of which is presented in this note.

Nearly all the mineral phosphates used in the manufacture of superphosphate consist chiefly of tricalcic phosphate ($Ca_3(PO_4)_2$). When treated with sulphuric acid, the tricalcic phosphate is turned into phosphoric acid ($H_3PO_4$), monocalcium phosphate ($CaH_4(PO_4)_2$), and dicalcium phosphate ($Ca_2H_2(PO_4)_2$) depending upon the strength and the amount of sulphuric acid used. The reactions that take place when tricalcic phosphate is acted upon by sulphuric acid can be represented as follows:—

(i) $3Ca_3(PO_4)_2 + 6H_2SO_4 + 2H_2O = 4H_3PO_4 + Ca_3(PO_4)_2 + 6CaSO_4 + 2H_2O$

(ii) $Ca_3(PO_4)_2 + 4H_3PO_4 + H_2O = 3(CaH_4(PO_4)_2 + H_2O$

(iii) $Ca_3(PO_4)_2 + H_2SO_4 + 2H_2O = Ca_2H_2(PO_4)_2 + CaSO_4 + 2H_2O.$

Sulphuric acid probably acts on about two thirds the tricalcic phosphate and the free phosphoric acid produced according to reaction (i) acts on the remainder. Similarly as $CaSO_4$ is not removed from the final product, the percentage of phosphoric acid in the final product is about half that in the original tricalcic phosphate. When sufficient acid has been used, the final product consists mainly of $CaH_4(PO_4)_2$ and $CaSO_4$, giving on an average 18 per cent soluble phosphoric acid. The percentage of soluble phosphoric acid is likely to very with the amount of acid used as well as on how effectively it comes into contact with the particles of the mineral phosphate. Bone meal which consists mainly of tricalcic phosphate also undergoes similar transformations when treated with sulphuric acid. Unlike the mineral phosphates, which can be pulverized to a fine condition, bone meal does not lend itself to such a treatment. Two sets of experiments were therefore arranged, one for studying the effect of fineness of bone meal on the soluble phosphoric acid of the final product, and the other for studying the effect of increasing quantities of acid on the solubilisation of phosphoric acid from bone meal.

*Experiment No. I.* The bone meal used in these experiments consisted of particles with an average diameter of 3/32 inch. It was graded into four

fractions by means of sieves, giving the following percentages on the original sample:—

| Size. | per cent on original sample. |
|---|---|
| 1. Greater than 2 m. m. | 39·87 |
| 2. Between 1·0 and 2·0 m. m. | 25·69 |
| 3. Between 0·5 and 1·00 m. m. | 11·29 |
| 4. Less than 0·5 m. m. | 23·14 |
| Total | 99·99 |

Each of the fractions was separately analysed for total phosphoric acid with the following results:—

| Size. | per cent total P205 |
|---|---|
| 1. Greater than 2 m. m. | 21·55 |
| 2. Between 1·0 and 2·0 m. m. | 21·26 |
| 3. Between 0·5 and 1·0 m. m. | 21·26 |
| 4. Less than 0·5 m. m. | 20·95 |
| Total | 21·25 |

In the manufacture of superphosphate from rockphosphate, they generally use sulphuric acid of 60 p. c. strength (having a specific gravity of 1·5 to 1·6). In the present experiment, the specific gravity of the acid used was 1·6 corresponding to a strength of 68·7 per cent by weight. Since concentrated acid (Sp. Gr. 1·84) causes charring of the product, the specific gravity of 1·6 was chosen, and this is not very much different from what is used in the commercial production of superphosphate.

*Details of Procedure*:—Portions weighing 100 gm. of each of the fractions of bone meal were transferred to porcelain dishes and were steeped with 34 cc. of distilled water for 24 hours. At the end of this period, each of the four lots was treated with 31·3 cc. of sulphuric acid of 1·6 specific gravity each lot being thoroughly mixed and stirred in order to ensure proper contact between the acid and the particles of the bone meal. The proportion of bone meal: acid:water was thus maintained at 1:1/3:1/3. Each lot was then periodically analysed for total and soluable phosphoric acid and the results of these analyses are presented in Table I.

TABLE NO. 1.

| | Size of the bone meal | | | |
|---|---|---|---|---|
| | greater than 2 mm. | between 1 & 2 mm. | between 0·5 & 1 mm. | less than 0·5 mm. |
| *3 days after start* | | | | |
| Soluble phosphoric acid (P 205) | 11·58 | 11·34 | 11·46 | 11·80 |
| Total phosphoric acid (P 205) | 15·95 | 16·04 | 16·92 | 15·44 |
| *One month after start* | | | | |
| Soluble phosphoric acid (P 205) | 11·33 | 11·60 | 11·54 | 11·95 |
| Total phosphoric acid (P 205) | 16·90 | 14·63 | 17·64 | 16·40 |
| *Two months after start* | | | | |
| Soluble phosphoric acid (P 205) | 10·38 | 9·68 | 9·20 | 9·57 |
| Total phosphoric acid (P 205) | 15·72 | 13·41 | 13·42 | 12·33 |

A scrutiny of the figures given in Table I shows that there is hardly any difference in the contents of soluable phosphoric acid of superphosphates prepared from different fractions of bone meal at all the three periods studied. This means that the size of the particles does not affect the solubilisation of bone meal by the acid. Secondly the action of the acid goes to completion within three days after its addition to the bone meal. On an average, with the quantity of acid used, more than fifty percent of the phosphate present in final product is in a soluable form.

*Experiment II.* In order to study the effect of increasing amounts of acid on the solubilisation of P 205, an experiment was carried out with the following quantities of bone meal ( 3/32" ), acid and water:—

| | Bone meal | Water | Acid |
|---|---|---|---|
| 1 | 100 gm. | 34 cc. | 33·3 gm. |
| 2 | 100 gm. | 34 cc. | 50·0 gm. |
| 3 | 100 gm. | 34 cc. | 75·0 gm. |
| 4 | 100 gm. | 34 cc. | 100·0 gm. |

The procedure as regards steeping, mixing, etc. was the same as in experiment I.

Representative samples from the lots shown above were periodically analysed and the results of these analyses are presented in Table II.

TABLE No. 2.

| Treatment. | Total P205 per cent on dry matter. | soluble P205 per cent on dry matter. | soluble P205 as % of total. |
|---|---|---|---|
| *Three days after start* | | | |
| i | 23·22 | 4·55 | 19·59 |
| ii | 17·82 | 9·27 | 52·02 |
| iii | 15·93 | 12·93 | 81·17 |
| iv | 14·00 | 12·23 | 87·56 |
| *One month after start* | | | |
| i | 18·65 | 7·11 | 38·13 |
| ii | 18·96 | 11·24 | 59·02 |
| iii | 15·70 | 11·98 | 76·38 |
| iv | 13·91 | 12·95 | 86·86 |
| *Two months after start* | | | |
| i | 19·77 | 5·87 | 26·98 |
| ii | 18·39 | 10·43 | 56·70 |
| iii | 16·91 | 12·83 | 75·86 |
| iv | 15·00 | 13·50 | 89·99 |

It will be seen from Table II that the percentage of soluable phosphoric acid goes on increasing with increase in the quantity of acid used and this is true at all the three periods studied. The action of the acid is nearly complete within the first three days after its addition to the bone meal. It will also be seen from column V that maximum solubilisation of phosphoric acid is brought about when the quantity of acid used is equal to that of bone meal. It was however found that the product obtained under this high quantity of acid is so pasty that it cannot be handled with ease. Due to the presence of large excess of acid, the storage of such a product is likely to be a difficult problem. The next high yield of soluable phosphoric acid is obtained under treatment III where the proportion of bone meal : acid is as 1·0 : 0·75. Here also the final product is found to be unsatisfactory, the particles sticking together in small lumps. It is only under treatment II where the quantity of acid used is half that of bone meal that a fairly high yield of soluble phosphoric acid is combined with an open and granular structure in the final

product. In the commercial production of superphosphate also the same proportion of acid to bone meal as under treatment II is used.

The sample of superphosphate prepared under treatment II along with that manufactured by a commercial firm from bones was subjected to complete analysis and the results are presented in Table III.

TABLE NO. 3.

| | Laboratory sample pre-under treatment II | Commercial bone super-phosphate |
|---|---|---|
| | per cent | per cent |
| Moisture | 11·39 | 4·85 |
| Soluble phosphoric acid (P 205) | 10·41 | 6·18 |
| Insoluble phosphoric acid (P 205) | 8·84 | 8·26 |
| Total Phosphoric acid (P 205) | 19·25 | 14·44 |
| Loss on ignition | 34·41 | 27·17 |
| Nitrogen | 3·56 | 3·00 |
| Acid insoluble matter | 1·10 | 7·82 |
| Total lime (CaO) | 23·38 | 24·75 |
| Monocalcium phosphate (CaH4( PO4 )2) | 17·15 | 10·18 |
| Tricalcic phosphate (Ca3 (PO4)2) | 19·31 | 18·03 |
| Calcium sulphate (CaSO4) | 21·42 | 30·41 |
| Extra lime (CaO) | ... | ... |
| Sulphuric acid (SO3) | 16·80 | 29·25 |

It will be seen from the table that the laboratory sample is nearly one and a half times as rich in soluble phosphoric acid as that manufactured by the commercial firm although both of them contain about the same quantity of insoluble phosphoric acid. The nitrogen contents as well as the organic matter as indicated by loss on ignition are slightly higher in the laboratory product than in the commercial sample. The contents of calcium sulphate, the figures for which are conventionally calculated by the combination of lime and sulphuric acid (SO3) determined individually, are considerably lower in the superphosphate prepared in the laboratory than in the commercial product thus bringing out its superiority over the latter. The amount of sulphuric acid is very much higher in the commercial sample than in the product prepared in the laboratory and this naturally reduces its quality as a fertilizer. It will thus be seen that the superphosphate prepared in the laboratory by treating bone meal (3/32″ size) with half its weight of sulphuric acid and one third its weight of water is far superior to that manufactured by a commercial firm.

Experiments on the preparation of superphosphate from bone meal on a large scale have been undertaken in order to work out the details of equipment and economics of manufacture.

**Summary**

( i ) Results of experiments carried out to study the effect of fineness of bone meal and varying quantities of sulphuric acid on the soluble phosphate contents of the superphosphate are presented and discussed.

(ii) Using bone meal of 3/32" size it is noticed that the fineness of particles does not affect the soluble phosphoric acid contents of the final product.

(iii) Increasing quantities of acid cause greater and greater solubilisation of phosphate, but the product obtained with large quantities of acid is difficult to handle.

( iv ) Superphosphate prepared from bone meal (3/32" size) and acid in the ratio of 1·0 : 1/2 is fairly high in soluble P2 O5 and at the same time granular in structure. In quality it is found to be superior to that manufactured by a commercial firm.

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# 4-H Clubs for Boys and Girls

By

S. P. DHAMALE, B. Sc. ( Agri. ), M. Sc. ( Iowa, U. S. A. )*

The most interesting and prominent feature of the cooperative extension work of the United States Department of Agaiculture that had struck me was the 4-H Clubs for boys and girls. The 4-H Club is an organised group of tural boys and girls each with a definite project to be done at home, with a planned programme of activities and working under an adult leader. The 4-H Club work is thus the junior phase of the Agricultural Extension programme. Every member of the club carries out some farm or home project and is taught to use the best ways of doing things in the home and on the farm as a means of training the 4-H life, that is training of the Head, the Heart, the Hand and the Health.

When the adult farmers did not respond to special efforts to get them to attend the farmers' institution in MACOUPIN Country I 11, Mr. W. B. Otwell as president of the country institutions, distributed carefully selected

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corn (maize) to 500 boys, who grew it and made an exhibit for prizes in 1900. This was so very successful that the next year 1,500 farmer boys entered the contest. Thus when agricultural education began to advance some 40 years ago, leaders started to give attention to the possibility of working with the youth, hoping that it might serve a double purpose of encouraging parents to adopt better methods and enable the coming generation to become better informed in agricultural pursuits. Young people between the ages of 10 and upwards in a community organise themselves into a group, with their own officers and their own local programme under the guidance of a man or a woman adviser.

The principle underlying the 4-H Club work is that the education of youth always aims towards a better educated adult citizenship. It would seem entirely proper for extension forces to lay great emphasis on work with young people. Many believe in U. S. A. that considerably more extension time could well be given to this kind of work because in a long period of time trained youth would become trained adults, the main objective of extension education.

The general trend in the selection of subjects for 4-H Clubs is to study closely the chief interests of the communities and also to closely parallel the trend in adult programme. It is for this reason that certain projects, for example dairy calf clubs, are selected where interest in dairying is prevalent. Thus, the 4-H club programme of sujbects can and should conform to the needs of the community concerned.

To ensure this correlation a definite plan of programme, selection and development is followed. A country committee is appointed by the farm bureau board for both the boys' and girls' activities. This committee selects the projects, plans the work for the season and assists the agents in supervising the work of leaders through the year. The programme proposed by these committees are approved by the country programme committee and then made a part of the general country extension programme.

Thus the 4-H club work forms one of the major Nation Building Programmes, based on the saying that the children of today are the citizens of tomorrow. If a large number of young people of today are properly trained in the vocation of farming and homemaking, the majority of adults in the rural districts a decade hence would be better trained people. It is also certain that the attitudes, leadership qualities, standards and view points of the club members can be so improved that these traits will also carry over into adult-hood and greatly improve all community life. It has been proved that the extension effort with youth brings best results because it deals with groups willing to learn and use new methods. Furthermore, the ability of young people to apply new methods and the greater ease with which they break old habits are other good reasons why extension work with youth is effective.

The main purpose, objective or goal in 4-H Club work is "to help rural youth in their growth, individually and socially." This major goal or objective may be broken down into the following statements which have been approved as objectives of 4-H Club work by the Land Grant College Association of the U. S. A.

(1) To help rural young people to develop desirable ideals and standards for farming, home making, community life, citizenship and a sense of responsibility for their attainment.

(2) To afford rural young people technical instruction in farming and home making, so that they may acquire skill and understanding in these fields and a clearer vision of agriculture as a basic industry and a home making as a worthy occupation.

(3) To provide rural young people an opportunity to learn by doing through conducting certain farm or home enterprises and demonstrating to others what they have learned.

(4) To instill in the minds of rural young people an intelligent understanding and an appreciation of nature and of the environment in which they live.

(5) To teach rural young people the value of research and to develop in them a scientific attitude towards the problems of the farm and the home.

(6) To train rural young people in cooperative action to the end that they may increase their accomplishments, and through associated efforts better assist in solving rural problems.

(7) To develop in rural young people habits of healthful living, to provide them with information and direction in the intelligent use of leisure and to arouse in them worthy ambition and a desire to learn in order that they may live fuller and richer lives.

(8) To teach and to demonstrate to rural young people methods designed to improve practices in Agriculture and homemaking to the end that farm incomes may be increased, standards of living improved and the satisfaction of farm life enhanced.

Dr. S. A. Knapp formerly of the United States Department of Agriculture, one time president of the IOWA State College and the father of so many extension ideas was the promoter of 4-H Club work. The objectives of the 4-H Clubs as stated by Dr. Knapp were as under:

(1) To place before the boy, the family and the community in general an example of crop-production under modern scientific methods.

(2) To prove to the boy, his father and the community in general that there is more in the soil than the farmer has ever got out of it, and to inspire the boy with the love of the land by showing him how he can get wealth out

of it by tilling it in a better way and keeping an expense account of his undertaking.

(3) To give the boys definite worthy purposes at an important period in their lives and to stimulate a friendly rivalry among them.

(4) To furnish an actual field example in crop production that will be useful to rural teachers in vitalizing the work of the scoool and correlating the teaching of Agriculture with actual practice.

### 4-H members Creed

I believe in 4-H Club work for the opportunity it will give me to become a useful citizen.

I believe in the training of my *Head* for the power it will give me to think, to plan and to reason.

I believe in the training of my *Heart* for the nobleness it will give me to become kind, sympathetic and true.

I believe in the training of my *Hands* for the dignity it will give me to be helpful, and skillful.

I believe in the training of my *Health* for the strength it will give me to enjoy life, to resist diseases and to work efficiently.

I believe in my country, in my state and in my community, and in my responsibility for their development.

In all these things, I believe and I am willing to dedicate my efforts to their fulfilment.

### Methods used in 4-H Clubs.

One of the principles adhered to is that every member must carry out a practice at home under the supervision of his parents and leaders. An example would be the work of a member of a poultry club. The member is required to secure at least 50 good baby chicks and raise these to maturity by the best known methods. A detailed dairy project proposed by the Ohio State University and the United States Department of Agriculture is appended to this note.

A universal requirement of all members is that they must keep record of their work and costs and the results secured. Not only do these records serve as an effective means of teaching but they furnish valuable training in the practice of keeping accounts.

In order to stimulate interest and broaden the experience of the members, contests of various kinds are held. Some of these require exhibits of the results of work done, others are measures of the skill and knowledge of members in judging and demonstration contests. Health contests in which members are scored by doctors and contests in recognizing music numbers are others often used.

The United States Department of Agriculture renders very helpful service to 4-H Clubs. The functions of its (U. S. D. A.) representatives are mainly to supervise the expenditure of the portion of federal funds used in club work, to collect plans and information to aid the states in conducting national events, to assist states in organization work when requested and to summarize reports from the states.

### Effectiveness and Results of 4-H Clubs.

The results of approximately 40 years of development and growth of 4-H clubs cannot be fully measured any more than the results of any educational enterprise. The rapid growth is one indication that the movement is viewed under two aspects, tangible and intangible.

Tangible results are evidenced by the beneficial effects upon boys and girls or the things they produce. Better livestock and improved practices on the farm and in the home, financial gains in certain projects and actual materials made or produced are other proofs that results are worth while. The development of latent abilities of many individuals is further proof of successful development of this work.

The intangible results are more difficult to point out. They take the form of training for leadership and citizenship, better attitudes toward rural life and more intelligent appreciation of country living.

The above brief description of the 4-H club work which form one of the major extension activities of the U. S. D. A. explains its usefulness in the education of the rural youth. It is not clear why this phase of Agricultural extension work is not included in the extension work (District Propaganda work as it is commonly called) for the Bombay Agricultural Department. I, therefore, feel it vary necessary that the Bombay Agricultural Department should introduce an organisation very similar to the 4-H Club organisation in U. S. A. Under such organisation we shall be able to introduce several projects for our younger generation who I believe will definitely come forward in large numbers and take the utmost advantage out of it. Proper training and moulding the mode of thinking of the rural youth is as important as any other phase of agricultural improvement and I, therefore, hope that this proposal will receive due attention of the authorities concerned.

Extract from Ohio 4-H Projects-4-H Circular 131, Revised, December, 1946:—

### Dairy

Purpose:—To provide the opportunity to learn about the selection, feeding, care, and management of dairy cattle. A member may select either a calf, heifer, or cow as a first dairy project. More satisfactory results may often be secured by starting

with a producing cow. If a member elects to start with a calf or heifer, he or she may skip the dairy cow project and start the continuous records provided in the dairy herd project.

DAIRY CALF.

Age:— Twelve years minimum.

Plan:— 1. Secure purebred or highgrade heifers, dropped between July 1 and December 31 of the year previous to starting the project. A highgrade heifer is one from a grade cow sired by a purebred bull of the same breed.

2. Secure calf and start feed records by January if possible; not later than April 1.

3. Exhibit heifer and Member's Book.

Literature:—Dairy Calf Project (Circular and Member's Book) 4-H, Circular 122.

DAIRY HEIFER

Plan:— 1. Continue with heifer used in the dairy calf project, or if for any reason it is necessary to use another heifer, it shall be purebred or highgrade yearling heifer, preferably one classed as a senior yearling.

2. Records should be a continuation of records in the dairy calf project and start immediately after the exhibit.

3. Exhibit heifer raised and Member's Book.

Lecture:—Dairy Heifer Project, Circular and Member's Book, 4-H Circular 123.

Judging Dairy Cattle, Farmers' Bulletin 1769 U. S. D. A.

DAIRY COW:—

Age:— Fourteen years, minimum.

Plan:— 1. Continue with heifer used in dairy heifer project. If just starting in this project select one or more purebred or highgrade cows.

2. Start feed records immediately after exhibit in the dairy heifer project. Milk to be weighed and tested at least once each month of the location period.

3. Exhibit cow, or cow and calf, and Member's Book.

Literature:—Dairy Cow, Member's Book.
Feeding Dairy Cattle, Extension Bulletin 72.
Care and Management of Dairy Cows.
Farmers' Bulletin 1470, U. S. D. A.
Producing Quality Milk, Extention Bul
Judging Dairy Cattle, Farmers' Bulletin



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DAIRY HERD.

Age:— Fourteen years minimum.

Plan:— 1. Continue with the cows in the dairy cow project or if just starting, select two or more purebred or highgrade females, one of which must be in production.

2. Keep continuous breeding, feeding, and production records.

3. Exhibit not to exceed two animals in each of the standard breed classification or other special project class set up by the country. Also Member's Book.

Literature:—Developing Market Areas in Northern Ohio.
Experiment Station Bulletin 469.
Feeding Dairy Cattle. Extension Bulletin 72.
Care and Management of Dairy Cows.
Farmers' Bulletin 1470, U. S. D. A.
Producing Quality Milk, Extension Bulletin 107.
Judging Dairy Cattle. Farmers' Bulletin 1769, U. S. D. A.

Advanced Projects.

The Dairy herd project is set up with the idea that it may be continued over a period of years. A loose-leaf member's book provides for the addition of new materials and record forms.

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# "Engineering in Agriculture"

BY

R. S. BASRUR *

Due to high cost of labour, most of the progressive cultivators are using modern agricultural machinery, in one or the other form. Cultivators are becoming familiar with pumps and engines and the present demand for pumps and engines far exceeds the supply. Cultivators have also shown a keen interest for labour saving devices like tractors and some have ventured as far as purchasing one. This tendency will be on the increase and it is high time that we should realise the important part played by engineering, specially the mechanical branch, in shaping the future development in Indian agriculture. It will be necessary to give due regard to this fact, in the present studies of agricultural colleges. This would probably mean additional lectures and practicals for the agricultural students and all students would raise a voice of protest against such new ideas. However, a time would come when agricultural graduates will have to be, both agriculturists and engineers. These two branches are complementary and application of engineering to agriculture. with a correct background of agricultural knowledge would be of great help in moulding the future of mechanisation of agriculture in this country. For the present, we do not seem to have good coordination between these two branches and it is upto our young agricultural graduates to blend these two branches to the mutual benefit of each other.

I wish to give a word of advice to all those youngsters, who want to take up advanced studies in agricultural engineering. Students, who have acquired good knowledge of agricultural engineering in foreign countries, like America and Australia, will have to apply their knowledge with due regard to local conditions of this country. It is not possible to apply mechanisation of agriculture in this country, without considering the following points.

1. *Economics of Mechanisation.*

With a few exceptions, there is nothing in the way of agricultural operations on the land, which cannot be done just as well or even better, by hand labour, though not by animals. What settles the question of adopting mechanisation, is the relative cost of the work and not the quality of it. To draw a balancesheet in favour of mechanical appliances, it will be necessary to get maximum output, against minimum expenditure. Factors, like depreciation and interest on the capital, account for a big slice of the expenditure,

* Mechanical Cultivation Engineer to Govt. B. P. Poona.

and this can only be compensated by maximum work, for which you would have had to pay the cost of labour, To give a concrete example, it will not pay a farmer to invest Rs. 15,000 in purchasing a tractor, capable of ploughing 600 acres in a season, to plough his 150 acres only. Only a quarter of the available capacity of the tractor is used by him and this would not prove an economic proposition to the owner.

2. *Technical efficiency.*

Our ploughing season is short and it will be necessary to keep our plant in perfect running order during the season to prevent breakdowns during this period. As compared to foreign cultivators, who have been using labour saving devices, since a long time, our farmers have inadequate knowledge of machinery, and have to rely on the technical assistance of operators. This arrangement is very unsatisfactory and it is desirable that every user of machines should have a working knowledge of his equipment. This can be achieved by training young farmers, in the use of machinery. Public response to the course run by the Agricultural Department of this Province is very encouraging and I am confident that the persons trained by the Department would be of great help to the cultivators. Adequate supply of spares for the machines should be arranged in advance,

It may be seen that mechanisation of agriculture, in this country, though desirable, would require real hard work to make it successful, and I hope that our agricultural students would contribute their might to this cause.

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# Cattle In India

BY

BRIJ MOHAN WAZIR

India is a predominantly an agricultural country, where the welfare of every section of the population depends directly or indirectly upon the amount of wealth produced from the soil, the efficiency of its livestock, and the economy of its distribution.

Agriculture being the vital industry, cattle form its backbone. Bullocks provide the country with the necessary draft for effective tillage and the cows and buffaloes provide millions and millions of the people of India, both children and adults, with milk–Nature's most nourshing food material.

Roughly speaking the cattle population of India is a hundred and eighty millions, a third of the world's stock. Of sheep and goats we have eightyseven million, which is the seventh of the world total. These animals unfortunately do not come upto the standard of efficiency as obtained in other countries. The farmer, therefore, is compelled to make use of a light type of indeginous implement because the strength of the animal available does not permit him to make use of any improved and heavier type of plough.

It is high time for our people to recognise fully the great economic importance of the cow, as an improved cow would mean an income of about Rs. 30 minimum per month. To maintain the cow in a healthy and profitable breeding condition, it is essential that she be welfed viz. on scientific and upto date economic lines, as out of hundred pounds of digestible neutrients consumed by it, the cow yields about 139 lbs milk containing 18 lbs. of milk solids, practically all digestible. Further by freeing the cow of ticks and other blood sucking pests it is known to increase its milk yield by 33 p. c.

As regards the natural resources of India it stands second to none. Unfortunately they are not exploited on a grand scale. There are many idle resources in India which call for immediate exploitation. Agriculture is the chief among them because the lands happen to be very fertile. Added to the fertility of the soil the hard labour that an Indian tenant is able to put in, goes a long way in improving the country's agricultural situation. In some parts of the country there is considerable agricultural activity and the cattle population is predominant. Live-stock industry is capable of playing a great part in the economic development of the country. Cattle breeding, sheep rearing, chair farming, poultry keeping and other allied cottage industries like rearing pigs, apiculture, handspinning etc., are the main props on which our agriculturists can depend for supplementing their income all the year round. But as is the case all over India, they follow more or less primitive methods. Our agriculturists confine most of their attention to crop growing and do not take to these industries with interest and zeal. Unless they do so it is difficult to see any hope for the amelioration of their condition.

The worse the conditions for rearing efficient cattle, the greater the number tends to be. So much so that every 100 acres of our land has to maintain 67 cattle along with 70 to 80 human souls. This results in under-sized and undeveloped cows, which in their turn do not satisfy the cultivators, who in their attempt to secure a sufficient number of bullocks breed more and more inferior type of cattle. As the number has increased and tillage has encroached on the grazing lands, the available supply of food and fodders has led to further deterioration. The promiscous breeding that has taken place has caused a havoc in our cattle population.

The custom of leaving animals free for grazing lands is an old one, which bears the impress of ages. This was sound at one time but requires modification in the light of changed conditions. Only a few years back one

could see tracts of land with good growth of grass on it. The conditions have changed beyond recognition. Every inch of the soil is being brought under cultivation, with the result that grazing land has diminished and it is not uncommon to find the so called grazing grounds denuded of all vegetation and overstocked. The stock owner lives in the false belief that his responsibility has finished as long as he sees his stock in these grazing grounds. In very few places do people cut high land grass from forest areas and a very small number of stock owners produce a fodder crop on their land for their live-stock. We in this country ought not to have any difficulty in providing food to our cattle, considering the enormous relief our stock owners get from pasture lands. In the changed conditions, the stall feeding alone will show him what his animals are getting and what he should expect in return from them.

The Government of Kashmir has taken a lead over other provinces and states by passing "The Live-stock Improvement Act", which is expected to go a long way towards reducing the number of cattle by preventing promiscuous breeding. Under this Act breeding by unfit scrub bulls has been stopped and licences are given to the bulls found fit for breeding purposes Besides a Grazing Committee, too, has been formed to carry out the survey of the grazing lands, to find out ways and means of improving them, and to control grazing so as to ensure better returns by placing restrictions on indiscriminate and wholesale grazing facilities allowed at present.

It is evident that the problem of cattle improvement involves reduction in the number of cattle, securing better progeny and improvement in their feeding in housing, rearing and general management.

The cattle breeding problem has been receiving due consideration of the Government for the last few years and practical steps are being taken to bring about improvement in the existing conditions. A number of Sindhi, Dhani, Kankrej, Amritmahal, Gir, Hissar, Sahiwal, Tharparkar, etc. breed stud bulls are being distributed at selected centres. The stud bulls are entrusted to well to do cultivators who are paid a small subsidy for their maintenance. A suitable number of cows in these centres is registered and a proper record is maintained about their progeny. The registered cows get free service of the bulls. The unfit male stock in the centres is castrated. The agents are responsible for maintaining the bull in good condition and also keep proper record of coverings. Premium is provided for a small number of cows and calves to encourage better care and feeding of animals.

The work already taken in hand requires to be continued for a number of years to get substantial results on a large scale.

# Every Day Statistics

BY

T. C. MOTWANI, B.Sc. (Agr.) Hons.*

Have we ever thought of the sorts of problems we come across in our every day life? Perhaps very few of us have taken note of them. Specially during the past few years the war and its sudden termination have brought in its wake many serious social, political and economic problems which need close attention and the immediate solution at the hands of the best brains of the country. India cannot remain aloof and unaffected in the changing order of the day.

As a result of the recent war and the partition of India, the imports of food grains, the long staple cotton and the best breeds of cattle have been cut off. The existing food supply of the country has not kept pace with the rapid increase in population. To meet the crisis, it is an important task to collect the facts and figures of not only the population of the country but also the total production of food and it is here that the science of statistics comes in. Statistics is an acquaintance with the events, the facts and figures of the past as well of the present with a " scientific out-look". It is no doubt an indispensable element in the modern consciousness.

India is in many respects an undeveloped country. We have a big leeway to make up. Our people are yet under-nourished, under-clothed and under-housed. We need more of food supply, more production of cloth and better and neater houses for living. So far we have paid more attention to politics and less to production. If you feed a man better, he will be more reasonable. A hungry man is an angry man. If the majority of the people in this country are assured of a livelihood in the future, there would not be so much feud and bitterness about what should be the political arrangement of the future.

One fact stands out sharp and clear, that agriculture, is and must remain for many years to come, India's most important industry. It is also necessary to remember that in India no policy of industrialisation can succeed, unless it is based on a prosperous and sound agriculture. Industrialisation will help Indian agriculture by providing for the raw materials produced by agriculture, such as cotton and sugar-cane, a stable and expanding internal market More food for the people and fodder for their cattle are linked needs because the bullock is still the cultivators's source of power on the land. And without cow's milk in abundance the diet of the masses in city or village can never be adequate. War conditions have brought urgency to these perpetual needs, which can only be met by bringing more land under the plough, extending irrigation, the use of better seed and improved methods of cultivation.

What India needs is not only more land under the plough, but a more balanced cultivation to fight the food and cloth famine. "Unless we tackle", says Mr Kumarappa, the Secretary of the All India Village Industries Association, "in all earnestness, this question of balanced cultivation with a view of self-sufficiency, all pious wishes to avoid famine of food and cloth will be in vain."

The table below provides for a balanced vegetarian diet yielding 2840 calories per day for the average person and allows for the growing of cotton for 25 yards of cloth per annum per head. For non-vegetarian diet 6 oz. of milk may be substituted by 4 oz. of meat or fish and one egg.

* Junior Statistical Assistant, under Statistican Department of Agriculture, B.P. Poona 5

| Diet | Ozs per day | Calories | Lbs. per annum | Per lakh of Population | | | Percentage land distribution |
|---|---|---|---|---|---|---|---|
| | | | | Land required in acres | For seed & waste 15% extra | Total | |
| Cereals | 16 | 1600 | 365·00 | 43·00 | 6·510 | 49·510 | 65·2 |
| Pulses | 2 | 200 | 45·60 | 5·40 | 0·810 | 6·210 | 8·0 |
| Gul | 2 | 200 | 45·60 | 1·20 | 0·180 | 1·380 | 1·8 |
| Nuts | 1 | 145 | 22·80 | 2·60 | 0·290 | 2·990 | 8·4 |
| Oils | 1/2 | 255 | 11·40 | 3·00 | 0·450 | 3·450 | 8·4 |
| Ghee | 1/2 | ... | 11·40 | ... | ... | ... | ... |
| Milk | 12 | 240 | 273·75 | ... | ... | ... | ... |
| Vegetables | 8 | 48 | 182·50 | 1·60 | 0·240 | 1·840 | 2·4 |
| Potatoes ( Tubers ) | 4 | 100 | 91·25 | 1·00 | 0·150 | 1·150 | 1·5 |
| Fruits | 4 | 52 | 91·25 | 0·90 | 0·135 | 1·035 | 1·5 |
| Cotton | ... | ... | 12·50 | 7·50 | 1·125 | 8·625 | 2·8 |
| Total | | 2840 | | 66·20 | 9·99 | | 100·0 |

# Reviews

**"Food Problem in India in General and in Kolhapur State in Particular" by Rao Bahadur P.C. Patil, ex-Professor of Agricultural Economics, College of Agricultural, Poona, 1948, Price Rs. 4-8-0, published by the author, Tarabai Park, Kolhapur.**

It is a timely publication on one of the important topics of the day. It provides comprehensive information, on all the aspects of the food problem. The instructive value of the book would have increased manyfold if the learned author had tried to examine the Grow More Food Activities of Government with a view to suggesting scope for improvement in the methods adopted by Government in tackling the food problem.

The author seems to have erred on the safer side in painting a gloomy picture of the food requirements of the country stating that the present production of foodgrains (53·9 million tons a year) shall have to be more than doubted (123·2 million tons) before 1971

It is presumed in his approach to the food problem that either (a) the whole population possess the requisite purchasing power to buy the full food requirements or (b) that it is the duty of Government to feed all people according to the standard if they have not got the purchasing power.

It is not a practical proposition to create such a veritable heaven on earth. As the author himself had quoted Sir John Boyd "Two-third the population of the world are undernourished all the time." Providing more food results in rapid growth of populotion, resulting ultimately in starvation. Food production and rise in population form a vicious circle. The quotation of the author about the results of famine relief in China throw a flood of light on this problem, "that result was an immediate increase in population, which meant increased misery in the form of more hunger and starvation of even more people than before."

Though doubling the present production of foodgrains is set as an ideal, the author has not ignored the real problem and has rightly laid strees on checking the growth of population by prudential restrain, which is possible by the spread of education and it is hoped that food problem when fought on both the fronts of checking growth of population and increasing food production, will ease the present food problem to a considerable extent.

The appendices have added to the value of the book, especially for a research worker

—(Dr. K. M. Shah)

## "आपली शेती"

"आपली शेती" नांवाचें मराठी मासिक गेले १॥–२ वर्षे चालूं आहे. मासिकांत निरनिराळे उपयुक्त असे विषय चर्चिलेले आहेत. मासिकांतील लेखकवर्ग हा अनुभवी असून अनेक प्रकारची माहिती प्रत्येकांत अनुभवलेली अशीच आहे.

मासिकाचे संपादक श्री. जी. अनन्तन हे आपल्या महाविद्यालयाचे विगत विद्यार्थी आहेत. आज शेतीशीं त्यांचा प्रत्यक्ष अप्रत्यक्ष असा १९३२ सालापासून संबंध आहे. गेलीं ३–४ वर्षे त्यांनीं निरनिराळ्या विषयांवर संशोधन सुरू केलेलें आहे. महाविद्यालयीन शिक्षण संपल्यावर लेखकानें सरकारी नोकरी न करतां शेतीच्या व्यवसायांतच आपलें लक्ष दिलेलें आहे.

सदर मासिकांत अनेक शेतीविषयक विचार तर आहेतच, शिवाय शेतकऱ्यांना अेकूण कसें वागावें, याविषयींचीहि सर्वसाधारण माहिती आहे.

मासिक दिवसेंदिवस लोकप्रिय होवो, असें आम्ही अिच्छितों.

— (श्री. वि. केतकर)

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## Gleanings

'Sweet Lupin', (Lupinus angutifelius) — under cultivation at the Agricultural Research Station, Nanjanad (Madras) can be used as a substitute for red gram. It is a 7 months crop, usually sown in April and harvested in October or November. Unlike gram it can thrive even at elevations higher than 4000 ft. Green seeds can be used for vegetable purposes and ripe ones are used for pulse. It is also a good green manure crop. A seed rate of 100 lbs. per acre yields 10,000 lbs. of green material.

—"The Madras Agricultural Journal—Vol. 35, No. 12, December, 1948."

Sugar, which forms an important part of human diet, is also becoming a very important material for chemical industry. British scientists are attempting in this direction and it is stated that a remarkbly large number of products including sulpha drugs, substances for deadening pain, intermediates for manufacturing nylon, a cheap anti-freeze for motor car engines and drugs which reduce blood pressure, can be prepared from sugar. To prepare these substances from sugar, it is first required to be converted into a white crystaline substance called levulinic acid. Sugar has the great advantage over coal and petroleum, which are cheif sources of dyes, drugs and plastics that it being derived from an annual crop, it is rapidly replaceable in large quantities

—"The Mysore Economic Journal—Vol. 34, No. 9, September, 1948."

"D – D", a new soil fumigant has given excellent results in controlling eelworm or nematode in South Africa. D – D is the commerical name of a liquid chemical comprising 1:3 dichloropropane and 1:3 dichloropropene.

— "Farming in South Africa—Vol. 23, No. 269, August, 1948."

A thin Aluminium foil wrapper for preserving butter suitably coated to prevent corrosion by brine and laminated to parchment has been recently developed in U. S. A. The wrapper preserves the butter flavour and protects its surface for a longer time than ordinary parchment. It also prevents the absorption of fruit and other odours when stored with other vegetable products. It protects the butter from the development of oxidation defects when exposed to sun light. By reducing the loss of moisture, it prevents the deterioration of surface colour.

—"Report of the Minister of Agriculture, for the Dominion of Canada for the year ended March 31, 1948."

As a result of experiments conducted at the University of Hawaii Agricultural Experimental Station, pineapple tops are found to be superior to Napier grass as a roughage for dairy cows. These tops constitute about 7 p. c. of the weight of the fresh fruit and may be fed either in fresh or in ensilaged state. The tops, which are at present wasted, if utilised, are estimated to supply roughage for about 3,000 dairy cows in that country.

It is experimentally proved that the ascorbic acid of papyas and guavas is just as available to the human body as pure synthetic ascorbic acid. Inclusion of either of these fruits in the diet would provide all the necessary supply of this vitamin.

A dehydrated guava juice powder was prepared by concentrating the guava juice by evaporation under reduced prassure until a syrupy liquid which contained about 20 p. c. solids was obtained, at Hawaii Agricultural Experiment Station. The mixture was dried quickly by vacuum drying. This product retained all the jellying properties of the guava pectine, a high percentage of the ascorbic acid, and the flavour and aroma of the fresh fruit.

Guava jellies were prepared from this dehydrated powder, Guava flavour has been incorporated into ice cream, pastries and candies. The powder blends readily with many other fruit juices and may be used to build up the vitamin C content of the juices poor in ascorbic acid.

—" University of Hawaii Experiment Station. Biennial Report 1944–46."

Total cultivable weste is estimated to be 151 million acres in China, 47·1 million acres in Burma, 5·0 million in Japan and 250 million acres in India.

Average yield of rice in lbs per acre is 4568 in Italy, 3444 in Japan, 2998 in Egypt, 2443 in China, 2185 in U. S. A. and 1240 in India.

—'United Asia'
Vol. 1 No. 2, Sept. '48.'

# College Notes and News

## D Coy. 2 Bombay Bn. N. C. C.

*Agricultural College Platoon*

During the second term of 1948-49, Lieut. U.K.Kanitkar left the N. C. C. due to pressure of work in the research side at the college and also because he was appointed 2nd -in-Command of the Poona Home Guards Organisation. 2/Lt. L. H. Patil, succeeded him as Coy.-Commander but was soon appointed as adjutant at the Bn. Head Quarters. Lieut. B. K. Ranade, took over the command of the Coy. prior to its movement to annual training camp.

The strength of the Agricultural College detachment was 75 including N. C. O.s due to the vacanies not filled by Law and M. E. T. Colleges. The cadets formed one complete platoon (No. 12 Platoon) and a part of No. 11 Platoon which belonged to M. E. S. College. The Annual Training Camp held from 20th December 48 to 4th January 1949, at Aundh. The cadets of the Agricultural College have put in excellent work both in military training and sports. Sgts. Shirname and Shinde worked enthusiastically to obtain the high standard from the cadets, with the co-operation of their Junior N.C. O,s. C S M Bholay and C. Q. M. S. T. Kurian worked untiringly throughout the training period. Cdt. U/Officers Chakravaty and S P. Zalke (who was attached to D Coy) guided the platoons very well.

The boxing team formed under C. Q. M. S. T. Kurian proved to be the formidable Boxing Team. C Q M S T. Kurian won the Bondale Cup for the most scientific boxer and Cdt. Shirolkar was awarded the championship belt in bantam weight.

Sgt. Shinde was the winner of the Prince of Yuvraj Mace in wrestling. He stood first in the cross-country and was followed by Cdts. D. S. Patil and V. P. Mane. The Agricultural College Platoon came first in cross country run winning the Graham Smith Cup.

Sgt. Shirmame worked enthusiastically to win Kaikobad Cup for the best drilling platoon and Karkpatrick Cup for the best squad in P. T. Sgt. Shinde's work with the newly rasied M. E. S. College Platoon was excellent. His platoon has won the Maj. Husain Cup for the most disciplined platoon.

Cdt. U/Officer Chakavarty was awarded the Bhor Gold Medal for the most efficient cadet.

During the camp, Principal L. S. S. Kumar visited the Coy and expressed his satisfaction at the work put in by the cadets. This year the camp was visited by many distinguished visitors like Lt. Gen. Maharaja Shree Rajendrasinhji, G. O. C. in-C. Southern Command, Hon'ble Sri. Morarji Desai, Rt. Hon'ble Dr. Jaykar, Dr. Mahajani and others. They all expressed satisfaction at the work done by cadets 2nd Bombay Bn. N. C. C.

In short, with the perfect co-operation and team work in N. C. O.s and (most of the N. C. O.s of the Coy. were from Agri. College) cadets this year 'D' Coy. was able to win 13 trophies out of 16 trophies. I hope, before I conclude this report, that staff and students of this college will try their utmost to maintain the high tradition established by this year's officers and cadets of the college.

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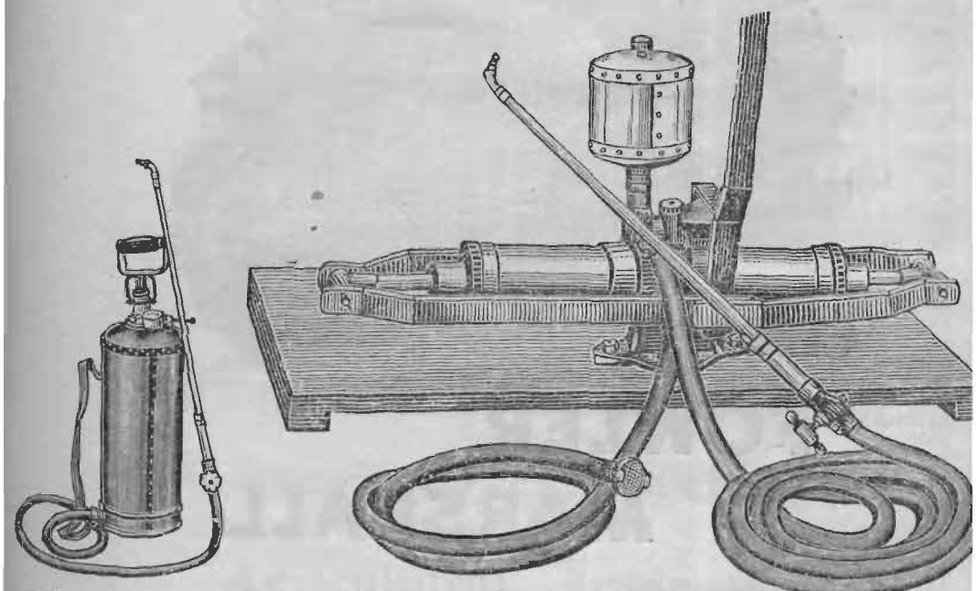

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# Agricultural Graduates' Employment Board

## College of Agriculture, Poona.

**Employers requiring agricultural graduates are invited to make use of the services of the Board. Applications should be addressed to the Secretary of the Board; no fees are charged.**

**Agricultural graduates of the College are also invited to register their names with the Board.**

Printed at the Aryabhushan Press, 915/1, Shivaji Nagar, Poona City, by Mr. KESHAV GANESH SHARANGPANI, and published by PROF. A. A. VASAVADA, at the Agricultural College, Poona.

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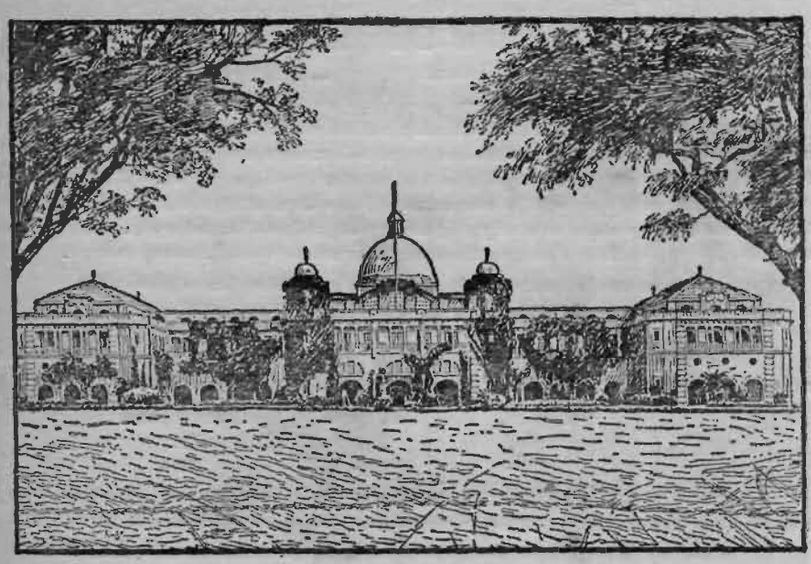
# Poona Agricultural College Magazine



**Urban authorities should consider it their sacred obligation to collect and conserve town refuse and make good manure out of it and place it at the disposal of gardeners and cultivators of land at a reasonable price.**

*—C. Rajagopolachari.*

**Whoever makes two ears of corn or two blades of grass to grow where only one grew before deserves better of mankind, and does more essential service to his country than the whole race of politicians put together.**

*—Swift.*

THE POONA

# AGRICULTURAL COLLEGE MAGAZINE.

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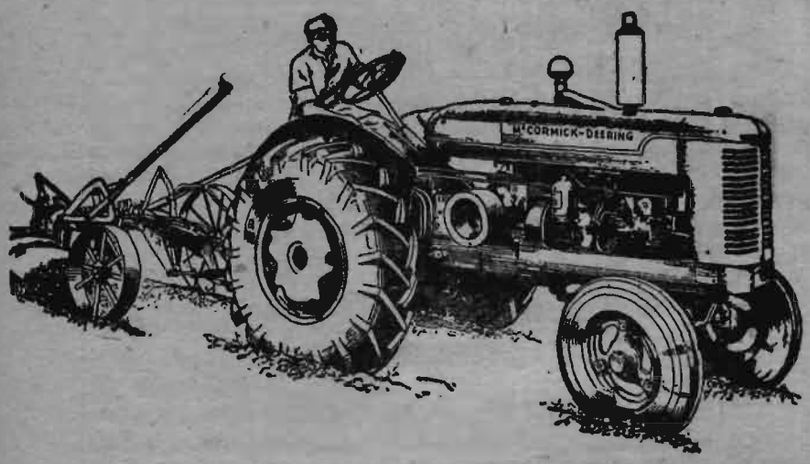


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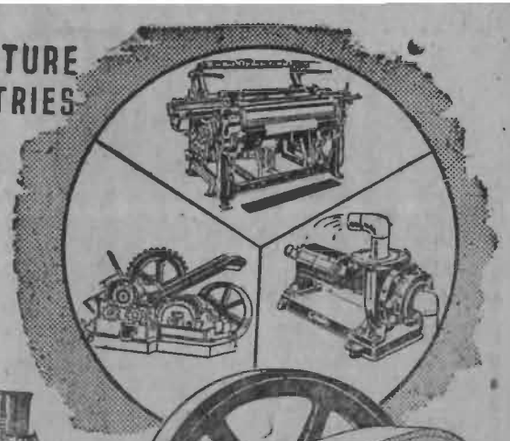

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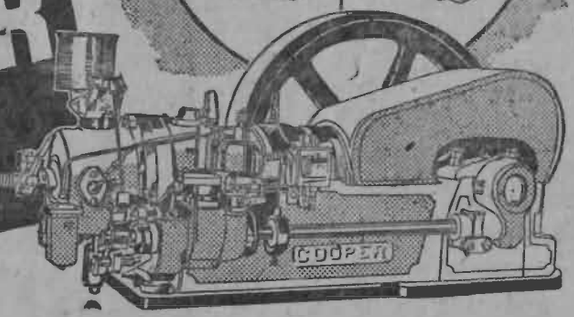

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THE POONA

AGRICULTURAL COLLEGE MAGAZINE

VOL. XL ] AUGUST, 1949 [ No. 2

# Editorial

August 15th, Independence Day of India is cherished by all the Indians as the day of attainment of freedom. For the last two years tree planting is associated with this day. Tree planting in India has been practised in the past and has been associated with the celebration of an auspicious occasion. Trees, flowers and leaves are indicative of fertility and are used for decoration on ceremonial occasions.

In our country trees are a boon against the scorching effects of the sun. Avenues of trees alongside of dusty roads offer a real blessing by way of shade and coolness to the weary traveller. Trees also serve as source of fruit, fuel and timber supply. It is argued that deforestation has caused a deficiency of rainfall. It has, however, been proved that afforested areas have 25 p. c. more rainfall than treeless one. Large scale tree planting, afforestation and private forest lots would go a great way in mitigating the rigours of famine in the tracts liable to such calamities.

Shri. M. P. Patil, Hon. Minister for Agriculture and Forests has issued an appeal to the people of the province about tree planting on the Independence Day of 1949. We earnestly exhort all the people of the province to lend a willing hand in carrying out tree planting. It should however be remembered that one must not be satisfied with planting alone. People must nurse and cherish the plants in their young age till they grow well and mature. We would further urge the people to plant quick growing trees to make up the shortage of fuel supply and thus save cow dung for manure.

* * * *

No stone should be left unturned to remove the food deficit in our country. India's Prime Minister Pandit Jawaharlal Nehru has impressed upon the agriculturists to do their level best to grow food in larger quantities and become self sufficient in a couple of years' time. In our province our own premier Shri. Balasahib Kher has stressed upon the urgent need of raising enough food to make the province self sufficient. The Hon. Minister for

Agriculture and Forests Shri. M. P. Patil, has moved over the whole province and has urged on farmers to do their level best in this direction.

Fortunately we have had a favourable monsoon and it behoves every cultivator to try his utmost and get a bumper crop by using compost and manure so that our needs of foodsupply be fulfilled and we may not have to depend upon the other countries for it. Incidentally the people should try out different kinds of food available to adjust their food requirements. It is upto every countryman to carry the war cry of Pandit Jawaharlal Nehru to the remotest corner of the country so that our countrymen may offer their best cooperation and effort in this direction. Bombay Province has always been foremost in adopting progressive meaures and policies. We trust that cultivators and people of our province will not remain behind in this crucial problem.

* * * *

It has been recently announced that the Government of Bombay have approved a scheme of cooperative farming eastimated to cost about Rs. 2,00,000. Four types of cooperative farming societies are envisaged in the scheme viz. (a) a cooperative better farming society meant to promote the economic interests of the members such as joint purchase of seed, manure etc, and joint sale of produce. Each member will carry out the cultivation of his area separately; (b) a cooperative joint farming society, wherein the lands of small holders will be pooled together. The members work jointly for the pooled land and receive their wages. This will enable better planning of crop programme and joint purchase of requirements and joint sale of produce; (c) a cooperative tenant farming society. Here the society takes the land as free hold or on lease and divides it into suitable sized economic holdings which are leased out to tenants. The society functions as the landlord. The society lays down the plan of cultivation and supplies seed, manure, implements, etc. and arranges for the sale of produce; and (d) a cooperative collective farming society. This society would ordinarily be formed by land-less agriculturists who undertake joint cultivation, pool their labour and other resources and draw the wages for their work days.

The societies when formed would present a new method of joint agriculture in our province. It is presumed that fragmented lands would be pooled together. Lands of absentee landlords, waste lands or lands to be reclaimed or developed would be better looked after and managed by such societies. The schemes will in the first instance be started in East and West Khandesh, Surat, Thana, Dharwar and Kanara districts, as there is a scope for forming such societies in these districts. It is envisaged that such societies will spring up and function in the other districts of the province later.

* * * *

We welcome the announcement by the central ministry of agriculture of the formation and setting up a Central Committee of Soil Science. The

Committee consisting of eight members will guide and coordinate the scientific study of soils in India. The Committee will advise on matters on soil research and right lines of soil survey. It is proposed to preserve, centrally at some place, differant soil types and soil profiles. This essential work, which has been long over due will enable a better understanding of the soil and its management, proper planning of crop programmes suitable to the different soil types and determination of proper methods of manuring, irrigation, cultivation, etc. so as to raise the best crops suitable to each soil type.

* * * *

Although the famine in Gujarat last year took its toll and affected the farmers of the area considerably, it has led to an impetus in a new direction for providing adequate water supply. Large scale boring and lift irrigation schemes have been resorted to for this purposes. The lift irrigation has proved successful and short range irrigation schemes which would give immediate results are being favoured. The Province abounds in a large number of sites where lift irrigation from rivers, and perennial streams can successfully be applied. The Govt. of Bombay proposes to have 114500 acres under command of lift irrigation all over the province. Of the 40 sites selected at present, a few schemes have already started operating, a few more will be completed by the end of this year and the rest by the end of 1950.

* * * *

A large number of distinguished visitors visited the college so far during its first session. Sir Sarvapalli Radhakrishnan and other members of the Universities Commission visited the college on 19th July. The Mysore Agricultural College Site Committee was at the college for two days visiting the various sections and obtaining detailed information about the working of the several sections at the college. Secretaries and other officers from the different provinces who had come to Bombay for the food conference also took an opportunity of visiting the college on 4th July. The Agricultural Policy Committee, C. P. and Berar went through a detailed programme of visit from 3rd August 1949 to 9th August 1949 and thoroughly acquainted themselves with the college research and other departmental agricultural activities.

* * * *

The second anniversary of the Independence of India was celebrated on 15th August, 1949, in full solemnity by the students, staff members, farm-staff, farm-school boys and other staff members of the departmental offices on the college estate. Dr. B. N. Uppal, Director of Agriculture, B. P. and Rao Bahadur D. A. Gadkary, Joint Director of Agriculture (Engineering) were present on the occasion.

This time, a special flag-post was erected on the Western-side of the College-play ground near the College main avenue. The flag-post base and its surroundings were decorated with plants in an artistic manner. The ground was lined out on the three sides of the flag-post and verybody took up the allocated position at 7-30 A. M. sharp. 2/Lt. L. H. Patil was in charge

the ceremony. At 7-40 A. M. the College N. C. C. platoon marched in d took up its position opposite the flag-post in the center of the square. hereafter Principal L. S. Kumar performed the flag-hoisting ceremony. The . C. C. platoon presented arms and the parade which was at attention aluted the flag as long as the bugle blew. Subsequently Shri Kumar deli- ered a message [which is printed elsewhere] appropriate to the occasion. The parade dispersed after the singing of the National anthem. A number of trees were planted round the play ground after the ceremony.

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# Independence Day—1949

BY

PRINCIPAL L. S. S. KUMAR*

We are this day entering the third year of our independence and when we look back over the events of the past two years it will be observed that the advent of freedom has not been attended with unmitigated joy or redemption from past handicaps and shortcomings in the life of the people. On the contrary, the country is still passing through a phase of unstable equilibrium. It is still faced with many difficult problems on the political, commercial, industrial, economic and agrarian fronts. Political dissentions, malpractices and unsound methods in commerce, never-ending industrial disputes are diverting the energies and are demanding the attention of our statesmen and leaders leaving them little time to pay their undivided attention to such nation-building measures as providing adequate food, clothing, shelter, and education and in raising the standard of living and power of earning of the people of the country.

From a consideration of the reaction of the masses to the advent of freedom, it is apparent that a great majority of the people of the country feel that the responsibility of setting things in order and of ending the inequities of previous administrations rests solely with the Government while they have little or nothing to do. This has led to the unhealthy practice of blaming Government for every thing that goes wrong. A little reflection would show

* Speech delivered by Principal L. S. S. Kumar, on 15th August, 1949 at the College of Agriculture, Poona 5.

that the root cause of many of our immediate ills is the attitude of indifference or apathy shown by the common citizen. No Government can bring about measures of reform without the cooperation of the citizens to the fullest extent.

It is a glaring fact that our country having achieved freedom from political bondage has inadvertantly slipped into a condition of dependence on the food front. Crores of rupees are being drained away from this country annually in importing food grains. This is a most regrettable state of affairs which does not redound to our credit. With freedom should also have come self-dependence and self-sufficiency in matters of food, clothing and shelter at least. The Prime Minister of India, Pandit Jawaharlal Nehru has acted none too early in issuing a directive that the Indian Union has to attain self-sufficiency in regard to food by 1951. If such a compelling directive had not been issued no effort would have been made to increase food production in this country. In this gigantic task of achieving self-sufficiency of food each individual has a role to play in helping the state. It is within the power of each one of us to help by avoiding waste of food, to be frugal and to adjust oneself to the availability of food grains. If the interest of the nation requires one should be prepared to adopt austerity measures as the people of Europe did during the war and are still doing. Those who live in large cities and towns and who cannot directly help in food production should help in avoiding waste, in food conservation and food economy.

A majority of the students of this college come from the farming class which is the back-bone of the nation. Their parents are agriculturist by profession or own lands. It is their duty to induce their parents and relatives to respond to the call of the Government in this hour of country's need to produce more food. Soon many of the students will be going home for a short vacation. This opportunity should be utilised by them to make propaganda for increased food production. Every such effort will aid in the task which has been set to the nation.

Self-sufficiency in the matter of food will be a permanent measure to be undertaken and not merely to be worked for a few years. Therefore, opportunity awaits all students who pass out from the agricultural colleges of the country to work to maintain a high level of food production and self-sufficiency in food supply.

If each citizen does whatever is in his power to save food, to grow and conserve food and be frugal until times of plenty arrive, the present unstable conditions can be largely remedied and the statesmen and leaders could be helped to usher in a period of peace, and contentment to all.

Jai Hind.

# Agriculture as Known to Panini

BY

DR. V. S. AGRAWALA.*

According to the traditional classification of sciences there were four Vidyās, viz., Dialectic, Triple Veda, Economics and Polity.[1] Vārttā or Economics as an important sphere of the activities of the state was responsible for the financial prosperity or decline of the realm.[2]

The scope of Vārttā according to the Arthasāstra comprises Agriculture (*Krishi*), Cattle-rearing (*Pāśu-pālyā*) and Commerce (*Vānijyā*), to which Banking (*Kusīda*) was also added in later literature (Vishnu Purāna, V, 10.28). Panini shows an intimate acquaintance with the principal branches of the economic science, and the Ashtadhyayī, provides valuable evidence on such topics as agriculture, trade, commerce, arts, crafts, cattle-rearing, currency, weights, measures, tolls, taxes, labour, banking and corporate organisations.

It is proposed to discuss here the Paninean evidence relating to one main branch of Vārttā, viz. Agriculture or *Krishi*[3].

*Antiquity* :—Agriculture has for long been the major profession with the bulk of the population in India. The masses have followed the occupation of cultivating the soil for their livelihood ever since their ancestors settled on land in the Vedic age. The sowing of grain and the use of the plough are mentioned in the Rigveda, (I. 117. 21); the Atharvaveda credits Prithi Vainya with the organisation of ploughing (VII. 10. 24). In the later Samhitas and the Brahmanas ploughing is repeatedly referred to. The Sūtra literature gives ample proof of the importance attached to agriculture. Even the Greeks in the fourth century B. C. and later were impressed with the great devotion which bound the people to agriculture and cultivation of the soil. Classifying the people of India into seven classes or 'castes', Megasthenes observes that the husbandmen who formed the second caste were "far more numerous than the others. Being moreover exempted from fighting and other public services, they devote the whole of their time to tillage; nor would an enemy coming upon a husbandman at work on his land do him any harm, for men of this class, being regarded as public benefactors, are protected from all

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* Superintendent, Central Asian Museum, New Delhi.

१. आन्वीक्षिकी त्रयी वार्ता दंडनीतिस्त्वेति विद्या: । (Arthaśāstra 1. 2.)

२. अर्थानर्थौवार्तायाम । अर्थ.

३. कृषिपाशुपाल्ये वणिज्या च वार्ता । अर्थशास्त्र.

injury."[4] Megasthenes is confirmed in his statement by Diodoros (II. 40), Strarbo (IX. 1. 40) and Arrian (Indica, XI), who not only speak of the husbandmen or tillers of the soil as forming the bulk of the population but have also noted their great skill in this profession. An extension of similar conditions of security and prosperity of the peasantry may be imagined to have existed in the days of Pānani who is not far removed from the time of the first observations of the Greeks made on Indian soil. He shows acquaintance with the diverse agricultural operations as ploughting,[5] sowing,[6] weeding,[7] harvesting,[8] threshing,[9] winnowing,[10] etc., and has drawn his material from a rich stock of agrarian vocabulary.

*Agriculture*:—The main word for agriculture is *Krishi*.[11] It is derived from the root *krish*, to plough, but the word was not restricted to mere ploughing. From long anterior usage *Krishi* had come to denote collectively all the diverse processes appertaining to agriculture. Both Kātyāyana and Patanjali have an interesting discussion on the point that the word *Krishi* denotes not merely the particular act of ploughing, but also includes the various other operations involved in agriculture[12] as a whole.

*Cultivators*:—The husbandmen are called *Krishīwala* by Panini who teaches the formation by means of a special rule: *rajah krishyāsutiparishado valach* (V. 2. 112). The word *krīshivala* is not used either in the Samhitās or in the voluminous Brāhmanical literature. The older Vedic word was *krishti*, denoting people in general, because the most numerous class amongst them was that of the agriculturists.[13] Another special word found in Rigveda (IV. 57. 8), in some other Samhitās and the Brāhmanas is *kīnāsa*[14] denoting the regular ploughman or cultivator of the soil. Pānani does not teach its formation but it is the subject of an *unādi* sūtra (V. 56) which is on the face of it a very artificial and probably post-Paninean etymology.

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4. Meg. Frag. I, Mc. Crindle, Calcutta, 1920, p. 39.

5. III. 1. 21; III. 1. 117; III. 2. 183; V. 4. 58; V. 4. 121; IV. 4. 81; IV. 4. 97.

6. IV. 3. 44; V. 1. 45.

7. IV. 4.88.

8. VI. 1. 140.

9. IV. 2.50.51.

10. III. 3.28.

11. V. 4. 58, कृष्णो द्वितीयतृतीय शम्बा बीजात कृष्णो।

१२. वा. कृष्यो दिषु चानुत्पत्तिर्नानाक्रयाणां कृष्यर्थेन्वीत। भा. नाना क्रियाः कषेरर्थाः। नावश्यं कृषिर्विलखने एव वर्तते। किं तर्हि पातिविद्यानेअपि वर्तते। यदसौ भक्त बीजं बलीवर्दैः प्रति विधाप करोति स कृष्यर्थः।

13. Vedic Index, I. 183.

14. Vedic Index, I. 159. Additional Brahmanical references are Satapatha, VII. 2.2.9; Taittiriya, III. 4. 9. I.

At the close of the Brāhmanical period the older and colourless word *krishti* came to be replaced by the more expressive word *krishīvala*. Pānini derives it not as a primary world from a verbal root, but as a word of secondary derivation from *krishi* by adding the possessive suffix *valach* in the sense of *matup*. This new suffix is a feature only of the classical speech. Thus *krishīvala*[15] denotes more clearly and completely the essential relationship which exists between cultivation and the cultivator of the soil.

*Land and Fields*:—The land is viewed in its two-fold division viz., uncultivated and cultivated. The uncultivated land was of two kinds *ūshara* or waste land (V. 2. 107) and *gochara* or pasture land (III. 3. 119). The cultivated or plough land was known as *kshetra* (*dhānyānām bhavane kshetra knan*, V. 2. 1.). Synonymous with it was *kedāra* (IV. 2. 40) which word is not found in the earlier Brahmanical literature. In the Arthasāstra[16] *kedāra* denotes a wet field, and possibly it was distinguished from *kshetra* in this special sense in the time of Panini also. Panini's use of the word *karsha* is in the same sense as that of the Arthastra, viz., ploughing. The area brought under the plough was called *halya*[17] (IV. 4. 97) and *sitya* (IV. 4. 9). The word *sītā* (IV. 4. 6) is as old as the Rigveda (IV. 57. 6, 7) and is used in the later Samhitās also, where it variously represents the personified deity of agriculture and also furrow. Gradually the former sense fell into disuse. In the Arthashastra *Sita* retains its older meaning of the goddess of agriculture only in one place and there also it appears to be in an old quotation: *Sītā me ridhyatām devī bījeshu cha dhaneshu cha*: Arth. Text, p. 118. Its more common meaning in Cautilya is agricultural produce, specially from the crown lands. 'Whatever in the shape of agricultural produce is brought in by the Superintendent of Agriculture (of crown lands) is termed *Sītā*.'[18]

In the Asthadhyayi *Sītā* has no such technical meaning. It simply means the furrow described by a plough, and *sitya* denotes a field btought under cultivation by a plough (*sītyā samitam sangatam kshetram sityam*, IV. 4. 91). Each and every ploughable area or *kshetra* would not be called *sītya* unless actually grown over with crops for the season, i. e., literally 'united with furrows'.

In the chapter on *Sāsya devatā* (IV. 2. 24–33) Pānini also mentions the Vedic agricultural deities *Suna* and *Sira* (V. 2. 32), personificatfons of Vayu and Aditya according to Yaska, but of 'the share and the plough' according to

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15. The usual word in the Arthashastra is *krishaka* not *krishivala*, Artha Text, p. 187.

16. Artha. Tr. pp. 58, 129.

17. *Mata-jana-halat karana-jalpa-karesheshu*, (iv. 4. 97) which teaches *yat* from *hala* in the sense of ploughing.

18. Artha. Tr., p. 97; also p. 60.

others (Vedic Index, II. 386). Most likely oblations to these deities continued to be made up to the time of Panini.

*Measurement and Survey.*—The *sitya* and *halya* areas (*kshetra-bhakti*) must have been measured and properly recorded, both for marking out boundaries of fields and for realising portions of produce payable to government. Megasthenes tells us that there were officers who measured the lands constantly as was done in Egypt for purposes of the assessment of revenue. (*Frag. 34*). These officers have been identified with the Rajjugrahakas of the Jatakas whose duty it was to measure the lands with a *rajju* or rope, or the *Rajukas* of Asoka (P. E. IV; Camb. History, Vol. I, p. 508), who were appointed over the people in the country side (*janas janapadasa*). Fortunately, Panini also gives a rule relating to the measurement of fields in terms of the *kāṇḍa* measure. The sutra, *kandantat kshetre* (IV. 1. 23), says that the word *kāṇḍa* preceded by a numeral in a Dvigu compound takes the feminine affix *tāp*, if it relates to a field. The illustrations given *dvikanda kshetrabhaktih* would refer to a field equal in measure to two *kandas*. Though *kanda* as a measure is not known in the Arthashastra, we are informed by later commentaries[19] to Panini that *kanda* was equal to 16 cubits of length. The institution of measuring units of land under cultivation was older even than Kautilya. Panini also mentions an officer called *Kshetra-kara* (III. 2. 21) who seems to have been entrusted with the special function of measuring and surveying fields. His duties appear to be identical with those of the *Rajjugrahaka* in the Jatakas.

*Nomenclature of fields* :—Panini introduces us to the two most natural principles for naming the different kinds of fields, firstly on the basis of the crop grown[20] (V. 2. 1. 4), and secondly on the basis of area determined in Sutra V. 2. 1., *dhanyanam bhavane kshetre khan*, teaches that after the name of a particular corn, in the sense of a place of its growing, when that place is a field, the affix *khan* is added to denote that field. For example, fields in which *vrihi* and *sali* crops were grown were respectively called *vraiheya* and *saleya* (V. 2. 2.). Other names of fields were *yavya* for barley, *vavakya* for a kind of rice, *shashtikya* for the *shashtika* rice so called from its maturing in two months, *tilya* or *tailina* field for seasmum, *māshya* or māshīna for beans, *umyap* or *aumina* for linseed, *bhangya* or *bhangina* for hemp, and *anavya* or *ānavīna* field for the *anu* kind of grain (Panicum miliaccum) (V. 2. 3. 4), now called *chīnā* and extensively grown in the Punjab.

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19. *Shodasāratnyāyāmo dandah kandamiti sthitih Balamanorama.*

२०. धान्यानां भवने क्षेत्रे खञ्। व्रीहि शाल्योर्ढक यव यवक षष्टिकाद्यत् विभाषा तिलमाषोमाभंगाणुम्य terms of the quantity of seed required to be shown in a field (V. 1. 45, 46).

२१. तस्य वापः। पात्राल्लुन्।

The mention of the quantity of seed required for sowing a field implies a reference to its size (*tasya vāpah.*, V. I. 45); for example, a field that required a *prastha* measure of seed was called *prāsthika*, and so *draunika* and *khārīka* fields were also known, which must have been of respectable size. Panini himself gives us one example, viz., *pātrāsya vāpah pātrikam kshetram* (*partāt-shthan*, V. I. 46), i. e., a field requiring a *pātra* measure of seed. It must have been a convenient way of designating different plots of cultivable land and distinguishing them from one another.

In addition to the above two principles, the fields also derived their names from a third factor, viz. their suitability for growing particular crops (*tasmai hitam*, V. 1. 5). Pānini has noted the names of three crops especially, which are sufficient to illustrate the point: *khala,-yavyamāsha tila-vrisha-brahmahnascha* 5, 1. 7. It says that plots of land suitable for growing barley were called *yavya*, for beans *māshya*, and for seasum *tilya*.

The selection of particular fields for particular crops must have depended on several factors, viz., nature of the soil, quantity of available water, and the process of crop-rotation with a view to replenish the exhausted energy of the soil. A group of fields was known as *kshaitram* (VI. 2. 38).[22]

*Agricultural Implements*:—The name of the plough (*sīranāma*, VI.2.187) in Pānini is *hala* (III. 2. 183; IV. 3. 124; IV. 4. 81; VI 3. 83), which is synonymous with *sīra*. (IV. 3. 124; IV. 4. 81) *Lāngala* which is a regular word for plough in the Rigveda and later,[23] is not directly mentioned in the Ashtādhyāyi, but it can be understood by implication as one of the synonyms of *sira* referred to in sūtra VI. 2. 187.[24] A large plough was called *hali* (III. 1. 117), which was also known as *jityā*, perhaps from its utility to break even the hardest ground or reclaim waste land. (III. 1. 117).[25] None of these two words is known to the Arthasāstra.

From the study of the village economy, Pānini mentions three classes of farmers, those not possessing a plough of their own (*ahali*), those having a

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22. *Kshetra* is read in the *anikshādi* group (IV. 2. 38) which seems to be genuine, as the *gana* was early subjected to a critical examination by *Kātyāyana* (*Bhāshya* II, 278, II. 323) who insists on the reading of *yuvati* in this group and devotes a *yarttika* to that end, and alse by Patanjali who initiates a lengthy and subtle discussion to prove the genunineness of the reading *garbhini* in this *gana*. (*Bhashya*, II. 323).

23. Vedic Index, II. 231.

24. Kātyayana is more explicit and mentions *langala* in a *varttka* on III. 2.9. (Bhashya, II. 99, lāngala-graha).

25. *Vipuya-vinìya-jitya munja-kalka-halishu*, Pan, III. 1. 117.

good plough (*suhalah, suhalih*), and those having an indifferent plough (*durhalı* or *durhala* V. 4. 121). The first kind (*apahala*) was known by such words *apasira*, or *apalāngala* (VI. 2. 187). To be in possession of good ploughs ensuring prosperity of crop should have been the coveted desire of all husbandmen, since Katyayana in a varttika to sūtra (VI. 3. 83) treats the ownership of a plough as a very good cause for a benedictory utterance (*āsisaha*), such as '*Svasti bhavate saha-halāya* or *sahalayā*. 'May luck attend you with your plough.'

The *hala* was made up of three parts, viz., the long wooden pole (*īshā*), the central bent portion called *potra* (III. 2. 183) and the plough-share or *kusi* fitted in the *potra* and made of iron (*ayo-vikāra*, IV. 1. 42). In the Vedic literature the share was called *phāla* (Vedic Index, II. 58, Rig. IV. 57–58), and both these names are current among the farmers in North India up to this day. The plough was drawn by oxen (IV. 4. 81) specially choser and called *hālika* or *sairika*, as distinguished from other bullocks used for dr: ving carts or chariots (IV. 4. 76; IV. 4. 80). They were fastended to the y ke by means of a rope called *yotra* or *yokta* (III. 2. 182), or leathern thong called *naddhri*, (III. 2. 182). In the Khandikadi[26] group we have *yuga* and *varatrā*, which refer to the yoke and the thick long rope used for lifting water from a well which is still called *barat* in western and *barra* (बरौ) in eastern Hindi. The whip was called *vyaja* (III. 3. 119) and *totra* (III. 2. 182), corresponding to the older Vedic word अष्टा (Rig. IV. 57. 4). The spade was called *khanitra* (III. 2. 184) and *ākhana* or *ākhāna* (III. 3. 125). The hoe for specially weeding out the stumps was known as *stambaghana* (III. 3. 83). The ripe grain was cut with a sickle for which besides the old Vedic word *dātra* (III. 2. 182) a new word *lavitra* (III. 2. 184) had come into use. We are indebted to Yāska (Nir. II. 2.), who is corroborated by Patanjali (Bhashya, 1. 9), for the valuable information that *datra* was the word for the scythe used in the speech of the notherners, while people living in the east called it *dāti*. Both these words correspond to western Hindi *darānt* and eastern *dāi*.

(*To be Continued*).

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26. The *khandikadi* group (IV. 2. 45) is one of those *ganas* which had been subjected to a searching analysis by Patanjali (II. 280) and all subsequent commentators, and hence its text may be considered reliable.

# Food and Nutrition

BY

DR. H. G. PANDYA.*

We are quite ignorant of practical nutrition also of the actual food values of various Indian foodstuffs. Even among the enlightened communities, the question of dietary adjustments is regarded as a fad. There is wide prevalence of undernourishment and malnutrition. The chief cause of this is, of course poverty, but ignorance, apathy and dietary customs add their contributory factors to faulty nutrition and ill health. This article, details in a broad sense what food is and what type of diet should be based so as to ensure a good sound health.

There are several ways of classifying the food we consume. On chemical basis, it can be divided into six groups, (i) carbohydrates (ii) fats (iii) proteins (iv) mineral matter (v) vitamins and (vi) water. There is no perfect food that can alone fill all the needs of nutrition. It would have to supply adequate heat and energy for muscular work, provide material to replace wear and tear of tissues and ensure the presence of those food substances which increase the resistance of the body to infection.

(*i*) *Carbo-hydrates*:—The present day food position in India can be described in one word, starvation. Where there is no question of starvation, the question of carbo-hydrate deficiency does not arise at all. Being the cheapest of all food factors, it should be within the reach of everybody. All of the food carbo-hydrates except milk sugar are found in the plant kingdom. Cereals, fruits and vegetables are the sources that supply carbo-hydrates. Sugar and honey are pure carbohydrates, but in many food stuffs such as rice, wheat, millet, peas, beans, potatœs, fruits and milk, they exist mixed with other substances. They are regarded as energy producing constituents. Cellulose is the husk element of grains, fruits and vegetables. It is a carbohydrate but has no food value as it cannot be digested, but its mechanical effect upon the digestive process is of considerable importance. Carbhohydrates are of three kinds:—(1) Polysaccharide e. g. flour and other starch of the grains (2) Disaccharides e. g. lactose, cane sugar, maltose (3) Monosaccharides e. g. glucose or fructose. In the process of digestion polysaccharides are reduced to disaccharides and disaccharides ultimately to monosaccharides. Monosaccharides like glucose only are absorbed into the blood. Excess of glucose is stored in the liver in the form of glycogen to maintain

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the balanced ratio of glucose of the blood. Normally 475 gramme of carbohydrates is necessary for a balanced diet to liberate approximately 1900 calories. An overdose of carbohydrates should be guarded by against especially for those who have sedentary occupation and whose staple diet is rice and also who take too much of sweet as it leads ultimately to diabetes.

(*ii*) *Fats*:—Fats give twice as much heat per gramme as the same quantity of carbohydrates and proteins. Nearly all foods contain some proportion of fats, but ghee, butter, eggs, cocoanut oil, groundnut oil, fish oil etc. are some of the familiar examples of food consisting almost entirely of fat. From fuel point of view both animal and vegetable fats are of the same value; but in other respects animal fats are more important than vegetable fats; the latter contain vitamins and are easily digested and assimilated than the former. Further investigation may suggest other advantages of animal fats over vegetable fats. Fat is not only a concentrated kind of fuel, it also serves as a reserve energy supply and hence called protective food constituent. Fat can be stored in the body to a considerable extent and this store house can be drawn upon in times of necessity and emergency. While there is a limit to the storage of glucose in the body, there is ample scope for fat being accumulated. As the fat is distributed throughout the body and is spread specially below the skin, it acts as a blanket and preserves the body heat. It fills up the body contours and makes it look beautiful. It is the fat that makes the face and skin look bright. Calcium is assimilated into the body if there is enough fat in the food. It is the fat that keeps the mucous membrane healthy and wards off disease germs. Butter, cream, ghee, cocoanuts, nuts of all kinds, soya bean etc. supply fats that are of value to the body. For a balanced diet, 50 gms. of fat is necessary which will supply 450 calories.

(*iii*) *Proteins*:—They differ from carbohydrates and fats in that they contain nitrogen which is an essential constituent of both plant and animal cells. They are necessary for growth, maintenance and repair of body tissues. They are derived from both animal and vegetable sources–gluten of cereals, legumin of pulses, casein of milk and albumin of eggs. They are of complex structure and cannot be utilized by the body unless they are split up into simpler forms called amino acids, which is easily absorbed into the blood. The number of proteins are large but there are only twenty two amino acids which are regarded as building stones of proteins. Out of these amino acids, there are only four–Histidime, Lysine, Tryptophane and Cystine–which are indispensable for growth and life as the body is not capable of synthesizing them from food materials. As compared to animal proteins, the vegetable proteins contain less of these suitable amino acids hence animal proteins are to be perferred. The presence of these essential amino acids in milk is one of the reasons why milk is considered essential in diet. All animal flesh, egg, milk, cheese, wheat, beans, peas and nuts contains these essential amino acids in their proteins. Proteins of maize (zein) contain none of these essential amino acids and therefore maize is an inferior cereal. Gelatin is low in nutri-

tional value because it lacks essential amino acids. There are a number of vegetable proteins, which resemble gelatin and hence animal proteins are more valued. For a balanced diet, the intake of 65 gms. of protein is necessary to give 260 calories. Out of these 13 gm. of protein should be of animal origin and the remaining protein should be taken from different articles belonging to different classes so as to ensure different kinds of amino acids.

(*iv*) *Mineral salts*:—Protein is the basic element for cell formation. Mineral salts are necessary for proper functioning of the organs and for maintaining the general health of the body. There are twenty two elements present in the composition of tissues. Each element serves its own purpose. Calcium is necessary for satisfactory working of nerves and muscles, chlorides for the production of hydrochloric acid in stomach, essential for protein digestion. Heart will not beat properly in the absence of potassium in the blood and so on.

The vegetable kingdom is divided into two distinct classes—acid forming and alkali forming. Wheat, bajri, pulses, nuts and seeds are acid forming; roots, leaves, fruits and vegetables are alkali forming. The mineral matters which are alkaline in character serve to maintain the proper fluid environment for cellular activity. The blood and tissue fluid should be slightly alkaline.

Out of these twenty two kinds of mineral salts only four are principal minerals (a) calcium (b) phosphorus, (c) iron and (d) iodine; if these are secured in sufficient quantities other will automatically have been obtained also.

(*a*) *Calcium*:—Milk is the richest source of calcium. Radish, onion, carrots, cucumbers and green vegetables supply a fair amount of calcium. The children require more calcium during their growth period than adults. It should be in the easily available form. Calcium from vegetable source is less easily absorbed than that from animal source. A diet consisting of milk, cheese, eggs, vegetables and nuts should ensure an adequate supply of calcium. In a balanced diet, the proportion of calcium should be 1·02 gms.

(*b*) *Phosphorus*:—It is an essential element in cell nuclii. It plays an important role in maintaining the tone of the actively functioning tissue of the body. Whole cereals are rich in phosphorus but not in calcium; egg, meat, fish, milk, legumes and nuts contain a fair amount of phosphorus. In a balanced diet, its proportion should be 1·47 gm.

(*c*) *Iron*:—It is concentrated in the blood. Its deficiency makes a person look pale. It acts as a carrier of oxygen in the body cells. Malaria and hook-worm destroy iron to an extraordinary extent. Chronic malaria therefore, necessarily results in anæmia. The yolk of egg, green leaves, nuts,

whole grains, legumes, dried fruits are the common sources which supply an appreciable amount of iron. Laddus of *til* seeds and *gur* are not only relatively cheap but also provide calcium, iron and protein in good quantities. In a balanced diet, iron should be 44 mgm. only.

(*d*) *Iodine*:—It is necessary for the proper functioning of thyroid gland. It is present in wheat, millet, carrot, goat's milk and condiments auch as cloves, gingers and black pepper.

(*e*) *Vitamins*:—Proteins and mineral matter are like bricks and mortar. Vitamins are masons and door-keepers of the body. Although they do much important work in the body, the proportion of their requirements is quite insignificant. They are quite essential to life. There are several kinds of vitamins and each seems to have its own definite function. One strengthens the nerve system, another helps the development of bones and teeth; and the third is essential for the growth and development of the body. The absence of vitamins affect health, growth and reproduction. We shall confine ourselves to the study of six vitamins—(i) A, (ii) $B_1$, (iii) $B_2$, (iv) C, (v) D and (vi) E.

Each one has a specific role in normal nutrition. Fat soluble vitamins are A, D and E and water soluble vitamins are—$B_1$, $B_2$ and C.

(i) *Vitamin A*: It is found associated with fatty foods. Whole milk, butter, eggs, liver, codliver oil are chief sources of Vitamin A. It is related to carotene a yellow pigment which is present in some vegetables and fruits. The pigment carotene appears to fulfil the physiological function of Vitamin A. Spinach, lettuce, cabbage, amranth leaves, and ripe fruits such as mangoes, papaya, oranges are good sources of Vitamin A. Lack of Vitamin-A causes the night blindness and makes the mucous membrane week and liable to be attacked by germs.

(ii) *Vitamin $B_1$*: It is abundant in outer layer of rice and other cereals. Unpolished rice, and other grains, yeast, egg yolk, nuts, legumes and green vegetables and fruits are the rich sources of this vitamin. Lack of this vitamin causes the disease known as beriberi.

(iii) *Vitamin $B_2$*: It is more heat resistant than $B_1$. Egg yolk, yeast, liver, dried peas, beans, leafy vegetables, milk products contains this vitamin. Cereals and root vegetable are not good sources thereof. Maize is almost deficient in it and hence the disease known as pellagre breaks out amongst the maize eating people.

(iv) *Vitamin C*: It is easily destroyed by ordinary cooking. Only uncooked vegetables are useful for Vitamin C. The mixing of coriander leaves and lemon juice with 'chewda' and 'dals' is a good method of obtaining Vitamin C. The best way is to eat salad and chutney as that is the only

sure way of getting vitamin C from vegetables. Among fruits, guavas, cashew, goras amli, oranges, amla, grape fruits, lemons seem to be the best sources of Vitamin C. One amla is equivalent to two oranges in its Vitamin C content. There is another good way of getting Vitamin C by sprouting the grams and pulses. Lack of Vitamin C causes the disease known as scurvy.

(v) *Vitamin D*: Like Vitamin A, it is found associated with fatty foods. The original source of this vitamin is sun. Therefore it is better to expose the body to the morning sun after massaging it with a little oil. The other source of this Vitamin are animal products such as milk, butter, ghee, eggs, fish oil etc. In the absence of this vitamin, the body cannot fully utilise calcium and phosphorus which are necessary for bone formation and hence cause rickets.

(vi) *Vitamin E*: It is essential for reproduction. The germ of the wheat grain is a rich source of vitamin E.

(vii) *Water*: We need water, though it has no fuel value as food. Nearly 2/3 of the body weight consists of water. It acts as a solvent and aids digestion and absorption of food stuffs. It sustains the proper concentration of food stuffs within the body cells and assists the removal of waste products. It is known that a healthy, well nourished person can fast for as many as forty days without permanent injury if he receives an adequate supply of water; he cannot fast for more than six days without water. The amount actually needed depends on climate, diet and occupation and the need is indicated by thirst.

All these six substances are necessary for the maintenance of metabolic balance. The body functions through the energy released by the different food constituents. If and when nutritional influences are withheld or food becomes deficient either in amount or in quality, that harmonious development of the structure and function of the body on which our health depends is interfered with.

We have seen above what food is. Now we shall consider how to balance it. The quality of food is more important than its quantity, although both are essential in maintaining health. We should not indulge in highly spiced foods as they irritate the mucous membrane of the alimentary tract though they contain appetizing ingredients which may be helpful in digestion. Instead of a monotonous diet consisting of cereals, legumes and insufficient vegetables, a mixed diet should be planned by improving our existing dietary habits by a wise selection of the available foods. It is better to use mixed cereals. The low protein content of rice can be made up by the consumption of wheat or millet, thereby increasing the nutritive value of the diet. Those, whose staple food is rice, should use unmilled or homepounded rice. Whenever possible, cereal grains should be steamed. The processed food stuffs

such as refined sugar, milled cereal grains, preserved foods stuffs should be avoided as far as possible. Gur, molasses and honey should take place of refined sugar. Our diet should include sufficient fat. The money spent on butter and ghee is an insurance against many ailments. In order to ensure essential inorganic substances and vitamins, a liberal supply of fresh fruits and vegetable should be included in our diet. Oilseed protein is superior to that of cereals and pulses. It is second to that of milk. Hence it should find a place in our daily diet. It is a very good source of mineral elements like calcium, phosphorus and iron etc. and Vitamin B. The cakes of almonds, groundnuts and *til* are fit for human consumption, others being too full of rough fibres. Every possible means should be adopted for increasing the consumption of milk and milk products. It is unfortunate that consumption of tea is increasing in India. Tea is not a food. Owing to the presence of an astrignant substance, tannin, tea may even be harmful to the digestive tract.

Lastly we should remember that nutrition is different from diet as the former includes the idea of keeping the body fit. The proper exercise of the body, the practice of deep breathing, sufficient rest and sleep, a cheerful happy mind—all these are helpful in improving the state of nutrition. There is a close relationship between physical exercise and diet. Proper nutrition and reasonable exercise must go together in making of a healthy body. We have seen from above that the sole object of eating is not just satisfying our hunger and appetite, but to keep the body in perfect health. The attainment of positive health is something more than freedom from disease. It is characterized by harmony and the well being of the entire self, i. e. of the body, the mind and the spirit. That is why our sages regarded eating as a kind of religious act. If we fail to achieve this harmony, we cannot offer the body, in the words of our Poet, as a lamp in the shrine of our Creator.

# The New Genetics

BY

A. V. GOKHALE.

## I

The sessions of the Lennin Academy of Agricultural Sciences and the enlarged councils of the Academies of Sciences and of Medical Sciences of the U. S. S. R. were held at Moscow from July 31 to August 7, 1948. The deliberations ended with the clearcut conclusions that the present theories in biology based on Weismannism-Morganism were sterile and misleading and should be discarded; and the Michurin teaching was the only right and realistic approach to the problems in Biology.[1] The new stand taken by the Soviet biologists has stirred the entire scientific world. The clumsy, malicious and often dishonest polemic in the public press has made the issue more confusing. The main problem is shrouded in the clouds of cheap allegations, personal rebuffs and false propaganda.

Lysenko's promotion and his theory had already been the occasion of propaganda in the capitalist press against Soviet Union. Even eminent British scientists such as C. D. Darlington and Sir Henry Dale have taken part along with Herbert Morrison and others. The propaganda includes allegations such as N. Vavilov, whom Lysenko displaced, has been killed by the Soviet Government for refusing to toe the line of Lysenko. Lysenko is called as 'an ignorant peasant' whose only merit is the 'greenfinger' success as a gardener. Lysenko is also accused by Darlington for not believing in chromosomes at all.[2] Mullèr is more fierce in his criticism and he has resigned from the Academy of Sciences. Lysenko is also charged for contemptuously dismissing Statistics. The most serious allegation is the interference of the Soviet State in Scientific matters. Sir Henry presents the Soviet action as parallel to the interference with Galileo by the Inquisition in the 17th Century.

From the Soviet side, the attack is being equally repulsed. In reply to Muller's letter of resignation the Presidium of the Academy stated that "Muller destroyed the interests of real science." In reply to Sir Henry, it is stated that he is identifying himself with the Inquisition and not with Galileo, as the Inquisition was brought about by orthodox scientists. Most of the British and American biologists are attacked as idealistic, reactionary enemies of science. Mendel is termed as 'pea-brained' and Bateson as obscurantists.[3] Goldschmidt Sturtevant and others are also not left out. While defending the State's interference, the Soviet press attacks American and British Governments as Capitalist States interfering with the science for promoting imperial-

istic aims and ordering scientists to work for mass-annihilation and manufacture Atom Bombs. [4]

Since the main issue is a challange to the very foundations of genetics, it requires a considered evaluation in the light of modern rationalism and without taking sides.

## II

It is now evident that there are two schools of genetics. One is the old, orthodox or classical school and the other is the new realistic schools.

The appearance of Darwin's teachings expounded in his book 'The Origin of Species, (1859) marked the beginning of scientific biology, and also with it, the classical genetics.

The leading idea of Darwin's theory is the teaching of natural and artificial selection. With this theory, Darwin gave scientific explanation of the origin and development of life and thereby refuted the idealistic theological explanation. His theories of 'Struggle for Existence' and 'Survival of the Fittest' were based on voluminous data and served as a great advance in the knowledge of living matter.

Another sponser of the classical school is Mendel, the Austrian monk (1866). He worked on hybridization in pea and put forth the laws of heredity. He assumes that characters are represented by pairs of factors and at the time of gamete formation, only one member of the factor comes in the gamete. He also puts forth the hypothesis of Dominance, numerical ratios, etc.

Then there is Weismann. In his 'Lectures on Evolutionery Theory' (1904) he has attacked Lamarck's theory of inheritance of Acquired Characters and labelled his own conceptions as 'Neo-Darwinism'. Weismann asserts that there are two great catagories of living material, the hereditary substance (Idioplasm) and the nutritive substance (Trophoplasm). He decaltes that "living body is merely a nutritive soil for the hereditary substance and the latter is immortal and never formed 'de novo' ".

deVries theory of Mutation (1900) refers to the sudden change in character of an organism-change that is unpredictable and not necessarily progressive.

Lastly there is the well known Chromosome Theory of Heredity put forth by Morgan-too well known for any elaboration.

The Darwinism-Weismannism, Mendelism-Morganism : constitutes the orthodox school of genetics. Johannsen, Bateson, Darlington, Hurst, Muller, Sturtevant and others are the 'Carriers' of this Classical Genetics.

In Soviet Russia also the same theories were accepted, till recently, by N. Vavilov, N. P. Dubbin and others. They are now replaced by the champions of New School.

III

I. V. Michurin, the great transformer of nature, laid the foundation of 'New Genetics'. Michurian biological science proceeds from the basic thesis of dialectical materialism.

Contrary to Mendelism-Moaganism, Nichurin's important conclusion is that "it is possible, with man's interventions, to force any form of animal or plant to change more quickly and in a direction desirable to a man". His teachings flatly reject that heredity is completely independent of the plants' or animals' conditions of life. It does not recognize the existence of a separate hereditary substance which is independent in the body. He says that "changes in the heredity of organism or in any part of its body are the results of changes in the living body itself; and such a change occurs as a result of departure from the normal in the type of metabolism."

The 'vegetable hybrids' obtained by Michrin are concrete proofs of his conception of heredity.

His teachings are further elaborated and crystalized by T. D. Lysenko, who is famous for his work on vernalization ( Yarovization ).

Lysenko observed that New Genetics also dates with Darwinism. He accepts Darwin's Theoy of Evolution but accuses him to be guilty of introducing in his thesis, Malthusian reactionary ideas side by side with materialistic principles ( The English person, Mathus propogated the idea of 'an eternal natural law' to the effect that living beings multiply more rapidly than the quantity of food at their disposal permits ).

Taking Darwin's theory as the basis, Lysenko attacks with all the vigour—the Weismann's thesis. "It is not Neo-Darwinism, but a complete denial of the material aspect of Darwinism. It simply insinuates idealism and metaphysics in biology" observes Lysenko. He thinks Weismann's conception of immortal hereditary substance as "idealist and mystical in essence". Because the experimental data collected by Michurians show result contrary to Weismannism, Lysenko finds a great deal of truth in the Lamarckian theory-as it recognizes the active role of external conditions in the formation of living body. However, his school is "neither Neo-Darwinism nor Neo-Lamarckism, but Creative Soviet Darwinism".

Lysenko denounces deVries theory of mutation and proclaims that "Science is the enemy of accidents" ( Mutations ). Lysenko further attacks the idiological contents of Morgan's genetics as the latter does not believe that nature of organisms can be altered by 'physiological means'. According to Lysenko, Mendelism-Morganism (i.e. the chromosome theory of heredity ) is idealism in biology, and is contrary to dialectic materialism. "Mendelism-Morganism", says Lysenko, "is built entirely on chance; this science,

therefore, denies the existence of necessary relationships in living matter and condemns practical workers to fruitlessness ".

Regarding chromosomes, Lysenko states that " we recognise chromosomes. We do not deny their existence. But we do not recognise the chromosome theory of heredity ". Similarly about statistics he states that statistics are not worthless or irrelevant ; but biology is more than mere statistics-mere calculations of probabilites.[5]

Lysenko's positive theoretical conclusions can be summarized as under:—

1. Heredity is the property of a living body to require definite conditions for its life and development and to respond in a definite way to various conditions.
2. Changes in the heredity of an organism or any part of its body are the results of changes in the living body itself as the results of conditions of life.
3. Once we know the natural requirements of an organism and its response to external conditions, we can direct its life and development.
4. Once we know how to regulate development, we can change the heredity of organisms in a definite direction.

According to Lysenko, creation of new varieties rests on various factors such as:—(1) grafting (2) action of conditions of environment acting at sensitive periods of the organism's development and (3) crossing of species clearly differentiated by their habitats or by their origin.

He calls this science as "Soviet Agrobiology ".

## IV

Thus it can be seen that there are two opposite camps one idealistic, other materialistic ; one believing in chromosome theory, the other in physiological phases ; one working in the laboratories, other producing outstanding results on collective farms.

Biology is at the crossroads. The theories of Michurian and Lysenko show the revolutionary content of their conception and it would be futile to deny their originality. Does this mean that classical genetics is entirely obsolete ?

The two above mentioned conceptions correspond to different economic and social situations. It is normal in Capitalist society that scientists should often be led to turn away from application. It is just as normal that the scientists of the U. S. S. R. should put forth their efforts in directions where practical applications may be expected.

The Michurians have put forth their thesis after conducting number of experiments on a giant scale. The wealth of factual material from Michurin Experimental Stations concerning vegetative transmission of various properties of potatoes, tomatoes and others show the correctness of his theory. Their famous experiment is 'grafting' where transmission of characters is noted from stock to scion and vice versa. The experiments in 'training', 'destabilizing' and applying 'open-pollinators' show the sterility of Morganism and accuracy of the new school. Vegetative hybridization, vernalization and intra-varietal crossing in most of the important economic and commerical crops have given outstanding results to prove the positive role of Soviet Agrobiology.

In the Capitalist countries belonging to classical genetics there is only an empty cry that the work of Soviet Scientists is bogus and the whole thing is a political stunt. However, the champions of the classical school are fast loosing the ground. To-day Weismann's conceptions can be challenged by the work of P. Brien, whose experiments on regeneration in sponges, Bryozoa, Tunicata and Hydroida brought evidence against the classical evidence of dichotomy of organisms mutually irreducible into some and germ-plasm. The classical conception of mutation is contraverted today by the results obtained with yeasts. The role of cytoplasm in transmission of heredity property (maternal inheritance) is evident by the works of Renner, Michælis, Correns, Baur and others. Prof. Holmes of the California University now (1948) characterizes Weismann as a "mechanistically minded person" and declares that "Weismann's doctrine is purely formalistic explanation based on assumptions that are improbable."[6] Muller himself emphasizes the important role of environment in inheritance in his book 'Genetics, Medicine and Man' (1947). In the latest edition of Sinnott and Dunn's Text book of Genetics, there is a direct statement on page ten where the authors dissociate from Weismann. Finally Bernare Stern of Columbia University appeals (1949) with these works: "Acadamician Lysenko has not done justice to the present theoretical position of genetic scientists of the United States and England. Not only is Weismann no longer accepted by American geneticists; it is further clear that the views of Mendel and Morgan are constantly being revised as scientific investigations, particularly in relation to developmental processes.[7]

## V

*Conclusions :—*

1. The fact that the Michurian School has called into question the foundation of genetics and of the mechanism of evolution in itself constitutes a positive achievement.

2. The 'New Genetics' is in full course of evolution and as it is putting forth amazing positive results, it is bound to gain ground.

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# Zanzibar and the Clove Industry

BY

YUSUF O. K. HASANIA, F. Sc. (Agri.) Class.

The coral islands of Zanzibar and Pemba are situated between 5° to 10° south of the equator, 25 miles off the east coast of Africa. Zanzibar is approximately 54 miles in length with an area of about 640 square miles. The sister island of Pemba is 42 miles in length with an area of 380 square miles. These evergreen islands, although tropical, enjoy equable climate; a not excessive average rainfall; probably the best road system in East Africa: and an excellent water supply. There are two rainy seasons viz. "MASIKA" and "VULI" the former between March and June and the latter from October to December. The uniform distribution of rain, the rich calcium soil, moderate temperature and free slave labour were the main factors in the development of the clove industry in these islands.

The foremost foreign rulers of these islands were the Persians and during the twelth century Zanzibar and Pemba were part of the Great Zanj Empire. The descendants of these Shivaji's, as they are called, are still traceable in these islands. Zanzibar flourished when the Great Pyramid of Cheops was being built, and in the earliest days it excited the interest of traders in

far off Hindustan. By fifteenth century the Portugese had already established their trading centres in India and the Far East, and on the other hand, the downfall of the Zanj Empire had begun. The route from Portugal to India via Cape of Good Hope being a long one, the Portugese decided to found their Empire on the Ruins of Persian Monarchy in East Africa. Zanzibar was consequently occupied by the Portugese and a fort which still exists was built. The Portugese could not retain these lands which they had conquered and were ultimately driven out by the Ruler of Maskat Seyyid Said Bin Sultan. From this time onwards the islands of Zanzibar and Pemba have been ruled by the Atlun Said dynasty. To-day the islands constitute the dominions of His Highness the Sultan of Zanzibar Seyyid Sir Khalifa bin Harub, G. B. E., K. C. M. G. Zanzibar, with its aspect more Orient than African, has a population of a quarter of a million with a large percentage of Indians. The streets of the capital are narrow, and down the winding, cobbled throughfare the colourful costumes of the slowly moving populace–Arabs, Indians, Africans, and Chinamen pass leisurely backwards and forwards imparting a delightful and changing series of brilliant pictures.

Cloves have been known for centuries and the earliest record of their use comes from China, where it was known as "Chicken tongue spice", and was used by officers of the Imperial Court to render their breath fragrant in the presence of their sovereign. Cloves are not indigenous to the islands of Zanzibar and Pemba. They were introduced in these islands in the beginning of the 19th century—somewhere between 1820 to 1830—and their cultivation soon proved successful. Seyyid Said bin Sultan the then ruler of East Africa was the man who introduced this crop in Zanzibar and Pemba. The idea of specialising in the growth of the favoured tree and the association of wealth with spice led to extensive and perhaps feverish cultivation. Within a few years cloves had become the single important commercial factor in Zanzibar. Late in the 19th century Zanzibar was hit by a terrible cyclone which caused a tremendous loss of clove trees. The free slave labour and the enthusiastic Sultan Seyyid Barghash bin Said made the replanting of the clove trees possible.

In the middle ages spices were a necessity and not a luxury as they are now. To make meat palatable spices were used, and this was the only cause for all the European nations to send expeditions and discover the spice islands some where in the Far East. After the great cyclone the harvests were very poor and the price rose fantastically.

The valorisation of cloves was suggested by some wise Indian traders, the object being to level prices, rendering less erratic and less disastrous the price influence of the "good" years. Thus under wise control the trade became steadily more remunerative.

The clove is the unopened flower bud from a tree or a large shrub of myrtle order. The evergreen tree when fully matured attains a height of 30

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to 40 feet. When the clove trees are to be propogated, the flower buds are allowed to open, to get pollinated for the seed to form. The ripe seeds are planted in the raised seed beds of size 30 ft. × 3 ft. × 1/2 ft. The seed beds are provided with a lot of manure and shade. Constant watering when the seeds have germinated is very essential. For one full year the seedlings are kept in the nursery. A month or so before the heavy monsoon starts the pits and rings are kept ready for transplanting the seedlings, which by that time attain a height of 12" to 18". After the first heavy showers of rain, the transplanting begins. Usually two seedlings are planted in each pit. The pits are spaced out at a distance of 22 ft., when young the clove seedlings require a thorough examination and constant tending. At the age of five the tree begins to bear the cloves varying from 1/2 lb. to 1½ lbs. Within 15 years the trees attain a height of 30 ft. to 40 ft. when they are said to be fully matured. The clove buds grow in clusters of, from 10 to 50 or more heads from a main stem and are harvested twice a year. The harvesting seasons are July to October and December to January. The average yield per tree per annum of dry clove is 7 lbs. Crops very extensively from 2000 tons upto as high as 20,000 tons. Zanzibar and Pemba supply 80 % of the world's need.

Harvesting in a good season is a scene of intense activity. Women and children are engaged in picking bunches of bunds from the lower brnches of the trees while men climb up to the remote branches and pick the bunches with the help of hooked sticks. Very tall trees are never completely picked owing to the inaccessibility of the buds which grow on the extremity of the rather frail and slender branches. The picking starts from early morning and ends late in the evening, when the labourers come down to the overseer's camp squat on mats and commence the work of removing buds from the stems. Taking the bunch in one hand and brushing it against the palm of the other, the buds fall in one growing heap, the stems are cast aside to form another heap. The cloves are then rapidly measured with a local brass measure known as "pishi" of about 4 lbs. capacity. Payment rates for labour vary with the crop and with the supply of labour available in the season.

The clove bud when picked is 3/4 "to 1" in length and the long calyx is tinged delicate pink. Small plantation owners spread them on mats while the bigger ones have them spread on specially prepared concrete platforms. Four to five days are sufficient for the drying of cloves which by that time attain a rich golden colour. All cloves in Zanzibar are hand picked and no machinery of any description is employed.

Clove oil is colourless or pale yellow which darkens on keeping. It has the characteristic aromatic odour of the plant and a pungent burning taste. The best clove oil contains 95 p. c. Eugenoe which is used in the perfumery and scent. The value of the clove oil is largely dependent on its eugenoe which is converted into a substance which crystalises in minute crystals "Vanillin" imparting the fragrance of the vanilla been is also used to

give a vanilla flavouring in confectionary. Prepared originally in 1876, it was quoted at £ 160 per lb. çompare that with the present price of 6/sh per lb. now. Apart from the above mentioned uses the extent of the application of cloves and their distillates is numerous and world-wide. Many medicines contain clove oil and dentists use it for stopping decay in teeth and giving temporary relief. Toothache has lost many of its terrors by a timely application of clove oil! Very good results have been achieved from clove oil as an embrocation. It is also used to stop coughs, cold and vomitting.

It is a well known fact that, when valuable commodities and much sought after object of commerce become plentiful, their price, following all natural and unrestricted marketing, must inevitably fall-in some cases so seriously as to render the continuance of their production doubtful. The clove industry in Zanzibar is not in its healthiest state. There are other competitors in the market such as Madagascar. The synthetic methods of preparing clove oil are fast improving. Moreover, in Zanzibar, particularly, the trees are being attacked by "sudden death" desease which is so serious that it has become a matter of constant headache to many plantation owners. The colonial office has recently sent a team of scientists who are seriously engaged in finding out the cause of this desease. Efforts are also being made to find the alternative cash crops, such as cocoa. Let us hope that out of all these efforts the continued prosperity of Zanzibar will be assured; for Zanzibar is virtually now the only place in the world whose prosperity depends primarily on the clove industry.

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# Soil pH and Availability of Nutrients to Plants

BY

N. G. PERUR*

All soils have a certain degree of acidity or alkalinity. That is soils may be acid or alkaline in reaction. This degree of reaction is known as pH. pH value is expressed in numerical figures as 1, 2, 3·5 and etc. pH scale is from 1–14. pH 1 indicates maximum acidity and pH 14 indicates maximum alkalinity. pH 7 is the neutral point. Pure water which is neutral in reac-

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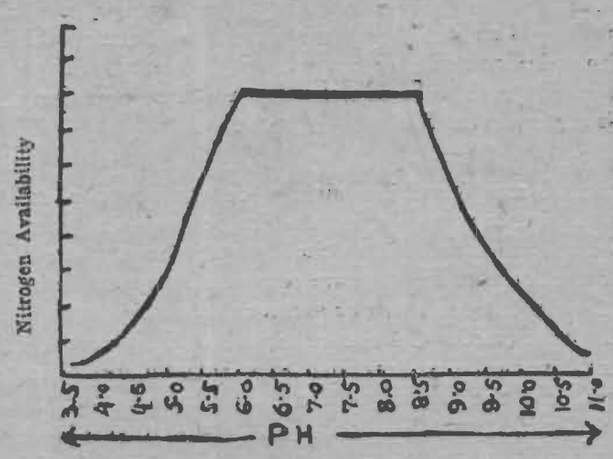
tion has pH 7. As the pH goes on lowering down from 7 to 1 the acidity increases and as the pH goes on increasing from 7 to 14 the alkalinity increases. A change in pH of one unit expresses a ten fold change in reaction. Thus pH 4 expresses acidity ten times as intense as at pH 5. Similarly at pH 10 the alkalinity is ten times as intense as at pH 9.

The nature of soil formation mainly determines the soil reaction. During the weathering of silicate minerals like felspars and micas inorganic exchangeable bases such as sodium, calcium, magnesium etc. are liberated. In course of soil formation if these bases are removed away by leaching due to high rain-fall, the resulting soil will be saturated with hydrogen ion and thus an acid soil will be formed. On the other hand if bases like sodium and calcium are not removed by leaching and accumulate to saturate the exchangeable material, the resulting soil will be alkaline. Such soils are met with in regions of scanty rainfall. Soils which are neither acid nor alkaline are called neutral soils. Acid soils are also formed due to the application of heavy doses of artificial fertilizers like sulphate of ammonia to the soil. Soils having poor drainage when irrigated with water containing a large amount of injurious salts like sodium-carbonate and sodium-bicarbonate, become alkaline.

The degree of reaction is one of the important factors which influences the growth of plants. Plants take up from the water in the soil all the required nutrients except oxygen and carbon which they obtain from the air. The nutrients from the soil are absorbed by the plant roots, only when they are in solution form. The degree of reaction of the soil has an important bearing on the solubility of the definite compounds i. e. the form in which the nutrients nitrogen, phosphorus, potassium and etc. exist in soil. Consequently it has a direct influence upon the availability of these constituents to plants.

In acid soils nitrogen is made available very slowly, while iron, calcium and manganese compounds are more soluble in acid soils so much so that they may act as toxic to plants in extreme cases. In highly acid soils, soil phosphates are fixed as insoluble compounds and are made unavailable. Similarly calcium and magnesium are not available with a soil of high acidity. On the other hand alkalinity renders copper and zinc less available and binds up manganese and iron into an unavailable form. In neutral reactions nitrogen and most of the other essential elements are made more readily available to plants.

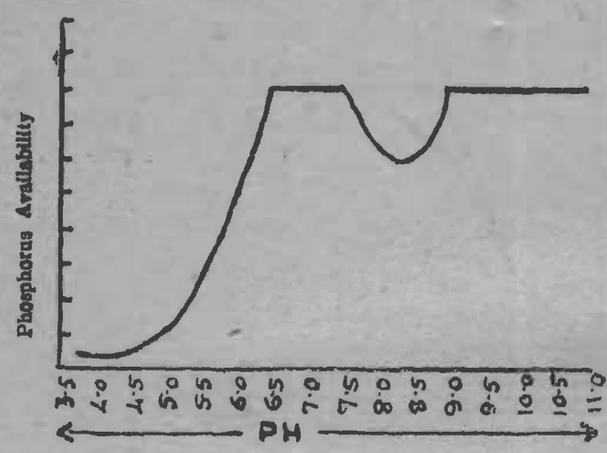
In the following paragraphs an attempt is made to describe in detail the influence of reaction and accompanying conditions on the availability of the important nutrients obtained by plants from the soil. Graphs are drawn to illustrate the description.




Graph No. 1.--Nitrogen Availability

A general nature of the availability of nitrogen at different soil reactions is represented in graph no. 1. From the graph it is clear that for an abundant supply of available nitrogen a pH range of 6·0 to 8·0 is the most favourable. This is true as long as other conditions in the soil are not uncongenial. Below pH 6 adequate nitrogen is not available to plants. Nitrogen from the soil is available to plants mostly in the form of soluble nitrates. In acid soils production of nitrogen is slow and therefore available nitrates are less. At low pH, deficiency of nitrogen in the soil prevails. Below pH 4 the conditions in the soil are totally unfavourable for the supply of nitrogen to plants. This is illustrated in the graph. The curve slopes down at pH 6 and gradually tries to approach minimum availability in accordance with the correspondingly decreasing pH values. This is due to the fact that at increasing acidity the fixation of nitrogen by leguminous plants slows down. The decomposition of organic matter to make the organic-nitrogen available to plants also becomes less. Fixation of atmospheric nitrogen and decomposition of organic matter in the soil are effected by the activity of micro-organisms. Micro-organisms work best in neutral or slightly alkaline conditions. At extreme acidity the conditions are not favourable for the activity of micro-organisms and hence the nitrogen fixation and decomposition of organic matter become increasingly slow. For the same reason nitrogen becomes decreasingly available with increasing pH values also. This is shown in the graph No. 1. The curve slopes down beyond pH 8.

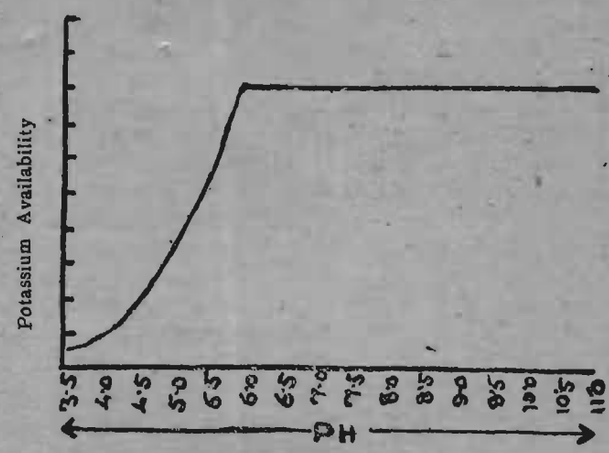
The nature of phosphate ion in the soil varies with the pH. When the soil is distinctly alkaline PO4 ion is the usual form. Plants can take this ion only with difficulty. As the pH drops down upto 6·5 ( that is in slightly acidic soil ) HPO4 and H2PO4 ions become more common. These two ions are more easily absorbed by plants. For high availability of phosphorus




Graph No. 2.--Phosphorus Availability

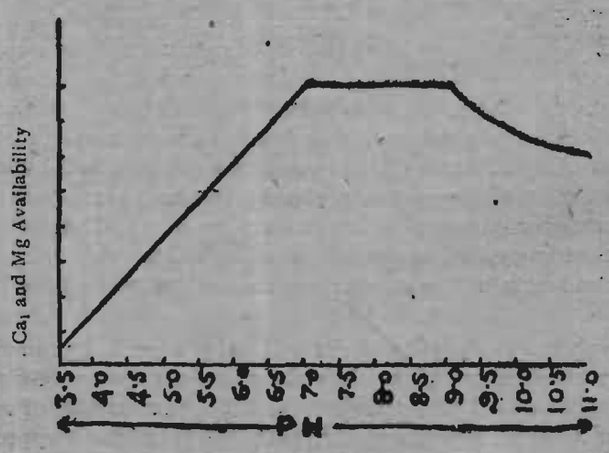
therefore a pH range of 6·5 to 7·5 is the most favourable. At higher acidity only $H_2PO_4$ ion prevails but in an unavailable form. Because below pH 6·5 availability of phosphorus becomes less due to the formation of sparingly soluble compounds of iron and aluminium, with phosphate ion. Therefore if soluble phosphate fertilizers are applied to acid soils they are made insoluble and hence the efficiency of the applied fertilizer is greatly lessened. This difficulty can be overcome by the application of right quantity of lime to the acid soil to maintain a pH range of 6·5 to 7·5. In this pH range phosphorus (in the form of calcium phosphate) is made soluble by the action of carbon dioxide in the soil air, and hence readily available to plants. Again beyond pH 7·5 the conditions for the availability of phosphorus gradually becomes less and less favourable. This is due to the high concentration of calcium ions in the soil. Calcium phosphate hydrolyses in the presence of calcium carbonte and thus increases the calcium ion concentration to the saturation point in the soil solution, when the dissolving action of carbonic acid ( carbon dioxide in the presence of water ) on calcium phosphate totally ceases. This is in accordance with the law of Mass Action. It is interesting to note that at still higher acidity ( more than pH 8·5 ) the phosphorus in the soil is once again made available in a very appreciable amount. This is because in this higher pH range sodium and potassium prevail in the soil solution which react with insoluble soil phosphates and form highly soluble sodium and potassium phosphates.

The phosphorus availability in the soil is governed by many factors and the subject itself is complex. It is therefore not always easy to predict how much phosphorus will be available to plants under any set of soil conditions. Availability of phosphorus at different soil reactions is approximately represented in graph 2.



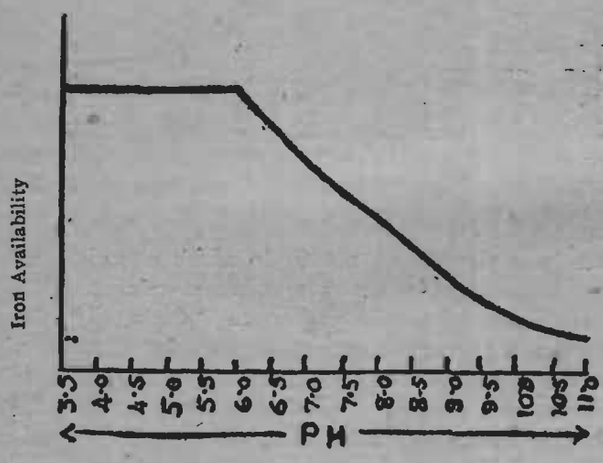

Graph No. 3.—Potassium Availability

Potassium becomes extremely soluble in acid soils and should readily be available to plants. But in practice it is not so. With increasing acidity the amount of potassium in a readily available form usually decreases because of severe leaching. Therefore plants cannot utilise the soluble potassium at lower pH soil conditions. Of course at higher pH values the potassium is always in an available form except at its very high concentration in the soil solution when plants cannot grow. More concentration of potassium in the soil means more alkalinity, that is increase in OH ion concentration. Plants can not grow in such soils due to the toxic effect of excess OH ions on plant cells. The influence of reaction on the availability of potassium has not been completely investigated and needs further study.




Graph No. 4.—Ca and Mg Availability

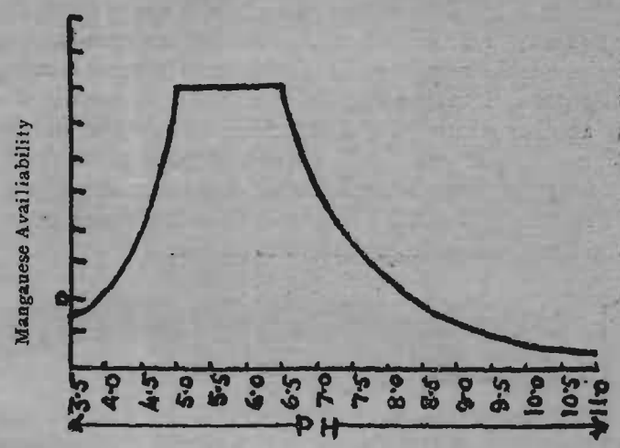
Availabilities of calcium and magnesium to plants are influenced by the soil reaction more or less in a similar manner. It can be seen from the graph no. 4 that below pH 6.5 calcium and magnesium become less available to plants. In soils of low pH values amount of calcium and magnesium is less. This happens because of the climatic conditions in which the acid soils are formed. In acid soils calcium and magnesium are removed away by leaching. With increasing acidity hydrogen ion concentration becomes more and more saturated in exchangeable complex and there seems greater competition for basic ions of calcium and magnesium by the hydrogen saturated exchange acides. This is another reason for the deficiency of calcium and magnesium in acid soils. Secondly whatever small amount of these bases present in the soil, is fixed up by the excess insoluble acids against solution and plant feeding. A pH range of 6.5 to 8.5 is best suited for the satisfactory availability of calcium and magnesium from the soil to plants.




Graph No. 5.—Iron Availability

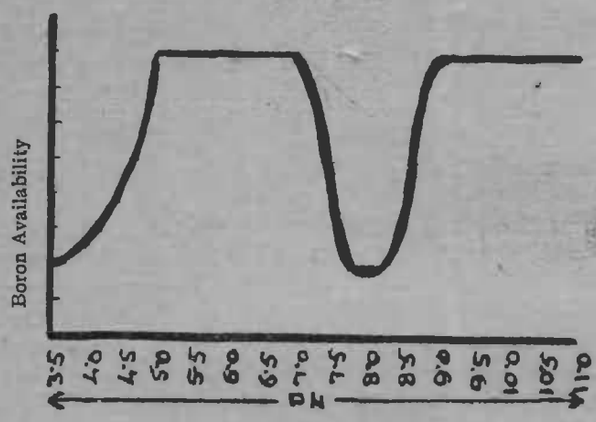
Iron becomes less available when the pH value rises above the neutral point. This may cause in some cases harmful effect on plant growth, especially when the soil is sandy and poor in organic matter. Soluble ferrous iron becomes oxidised to ferric oxide, which is so insoluble under neutral and alkaline conditions that plants suffer from iron deficiency. But this is not so with soils containing good amount of organic matter. Organic matter in the soil reduces the insoluble ferric iron even at high pH soil conditions and makes it readily available to plants. Below pH. 6.5 iron in the soil exists in ferrous state. In this form iron is readily soluble in the presence of carbonic acid and hence it is readily available to plants. But at extreme acidity iron becomes so much soluble that the increased concentration in soil solution causes toxic effect upon the plant, especially in soils of poor sanity. Many

plant failures, uptill now looked upon as mostly due to the deficiency of plant nutrients in the soil, have been actually the result of the excessive amounts of some of the more toxic minor food elements like iron, aluminium, manganese and etc. It is now generally believed that soluble iron along with aluminium is one of the main factors for the poor plant growth in strongly acid soils.



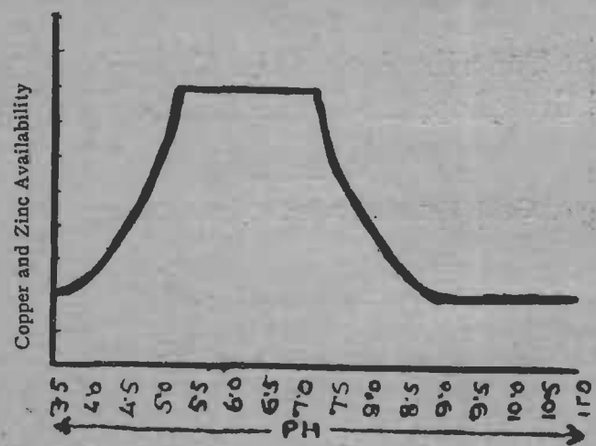

Graph No. 6.—Manganese Availability

At higher pH values managanese behaves exactly similar to that of iron. This can be seen from the graph. no. 6 In alkaline soils, availability of managanese becomes restricted. In sandy soils and calcareous soils that are low in organic matter when their pH rises above 7 the supply of managanese in the available form is frequently too small for the need of plants. At higher pH values the soluble divalent manganese ( manganous form ) oxidises to tetravalent manganese dioxide. This tetravalent oxide compound of manganese is insoluble in carbonic acid. Therefore in alkaline soil conditions manganese is not available for plant use. In heavy soils that are rich in organic matter, lack of manganese availability at higher pH is less frequently met with. Organic matter on decomposition releases its manganese content in an available form and also favours the transformation of manganese minerals to the available type. In presence of organic matter divalent manganese does not readily oxidise to unavailable tetravalent form. Therefore lack of available manganese at higher pH is less frequently seen in the heavier soil than in the lighter ones. Below pH 7 a considerable amount of manganese in the divalent form is readily available to plants. Divalent manganese in the acid soil conditions behaves like other bases as an exchangeable cation. By the action of carbonic acid it goes into solution as manganese bicarbonate which the plants utilise easily. At high acidity (below pH 5) the manganese leaches out and once again its supply becomes restricted. It is shown in the graph no. 6 that within a pH range of 5·0 to 6·5 supply of manganese is abundant.




* Graph No. 7. Boron Availability

Borone is used by plants in a very minute quantity. The availability of boron seems to be greatly influenced by soil reaction. Within a pH range of 5 to 7 boron availability is quite satisfactory. In strongly acid soils however boron becomes less available due to leaching. Above pH 7 also available boron is scanty because of high concentration of calcium which forms sparingly soluble metaborates with boron. It is interesting to note that at still higher pH values (beyond pH 8·5) boron is one again in a more readily available form. At these higher pH values sodium hydroxide in the soil solution forms soluble salts with boron which the plants easily utilise.




* Graph No. 8. Copper and Zinc Availability

* (i) Graphs are only approximate.

* (ii) Graphs are drawn for the pH range 3·5 to 11 only because at extreme acidity and alkalinity plants do not survive even though nutrient elments are abundant.

Copper and zinc are also important plant food nutrients even though they are needed only in minute quantity. In acid to slightly alkaline conditions these two elements are readily available to plants. At extreme acidity copper and zinc are not available as they leach away during the formation of acid soils. Deficiency of these two elements is also frequently met with in highly alkaline and calcareous soils. Under these conditions the solubility of copper and zinc compounds is greatly lowered and causes the scarcity.

The importance of soil reaction on the availability of nutrient elements to plants is quite obvious from the above treatise. In short we can say that soil pH dignoses the fertility of soils in general From the graphs, soil pH 6·5 can be looked upon as the most favourable condition for the satisfactory availability of all elements described above. Physical conditions of soil and activities of microorgnisms are also well guarded at this pH. How to maintain this pH in the soil is a separate subject, however the efforts of the farmer should be towards the maintenance of soil reaction round about pH 6·5 to obtain the maximum outturn from his land undiminished for a number of years.

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# A Current Contribution to the Control of Common Paddy Grasshoppers in the Bombay Province

By

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Paddy grasshopper (*Hieroglyphus banian*) is a winged type of grasshopper prevalent in most of the paddy growing tracts of the province. It is equally a severe pest on Sugarcane. Its severity as a pest on paddy can be well judged from the heavy toll of paddy crop that is being eaten away every year in the Belgaum and Dharwar Districts. At times the damage is so severe, it may result in total failure of the crop. This potential danger to the paddy crop in the times of food scarcity is affecting every farmer. To avert this

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danger, every intelligent cultivator should acquaint himself with the life history, habits and the recent developments in the control of the pest.

The full grown grasshopper is yellowish green in colour with three to four incomplete black wavy lines on the neck and with lower half of legs bluish in colour. It measures about 2 to 3 inches in length. The female is slightly bigger than male. Eggs are laid during October to December in clusters of 40–60 about 2" deep in the slopes of the bunds which generally surround the fields. With setting in of cold weather, the parent grasshoppers die out. The eggs remain in the soil till the beginning of the next monsoon in June-July when small hoppers about $\frac{1}{4}$" in length hatch out. The hatching out of the eggs synchronises with the germination of the drilled paddy. On hatching the young hoppers live for a few days on grass surrounding bunds and then creep into the crop proper. They grow rapidly and pass through 5 to 6 instars at an interval of 10–15 days and become adult (winged) insects.

Looking to the feeding and breeding habits of grasshoppers, control measures can be applied at different stages of their life cycle namely, (1) destruction of egg masses when they are lying dormant in the soil during off-season of paddy crop. For this purpose, scraping the sides of the bunds by different farm-tools is recommended wherever possible. (2) Destruction of the hoppers either by mechanical or chemical means. But the time-honoured practice of mechanical method of bagging the hopper although quite effective in reducing the general population of the pest, is a labourious and endless task. It was therefore thought of concentrating more on the

Fig. 1.—Spectacular Dusting Operations in Progress at Belgaum

chemical methods since 1947 with the inception of the research scheme for the tests with the recent insecticides like DDT, and BHC (Benzene-Hexa-Chloride) against agricultural pests. Thus within a course of two years' strenuous research work under this scheme, the present author could find out a very effective dust formulation containing 5 percent BHC against this grasshopper. This is now available under the trade names of 5 percent Gammexane and 5 percent Hexyclan. With one to two applications of this insecticide (Fig. 1) depending upon the severity of attack, the paddy grasshopper can be effectively brought under control when applied at the rate of 15–20 lbs. per acre. The proper stage of dusting would be just when the majority of the young hoppers emerge out on the slopes of the bunds and just prior to their migration to the crop proper. It is better to choose a dry ( rainless ) day to allow at least 6–8 hours for the dust to have effect on hoppers (Fig. 2). Application of dust can

Fig. 2.—Dead-Grass Hoppers Floating on water after six hours of 5 percent BHC Dusting.

be made with rotary hand dustguns now available at the rate of Rs. 110 each. The cost of dusting per acre however, may range from Rs. 6 to 10 depending upon the labour and cost of the insecticides.

The author is deeply indebted to the Indian Council of Agricultural Research, New Delhi and Bombay Department of Agriculture, under whose combined financial help, the present investigations were carried out. He also expresses his sincere thanks to his colleague Shri S. R. Dhareshwar and the District Agricultural Officer, Belgaum, for the cooperation during the field trials at Belgaum in 1948.

# Indian Agriculture

By

T. C. MOTWANI, B.Sc. (Agri.) Hons,*

An article entitled "How Efficient is American Agriculture" by Theodore W. Schultz appeared in the "Journal of Farm Economics", August 1947. This article would naturally create a desire in us to examine the efficiency of production in our Indian agriculture, but with what standard is yet difficult to decide at this stage, as unlike in well-established industries, where the factors of production are very well under control. When prices fall, the manufacutrer can reduce his cost by dismissing some labourers and withdrawing some capital, but in agriculture the farmer cannot check his production and has to continue cultivating the land as he has no other source of earning a livelihood and has solely to depend upon land and land alone. Agriculture out-put also depends more on uncontrolled factors of soil and climate and crops have to grow before they are harvested. Nature does the business and man is merely the manager.

Specially in India, agriculture is said to be a gamble on the monsoons. A large portion of the country depends upon rain for the successful growth of its crops and monsoon is extremely uncertain. When the rains fail, the poor peasant is in distress. Thus constant variation in the yield of the land, the greater applicability of the Law of Diminishing Returns, the specialization of the factors of production employed in agriculture and the inelastic demand for agricultural products result consequently in the unstable income of the farmer and force him to borrow to meet his expenses during lean years. Hence comparison between crop and crop or between tract and tract in the real sense will be of no use. There are wide differences between the agricultural out-puts of new countries like Canada, Australia ( where the farmers grow certain crops mainly for the foreign markets ) and that of countries like India and China where the majority of farmers produce mainly for subsistance.

India is a land of villages and will continue to be so for many years to come and they form the back bone of the economic life of the country. They have a higher and distinct national importance. They represent an organic part of the economic life of India-a part that is lively and growing-that will uplift the standard of life of the people as it grows. The soul of India lies in the muddy huts of the poor peasants who speak broken language, and lead a simple life and not in the busy life of industrial cities and towns, which is one of continuous polish and pose, hardly natural and national. A large majority

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of them are under the tight grip of three devils-debt, disease and illiteracy. No real large scale improvement, economic or otherwise, in the country, is possible and shall be durable, unless it has roots deep in the villages, and an adequate provision is made to safeguard the poor tillers of the soil against the landlords from the verge of ruin and robbing of all incentive to industry. One fundamental fact may be pointed out in this direction that no progress is possible without the education of the farmer. A real and lasting solution can only be seen in the spread of education, the starting of co-operative credit system, and removing the economic and social disabilities from which the farmer is suffering, such as small and fragmented holdings, primitive methods, heavy cattle mortality, costly credit, a disorganised system of marketing and absence of subsidiary industries.

It is true that various Government departments do a certain amount of "village uplift" work, as for instance, the Agricultural Department, the Veternary Department, and the Co-operative Credit Department. But these departments work quite independently and do their work through a host of minor officials who mostly lack sympathy and personal touch which counts for so much in human relationships. We, therefore, want some agencies which will deal with village life as a whole, and which will deal with villagers by personal influence and in the spirit of service.

Thus under the present circumstances the comparison made on the American model gives us a very good idea of the extent to which the available human and natural resources are put to use in each tract. Sincere attempts are made by the Agricultural Departments of mostly all the provinces (and the States merged) in the Indian Dominion to meet this deficit. To raise the efficiency of Indian agriculture, the income and the standard of life of the Indian farmers, the programme already started viz, popularisation of improved methods of cultivation, improvements in live-stock and starting of subsidiary cottage industries is fast in progress.

In short, we are once again driven back to the only fact that judging efficiency of production, particularly in agriculture, is not an easy task and sometimes may even lead to controversy. But one and the only fact remains clear at the end that "*Agriculture is the back-bone of Indian economic system and the economic prosperity of India is extremely bound up with the prosperity of Indian Agricultnre.*"

# Lay Out of Cucurbits

BY

N. G. DASTANE & P. C. PENDSE *

Cucurbits are the economic crops near the marketing centres and, therefore, are grown by many cultivators in early kharif season.

Cucurbits require maximum spacing among all the vegetable crops and hence the rings and basin system of planting is a characteristic lay out and is popularly followed.

The usual method followed for lay-out is that after the field has been ploughed, harrowed and manured, the land is marked at required distances. Taking each mark as the centre, a basin of about 3' in diameter is prepared. The *soil inside* is removed by spade and placed at the circumference of basin.

*Thus the basin stands at a lower level than the field level.*

Instead of having the basin in the above mentioned fashion it would be better to prepare them in other way.

After marking the field with some ash or lime at required distances draw a circle of 3' diameter with the marked place as centre. *The soil outside this circle*, should then be placed at the circumference of the circle. In this case the basin will be at the same level as that of field.

*Advantage of this new method :—*

In the former case we remove the surface soil of about 3" to 4" in depth from basin and place it on the circumference. Thus we *lose a rich layer of* surface soil.

In new method, we take the surrounding soil on the circumference of basin and not from within the basin. So the crop gets upper rich soil layer. The surface layer of soil is comparatively a richer layer. Besides it has been acted upon much more by the sun-rays. The crop thrives better in a soil which is acted upon by sun rays than the one below which is not. It is, therefore, essential that the surface layer should not be lost for the crop. By taking advantage of the surface layer, the crop may yield more. The yield here may be greater by 5 p. c. over the former method.

The basins or rings should therefore be prepared at the field level. The soil from inside the basin should not be used but the outside soil should be heaped at the circumference.

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* Agronomy ;

| No. | 1 : 1 | | Limit of Deviation | 3 : 1 | | Limit of Deviation | 9 : 7 | | Limit of Deviation | 15 : |
|---|---|---|---|---|---|---|---|---|---|---|
| 281 | 140·50 | 140·50 | 16·76 | 210·75 | 70·25 | 14·52 | 158·06 | 122·94 | 16·62 | 263·44 |
| 282 | 141·00 | 141·00 | 16·78 | 211·50 | 70·50 | 14·54 | 158·62 | 123·38 | 16·66 | 264·38 |
| 283 | 141·50 | 141·50 | 16·82 | 212·25 | 70·75 | 14·56 | 159·19 | 123·81 | 16·68 | 265·31 |
| 284 | 142·00 | 142·00 | 16·84 | 213·00 | 71·00 | 14·60 | 159·75 | 124·25 | 16·72 | 266·25 |
| 285 | 142·50 | 142·50 | 16·88 | 213·75 | 71·25 | 14·62 | 160·31 | 124·69 | 16·74 | 267·19 |
| 286 | 143·00 | 143·00 | 16·90 | 214·50 | 71·50 | 14·64 | 160·88 | 125·12 | 16·78 | 268·12 |
| 287 | 143·50 | 143·50 | 16·94 | 215·25 | 71·75 | 14·66 | 161·44 | 125·56 | 16·80 | 269·06 |
| 288 | 144·00 | 144·00 | 16·96 | 216·00 | 72·00 | 14·70 | 162·00 | 126·00 | 16·84 | 270·00 |
| 289 | 144·50 | 144·50 | 17·00 | 216·75 | 72·25 | 14·72 | 162·56 | 126·44 | 16·86 | 270·94 |
| 290 | 145·00 | 145·00 | 17·02 | 217·50 | 72·50 | 14·74 | 163·12 | 126·88 | 16·90 | 271·88 |
| 291 | 145·50 | 145·50 | 17·06 | 218·25 | 72·75 | 14·78 | 163·69 | 127·31 | 16·92 | 272·81 |
| 292 | 146·00 | 146·00 | 17·08 | 219·00 | 73·00 | 14·80 | 164·25 | 127·75 | 16·96 | 273·75 |
| 293 | 146·50 | 146·50 | 17·12 | 219·75 | 73·25 | 14·82 | 164·81 | 128·19 | 16·98 | 274·60 |
| 294 | 147·00 | 147·00 | 17·14 | 220·50 | 73·50 | 14·84 | 165·38 | 128·62 | 17·02 | 275·67 |
| 295 | 147·50 | 147·50 | 17·16 | 221·25 | 73·75 | 14·86 | 165·94 | 129·06 | 17·04 | 276·58 |
| 296 | 148·00 | 148·00 | 17·20 | 222·00 | 74·00 | 14·90 | 166·50 | 129·50 | 17·06 | 277·50 |
| 297 | 148·50 | 148·50 | 17·22 | 222·75 | 74·25 | 14·92 | 167·06 | 129·94 | 17·10 | 278·44 |
| 298 | 149·00 | 149·00 | 17·26 | 223·50 | 74·50 | 14·94 | 167·62 | 130·38 | 17·12 | 279·38 |
| 299 | 149·50 | 149·50 | 17·28 | 224·25 | 74·75 | 14·98 | 168·19 | 130·81 | 17·14 | 280·31 |
| 300 | 150·00 | 150·00 | 17·32 | 225·00 | 75·00 | 15·00 | 168·75 | 131·25 | 17·18 | 281·25 |
| 301 | 150·50 | 150·50 | 17·34 | 225·75 | 75·25 | 15·02 | 169·31 | 131·69 | 17·20 | 282·19 |
| 302 | 151·00 | 151·00 | 17·38 | 226·50 | 75·50 | 15·04 | 169·88 | 132·12 | 17 24 | 283·12 |
| 303 | 151·50 | 151·50 | 17·40 | 227·25 | 75·75 | 15·06 | 170·44 | 132·56 | 17·26 | 284·06 |
| 304 | 152·00 | 152·00 | 17·42 | 228·00 | 76·00 | 15·10 | 171·00 | 133·00 | 17·28 | 285·00 |
| 305 | 152·50 | 152·50 | 17·46 | 228·75 | 76·25 | 15·12 | 171·56 | 133·44 | 17·32 | 285·94 |
| 306 | 153·00 | 153·00 | 17·48 | 229·50 | 76·50 | 15·14 | 172·12 | 133·88 | 17·34 | 286·88 |
| 307 | 153·50 | 153·50 | 17·52 | 230·25 | 76·75 | 15·18 | 172·69 | 134·31 | 17·38 | 287·81 |
| 308 | 154·00 | 154·00 | 17·54 | 231·00 | 77·00 | 15·20 | 173·25 | 134·75 | 17·40 | 288·75 |
| 309 | 154·50 | 154·50 | 17·58 | 231·75 | 77·25 | 15·22 | 173·81 | 135·19 | 17·44 | 289·69 |
| 310 | 155·00 | 155·00 | 17·60 | 232·50 | 77·50 | 15·24 | 174·38 | 135·62 | 17·46 | 290·62 |
| 311 | 155·50 | 155·50 | 17·62 | 233·25 | 77·75 | 15·26 | 174·94 | 136·06 | 17·48 | 291·56 |
| 312 | 156·00 | 156·00 | 17·66 | 234·00 | 78·00 | 15·30 | 175·50 | 136·50 | 17·52 | 292·50 |
| 313 | 156·50 | 156·50 | 17·68 | 234·75 | 78·25 | 15·32 | 176·06 | 136·94 | 17·54 | 293·44 |
| 314 | 157·00 | 157·00 | 17·72 | 235·50 | 78·50 | 15·34 | 176·62 | 137·38 | 17·58 | 294·38 |
| 315 | 157·50 | 157·50 | 17·74 | 236·25 | 78·75 | 15·36 | 177·19 | 137·81 | 17·60 | 295·31 |
| 316 | 158·00 | 158·00 | 17·78 | 237·00 | 79·00 | 15·40 | 177·75 | 138·25 | 17·64 | 296·25 |
| 317 | 158·50 | 158·50 | 17·80 | 237·75 | 79·25 | 15·42 | 178·31 | 138·69 | 17·66 | 297·19 |
| 318 | 159·00 | 159·00 | 17·82 | 238·50 | 79·50 | 15·44 | 178·88 | 139·12 | 17·68 | 298·12 |
| 319 | 159·50 | 159·50 | 17·86 | 239·25 | 79·75 | 15·46 | 179·44 | 139 56 | 17·72 | 299·06 |
| 320 | 160·00 | 160·00 | 17·88 | 240·00 | 80·00 | 15·50 | 180·00 | 140·00 | 17·74 | 300·00 |
| 321 | 160·50 | 160·50 | 17·92 | 240·75 | 80·25 | 15·52 | 180·56 | 140·44 | 17·78 | 300·94 |
| 322 | 161·00 | 161·00 | 17·94 | 241·50 | 80·50 | 15·54 | 181·12 | 140·88 | 17·80 | 301·88 |
| 323 | 161·50 | 161·50 | 17·96 | 242·25 | 80·75 | 15·56 | 181·69 | 141·31 | 17·82 | 302·81 |
| 324 | 162·00 | 162·00 | 18·00 | 243·00 | 81·00 | 15·58 | 182·25 | 141·75 | 17·86 | 303·75 |
| 325 | 162·50 | 162·50 | 18·02 | 243·75 | 81·25 | 15·62 | 182·81 | 142·19 | 17·88 | 304·69 |
| 326 | 163·00 | 163·00 | 18·04 | 244·50 | 81·50 | 15·62 | 183·38 | 142·62 | 17·90 | 305·62 |
| 327 | 163·50 | 163·50 | 18·08 | 245·25 | 81·75 | 15·66 | 183·94 | 143·06 | 17·94 | 306·56 |
| 328 | 164·00 | 164·00 | 18·10 | 246·00 | 82·00 | 15·68 | 184·50 | 143·50 | 17·96 | 307·50 |
| 329 | 164·50 | 164·50 | 18·14 | 246·75 | 82·25 | 15·70 | 185·06 | 143·94 | 18·00 | 308·44 |
| 330 | 165·00 | 165·00 | 18·16 | 247·50 | 82·50 | 15·72 | 185·62 | 144·38 | 18·02 | 309·38 |
| 331 | 165·50 | 165·50 | 18·18 | 248·25 | 82·75 | 15·76 | 186·19 | 144·81 | 18·04 | 310·31 |
| 332 | 166·00 | 166·00 | 18·22 | 249·00 | 83·00 | 15·78 | 186·75 | 145·25 | 18·08 | 311·25 |
| 333 | 166·50 | 166·50 | 18·24 | 249·75 | 83·25 | 15·80 | 187·31 | 145·69 | 18·10 | 312·19 |
| 334 | 167·00 | 167·00 | 18·26 | 250·50 | 83·50 | 15·82 | 187·88 | 146·12 | 18·12 | 313·12 |
| 335 | 167·50 | 167·50 | 18·30 | 251·25 | 83·75 | 15·84 | 188·44 | 146·56 | 18·16 | 314·06 |
| 336 | 168·00 | 168·00 | 18·32 | 252·00 | 84·00 | 15·88 | 189·00 | 147·00 | 18·18 | 315·00 |

# TABLES OF THEORETICAL FREQUENCIES OF COMMON MENDELIAN RATIOS FOR 'N' = 1 to 500 WITH LIMITS OF DEVIATIONS

COMPILED BY
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*( The following tables are continued from the Poona Agricultural College Magazine, Vol. 35 Nos. 3 and 4, of February 1944. )*

*— Editor.*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 18·56 | 8·34 | 241·31 | 55·69 | 13·44 | 129·60 | 172·10 | 17·06 | 293·54 | 4·66 | 4·28 |
| 18·62 | 8·36 | 242·12 | 55·88 | 13·46 | 125·72 | 172·28 | 17·06 | 293·54 | 4·66 | 4·28 |
| 18·69 | 8·36 | 242·94 | 56·06 | 13·48 | 126·14 | 172·86 | 17·08 | 294·33 | 4·67 | 4·28 |
| 18·75 | 8·38 | 243·75 | 56·25 | 13·50 | 126·56 | 173·44 | 17·12 | 295·31 | 4·69 | 4·30 |
| 18·81 | 8·40 | 244·56 | 56·44 | 13·54 | 126·98 | 174·02 | 17·14 | 296·30 | 4·70 | 4·30 |
| 18·88 | 8·40 | 245·38 | 56·62 | 13·56 | 127·41 | 174·59 | 17·16 | 297·28 | 4·72 | 4·30 |
| 18·94 | 8·42 | 246·19 | 56·81 | 13·58 | 127·83 | 175·17 | 17·18 | 298·27 | 4·73 | 4·32 |
| 19·00 | 8·44 | 247·00 | 57·00 | 13·60 | 128·25 | 175·75 | 17·22 | 299·25 | 4·75 | 4·32 |
| 19·06 | 8·44 | 247·81 | 57'19 | 13·62 | 128·67 | 176·33 | 17·24 | 300·23 | 4·77 | 4·32 |
| 19·12 | 8·46 | 248·62 | 57·38 | 13·64 | 129·09 | 176·91 | 17·28 | 301·22 | 4·78 | 5·34 |
| 19·19 | 8·48 | 249·44 | 57·56 | 13·66 | 129·52 | 177·48 | 17·30 | 302·20 | 4·80 | 4·34 |
| 19·25 | 8·50 | 250·25 | 57·75 | 13·68 | 129·94 | 178·06 | 17·34 | 303·19 | 4·81 | 4·36 |
| 19·31 | 8·50 | 251·06 | 57·94 | 13·72 | 130·36 | 178·64 | 17·36 | 304·17 | 4·83 | 4·36 |
| 19·38 | 8·52 | 251·88 | 58·12 | 13·74 | 130·78 | 179·22 | 17·40 | 305·16 | 4·84 | 4·36 |
| 19·44 | 8·54 | 252·69 | 58·31 | 13·76 | 131·20 | 179·80 | 17·42 | 306·14 | 4·86 | 4·38 |
| 19·50 | 8·54 | 253·50 | 58·50 | 13·76 | 131·62 | 180·38 | 17·44 | 307·13 | 4·87 | 4·38 |
| 19·56 | 8·56 | 254·31 | 58·69 | 13·80 | 132·05 | 180·95 | 17·48 | 308·11 | 4·89 | 4·38 |
| 19·62 | 8·58 | 255·12 | 58·88 | 13·82 | 132·47 | 181'53 | 17·50 | 309·09 | 4·91 | 4·40 |
| 19·69 | 8·58 | 255·94 | 59·06 | 13·84 | 132·89 | 182·11 | 17·54 | 310·10 | 4·92 | 4·40 |
| 19·75 | 8·60 | 256·75 | 59·25 | 13·86 | 133·31 | 182·69 | 17·56 | 311·06 | 4·94 | 4·40 |
| 19·81 | 8·62 | 257·56 | 59·44 | 13·88 | 133·73 | 183·27 | 10·58 | 312·05 | 4·95 | 4·42 |
| 19·88 | 8·62 | 258·38 | 59·62 | 13·90 | 134·16 | 183·84 | 17·62 | 313·03 | 4·97 | 4·42 |
| 19·94 | 8·64 | 259·19 | 59·81 | 13·92 | 134 58 | 184·42 | 17·64 | 314·02 | 4·98 | 4·42 |
| 20·00 | 8·66 | 260·00 | 60·00 | 13·96 | 135·00 | 185·00 | 17·68 | 315·00 | 5·00 | 4·44 |
| 20·06 | 8·68 | 260·81 | 60·19 | 13·98 | 135·42 | 185·58 | 17·70 | 315·98 | 5·02 | 4·44 |
| 20·12 | 8·68 | 261·62 | 60·38 | 14·00 | 135·84 | 186·16 | 17·72 | 316·97 | 5·03 | 4·44 |
| 20·19 | 8·70 | 262·44 | 60·56 | 14·02 | 136·27 | 186·70 | 17·76 | 317·95 | 5·05 | 4·46 |
| 20·25 | 8·72 | 263·25 | 60·75 | 14·04 | 136·69 | 187·31 | 17·78 | 318·94 | 5·06 | 4·46 |
| 20·31 | 8·72 | 264·06 | 60·94 | 14·06 | 137·11 | 187·69 | 17'82 | 319·92 | 5·08 | 4·46 |
| 20·38 | 8·74 | 264·88 | 61·12 | 14·08 | 137·53 | 188·47 | 17·84 | 320·91 | 5·09 | 4·48 |
| 20·44 | 8·74 | 265·69 | 61·31 | 14·10 | 137·95 | 189·05 | 17·86 | 321·89 | 5·11 | 4·48 |
| 20·50 | 8·76 | 266·50 | 61·50 | 14·12 | 138·38 | 189·62 | 17·90 | 322·87 | 5·13 | 4·48 |
| 20·56 | 8·78 | 267·31 | 61·69 | 14·14 | 138·80 | 190·20 | 17·92 | 323·86 | 5·14 | 4·50 |
| 20·62 | 8·78 | 268·12 | 61·88 | 14·16 | 139·22 | 190·78 | 17·94 | 324·84 | 5·16 | 4·50 |
| 20·69 | 8·80 | 268·94 | 62·06 | 14·18 | 139·64 | 191·36 | 17·96 | 325·83 | 5·17 | 4·50 |
| 20·75 | 8·82 | 269·75 | 62·25 | 14·20 | 140·06 | 191·94 | 17·98 | 326·81 | 5·19 | 4·52 |
| 20·81 | 8·84 | 270·56 | 62·44 | 14·24 | 140·48 | 192·52 | 18·02 | 327·80 | 5·20 | 4·52 |
| 20·88 | 8·84 | 271·38 | 62·62 | 14·24 | 140·91 | 193·09 | 18·02 | 328·78 | 5·22 | 4·52 |
| 20·94 | 8·86 | 272·19 | 62·81 | 14·28 | 141·33 | 193·67 | 18·06 | 329·77 | 5·23 | 4·54 |
| 21·00 | 8·86 | 273·00 | 63·00 | 14·30 | 141·75 | 194·25 | 18·10 | 330·75 | 5·25 | 4·54 |

| 1 | Limit of Deviation | 13 : 3 | | Limit of Deviation | 27 : 37 | | Limit of Deviation | 63 : 1 | | Limit of Deviation |
|---|---|---|---|---|---|---|---|---|---|---|
| 17·56 | 8·10 | 228·31 | 52·69 | 13·08 | 118·55 | 162·45 | 16·56 | 276·61 | 4·39 | 4·16 |
| 17·62 | 8·12 | 229·12 | 52·88 | 13·10 | 118·97 | 163·03 | 16·58 | 177·59 | 4·41 | 4·16 |
| 17·69 | 8·14 | 229·94 | 53 06 | 13·12 | 119·39 | 163·61 | 16·62 | 278·58 | 4·42 | 4·16 |
| 17·75 | 8·16 | 230·75 | 53·25 | 13·14 | 119·81 | 164·19 | 16·64 | 279·56 | 4·44 | 4·18 |
| 17·81 | 8·16 | 231·56 | 53·44 | 13·16 | 120·23 | 164·77 | 16·68 | 280·55 | 4·45 | 4·18 |
| 17·88 | 8·18 | 232·38 | 53·62 | 13·18 | 120·66 | 195·34 | 16·70 | 281·53 | 4·47 | 4·20 |
| 17·94 | 9·20 | 233·19 | 53·81 | 13·22 | 121·08 | 166·92 | 16·74 | 282·52 | 4·48 | 4·20 |
| 18·00 | 8·22 | 234·00 | 54·00 | 13·24 | 121·50 | 166·50 | 16·76 | 283·50 | 4 50 | 4·20 |
| 18·06 | 8·22 | 234·81 | 54·19 | 13·26 | 121·92 | 167·08 | 16·80 | 284·48 | 4·52 | 4·22 |
| 18·12 | 8·24 | 235·62 | 54·38 | 13·28 | 122·34 | 167·66 | 16·82 | 285·47 | 4·53 | 4·22 |
| 18·19 | 8·26 | 236·44 | 54·56 | 13·30 | 122·77 | 168·23 | 16·86 | 286·45 | 4·55 | 4·22 |
| 18·25 | 8·26 | 237·25 | 54·75 | 13·32 | 123·19 | 168·81 | 16·88 | 287·44 | 4·56 | 4·24 |
| 18·31 | 8·28 | 238·06 | 54·94 | 13·36 | 123·61 | 169·39 | 16·92 | 288·42 | 4·58 | 4·24 |
| 18 38 | 8·30 | 238·88 | 55·12 | 13·38 | 124·03 | 169·97 | 16·94 | 289·41 | 4·59 | 4·26 |
| 18·44 | 8·30 | 239·69 | 55·31 | 13·40 | 124·45 | 170·55 | 16·96 | 290·39 | 4·61 | 4·26 |
| 18·50 | 8·32 | 240·50 | 55·50 | 13·42 | 124·88 | 171·12 | 17·00 | 291·38 | 4·62 | 4·26 |
| 18·56 | 8·34 | 241·31 | 55·69 | 13·44 | 125·30 | 171·70 | 17·02 | 292·36 | 4·64 | 4·28 |
| 18·62 | 8·36 | 242·12 | 55·88 | 13·46 | 125·72 | 172·28 | 17·06 | 293·54 | 4·66 | 4·28 |
| 18·69 | 8·36 | 242·94 | 56·06 | 13·48 | 126·14 | 172·86 | 17·08 | 294·33 | 4·67 | 4·28 |
| 18·75 | 8·38 | 243·75 | 56·25 | 13·50 | 126·56 | 173·44 | 17·12 | 295·31 | 4·69 | 4·30 |
| 18·81 | 8·40 | 244·56 | 56·44 | 13·54 | 126·98 | 174·02 | 17·14 | 296·30 | 4·70 | 4·30 |
| 18·88 | 8·40 | 245·38 | 56·62 | 13·56 | 127·41 | 174·59 | 17·16 | 297·28 | 4·72 | 4·30 |
| 18·94 | 8·42 | 246·19 | 56·81 | 13·58 | 127·83 | 175·17 | 17·18 | 298·27 | 4·73 | 4·32 |
| 19·00 | 8·44 | 247·00 | 57·00 | 13·60 | 128·25 | 175·75 | 17·22 | 299·25 | 4·75 | 4·32 |
| 19·06 | 8·44 | 247·81 | 57'19 | 13·62 | 128·67 | 176·33 | 17·24 | 300·23 | 4·77 | 4·32 |
| 19·12 | 8·46 | 248·62 | 57·38 | 13·64 | 129·09 | 176·91 | 17·28 | 301·22 | 4·78 | 5·34 |
| 19·19 | 8·48 | 249·44 | 57·56 | 13·66 | 129·52 | 177·48 | 17·30 | 302·20 | 4·80 | 4·34 |
| 19·25 | 8·50 | 250·25 | 57·75 | 13·68 | 129·94 | 178·06 | 17·34 | 303·19 | 4·81 | 4·36 |
| 19·31 | 8·50 | 251·06 | 57·94 | 13·72 | 130·36 | 178·64 | 17·36 | 304·17 | 4·83 | 4·36 |
| 19·38 | 8·52 | 251·88 | 58·12 | 13·74 | 130·78 | 179·22 | 17·40 | 305·16 | 4·84 | 4·36 |
| 19·44 | 8·54 | 252·69 | 58·31 | 13·76 | 131·20 | 179·80 | 17·42 | 306·14 | 4·86 | 4·38 |
| 19·50 | 8·54 | 253·50 | 58·50 | 13·76 | 131·62 | 180·38 | 17·44 | 307·13 | 4·87 | 4·38 |
| 19·56 | 8·56 | 254·31 | 58·69 | 13·80 | 132·05 | 180·95 | 17·48 | 308·11 | 4·89 | 4 38 |
| 19·62 | 8·58 | 255·12 | 58·88 | 13·82 | 132·47 | 181'53 | 17·50 | 309·09 | 4·91 | 4·40 |
| 19·69 | 8·58 | 255·94 | 59·06 | 13·84 | 132·89 | 182·11 | 17·54 | 310·10 | 4·92 | 4·40 |
| 19·75 | 8·60 | 256·75 | 59·25 | 13·86 | 133·31 | 182·69 | 17·56 | 311·06 | 4·94 | 4·40 |
| 19·81 | 8·62 | 257·56 | 59·44 | 13·88 | 133·73 | 183·27 | 10·58 | 312·05 | 4·95 | 4·42 |
| 19·88 | 8·62 | 258·38 | 59·62 | 13·90 | 134·16 | 183·84 | 17·62 | 313·03 | 4·97 | 4·42 |
| 19·94 | 8·64 | 259·19 | 59·81 | 13·92 | 134 58 | 184·42 | 17·64 | 314·02 | 4·98 | 4·42 |
| 20·00 | 8·66 | 260·00 | 60·00 | 13·96 | 135·00 | 185·00 | 17·68 | 315·00 | 5·00 | 4·44 |
| 20·06 | 8·68 | 260·81 | 60·19 | 13·98 | 135·42 | 185·58 | 17·70 | 315·98 | 5·02 | 4·44 |
| 20·12 | 8·68 | 261·62 | 60·38 | 14·00 | 135·84 | 186·16 | 17·72 | 316·97 | 5·03 | 4·44 |
| 20·19 | 8·70 | 262·44 | 60·56 | 14·02 | 136·27 | 186·70 | 17·76 | 317·95 | 5·05 | 4·46 |
| 20·25 | 8·72 | 263·25 | 60·75 | 14·04 | 136·69 | 187·31 | 17·78 | 318·94 | 5·06 | 4·46 |
| 20·31 | 8·72 | 264·06 | 60·94 | 14·06 | 137·11 | 187·69 | 17'82 | 319·92 | 5·08 | 4·46 |
| 20·38 | 8·74 | 264·88 | 61·12 | 14·08 | 137·53 | 188·47 | 17·84 | 320·91 | 5·09 | 4·48 |
| 20·44 | 8·74 | 265·69 | 61·31 | 14·10 | 137·95 | 189·05 | 17·86 | 321·89 | 5·11 | 4·48 |
| 20·50 | 8·76 | 266·50 | 61·50 | 14·12 | 138·38 | 189·62 | 17·90 | 322·87 | 5·13 | 4·48 |
| 20·56 | 8·78 | 267·31 | 61·69 | 14·14 | 138·80 | 190·20 | 17·92 | 323·86 | 5·14 | 4·50 |
| 20·62 | 8·78 | 268·12 | 61·88 | 14·16 | 139·22 | 190·78 | 17·94 | 324·84 | 5·16 | 4·50 |
| 20·69 | 8·80 | 268·94 | 62·06 | 14·18 | 139·64 | 191·36 | 17·96 | 325·83 | 5·17 | 4·50 |
| 20·75 | 8·82 | 269·75 | 62·25 | 14·20 | 140·06 | 191·94 | 17·98 | 326·81 | 5·19 | 4·52 |
| 20·81 | 8·84 | 270·56 | 62·44 | 14·24 | 140·48 | 192·52 | 18·02 | 327·80 | 5·20 | 4·52 |
| 20·88 | 8·84 | 271·38 | 62·62 | 14·24 | 140·91 | 193·09 | 18·02 | 328·78 | 5·22 | 4·52 |
| 20·94 | 8·86 | 272·19 | 62·81 | 14·28 | 141·33 | 193·67 | 18·06 | 329·77 | 5·23 | 4·54 |
| 21·00 | 8·86 | 273·00 | 63·00 | 14·30 | 141·75 | 194·25 | 18·10 | 330·75 | 5·25 | 4·54 |

| No. | 1 : 1 | | Limit of Deviation | 3 : 1 | | Limit of Deviation | 9 : 7 | | Limit of Deviation | 15 : |
|---|---|---|---|---|---|---|---|---|---|---|
| 337 | 168·50 | 168·50 | 18·36 | 252·75 | 84·25 | 15·90 | 189·56 | 147·44 | 18·22 | 315·94 |
| 338 | 169·00 | 169·00 | 18·38 | 253·50 | 84·50 | 15·92 | 190·12 | 147·88 | 18·24 | 316·88 |
| 339 | 169·50 | 169·50 | 18·40 | 254·25 | 84·75 | 15·94 | 190·69 | 148·31 | 18·26 | 317·81 |
| 340 | 170·00 | 170·00 | 18·44 | 255·00 | 85·00 | 15·96 | 191·25 | 148·75 | 18·30 | 318·75 |
| 341 | 170·50 | 170·50 | 18·46 | 255·75 | 85·25 | 16·00 | 191·81 | 149·19 | 18·32 | 319·69 |
| 342 | 171·00 | 171·00 | 18·48 | 256·50 | 85·50 | 16·02 | 192·38 | 149·62 | 18·34 | 320·62 |
| 343 | 171·50 | 171·50 | 18·52 | 257·25 | 85·75 | 16·04 | 192·94 | 150·06 | 18·36 | 321·56 |
| 344 | 172·00 | 172·00 | 18·54 | 258·00 | 86·00 | 16·06 | 193·50 | 150·50 | 18·40 | 322·50 |
| 345 | 172·50 | 172·50 | 18·56 | 258·75 | 86·25 | 16·08 | 194·06 | 150·94 | 18·42 | 323·44 |
| 346 | 173·00 | 173·00 | 18·60 | 259·50 | 86·50 | 16·10 | 194·62 | 151·38 | 18·44 | 324·38 |
| 347 | 173·50 | 173·50 | 18·62 | 260·25 | 86·75 | 16·14 | 195·19 | 151·81 | 18·48 | 325·31 |
| 348 | 174·00 | 174·00 | 18·64 | 261·00 | 87·00 | 16·14 | 195·75 | 152·25 | 18·50 | 326·25 |
| 349 | 174·50 | 174·50 | 18·68 | 261·75 | 87·25 | 16·18 | 196·31 | 152·69 | 18·52 | 327·19 |
| 350 | 175·00 | 175·00 | 18·70 | 262·50 | 87·50 | 16·20 | 196·88 | 153·12 | 18·56 | 328·12 |
| 351 | 175·50 | 175·50 | 18·72 | 263·25 | 87·75 | 16·22 | 197·44 | 153·56 | 18·58 | 329·06 |
| 352 | 176·00 | 176·00 | 18·76 | 264·00 | 88·00 | 16·24 | 198·00 | 154·00 | 18·60 | 330·00 |
| 353 | 176·50 | 176·50 | 18·78 | 264·75 | 88·25 | 16·28 | 198·56 | 154·44 | 18·64 | 330·94 |
| 354 | 177·00 | 177·00 | 18·80 | 365·50 | 88·50 | 16·28 | 199·12 | 154·88 | 18·66 | 331·88 |
| 355 | 177·50 | 177·50 | 18·84 | 266·25 | 88·75 | 16·32 | 199·69 | 155·31 | 18·68 | 332·81 |
| 356 | 178·00 | 178·00 | 18·86 | 267·00 | 89·00 | 16·34 | 200·25 | 155·75 | 18·72 | 333·75 |
| 357 | 178·50 | 178·50 | 18·88 | 267·75 | 89·25 | 16·36 | 200·81 | 156·19 | 18·74 | 334·69 |
| 358 | 179·00 | 179·00 | 18·92 | 268·50 | 89·50 | 16·38 | 201·38 | 156·62 | 18·76 | 335·62 |
| 359 | 179·50 | 179·50 | 18·94 | 269·25 | 89·75 | 16·40 | 201·94 | 157·06 | 18·80 | 336·56 |
| 360 | 180·00 | 180·00 | 18·96 | 270·00 | 90·00 | 16·42 | 202·50 | 157·50 | 18·82 | 337·50 |
| 361 | 180·50 | 180·50 | 19·00 | 270·75 | 90·25 | 16·46 | 203·06 | 157·94 | 18·84 | 338·44 |
| 362 | 181·00 | 181·00 | 19·02 | 271·50 | 90·50 | 16·48 | 203·62 | 158·38 | 18·88 | 339·38 |
| 363 | 181·50 | 181·50 | 19·04 | 272·25 | 90·75 | 16·50 | 204·19 | 158·81 | 18·90 | 340·31 |
| 364 | 182·00 | 182·00 | 19 08 | 273·00 | 91·00 | 16·52 | 204·75 | 159·25 | 18·92 | 341·25 |
| 365 | 182·50 | 182·50 | 19·10 | 273·75 | 91·25 | 16·54 | 205·31 | 159·69 | 18·94 | 342·19 |
| 366 | 183·00 | 183·00 | 19·12 | 274·50 | 91·50 | 16·56 | 205·88 | 160·12 | 18·98 | 343·12 |
| 367 | 183·50 | 183·50 | 19·16 | 275·25 | 91·75 | 16·60 | 206·44 | 160·56 | 19·00 | 344·06 |
| 368 | 184·00 | 184·00 | 19·18 | 276·00 | 92·00 | 16·60 | 207·00 | 161·00 | 19·02 | 345·00 |
| 369 | 184·50 | 184·50 | 19·20 | 276·75 | 92·25 | 16·64 | 207·56 | 161·44 | 19·06 | 345·94 |
| 370 | 185·00 | 185·00 | 19·22 | 277·50 | 92·50 | 16·66 | 208·12 | 161·88 | 19·08 | 346·88 |
| 371 | 185·50 | 185·50 | 19·26 | 278·25 | 92·75 | 16·68 | 208·69 | 162·31 | 19·10 | 347·81 |
| 372 | 186·00 | 186·00 | 19·28 | 279·00 | 93·00 | 16·70 | 209·25 | 162·75 | 19·14 | 348·75 |
| 373 | 186·50 | 186·50 | 19·30 | 279·75 | 93·25 | 16·72 | 209·81 | 163·19 | 19·16 | 349·69 |
| 374 | 187·00 | 187·00 | 19·34 | 280·50 | 93·50 | 16·74 | 210·38 | 163·62 | 19·18 | 350·62 |
| 375 | 187·50 | 187·50 | 19·36 | 281·25 | 93·75 | 16·76 | 210·94 | 164·06 | 19·20 | 351·56 |
| 376 | 188·00 | 188·00 | 19·38 | 282·00 | 94·00 | 16·78 | 211·50 | 164·50 | 19·24 | 352·50 |
| 377 | 188·50 | 188·50 | 19·42 | 282·75 | 94·25 | 16·82 | 212·06 | 164·94 | 19·26 | 353·44 |
| 378 | 189·00 | 189·00 | 19·44 | 283·50 | 94·50 | 16·84 | 212·62 | 165·38 | 19·28 | 354·38 |
| 379 | 189·50 | 189·50 | 19·46 | 284·25 | 94·75 | 16·86 | 213·19 | 165·81 | 19·32 | 255·31 |
| 380 | 190·00 | 190·00 | 19·48 | 285·00 | 95·00 | 16·88 | 213·75 | 166·25 | 19·34 | 356·25 |
| 381 | 190·50 | 190·50 | 19·52 | 285·75 | 95·25 | 16·90 | 214·31 | 166·69 | 19·36 | 357·19 |
| 382 | 191·00 | 191·00 | 19·54 | 286·50 | 95·50 | 16·92 | 214·88 | 167·12 | 19·38 | 358·12 |
| 383 | 191·50 | 191·50 | 19·56 | 287·25 | 95·75 | 16·94 | 215·44 | 167·56 | 19·42 | 359·06 |
| 384 | 192·00 | 192·00 | 19·58 | 288·00 | 96·00 | 16·96 | 216·00 | 168·00 | 19·44 | 360·00 |
| 385 | 192·50 | 192·50 | 19·62 | 288·75 | 96·25 | 16·98 | 216·56 | 168·44 | 19·46 | 360·94 |
| 386 | 193·00 | 193·00 | 19·64 | 289·50 | 96·50 | 17·02 | 217·12 | 168·88 | 19·50 | 361·88 |
| 387 | 193·50 | 193·50 | 19·66 | 290·25 | 96·75 | 17·04 | 217·69 | 169·31 | 19·52 | 962·81 |
| 388 | 194·00 | 194·00 | 19·70 | 291·00 | 97·00 | 17·06 | 218·25 | 169·75 | 19·54 | 363·75 |
| 389 | 194·50 | 194·50 | 19·72 | 291·75 | 97·25 | 17·08 | 218·81 | 170·19 | 19·56 | 364·69 |
| 390 | 195·00 | 195·00 | 19·74 | 292·50 | 97·50 | 17·10 | 219·38 | 170·62 | 19·60 | 365·62 |
| 391 | 195·50 | 195·50 | 19·76 | 293·25 | 97·75 | 17·12 | 219·94 | 171·06 | 19·60 | 366·56 |
| 392 | 196·00 | 196·00 | 19·80 | 294·00 | 98·00 | 17·14 | 220·50 | 171·50 | 19·64 | 367·50 |

| 1 | Limit of Deviation | 13 : 3 | | Limit of Deviation | 27 : 37 | | Limit of Deviation | 63 : 1 | | Limit of Deviation |
|---|---|---|---|---|---|---|---|---|---|---|
| 21·06 | 8·88 | 273·81 | 63·19 | 14·32 | 142·17 | 194·83 | 18·14 | 331·73 | 5·27 | 4·56 |
| 21·12 | 8·90 | 274·62 | 63·38 | 14·34 | 142·59 | 195·41 | 18·16 | 332·72 | 5·28 | 4·56 |
| 21·19 | 8·90 | 275·44 | 63·56 | 14·36 | 143·02 | 195·98 | 18·18 | 333·70 | 5·30 | 4·56 |
| 21·25 | 8·92 | 276·25 | 63·75 | 14·38 | 143 44 | 196·56 | 18·22 | 334·69 | 5·31 | 4·58 |
| 21·31 | 8·94 | 277·06 | 63·94 | 14·40 | 143·86 | 197·14 | 18·26 | 335·67 | 5·33 | 4·58 |
| 21·38 | 8·94 | 277·88 | 64·12 | 14·42 | 144·28 | 197·72 | 18·28 | 336·66 | 5·34 | 4·58 |
| 21·44 | 8·96 | 278·69 | 64·31 | 14·44 | 144·70 | 198·30 | 18·30 | 337·64 | 5·36 | 4·60 |
| 21·50 | 8·98 | 279·50 | 64·50 | 14·46 | 145·12 | 198·88 | 18·34 | 338·62 | 5·38 | 4·60 |
| 21·56 | 8·98 | 280·31 | 64·69 | 14·48 | 145·55 | 199·45 | 18·36 | 339·61 | 5·39 | 4·60 |
| 21·62 | 9·00 | 281·12 | 64·88 | 14·50 | 145·97 | 200·03 | 18·38 | 340·59 | 5·41 | 4·62 |
| 21·69 | 9·02 | 281·94 | 65·06 | 14·52 | 146·39 | 200·61 | 18·42 | 341·58 | 5·42 | 4·62 |
| 21·75 | 9·02 | 282·75 | 65·25 | 14·54 | 146·81 | 201·19 | 18·44 | 342·56 | 5·44 | 4·62 |
| 21·81 | 9·04 | 283·56 | 65·44 | 14·56 | 147·23 | 201·77 | 18·46 | 343·55 | 5·45 | 4·64 |
| 21·88 | 9·06 | 284·38 | 65·62 | 14·60 | 147·66 | 202·34 | 18·50 | 344·53 | 5·47 | 4·64 |
| 21·94 | 9·06 | 285·19 | 65·81 | 14·60 | 148·08 | 202·92 | 18·52 | 345·52 | 5·48 | 4·64 |
| 22·00 | 9·08 | 286·00 | 66·00 | 14·64 | 148·50 | 203·50 | 18·54 | 346·50 | 5·50 | 4·66 |
| 22·06 | 9·10 | 286·81 | 66·19 | 14·66 | 148·92 | 204·08 | 18·56 | 347·48 | 5·52 | 4·66 |
| 22·12 | 9·10 | 287·62 | 66·38 | 14·66 | 149·34 | 204·66 | 18·58 | 348·47 | 5·53 | 4·66 |
| 22·19 | 9·12 | 288·44 | 66·56 | 14·70 | 149·77 | 205·23 | 18·62 | 349·45 | 5·55 | 4·68 |
| 22·25 | 9·14 | 289·25 | 66·75 | 14·72 | 150·19 | 205·81 | 18·64 | 350·44 | 5·56 | 4·68 |
| 22·31 | 9·14 | 290·06 | 66·94 | 14·74 | 150·61 | 206·39 | 18·66 | 351·42 | 5·58 | 4·68 |
| 22·38 | 9·16 | 290·88 | 67·12 | 14·76 | 151·03 | 206·97 | 18·70 | 352·41 | 5·59 | 4·70 |
| 22·44 | 9·16 | 291·69 | 67·31 | 14·78 | 151·45 | 207·55 | 18·72 | 353·39 | 5·61 | 4·70 |
| 22·50 | 9·18 | 292·50 | 67·50 | 14·80 | 151·88 | 208·12 | 18·74 | 354·38 | 5·62 | 4·70 |
| 22·56 | 9·20 | 293·31 | 67·69 | 14·82 | 152·30 | 208·70 | 18·78 | 355·36 | 5·64 | 4·72 |
| 22·62 | 9·20 | 294·12 | 67·88 | 14·84 | 152·72 | 209·28 | 18·80 | 356·34 | 5'66 | 4·72 |
| 22·69 | 9·22 | 294·94 | 68·06 | 14·86 | 153·14 | 209·86 | 18·82 | 357·33 | 5·67 | 4·72 |
| 22·75 | 9·24 | 295·75 | 68·25 | 14·88 | 153·56 | 210·44 | 18·84 | 358·31 | 5·69 | 4·72 |
| 22·81 | 9·24 | 296·56 | 68·44 | 14·90 | 153·98 | 211·02 | 18·86 | 359·30 | 5·70 | 4·74 |
| 22·88 | 9·26 | 297·38 | 68·62 | 14·92 | 154·41 | 211·59 | 18·90 | 360·28 | 5·72 | 4·74 |
| 22·94 | 9·28 | 298·19 | 68·81 | 14·94 | 154·83 | 212·17 | 18·92 | 361·27 | 5·73 | 4·74 |
| 23·00 | 9·28 | 299·00 | 69·00 | 14·96 | 155·25 | 212·75 | 18·94 | 362·25 | 5·75 | 4·76 |
| 23·06 | 9·30 | 299·81 | 69·19 | 14·98 | 155·67 | 213·33 | 18·98 | 363·23 | 5·77 | 4·76 |
| 23·12 | 9·30 | 300·62 | 69·38 | 15·00 | 156·09 | 213·91 | 19·00 | 364·22 | 5·78 | 4·76 |
| 23·29 | 9·32 | 301·44 | 69·56 | 15·02 | 156·52 | 214·48 | 19·02 | 365·20 | 5·80 | 4·78 |
| 23·25 | 9·34 | 302·25 | 69·75 | 15·04 | 156·94 | 215·06 | 19·06 | 366·19 | 5·81 | 4·78 |
| 23·31 | 9·34 | 303·06 | 69·94 | 15·06 | 157·36 | 215·64 | 19·08 | 367·17 | 5·83 | 4·78 |
| 23·38 | 9·36 | 303·88 | 70·12 | 15·08 | 157·78 | 216·22 | 19·10 | 368·16 | 5·84 | 4·80 |
| 23·44 | 9·36 | 304·69 | 70·31 | 15·10 | 158·20 | 216·80 | 19·12 | 369·14 | 5·86 | 4·80 |
| 23·50 | 9·38 | 305·50 | 70·50 | 15·12 | 158·62 | 217·38 | 19·16 | 370·13 | 5·87 | 4·80 |
| 23·56 | 9·40 | 306·31 | 70·69 | 15·14 | 159·05 | 217·95 | 19·18 | 371·11 | 5·89 | 4·82 |
| 23·62 | 9·40 | 307·12 | 70·88 | 15·16 | 159·47 | 218·53 | 19·20 | 372·09 | 5·91 | 4·82 |
| 23·69 | 9·42 | 307·94 | 71·06 | 15·18 | 159·89 | 219·11 | 19·24 | 373·08 | 5·92 | 4·82 |
| 23·75 | 9·44 | 308·75 | 71·25 | 15·20 | 160·31 | 219·69 | 19·26 | 374·06 | 5·94 | 4·84 |
| 23·81 | 9·44 | 309·56 | 71·44 | 15·22 | 160·73 | 220·27 | 19·28 | 375·05 | 5·95 | 4·84 |
| 23·88 | 9·46 | 310·38 | 71·62 | 15·24 | 161·16 | 220·84 | 19·30 | 376·03 | 5·97 | 4·84 |
| 23·94 | 9·46 | 311·19 | 71·81 | 15·26 | 161·58 | 221·42 | 19·34 | 377·02 | 5·98 | 4·86 |
| 24·00 | 9·48 | 312·00 | 72·00 | 15·28 | 162·00 | 222·00 | 19·36 | 378·00 | 6·00 | 4·86 |
| 24·06 | 9·50 | 312·81 | 72·19 | 15·30 | 162·42 | 222·58 | 19·38 | 378·98 | 6·02 | 4·86 |
| 24·12 | 9·50 | 313·62 | 72·38 | 15·32 | 162·84 | 223·16 | 19·42 | 379·97 | 6·03 | 4·88 |
| 24·19 | 9·52 | 314·44 | 72·56 | 15·34 | 163·27 | 223·73 | 19·44 | 380·95 | 6·05 | 4·88 |
| 24·25 | 9·54 | 315·25 | 72·75 | 15·36 | 463·69 | 224 31 | 19·46 | 381·94 | 6·06 | ·88 |
| 24·31 | 9·54 | 316·06 | 72·94 | 15·38 | 164·11 | 224·89 | 19·48 | 382·92 | 6 08 | ·88 |
| 24·38 | 9·56 | 316·88 | 73·12 | 15·40 | 164·53 | 225·47 | 19·52 | 383·91 | 6·09 | ·90 |
| 24·44 | 9·56 | 317·69 | 73·31 | 15·42 | 164·95 | 226·05 | 19·54 | 384·89 | 6·11 | ·90 |
| 24·50 | 9·58 | 318·50 | 73·50 | 15·44 | 165·38 | 226·62 | 19·56 | 385·87 | 6·13 | 4 ·90 |

| No. | 1 : 1 | | Limit of Deviation | 3 : 1 | | Limit of Deviation | 9 : 7 | | Limit of Deviation | 15 : |
|---|---|---|---|---|---|---|---|---|---|---|
| 393 | 196·50 | 196·50 | 19·82 | 294·75 | 98·25 | 17·16 | 221·06 | 171·94 | 19·66 | 368·44 |
| 394 | 197·00 | 197·00 | 19·84 | 295·50 | 98·50 | 17·18 | 221·62 | 172·38 | 19·68 | 369·38 |
| 395 | 197·50 | 197·50 | 19·86 | 296·25 | 98·75 | 17·20 | 222·19 | 172·81 | 19·70 | 370·31 |
| 396 | 198·00 | 198·00 | 19·90 | 297·00 | 99·00 | 17·24 | 222·75 | 173·25 | 19·74 | 371·25 |
| 397 | 198·50 | 198·50 | 19·92 | 397·75 | 99·25 | 17·24 | 223·31 | 173·69 | 19·76 | 372·19 |
| 398 | 199·00 | 199·00 | 19·94 | 298·50 | 99·50 | 17·28 | 223·88 | 174·12 | 19·78 | 373·12 |
| 399 | 199·50 | 199·50 | 19·96 | 299·25 | 99·75 | 17·30 | 224·44 | 174·56 | 19·80 | 374·06 |
| 400 | 200·00 | 200·00 | 20·00 | 300·00 | 100·00 | 17·32 | 225·00 | 175·00 | 19·84 | 375·00 |
| 401 | 200·50 | 200·50 | 20·02 | 300·75 | 100·25 | 17·34 | 225·56 | 175·44 | 19·86 | 375·94 |
| 402 | 201·00 | 201·00 | 20·04 | 301·50 | 100·50 | 17·36 | 226·12 | 175·88 | 19·88 | 376·88 |
| 403 | 201·50 | 201·50 | 20·06 | 302·25 | 100·75 | 17·38 | 226·69 | 176·31 | 19·90 | 377·81 |
| 404 | 202·00 | 202·00 | 20·10 | 303·00 | 101·00 | 17·40 | 227·25 | 176·75 | 19·94 | 378·75 |
| 405 | 202·50 | 202·50 | 20·12 | 303·75 | 101·25 | 17·42 | 227·81 | 177·19 | 19·96 | 379·69 |
| 406 | 203·00 | 203·00 | 20·14 | 304·50 | 101·50 | 17·44 | 228·38 | 177·62 | 19·98 | 380·62 |
| 407 | 203·50 | 203·50 | 20·16 | 305·25 | 101·75 | 17·46 | 228·94 | 178·06 | 20·00 | 381·56 |
| 408 | 204·00 | 204·00 | 20·20 | 306·00 | 102·00 | 17·50 | 229·50 | 178·50 | 20·04 | 382·50 |
| 409 | 204·50 | 204·50 | 20·22 | 306·75 | 102·25 | 17·50 | 230·06 | 178·94 | 20·06 | 383·44 |
| 410 | 205·00 | 205·00 | 20·24 | 307·50 | 102·50 | 17·54 | 230·62 | 179·38 | 20·08 | 384·38 |
| 411 | 205·50 | 205·50 | 20·26 | 308·25 | 102·75 | 17·56 | 231·19 | 179·81 | 20·10 | 385·31 |
| 412 | 206·00 | 206·00 | 20·30 | 309·00 | 103·00 | 17·58 | 231·75 | 180·75 | 20·14 | 386·25 |
| 413 | 206·50 | 206·50 | 20·32 | 309·75 | 103·25 | 17·60 | 232·31 | 180·69 | 20·16 | 387·19 |
| 414 | 207·00 | 207·00 | 20·34 | 312·50 | 103·50 | 17·62 | 232·88 | 181·12 | 20·18 | 388·12 |
| 415 | 207·50 | 207·50 | 20·36 | 311·25 | 103·75 | 17·64 | 233·44 | 181·56 | 20·20 | 389·06 |
| 416 | 208·00 | 208·00 | 20·40 | 312·00 | 104·00 | 17·66 | 234·00 | 182·00 | 20·24 | 390·00 |
| 417 | 208·50 | 208·50 | 20·42 | 312·75 | 104·25 | 17·68 | 334·56 | 182·44 | 20·26 | 390·94 |
| 418 | 209·00 | 209·00 | 20·44 | 313·50 | 104·50 | 17·70 | 235·12 | 182·88 | 20·28 | 391·88 |
| 419 | 209·50 | 209·50 | 20·46 | 314·25 | 104·75 | 17·72 | 235·69 | 183·31 | 20·30 | 392·81 |
| 420 | 210·00 | 210·00 | 20·48 | 315·00 | 105·00 | 17·74 | 236·25 | 183·75 | 20·32 | 393·75 |
| 421 | 210·50 | 210·50 | 20·52 | 315·75 | 105·25 | 17·76 | 236·81 | 184·19 | 20·36 | 394·69 |
| 422 | 211·00 | 211·00 | 20·54 | 316 50 | 105·50 | 17·78 | 237·38 | 184·62 | 20·38 | 395·62 |
| 423 | 211·50 | 211·50 | 20·56 | 317·25 | 105·75 | 17·82 | 237·94 | 185·06 | 20·40 | 396·56 |
| 424 | 212·00 | 212·00 | 20·58 | 318·00 | 106·00 | 17·82 | 238·50 | 185·50 | 20·42 | 397·50 |
| 425 | 212·50 | 212·50 | 20·60 | 318·75 | 106·25 | 17·84 | 239·06 | 185·94 | 20·44 | 398·44 |
| 426 | 213·00 | 213·00 | 20·64 | 319·50 | 106·50 | 17·88 | 239·62 | 186·38 | 20·48 | 399·38 |
| 427 | 213·50 | 213·50 | 20·66 | 320·25 | 106·75 | 17·88 | 240·19 | 186·81 | 20·50 | 400·31 |
| 428 | 214·00 | 114·00 | 20·68 | 321·00 | 107·00 | 17·92 | 240·75 | 187·25 | 20·52 | 401·25 |
| 429 | 214·50 | 214·50 | 20·70 | 321·75 | 107·25 | 17·94 | 241·31 | 187·69 | 20·54 | 402·19 |
| 430 | 215·00 | 215·00 | 20·74 | 322·50 | 107·50 | 17·96 | 241·88 | 188·12 | 20·58 | 403·12 |
| 431 | 215·50 | 215·50 | 20·76 | 323·25 | 107·75 | 17·98 | 242·44 | 188·56 | 20·60 | 404·06 |
| 432 | 216·00 | 216·00 | 20·78 | 324·00 | 108·00 | 18·00 | 243·00 | 189·00 | 20·62 | 405·00 |
| 433 | 216·50 | 216·50 | 20·80 | 324·75 | 108·25 | 18·02 | 243·56 | 189·44 | 20·64 | 405·94 |
| 434 | 217·00 | 217·00 | 20·82 | 325·50 | 108·50 | 18·04 | 244·12 | 189·88 | 20·66 | 406·88 |
| 435 | 217·50 | 217·50 | 20·86 | 326·25 | 108·75 | 18·06 | 244·69 | 190·31 | 20·70 | 407·81 |
| 436 | 218·00 | 218·00 | 20·88 | 327·00 | 109·00 | 18·08 | 245·25 | 190·75 | 20·72 | 408·75 |
| 437 | 218·50 | 218·50 | 20·90 | 327·75 | 109·25 | 18·10 | 245·81 | 191·19 | 20·74 | 409·69 |
| 438 | 219·00 | 219·00 | 20·92 | 328·50 | 109·50 | 18·12 | 246·38 | 191·62 | 20·76 | 410·62 |
| 439 | 219·50 | 219·50 | 20·94 | 329·25 | 109·75 | 18·14 | 246·94 | 192·06 | 29·78 | 411·56 |
| 440 | 220·00 | 220·00 | 20·98 | 330·00 | 110·00 | 18·16 | 247·50 | 192·50 | 20·82 | 412·50 |
| 441 | 220·50 | 220·50 | 21·00 | 330·75 | 110·25 | 18·18 | 148·06 | 192·94 | 20·84 | 413·44 |
| 442 | 221·00 | 221·00 | 21·02 | 331·50 | 110·50 | 18·20 | 248·62 | 193·38 | 20·84 | 414·38 |
| 443 | 221·50 | 221·50 | 21·04 | 332·25 | 110·75 | 18·22 | 249·19 | 193·81 | 20·88 | 415·31 |
| 444 | 222·00 | 222·00 | 21·06 | 333·00 | 111·00 | 18·24 | 249·75 | 194·25 | 20·90 | 416·25 |
| 445 | 222·50 | 222·50 | 21·08 | 333·75 | 111·25 | 18·26 | 250·31 | 194·69 | 20·92 | 417·19 |
| 446 | 223·00 | 223·00 | 21·12 | 334·50 | 111·50 | 18·28 | 250·88 | 195·12 | 20·94 | 418·12 |
| 447 | 223·50 | 223·50 | 21·14 | 335·25 | 111·75 | 18·30 | 251·44 | 195·56 | 20·96 | 419·06 |
| 448 | 224·00 | 224·00 | 21·16 | 336·00 | 112·00 | 18·34 | 252·00 | 196·00 | 21·00 | 420·00 |

| 1 : | Limit of Deviation | 13 : 3 | | Limit of Deviation | 27 : 37 | | Limit of Deviation | 63 : 1 | | Limit of Deviation |
|---|---|---|---|---|---|---|---|---|---|---|
| 24·56 | 9·60 | 319·31 | 73·69 | 15·46 | 165·80 | 227·20 | 19·58 | 386·86 | 6·14 | 4·92 |
| 24·62 | 9·60 | 320·12 | 73·88 | 15·48 | 166·22 | 227·78 | 19·60 | 387·84 | 6·16 | 4·92 |
| 24·69 | 9·62 | 320·94 | 74·06 | 15·50 | 166·64 | 228·36 | 16·62 | 388·83 | 6·17 | 4·92 |
| 24·75 | 9·62 | 321·75 | 74·25 | 15·52 | 167·06 | 228·94 | 19·66 | 489·81 | 6·19 | 4·94 |
| 24·81 | 9·64 | 322·56 | 74·44 | 15·54 | 167·48 | 229·52 | 19·68 | 390·80 | 6·20 | 4·94 |
| 24·88 | 9·66 | 322·38 | 74·62 | 15·56 | 167·91 | 230·09 | 19·70 | 391·78 | 6·22 | 4·94 |
| 24·94 | 9·66 | 324·19 | 74·81 | 15·58 | 168·33 | 230·67 | 19·72 | 392·77 | 6·23 | 4·96 |
| 25·00 | 9·68 | 325·00 | 75·00 | 15·60 | 168·75 | 231·25 | 19·76 | 393·85 | 6·25 | 4·96 |
| 25·06 | 9 68 | 325·81 | 75·19 | 15·62 | 169·17 | 231·83 | 19·78 | 394·73 | 6·27 | 4·96 |
| 25·12 | 9·70 | 326·62 | 75·38 | 15·64 | 269·59 | 232·41 | 19·80 | 395·72 | 6·28 | 4·98 |
| 25·19 | 9·72 | 327 44 | 75·56 | 15·66 | 170·02 | 232·98 | 19·82 | 396·70 | 6·30 | 4·98 |
| 25·25 | 9·72 | 328·25 | 75·75 | 15·68 | 170·44 | 233·56 | 19·86 | 397·69 | 6·31 | 4·98 |
| 25·31 | 9·74 | 329·06 | 75·94 | 15·70 | 170·86 | 234·14 | 19·88 | 398·67 | 6·33 | 4·98 |
| 25·38 | 9·76 | 329·88 | 76·12 | 15·72 | 171·28 | 234·72 | 19·90 | 399·66 | 6·34 | 5·00 |
| 25·44 | 9·76 | 330·69 | 76·31 | 15·74 | 171·70 | 235·30 | 19·92 | 400·64 | 6·36 | 5·00 |
| *25·50* | *9·78* | *331·50* | *76·50* | 15·76 | *172·12* | *235·88* | *19·96* | *401·62* | *6·38* | *5·00* |
| 25·56 | 9·78 | 332·31 | 76·69 | 15·76 | 172·55 | 236·45 | 19·98 | 402·61 | 6·39 | 5·02 |
| 25·62 | 9·80 | 333·12 | 76·88 | 15·80 | 172·97 | 237·03 | 20·00 | 403·59 | 6·41 | 5·02 |
| 25·69 | 9·80 | 333·94 | 77·06 | 15·80 | 173·39 | 237·61 | 20·02 | 404·58 | 6·42 | 5·02 |
| 25·75 | 9·82 | 334·75 | 77·25 | 15·84 | 173·81 | 238·19 | 20·06 | 405 56 | 6·44 | 5·04 |
| 35·81 | 9·84 | 335·56 | 77·44 | 15·84 | 174·23 | 238·77 | 20·08 | 406·55 | 6·45 | 5·04 |
| 25·87 | 9·84 | 336·38 | 77·62 | 15·88 | 174·66 | 239·34 | 20·10 | 407·53 | 6·47 | 5·04 |
| 25·94 | 9·86 | 337·19 | 77·81 | 15·88 | 175·08 | 239·92 | 20·12 | 408·52 | 6·48 | 5·04 |
| 26·00 | 9·88 | 338·00 | 78·00 | 15·92 | 175·50 | 240·50 | 20·16 | 409·50 | 5·50 | 5·06 |
| 26·06 | 9·88 | 338·81 | 78·19 | 15·92 | 175·92 | 241·08 | 20·18 | 410·48 | 6·52 | 5·06 |
| 26·12 | 9·90 | 339·62 | 78·38 | 15·94 | 176·34 | 241·66 | 20·20 | 411·47 | 6·53 | 5·06 |
| 26·19 | 9·90 | 340·44 | 78·56 | 15·98 | 176·77 | 242·23 | 20·22 | 412·45 | 6·55 | 5·08 |
| 26·25 | 9·92 | 341·25 | 78·75 | 15·98 | 177·19 | 242·81 | 20·24 | 413·44 | 6 56 | 5·08 |
| 26·31 | 9·92 | 342·06 | 78·94 | 16·00 | 177·61 | 243·39 | 20·28 | 414·42 | 6·58 | 5·00 |
| 26·38 | 9·94 | 342·87 | 79·12 | 16·02 | 178·03 | 243·97 | 20·30 | 415·41 | 6·59 | 5·10 |
| 26·44 | 9 96 | 343·69 | 79·31 | 16·04 | 178·45 | 244·55 | 20·32 | 416·39 | 6·61 | 5·10 |
| 26·50 | 9·96 | 344·50 | 79·50 | 16·06 | 178·88 | 245·12 | 20·34 | 417·38 | 6·62 | 5·10 |
| 26·56 | 9·98 | 345·31 | 79·69 | 16·08 | 179·30 | 245·70 | 20·36 | 418·36 | 6·64 | 5·12 |
| 26·62 | 9·98 | 346·12 | 79·88 | 16·10 | 179·72 | 246·28 | 20·40 | 419·34 | 6·66 | 5·12 |
| 26·69 | 10·00 | 346·94 | 80·06 | 16·12 | 180·14 | 246·86 | 20·42 | 420·33 | 6·67 | 5·12 |
| 26·75 | 10·02 | 347·75 | 80·25 | 16·14 | 180·56 | 247·44 | 20·44 | 421·31 | 6·69 | 5·12 |
| 26·81 | 10·02 | 348·56 | 80·44 | 16·16 | 180·98 | 248·02 | 20·46 | 422·30 | 6·70 | 5·14 |
| 26·88 | 10·04 | 349·38 | 80·62 | 16·18 | 181·41 | 248·59 | 20·48 | 423·28 | 6·72 | 5·14 |
| 26·94 | 10·04 | 350·19 | 80·81 | 16·20 | 181·83 | 249·17 | 20·50 | 424·27 | 6·73 | 5·14 |
| 27·00 | 10·06 | 351·00 | 81·00 | 16·20 | 182·25 | 249·75 | 50·52 | 425·25 | 6·75 | 6·16 |
| 27·06 | 10·08 | 351·81 | 81·19 | 16·22 | 182·67 | 250·33 | 20·56 | 426·23 | 6·77 | 5·16 |
| 27·12 | 10·08 | 352·62 | 81 38 | 16·24 | 183·09 | 250·91 | 20·58 | 427·22 | 6·78 | 5·16 |
| 27·19 | 10·10 | 353·44 | 81·56 | 16·26 | 183·52 | 251·48 | 20·60 | 428·20 | 6·80 | 5·18 |
| 27·25 | 10·10 | 354·25 | 81·75 | 16·28 | 183·94 | 252·06 | 20·62 | 429·19 | 6·81 | 5·18 |
| 27·31 | 10·12 | 355·06 | 81·94 | 16·30 | 184·36 | 252·64 | 20·64 | 430·17 | 6·83 | 5·18 |
| 27·38 | 10·12 | 355·88 | 82·12 | 16·32 | 184·78 | 253·22 | 20·68 | 431·16 | 6·84 | 5·18 |
| 27·44 | 10·14 | 356·69 | 82·31 | 16·34 | 185·20 | 253·80 | 20·70 | 432·14 | 6·86 | 5·20 |
| 27·50 | 10·16 | 357·50 | 82·50 | 16·36 | 185·62 | 254·38 | 20·72 | 433·13 | 6·87 | 5·20 |
| 27·56 | 10·16 | 358.31 | 82·69 | 16·38 | 186·05 | 254·95 | 20·74 | 434·11 | 6·89 | 5·20 |
| 27·62 | 10·18 | 359·12 | 82·88 | 16·40 | 186·47 | 255·53 | 20·76 | 435·09 | 6·91 | 5·22 |
| 27·69 | 10·18 | 359·94 | 83·06 | 16·42 | 186 89 | 256·11 | 20·80 | 436·08 | 6·92 | 5·22 |
| 27·75 | 10·20 | 360·75 | 83·25 | 16·44 | 187·31 | 256·69 | 20·82 | 437·06 | 6·94 | 5·22 |
| 27·81 | 10·20 | 361·56 | 83·44 | 16·44 | 187·73 | 257·27 | 20·84 | 438·05 | 6·95 | 5·22 |
| 27·88 | 10·22 | 362·38 | 83·62 | 16·48 | 188·16 | 257·84 | 20·86 | 439·03 | 6·97 | 5·24 |
| 27·94 | 10·22 | 363·19 | 83·81 | 16·48 | 188·58 | 258·42 | 20·88 | 440·02 | 6·98 | 5·24 |
| 28·00 | 10·24 | 364·00 | 84·00 | 16·52 | 189·00 | 259·00 | 20·92 | 441·00 | 7·00 | 5·24 |

# College Notes and News

The Gymkhana activity started with the election of the office-bearers held on 18th June, 1949. There was a keen contest between a large number of candidates for the different posts. The following people were elected.

(1) Hon. Gen. Secretary for Social Gathering: Shri D. S. Narkhede.

**Gymkhana Managing Committee:**

| | | |
|---|---|---|
| (1) | Hon. Gen. Secretary: | Shri A. N. Shinde. |
| (2) | Hon. Gen. Secretary: for Cricket. | Shri V. P. Dalaya. |
| (3) | ,, ,, ,, for Tennis: | Shri C. B. Pande. |
| (4) | ,, ,, ,, ,, Foot-ball: | ,, V. S. Rane. |
| (5) | ,, ,, ,, ,, Hockey: | ,, J. Mascarenhas. |
| (6) | ,, ,, ,, ,, Athletics: | ,, U. R. Pawar. |
| (7) | ,, ,, ,, ,, Indian Games & Gymnasium: | ,, N. K. Patil. |
| (8) | ,, ,, ,, ,, Minor Games: (Indoor). | ,, V. V. Tembhekar. |
| (9) | ,, ,, ,, ,, Minor Games: (Outdoor). | ,, S. B. Sulke. |
| (10) | ,, ,, ,, ,, Reading Room: | ,, A. R. Patil. |
| (11) | ,, ,, ,, ,, Agricultural Association & Debating Society. | ,, J. S. Paradeshi. |

**College Magazine:**

| | | |
|---|---|---|
| (1) | Senior Editor: | Shri V. T. Patil. |
| (2) | Junior Editor: | ,, S. G. Kolhe. |
| (3) | Senior Manager: | ,, S. N. Parasnis. |
| (4) | Junior Manager: | ,, L. M. Chavan. |

**Student's Welfare Committee:**

| | B. Sc. (Agri.) | S. Sc. (Agri.) | F. Sc. (Agri.) |
|---|---|---|---|
| (1) | Shri V. D. Magre. | Shri K. G. Agaram. | Shri V. M. Deshpande. |
| (2) | ,, V. S. Khuspe. | ,, P. P. Joshi. | ,, M. A. Gade. |
| (3) | ,, M. R. Chaudhari. | Shrimati M. T. Swadi. | ,, M. P. Grover. |
| (4) | ,, S. B. Kadrekar. | Shrimati R. Bhattacharya. | |
| (5) | ,, A. R. Karve. | | |

We offer our hearty congratulations to the electees.

All Secretaries of the various departments have started their work with great enthusiasm and are working hard in the interests of the College.

A. N. SHINDE,
**Hon. Gen. Secretary.**

## Gleanings

— A visual thermometer in which heat is measured by means irradiated phosphors is discovered by American scientists. Phosphors glow in the dark and are extremely sensitive to temperature changes. The light emitting properties of phosphors are changed by the slightest variation in heat radiation. They are so sensitive to heat that an increase of a degree centigrade will produce a 20 p. c. decrease in brightness emmitted by a phosphor-coated fluorescent screen. The thermometer when fully developed can be used to a variety of industrial uses.

— American Newsfeature, May 17, 1949.

— Aerosol "Bombs" were extensively used during the last war for destruction of Malaria-carrying mosquitoes in the tropics. Now in peace time they are put to a veriety of uses such as destruction of insects, germs and offensive odors. Doctors use them to spray sore throats, veterinarians use them to keep pests off household animals and cattle and industry uses them for rust-proofing metal tools and equipment.

The container of an aerosol bomb is made up of thin steel or aluminium which can be operated by pressing with the finger-tip a lever on the neck of the container. Fluids mixed with freon gases kept under pressure in the container, are released from the container under pressure of the freon gases. The fluids are broken into particles so small that they remain in the air for a very very long time. Thus an aerosol bomb is much more effective than an ordinary sprayer. Any liquid can be put in an aerosol bomb according to the requirement—such an insecticide, medicine, deodorant or paint. An aerosol bomb is operated by pressing a lever on the neck of the container.

— American Newsfeature, May 17, 1949.

— It is a well known fact that ordinary conventional compasses with magnetic needles cannot be used in Arctic and Antarctic regions due to nearness of earth's magnetic poles. For this reason the United States National Bureau of Standards has developed a special non-magnetic compass.

It consists of a polarold glass which shuts out direct rays of sunlight and only admits light-vibrations issued at right angles to the rays. The compass is trained on the sky and the position of the sun can be accurately located even though it is below the horizon. The true north-south line is established by computations involving the angle of polarized light and the time of day. This device is called as a "sky compass", because it measures light in the sky to find the position of the sun.

— American Newsfeature, May 24, 1949.

— A Chinese scientist, working in an American University has discovered the harmone, known as FSH (follicle stimulating harmone) which starts

the life making process in humans and animals causing ovulation in females and production of sperm in males. It is an almost crystalline protein.

— American Newsfeature, May 31, 1949

— Some of the prominant Australian scientists have collaborated in investigations which have laid to very significant discoveries They have found that large stretches of land on the earth's surface are less productive not because of low fertility but due to need of minute traces of certain elements. These elements, which are essential for good productive growth of the crop, chiefly consist of copper cobalt, manganese, molybdenum and zinc.

—Australian Newsletter.

— A number of experiments conducted in Australia has shown that harmone sprays are effective weed-killers. These sprays are not harmful to the crops. The weed "Tree of Heaven" is a nuisance weed to the Australian dairy farmers and stock growers because of its prolific suckering habit. But a water spray of 0.5 p. c. Methoxone was found to kill these suckers completely.

— Australian Newsletter.

— The Council for Scientific and Industrial Research in Australia has decided to carry out a large scale production of papain. Papain has a large number of industrial uses, for tanning hides for processing the wool and also for medicinal purposes. The council has recommended bulk plantation of papaya with a spacing of only 2'. The plants are to be cut while young, and the latex is to be extracted by milling the stems and leaves. This method is said to be more economical than extracting the latex from the fruit.

— Australian Newsletter.

— The American astronomers have found an evidence showing that new solar systems are being formed forever in the extreme reaches of the universe. It is stated that millions of solar systems like our own may be already existing and planets like the earth may be common in them. Dr. Otto Struve of Yankes Observatory of the University of Chicago said, "We are seeing stars formed before our very eyes and we are finding many that are only 10,000,000 years old. ... My guess is that the formation of planets is a very common process."

— American Newsfeature.

— A poultry farmer at Desmoines after carrying out a selective breeding for over 12 years has developed chickens without wings which are claimed to produce more meat while laying the average number of eggs.

— The Sunday News of India, 10th July '49.

— New potential uses of sodium fluosilicate—which was so far used for keeping moths out of clothes—are being developed by the American scientists. It is expected to keep rats out of shipping cartons, repel cockroaches from food packages, help mosquito control, prohibit termites and

prevent dry rot in wood. Especially it is found to be effective against mosquitoes in ponds and pools: one part of sodium fluosilicate in 80,000 parts of water is sufficient to kill the mosquitoes.

— American Newsfeature, July 14, 1949.

— A method of packing and shipping refrigerated fresh orange juice over long distances without affecting flavour and nutritional qualities, has been found by the research workers of the Bureau of Agricultural and Industrial Chemistry in California. The process consists of squeezing the fruit carefully so that a very little peel oil which deteriorates the flavour of the juice, gets into the juice. The juice is then chilled immediately to 32°F. after removing most of the air from the juice, and it is filled full in either bottles, cartons or cans, which are closed tight and sealed. The juice prepared in this manner retains its flavour and vitamin-C content for more than three weeks under refrigeration. Cartloads of such fresh orange juice refrigerated with ice and salt are shipped 3,000 miles across the continent to New York.

— American Newsfeature, July 12, 1949.

— The Linlithgow Library of the Indian Agricultural Research Institute in New Delhi is considered to be one of the best libraries in the world and the finest of its kind in the East. It contains 20,517 volumes, 32,247 pamphlets and 50,420 technical journals. This scientific literature touches all the branches and sub branches of agriculture, which dates back as far as 1665. It includes some of the greatest works on the biological sciences. It receives more than 1200 periodicals from all over the world. It is the only library in Delhi (and probably in India) which is open on all days and for the largest number of hours.

— Sunday News of India, May 22nd, 1949.

— The legend of the invention of the silk fibre which goes to make the luxurious fashion fabrics of today, first invented nearly 5,000 years ago in China, is very interesting. A little Chinese princess, daughter of Hoang-ti, third Emperor of China, while playing dropped a fuzzy cacoon into her mother's steaming tea-cup. The girl was astonished to see the cacoon unfurl itself into slender fibres. The mother immediately began to study the habits of the caterpiller which was found to be emitting a silky substance for wrapping its body. Shortly after this the Emperor Hoang-ti, started cultivating more silk worms and utilising the silken fibres for weaving.

The secret of producing silk fibre was zealously guarded by the Chinese for a very long time. For almost three centuries before Christ, this great industry flourished exclusively within the Great Wall of China only.

— The Sunday News of India, 17th July '49.

# पूना ॲग्रिकल्चरल् कॉलेज मॅगेझिन्

वर्ष ४० वें ] ऑगस्ट, १९४९ [ अंक २ रा


## सुनहरी शहद

शहद अेक अुत्तम खोराक है। अिससे बढकर मीठा और अितना शुद्ध खाद्यपदार्थ न तो अभीतक किसीने खोज किया है और न बनायाही है। शहद और मधुमक्खी अितनी पुराने है कि वह किस कालमें पैदा हुअे अिसका पता अभीतक नहीं मिलता। जिस समय मनुष्य गुफामें रहता था और पत्थरके बरतनों और औजारोंका अुपयोग करता था उस समयके चित्र जो कि गुफाओंकी दीवारपर पाये जाते हैं अुनमें मनुष्यको मक्खीके छत्तेसे शहद निकालता हुआ दिखाय गया है। ३२०० वर्षके पूर्व अेक मिस्रके राजाकी कबरमेंसे शुद्ध शहद मिला है। अिस सबसे यह ज्ञात होता है कि मधुमक्खी और शहद हजारों वर्ष पहलेभी मौजूद थे।

शहदमें फलोंकी शक्कर ( Levulose ) अधिक प्रमाणमें होने के कारण वह शक्करसेभी दुगना मीठा होता है। फलोंकी शक्करसे मीठी और दूसरी कोअीभी प्रकारकी शक्कर नहीं है। शक्करमें केवल अेकही प्रकारका मीठा स्वाद होता है किंतु शहदकी शक्करमें कितनेही वर्षोंका सूर्य तेज जमा हुआ रहता है और अिसी कारण शहद सूर्य तेजके समान चमकता है। शहदमें भिन्न भिन्न प्रकारके फूलोंकी सुगंध भरी हुअी होती है अिसीलिये अुसका स्वादभी अलग अलग प्रकारका होता है। अपने देशके खेतों और जंगलोंमें अनेक प्रकारके फूल अुत्पन्न होनेके कारणही शहदभी अनेकों प्रकारका बनता है। भिन्न भिन्न प्रकारके शहदकी परिक्षा करना मनुष्यके प्रयत्नोंके बाहर है अिसे वह अपनी समस्त आयुष्यमेंभी पूरा नहीं कर सकता।

शुद्ध और परिपक्व शहदमें शक्करका प्रमाण अितना अधिक होता है कि अुसमें किसीभी किस्मके सूक्ष्मजंतु ( Bacteria ) अेक या दो घंटोंसे अधिक जीवित नहीं रह सकते। शहदमें और कोअी तरहकी शक्कर मिलाअी गयी हो तो वह तुरंग पहचानी जा सकती है क्योंकि अगर शुद्ध शहदमें पानी मिलाया जाय तो वह बिगड ( Ferment ) जायगा। मधुमक्खीद्वारा तैयार किअे हुअे मोमके बराबर शुद्ध और कोअी दूसरा मोम नहीं पैदा किया गया है। शहद अेक शुद्ध पदार्थ होनेके कारणही अपने देशमें अिसका उपयोग देवपूजन और पंचामृतमें किया जाता है और विदेशोंमें शादी इत्यादि शुभ अवसरोंपर अिसका अुपयोग किया जाता है। विदेशोंमें शादीकी प्रथ

रात्रिको मधुरजनी ( Honey Moon ) कहते हैं और पती अपनी पत्नीको शहद अर्थात् ( Honey ) के नामसे प्रेमसे पुकारता है ।

शहद सचमुचही मधुमक्खी और फूलोंकी शानदार मीलनका अेक अद्‌भुत नमुना है। प्रकृतिने फूलोंका रूप, रंग, सुगंध और आकृति अैसे ढंगकी बनाअी है कि वह मधुमक्खोंको आकर्षित करती है । अिसके साथही साथ मधुमक्खीके शरीरका आकारभी अैसा बनाया है कि वह फूलोंके अंदर आसानीसे घुस सके । फूलोंका रस चूसतेसमय पुष्पपरागके कण मक्खीसे शरीरपर चिपक जाते हैं। और जब वह दूसरे फूलोंके अंदर रस चुसनेको घुसती है अुस समय वे कण फूलके स्त्री केसरसे मिलकर फूलको फलित करते हैं । अिसी प्रकार वह अेक फूलके परागके कण दूसरें फूलतक पहुँचानेमें सफल होती हैं । अगर मधुमक्खी न होती तो करीब कोअी १०००० प्रकारके फूल अिस संसारमेंसे नष्ट हो जाते। अगर फूल नहीं होते तो मधुमक्खीभी जिंदा नहीं रह सकती ।

हवा जब गरम और गीली होती है तब फूलोंमें अमीरस बढ़ता है और फूलोंकी सुवास हवामें प्रसरित होती है । अिससे दूरदूरसे मक्खियाँ फूलोंकी ओर आकर्षित होती हैं और पेडोंके आसपासकी हवा मक्खियोंके गुंजारसे भनभन करती रहती है व मक्खियाँ फूलोंका अमीरस चूसती रहती हैं । सुबहसे लेकर शामतक हरअेक मक्खी अपने वजनसे १० गुना अमीरस फुलोंसे छत्तेतक पहुँचाती है। मालुम हुवा है कि अेक सेर शहद बनानेमें ७४००० मक्खीयोंको दसबार फूलोंसे छत्तेतक सफर करना पडता है। वसंत ऋतु और गरमियोंमें हरअेक मक्खी आधिक काम करती है अिस प्रकार फूलोंका अमीरस छत्तोतक पहुँचानेका काम करते करतेही मक्खी कहीं रास्तेमें गिरकर मर जाती है । और अिस कामको जारी रखनेको अिसी बीचमें दुसरी मक्खी उत्पान्नभी हो जाती अेक शहदका छत्ता तय्यार करनेमें प्रत्येक मक्खी हरसाल ११ करोड मीलका सफर करती है । अेक छत्तेकी माक्खियोंको खोराकेलिये ५० सेर शहदकी आवश्यकता होती है। अिसके सिवाय हमें जो शहद प्राप्त होता है उसकेलिये मक्खियोंको कितनेही करोड मीलोंका सफर करना पडता है ।

मधुमक्खीकी यह खास आदत है कि जिस किस्मके फूलोंमे उसे ज्यादा प्रमाणमें अमीरस दिखाती देता है वह उन्हीं फूलोंसे रस चूसना पसंद करती है और अिस किस्मके फूल जबतक उसे मिल सकें तबतक वह दूसरे प्रकारके फूलोंको नहीं छूती । अिसीलिये अेक प्रकारके फूलोंका पराग दूसरे प्रकारके फूलोंपर ले जाना कठीन है। अिसीकारण अलग अलग प्रकारका शहद अैसे कि जामुन, गुलाब, गेंदा, नारंगी वगैरहका बन सकता है।

शहदमें हरप्रकारके क्षार, अेन्झाअिम ( Enzyme ) और खुराककी चीजें होती हैं। उसमें लोहा, तांबा, मेंगेनीज ( Manganese ) प्रोटीन और विटामिन ( Vitamin ) भी होते है। अिसकेलिये मक्खीयोंको रसासनशास्त्र सिखनेकी आवश्यकता नहीं होती। अिन रसायनिक पदार्थोंके कारणही शहदका उपयोग ' मधुमेह ' ( Diabetes ) के रोगीभी कर सकते हैं। बच्चोंको शहद खिलानेसे अुनको आवश्यक मात्रामें हड्डियों और दातोंके लिये चूना ( Calcium ) मिल जाता है ।

फूलोंके रससे शहद किस प्रकार बनाता है यह अभीतक नहीं मालूम हो सका है। मक्खी पालनेवालोंने यह देखा है कि उडनेवाली मक्खी अपना लाया हुवा अमीरस छत्तेमें रहनेवाली मक्खीके मुहमें भर देती है और फिर यह छत्तेकी मक्खी अपनी जीभ अंदर और बाहर बार बार निकालती रहती है। अैसा करनेसे अमीरसका पाणी सुख जाता है और साथही साथ रसकी शक्करमें अेन्झाअिम्स ( Enzymes ) मिलाकर दो प्रकारकी शक्कर डेक्स्ट्रोज ( Dextrose ) और लेव्यूलोज ( Levulose ) तैयार करती है। शहद तैयार होनेकेबाद मक्खी उसे छत्तेके हरअेक सुराख ( Cell ) भर जानेकेबाद उन्हें मोम लगाकर अूपरसे बंद कर देती है। अिसके बाद सुराखके-अंदर अेन्झाअिम्स ( Enzymes ) अपना काम करते रहते है और कितनेही हप्तोंकेबाद शुद्ध शहद तैयार हो जाता है। यह शहद छत्तेसे निकालकर बाजारमें बेचनेके काममें लाया जाता है।

अमेरिकामें जहाँपर शहदका खोराकमें अच्छीप्रकारसे उपयोग किया जाता है वहाँ हरसाल २ अब्ज पाअूंड शहद बेचा जाता है। अुस देशके मक्खी पालेनेवालोंका कहना है कि मक्खियोंसे जितनी शहदद्वारा अुत्पन्न होती है उससे ३० गुनी अधिक अुत्पन्न अुनके कारनही खेतीसे होती है क्यों कि ८००००० अेकडके फूलोंको फलित करनेमें मक्खियोंकी पूर्णरूपसे सहायता मिलता है।

सुनहरी रंगका शहद खाना सब लोग अधिक पसंद करते हैं क्यों कि अुसका रंग शुद्ध होता है। कअी प्रकारके शहद रंगमें काले अुग्र सुगंधीवाले होनेके कारणही अुनका खानेमें कम उपयोग किया जाता है। अैसे किस्मके शहदको केक ( Cake ) वगैरह खानेकी चीजोंमें आटेके साथ मिलाकर उपयोग किया जाता है। गरम करनेसे शहदकी सुगंधी अुड जाती है किंतु उसका गुण कम नहीं होता। सिगरेट और दवाओंके बनानेमेंभी अैसे काले रंगके शहदका अुपयोग किया जाता है।

मक्खी और फूलोंके मेलजोल और मधुमक्खिकी महनतकी मनुष्यजातिको शहद अेक अनुपम बक्षिस है। शहद अेक अुत्तम प्रकारकी खुराकमें तो माना जाताही है किंतु अिस प्राकृतिक वस्तुकी अेक बुंदभी जीभपर रखनेही स्वर्गका अनुभव होने लगता है।

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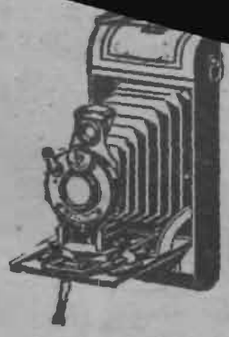

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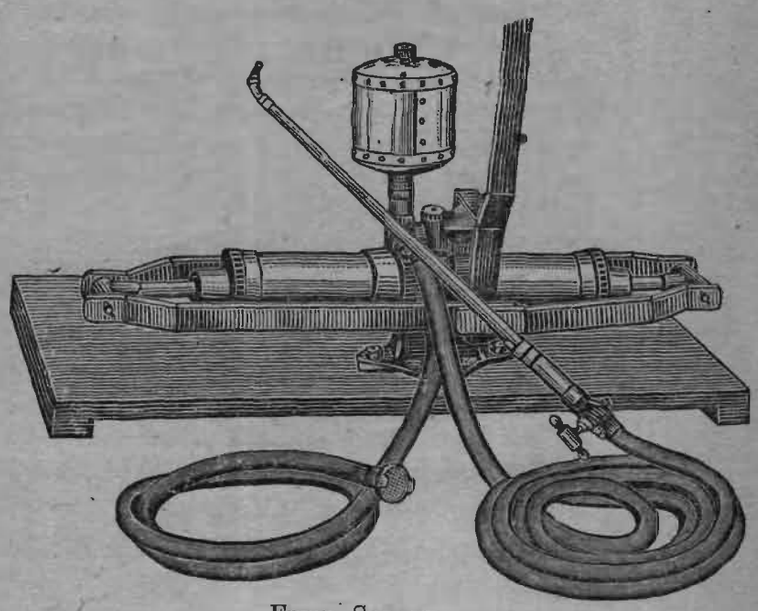

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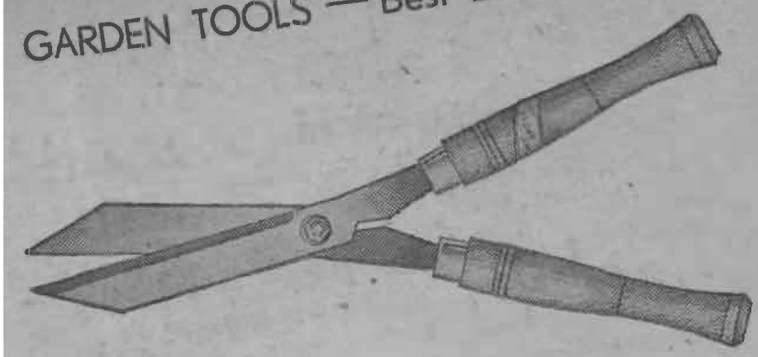

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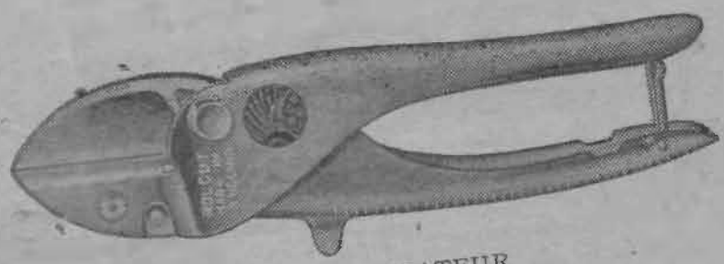

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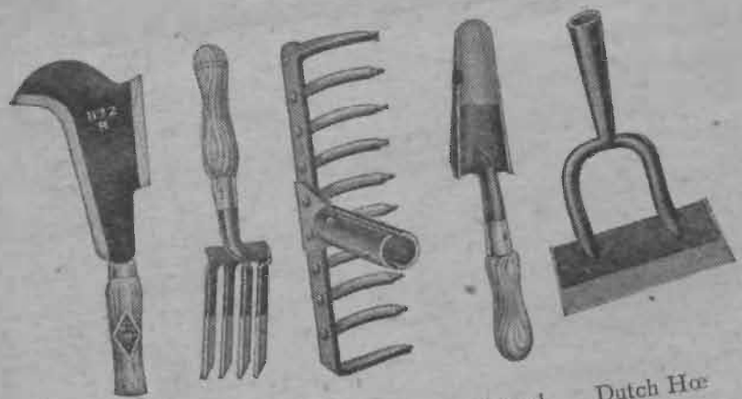

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## PRIZE I

Government of Bombay, with a view to encouraging increased production of foodcrops, have provided many facilities, such as supply of improved seeds and manures at concessional rates, subsidies for digging wells and repairs to old ones, subsidies for preparing compost manure etc. Government desire that all these facilities should be availed of by the agriculturists and they should contribute their might towards increased production. To introduce the spirit of competition amongst the cultivators, who would produce maximum yields per acre of staple food-grain crop, Government have announced prizes. The first prize is of the value of Rs. 75, the second of Rs. 50 and the third of Rs. 25, for each taluka as a unit.

The prizes will be distributed by the District Rural Development Boards, who have been empowered to receive applications, select staple crop of the locality, hold competitions and announce the prizes.

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For details, please approach the District Agricultural Officer or the District Rural Development Board of your district.

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VOL. XL, NO. 3 ] THE [ NOVEMBER, 1949

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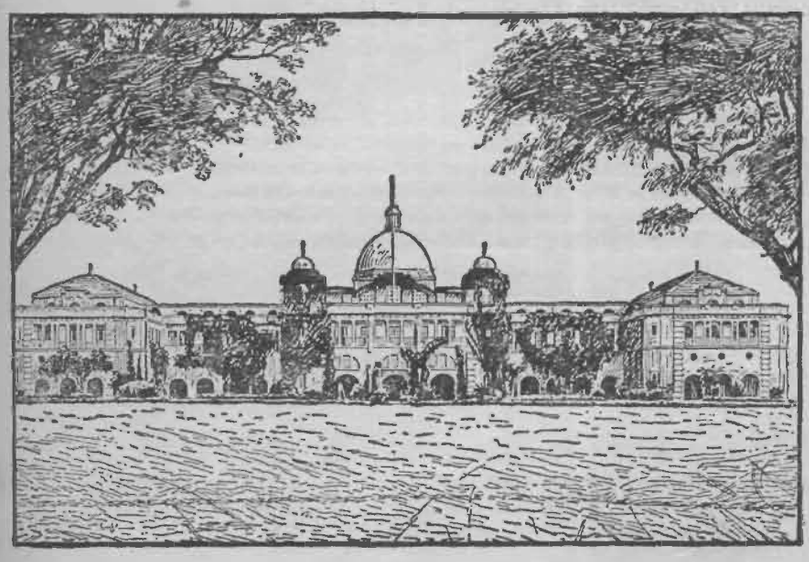

As the bee—injuring not the flower, its colour or scent—flies away, taking the nectar, so let the wise man dwell upon the earth.

—*Dhamma-pada*

To look out-side sources for food supply is to invite starvation.

—*Mahatma Gandhi*

I claim that in a well-ordered society there should be always prearranged methods of successful treatment of searcity of water and food crops.

—*Mahatma Gandhi*

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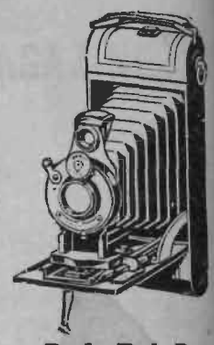

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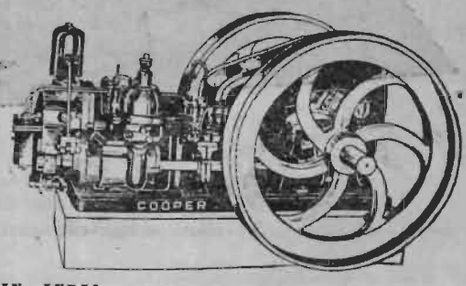


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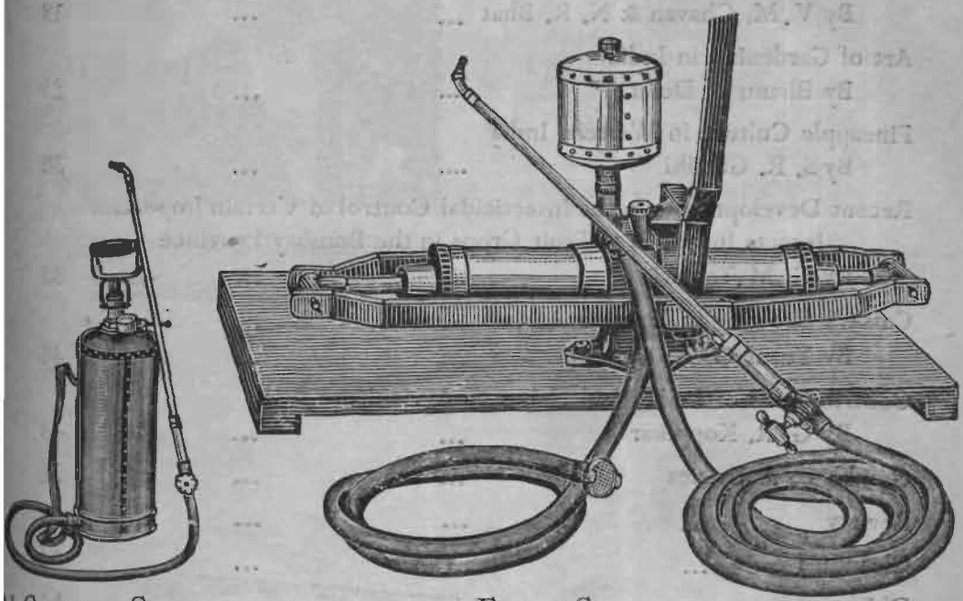

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**Mr. N. G. Dastane**

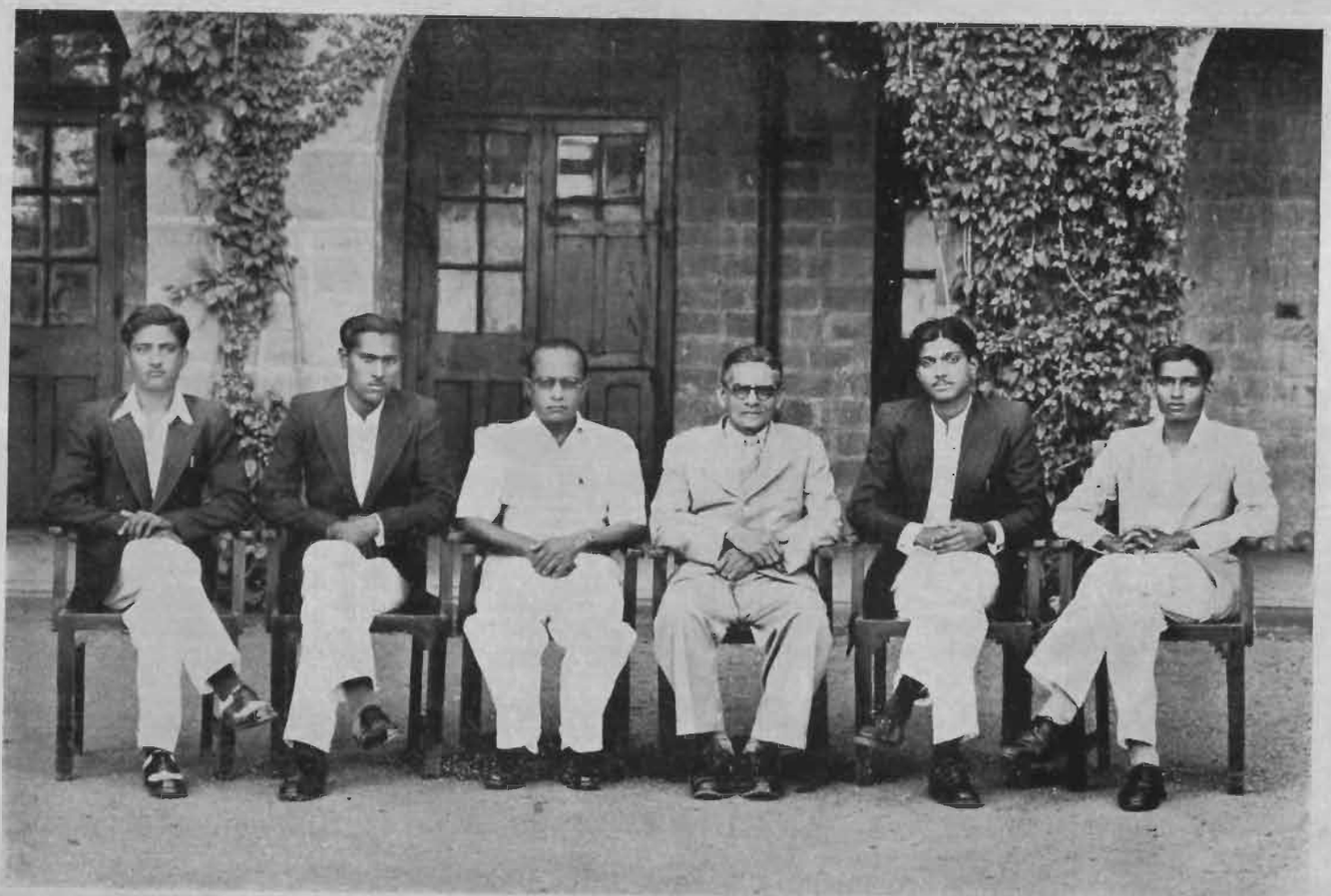
First Class First in B. Sc (Agri.) examination of the Bombay University, April 1949.

**Mr. S. B. Brahme**

General Champion in the College Sports 1949. He has won the General Championship Cup for the third time in succession.

# COLLEGE OF AGRICULTURE, POONA.

## Magazine Committee, 1949 -- 50



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THE POONA

# AGRICULTURAL COLLEGE MAGAZINE

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## Editorial

For implementing the policy of greater food drive and self-sufficiency of our country's food supply the Central Government have appointed Shri. R. K. Patil as the Food Commissioner for India. We welcome the appointment and trust that Shri. Patil will successfully fulfill the responsible task set before him. He has fixed an increase of 45,00,000 tons as the target for food output by the end of 1951. If the farmers were to work up with a will and with judicious use of selected seed, manure, etc, it is felt that it would not be difficult to produce the extra food wanted by the country or even to be self-sufficient in the year 1950-51.

Our countrymen should not, however, be satisfied by increasing the food supply during the next two years. A still greater effort will be necessary on our part to obtain much larger yields to cope up with the requirements of the increasing population. Unless this point is fully envisaged and proper planning of food increase and its transport facilities are attended to, it is felt, we will be in the same unhappy position a few years hence, as we have been in so far. A proper step in the direction of growing more food is collectivisation of farms and co-operative farming. Much labour and money is being wasted uneconomically at present in cultivating smaller units. Adjustment of the size of holdings, land tenure reforms, creation of interest amongst the crop growers, utilisation of the manpower released from agriculture due to collectivisation or co-operative farming are some of the problems which our ministers, the industrialists and the whole nation must consider, if they have the future well-being of our country and countrymen at heart.

In the fight for food Shri. R. K. Patil has rightly stressed the need for the urban workers to tour the villages. A large army of workers with a high sense of national duty is absolutely essential if the cry for the food front is to be carried to the remotest corner of the country. Fortunately the province is blessed with a good monsoon over most of its area this year and one can certainly

hope to get a fair return from the crops grown. An intensive effort on the part of those who have realised the gravity of the food situation will go a great way towards easing the same.

An urgent appeal bearing on this important issue has been issued by our Prime Minister Shri. Balasaheb Kher, calling for a number of volunteer workers to come forward and help in the raising of more food. The appeal is further backed up by the Minister of Agriculture Shri. M. P. Patil. If everybody considers it his bounden duty to help in this cause, it is certain that we can make a great headway in this most urgent national cause. It is no use depending upon other nations to help us out of the trouble, year after year. Self-help is the best kind of help and God helps those who help themselves. In this connection it is not out of place to mention that we have a large army of strong and stalwart beggars, who can be trained and put to profitable use in food production.

* * * *

A conference of actuaries and experts in agriculture and animal husbandry was held at Bombay on September 12th to consider a scheme of crop and cattle insurance. The conference recommended a pilot scheme of crop insurance in respect of three or four crops of major importance to be introduced at some selected representative centres. The research pilot Scheme will be introduced in agriculturally homogenous areas spread over India. The insurance benefit will be given to the extent of two thirds of the loss suffered on the basis of 75% of the standard yield to be determined by crop cutting survey by the Government. The conference also recommended the working out of a pilot scheme on cattle insurance in selected areas where it is possible to insure 1000 to 2000 cattle. The details are put up for the consideration of the Govt. of India and it is hoped that the scheme will be launched in the near future. The scheme if successful will serve as a basis for future insurance of all crops in the country. The scheme when introduced will be sure to be beneficial to the agriculturists. We look forward to the time when crop insurance is generally adopted all over India.

* * * *

Jute has been a very important crop in India's economy. It formed one of the main sources of export material in the foreign trade of India. With the separation of Pakistan 75% of the supply of raw material has gone to the lot of Eastern Pakistan. This has hit the jute manufacturing industry in India, as most of the jute mills are situated in West Bengal. It, therefore, becomes necessary for India to grow more jute with a view to supply the demands of its industry. Experiments tried out in the Travancore region indicate the possibility of successful jute growing in that region. It is interesting to note that jute growing is tried out in the Surat District at the suggestion of the Director of Agriculture, B. P. and its growth has been found to be successful. Jute is expected to thrive on the coastal strip of Thana, Kolaba and Ratnagiri Districts. If it grows

successfully, it will be a source of considerable income to the agriculturists of these tracts.

* * * *

It is understood that the Central Government has decided not to recruit agricultural graduates to the administrative services. We consider this decision to be most regrettable, especially under the present regime with a new outlook for the development and advancement of agriculture. The Central and the Provincial Governments have been and are planning large scale agrarian reforms. Many bold schemes are envisaged and quite a lot of expenditure is incurred on these schemes with a view to co-ordinate and increase food production. The practice of recruiting agricultural graduates in the revenue, agriculture, cooperative and irrigation departments as followed at present in many provinces of India is most logical. Besides the agricultural graduate has to take his chance in competetion with other arts and science graduates for selection by the Public Service Commission, which selects the fittest men. One, therefore, fails to understand why agricultural graduates are debarred by the Central Government. We feel that the Central Government should have a broader outlook and take a bold lead in this direction by removing the ban against the agricultural graduates. If it is felt that the agricultural graduates are not as well suited as other graduates, it is upto the Goverument to investigate the matter and appoint a committee to revise the agricultural courses if necessary. This matter is of a very great and vital importance to the agricultural graduates and we trust that the Central Government will reconsider the matter at a very early date.

* * * *

We congratulate Dr. B. A. Chaugule, Dr. H. R. Arkeri and Shri. N. Gopalkrishna, old *alumni* of our college, on their return after a successful career of studies in U. S. A. Dr. Chaugule took M. S. in Agronomy and Ph. D. in Plant Physiology of the California University. He was elected a member of the "Sigma XI" Research Society of U. S. A. and the Society of Horticultural Science because of his excellent work and record at California. He has been appointed here as Assistant Professor of Agronomy, after his return. Dr. H. R. Arkeri, obtained M. S. and Doctorate degrees in Agronomy at the Minnesotta University. On his return in September he has been appointed Professor of Agronomy at the Agricultural College, Dharwar. Shri. N. Gopalkrishna took M. S. of the University of Illinois in Horticulture obtaining best grades. He has also done the necessary work for Ph. D., and will submit the thesis therefor from here. He has been appointed as Assistant Horticulturist to Government, B. P. Poona.

* * * *

We have been hunoured by the visit of Shri. R. K. Patil, Food Commissioner, Central Government. He was taken round the college on 18th September 1949, and shown the working of various sections and research activities going on at the college. Later he met the heads of sections of the Department of

Agriculture and Rural Development workers in a conference, when problems dealing with increase of food production and necessary steps to be taken in this direction were discussed. The Assistant and Deputy Collectors who came for a training course in agriculture for a fortnight from 20-9-49 to 1-10-49 were amongst the other visitors at the college. Mr. Vladimir Ignatieff, Fertilizer Expert, F. A. O. and Mr. Edward Slim, Economic Affairs Officer, UNO visited the college on 25-10-49.

* * * *

The Department has lost a capable and conscientious worker by the retirement of Shri. H. M. Desai. He joined the Poona Agricultural College as a demonstrator in agriculture in 1917 and was later appointed as Lecturer in Agriculture. After a long period of service at the College he was transferred to Gujarat as District Agricultural Officer. He acted for some time as Cotton Superintendent, Surat. Later he worked as Personal Assistant to the Director of Agriculture, B.P., Assistant Director of Agriculture and Professor of Agriculture, Agricultural College, Poona. In January 1947 he was transferred to Dharwar to organise and establish the new Agricultural College there. He has very ably and satisfactorily conducted the duties of Principal, Agricultural College, Dharwar. We wish Shri. Desai a long and happy life with a well deserved rest.

* * * *

A meeting of the staff members and students was held on 24th October 1949 in New Lecture Hall to celebrate the United Nations Day, when Principal L. S. S. Kumar explained the ideals and importance of the Organization of the UNO under the present conditions.

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# Agriculture as a Career

By

PRINCIPAL L. S. S. KUMAR *

The students about to finish their secondary or high school education are often faced with the dilemma of choosing their course of further education to fit them to a suitable career. They know that higher education is provided in the arts and science colleges and the technical colleges turn out medical, engineering or agricultural graduates. But which one of these courses offer a good prospect is a question that often occurs to the students about to finish their school education. In answer to this question the advantages that would result from choosing agriculture as a career will be explained in this brief talk.

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* Radio talk given on 7th September 1949 on A. I. R. Bombay.

First, it is necessary to consider the importance of agricultural education. It is common knowledge that our country is predominantly agricultural, its economy is mainly based on agriculture and further our national income is derived mainly from this same source. Notwithstanding all this, it is observed that agriculture has declined during the past few centuries and that the few sporadic attempts made in the past to develop agriculture, have proved ineffective in times of emergency as the one at present. Therefore it is necessary now to develop our agriculture by intensified efforts to make the country self-sufficient in regard to food.

The trend of agriculture in Western Countries during this century has been quite different compared to that generally followed in the East. The West has advanced considerably in agricultural practices and methods. Our country too has to change its methods and adopt practices to meet the increased demand for agricultural products. But, this can only be done by adopting scientific methods of agriculture, which is only possible if sufficient number of technically trained persons are available. In countries agriculturally advanced there is considerable evidence to prove that agricultural education by research and propaganda has helped largely in improving the practices and in increasing food production.

What this education is and how it is obtained will be briefly considered now. To train young men and women in agricultural science, two types of facilities are available. To those who have completed secondary education and are fit to receive collegiate training every major province and state in this country has one or more agricultural colleges. To those that are less educated, training of a more practical but less theoretical nature is provided for in agricultural schools.

Thus in our province there are three agricultural colleges at Poona, Dharwar and Anand to train up graduates in scientific agriculture to meet the requirements of the regions of Maharashtra, Karnatak and Gujarat respectively. These colleges provide, for the present, a three years course leading to the Bachelor's degree in Agriculture of the University to which they are affiliated. Candidates having the First Year Science examination with a certain minimum fixed standard are admitted. The students entering the agricultural college are given both theoretical and practical instructions. The theoretical instruction is provided in the lectures given by specialists in the different subjects. The practical training is provided for both in the laboratory and the field. The field training in particular is of considerable importance. It is here that the student learns the principles underlying the various practices followed by the peasant. Each student is given a plot of land in which he practices by his own efforts everything that is required from beginning to end for successful production of crops. The student thus becomes self-confident and acquires mastery in handling various farm implements and managing the farm animals. At the end of the three years course a student becomes trained in the various aspects of agriculture and is ready to take service in one capacity or another to promote agricultural development.

At each agricultural college, for each of the years, a certain number of Government merit scholarships are awarded to students belonging to advanced and intermediate communities. These are offered as incentives to students to work and study to secure the scholarships. Greater concession is shown to students belonging to Backward class. Every such student admitted is not only given a scholarship and free lodging but also other aids to complete his training. The open air life and the health giving occupation in the agricultural college makes the students benefit both in mind and body.

We shall now consider what lines of work await the graduates in agriculture. There are three lines in which they are employed.

Firstly there is the Government service. Here agricultural graduates are required for the organisation and supervision of the district work, doing propaganda and giving advice to peasants. Persons entering this line as juniors have in course of years opportunities to rise to responsible posts of district officers. The counterpart of the district organisation is the research line. A large number of graduates are employed for undertaking research in the different branches of agricultural science on Government farms and experimental stations. Researches on plant and animal improvement by breeding, investigations into the causes and control of animal and plant diseases and pests, amelioration and reclamation of soils, improving the methods of tillage for increasing crop production, devising of suitable machinery for speeding up and increasing the efficiency of agricultural operations, economics of the different systems of farming and many other problems require investigation. Besides this, certain number of graduates are employed as teachers not only in agricultural colleges and schools, but also in schools run by education department where agriculture is one among many other subjects taught for the S. S. C. examination. Further some of the persons employed by Government have been sent abroad for training to fit them on their return for occupying responsible positions. In addition Government has planned to clear some of the forest areas to bring more land under cultivation and to utilise waste lands of the province for producing more food. The agricultural graduates will be given opportunities to settle on these reclaimed lands. Government on their part will give every kind of help by way of loans, seed, manure, implements and other concessions to encourage the agricultural graduates. Thousands of acres so reclaimed will be available for colonisation by many agricultural graduates.

The second avenue of occupation is provided by the industrial and commercial concerns which either directly produce and process on a large scale agricultural commodities or those that use agricultural produces as raw materials of manufacture. Thus sugar, canned foods, silk and fibre factories own their estates or plantations to obtain the raw material. These factories employ agricultural graduates for raising the crop, or to work as estate managers. Likewise coffee, tea, rubber, sisal, cinchona, cardamon, clove and cocoanut estates require the

services of knowledgeable agricultural graduates. Industrial concerns dealing in agricultural machinery, fertilizers, chemicals for the eradication and control of weeds, insect pest and plant diseases, require agricultural graduates to sell their goods to their customers. The mechanization of agriculture would require agricultural graduates with engineering knowledge. As more and more uses are made of raw materials of agriculture in industry, there will be greater demand for agricultural graduates to produce these raw materials of highest and best quality in the most scientific and economic manner. Therefore without a well developed agriculture the industries of a country will lag behind. Both are complementary to each other and scientific development of agriculture requires a large number of trained agricultural graduates. Many agricultural graduates who have been employed in industry have rendered very good account of themselves.

The third avenue of employment is provided by private farming which is of two kinds–i. e., private farming on one's own or as an agent of another. Several agricultural graduates are farming very successfully on their own because of their scientific training. Many graduates have managed successfully private farms of big land owners. Successful private farming either on one's own or as an agent of another is only possible if one has himself gone through the pre–requisite scientific training. Otherwise it would be amature farming without any scientific basis.

Sons of well to do land owners could take to agricultural education so that they can have their private dairy, poultry, sheep or bee farms or vegetable or fruit orchards on a commercial scale. Small scale private farming can be undertaken by those of limited means.

The agricultural trend of this country in future would be co–operative farming. For this, help and guidance of technically trained persons in agriculture would be required.

Agricultural graduates employed by Government are paid in accordance with the standard of passing. Thus a graduate of pass class is started on Rs. 95 per month. An honours graduate will receive Rs. 100 p. m. and one with first-class honours Rs. 105. The salaries rise upto Rs. 200/– p. m. with annual increments varying from Rs. 5 to Rs. 10. These pays are exclusive of the dearness and house rent allowances. Many of the Gazetted officers of the Agricultural Department today are those who started on a small pay and have now risen to occupy responsible positions with high salaries. The salaries paid by private firms are about the same or sometimes even higher.

To make the country self–sufficient regarding food, Central and Provincial Governments are planning large multipurpose irrigation projects. These will bring millions of acres under cultivation, to await development scientifically. Similarly the soil conservation measures to prevent destruction of agricultural lands and lift–irrigation projects to command greater area under crop production are further activities that would require the services of agricultural graduates. It will thus be seen that agriculture opens up a career for the enterprising and enthusiastic young men and women who have at heart the development and prosperity of their country.

# Agriculture as Known to Panini

( Continued from August '49 issue )

By

DR. V. S. AGRAWALA *

The operations of agriculture are neatly summed up in the *Satapatha Brāhmana*( I. 6., 1. 3 ), as ploughing, sowing, reaping and thrashing (*Krishantaḥ, vapantaḥ lunantaḥ, mṛiṇantaḥ*). In the *Ashṭādhyāyī* all these are distinctly described.

( i ) **Ploughing** ( *Karsha* ):—*Karsha* was done by means of the plough, the ploughed land being called *halya* ( IV.4. 97 ). A new root *halayati*, ' he uses the plough', derived from the noun *hali* had come into use which Pāṇini teaches in *sūtra* III. 1. 21**. We learn from *Patañjali* that agricultural labour was employed for ploughing, by means of which it was possible for the owner of the field to sit in a corner of his field and supervise silently the ploughing done by five hired labourers (*ekānte tūshṇīm-āsīna uchyate panchabhir-halaih kṛishatiti, tatra bhavitavyaṁ panch-abhir-halaiḥ karshayat-īti, Bhāshya*, II. 33). The labour received *bhakta* or food in lieu of wages which it was the duty of the husbandman to provide at the proper time. The Greeks observed the careful ploughing habits of the people in this country. They were struck with the amazing fertility of the soil ( Meg. Frag: I. ) and the skill of the agriculturists (Arr. *Anab.*, V. 6). We are indebted to Pāṇini ( V. 4. 58. ) for the information that deeper and deeper furrows were cut by repeating twice and thrice the process of ploughing on the same field, viz. two times ( *dvitīyākaroti* ) and three times ( *tṛitīyā-karoti* ). The *Arthaśāstra* (Text, P. 116) describes such heavy rainfall as would need three ploughings (*trīn karshakān*). To achieve even better results, it was the custom to plough the same field over again from one end to the other in a reverse direction (*śambā-karoti*, V. 4. 58) *anulomakṛishṭaṁ kshetraṁ punaḥ pnatilomam kṛishatity-arthaḥ*). Provision is also made in the next *sūtra* for expressing cases in which the number of ploughings exceeded even three (*Saṁkhyāyāś cha Guṇāntāyāḥ* V. 4. 59).

(ii) **Sowing** (*vāpa*):—After the requisite number of ploughings and the preliminary preparation of soil ( *kshetroparjana, Bhashya*, I. 453 ), the field becomes 'ready for immediate sowing' (*vāpya*, III. 1. 126). In places where the

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* Superintendent, Central Asian Museum New Delhi.

** *Munda... hala-kala-kṛita-tūstebhyaḥ ṇich*, III. 1.21. According to Kātyāyana *hala* is the substitute for the original *hali* (See *Bhāshya*, II.28)

ground was extremely fertile, intensive ploughing before sowing was not necessary, and ploughing and sowing were done together. Strabo says that after the subsidence of the floods, the half-dried soil 'though scratched into furrows by any common labourer brought whatever was planted to perfection' (*Strabo*, XV.1.13). It is for such fields that Pāṇini was making provision in the word-form *bijā-karoti* (*saha bijena vilekhanaṁ karoti*, *Kāśikā*, V. 4. 58), i.e., 'after scattering the seeds he scratches the field by the plough.'

We have seen that the quantity of seed required for a field of particular size was determined by weight. In illustration to Pāṇini V. 1. 45 (*Tasya vāpaḥ*) the commentators cite *prāsthikam*, *draunikam*, *khārīkam*, i. e. fields requiring one *prastha*, one *droṇa* or one *khārī* weight of seed.

*Mixed crops:*—The custom of sowing mixed crops also seems to have been known specially in the case of sowings in the rainy season. We are told by Patañjali that sesamum seeds were sown mixed with beans, but in such mixing the beans (*māsha*) remained the principal crop and sesamum (*tila*) only secondary. The practical effect of this relationship of primary and secondary was that the farmer ploughed his field with an eye on the principal crop, and at the time of actual sowing the other kind of seed was casually mixed and scattered (*Bhāshya* on VIII.4.13). The trend of Patañjali's discussion is that the mixing of *tila* with *māsha* is not obligatory for good germination, for if it were so, then both the crops would have to be considered primary. Only when one is the principal (*pradhāna*) crop as *māsha* and the other secondary as *tila*, can the sentense *tilaiḥ saha māshān vapatīti* be an appropriate example of Pāṇini II.3.19, *Sahayukte apradhāne* (*Bhāshya* on II. 3. 19).

Farming is an operation vitally connected with Mother Earth and the farmers naturally attached great religious significance to the actual ceremony of the sowing of seed, for which purpose they selected auspicious days. Pāṇini tells us that one of the auspicious days for sowing was the full-moon day of the month of Agrahāyaṇa (*Āsvayujī Paurṇamāsī*, IV. 3. 45). The *Sarat-pūrṇimā* is the brightest and clearest moon-lit night in the whole year and is still considered auspicious for operations connected with the plant kingdom.

(iii) **Reaping** (*Lavana*, VI. 1. 140):—The ripened grain* was cut by a sickle (*dātra* or *lavitra*, III. 2. 182;184). The entire operation of mowing was called *abhilāva* (III. 3. 28, *nirabhvoḥ pūlvoh*). In the present day dialects it is called simply *lāva*; at the time of *lāva* there is much buzzing activity in the fields and extra labour is engaged. The mowers were known as *lāvakāḥ* (III. 1. 149). *Pāṇini* also refers to a special method of harvesting (VI. 1. 140, *kiratau lavane* ) expressed by the verb *upaskirati* which refers to reaping, not begun from one end of the field and carried to the other but in a disorderly manner. We learn from the *Kāśikā* that such a practice prevailed in the countries of Madra and Kashmir (*Upashāraṁ*

* The grain which had so much ripened as to require immediate reaping was called *lāvya* by the Pāṇinean rule III.1.126.

*Madrakā lunanti; upaskāraṁ Kaśmīrakā lunanti*). Some cereals cannot be harvested without uprooting the whole plant and these e.g., *māsha* and *mudga* were called *mūlyāḥ* (IV. 4. 88, *mūlamasyābarhi*). The stumps were weeded by a special kind of hoe called *stambaghna* (III.3.83).

(iv) **Thrashing**, (*nishpāva*, III. 3. 28):—The reaped crop was stacked on a thrashing floor, *khala*. The Pāṇinian word *khalya*, a field good for thrashing floor (V. 1.7) shows that special plots were selected on the basis of their being suitable for thrashing operations possibly for considerations of shade and safety. Of the group of fields under his cultivation, the agriculturist reserved some special ones for thrashing, probably those affording shade and situated at a high level. Pāṇini also gives a rule for naming a collection of thrashing floors (*khalyā*, IV.2.50 or *khalinī*, IV.2.51), which shows that several farmers chose to locate their thrashing floors as compactly together as possible. The *Arthaśāstra* corraborates this by saying that 'The thrashing floors of different fields shall be situated close to each other' (*Arth.* II. 24). The obvious reason for such a course was corporate measures of safety against thieves and wild animals.

The method of winnowing was the same as followed even now by the Indian peasant, viz. the scattering of corn (*utkāra* or *nikara* from *kri dhānye*, III. 3. 30) by means of the winnowing fan, *śūrpa* (V. 1. 26), in the direction of the wind and separating grain from chaff (*nishpāva*, III. 3. 28).

*Bee-hive activity of the harvesting season.*:—The following interesting list of words indicates the beehive activity of the harvesting season; they were used as time-denoting words synchronising with the different operations carried on in that part of the year.

(1) *Khale-Yavam;* "barley-in-the-thrashing-floor" period (2) *Khale busam;* "barley-straw-in-the-thrashing-floor" period. (3) *Lūna-Yavam;* "barley-having-been-reaped" period. (4) *luyamāna-yavam* "barley-being-reaped period. (5) *Pūta-Yavam*; "barley-having-been-winnowed" period. (6) *pūyamāna-yavam*. "barley-being-winnowed" period. (7) *Saṁhṛita-yavam*: "barley removed-to-barn" period. (8) *saṁhṛiyamaṇa-yavam*. "barley-being-removed to-barn" period. (9) *Saṁhṛita-busam*; "barley-straw-removed-to-storage period. (10) *saṁhriyamaṇa-busam*. "barley-straw-being-removed-to-storage period.

The ten words in this list form part of the *Tishthadgu* group (Pāṇ. II. 17). Kātyayāna's *vārttika* on it, *khaleyāvādīni prathamāntāni anyapadarthe*, and Patañjali's comments on the same (*Bhāshya*, I. 381) leave no doubt that the words can be genuinely ascribed to Pāṇini himself. The meanings are given in detail by Vardhamāna in the *Gaṇaratnamahodadhi*, e. g., *khale busāni yavāś-ca yasmin-kāle, i. e.*, the time when the barley crop or barley straw is heaped in the thrashing ground is *khale-yava* and *khalebusa; lūnā* or *lūyamānāś-cha yavā yasmin kale* i. e. the time when barley had been reaped or was being reaped was call

*lūna-yava* or *lūyamāna yava* and so on. If we just change the order of nos. 1–2 by nos. 3–4, the five pairs of words would point to the harvesting operations of the barley crop in a real sequence. Nos. 7–8 and 9–10 denote the removal of corn and straw from the thrashing floor to the barn. Kautilya also directs that, grain and other crops shall be collected as often as they are harvested. No wise man shall leave anything in the fields, not even straw' (*Arth.* II. 24). That most of the above terms refer to the barley crop is suggestive of the place of origin of these terms being the Punjab where barley had always been one of the principal crops.

Pāṇini also tells us that debts were contracted on the stipulation of being paid back at the time when barley was thrashed. The barley harvesting season was nick-named *Yava-busa* (barley-straw), and the debt to be paid in the *Yavabusa* season was called *Yavabusaka* (IV. 3. 48). The *Yavabusa* season would literally correspond to the harvesting time denoted by *khale-yava, khale-busa* etc., given above. For the Punjab barley crop meant prosperity and loan-repayment. As Patañjali informs us a bumper crop of barley or rice guaranteed prosperous times (*Eko vrihih sampannah subhiksham karoti; eko yavah sampannah subhiksnam karoti*, (*Bhāshya*, I. 230), the two crops having reference to the *udīchya* and *prāchya* or Madra and Magadha divisions of India. The barley crop of the Vāhīka region finds mention in Patañjali, *Uśīnaravan-Madreshu yavāh* (*Bhāshya*, I. 147) and so the *sāli* crop in the Magadha country, *tāneva śālīn bhuñjmahe ye Magadheshu* (*Bhāshya*, I. 19). Of all the crops then cultivated, it is for barley alone that we are told by Pāṇini that special officers called *yavapāla* (*Gotanti-yavam pāle*; VI. 2. 78) were appointed to keep watch over those fields.*

**Rainfall and irrigation**. :—The crops in India have usually depended for irrigation on four sources of water supply, viz. rain water, rivers, well-water and canals. Pāṇini refers to the rainy season as prāvrish (IV. 3. 26, VI. 3. 14) and *varshā* (IV. 3. 18) the former according to Hopkins denoted the first part of the rains (Epic chronology, J. A. O. S., 1903, p. 26). The duration of the rainy season is not indicated although Pāṇini divides the season into a first and a second half (VII. 3. 11) known as *pūrva-varshā* and *aparavarshā*. He also refers to *varsha—pramāṇa* (III. 4. 32), measurement of rain-fall of which *goshpada* (cow's foot-print) is stated as a measure (VI. 1. 145), but the evidence is not as full as in the Arthaśāstra which states the quantity of rain (*varsha prāmāṇa*) in Jāṅgala and other parts of the country. In one place failure of rain or drought, *varsha-pratibandha*, is referred to as *avagraha* ** (III. 3. 51). But there is no

* Patañjali refers to the possibility of danger to barley crop from herds of deer:— '*Na cha mrigāh santiti yava nopyante*'. The presence of the deer herds does not deter one from sowing barley-crop' (*Bhāshya* 1. 100). This proverb with that of the *Sthali* and *Bhikshus* is quoted in the Kāmasūtra under the name of Vātsyāyana.

** Besides *avagraha* known to Pāṇini, Patañjali mentions other pests to crops from swarms of mice, locusts and hawks (*Ākhūttha, śalabhottha, śvanottha*, II. 98).

indication of the visitation of famines. Megasthenes tells us that famines were unknown, because there was an abundanee of food-crop, and secondly, because India had a double rainfall in course of a year, one in winter and the other in summer. On account of this double rainfall there was a double crop every year. Pāṇini mentions the double crop system as *vāsantaka* ( vernal ) and *āsvayujaka* ( autumnal ) ( IV. 3. 45; 46 ).

River irrigation is an important source of water supply in India. Pāṇini refers to many important rivers as the Sindhu, Suvāstu ( IV. 2. 77 ), Varṇu ( IV. 2. 103 ), Sarayū ( IV. 4. 174 ), Vipāśā (Beas, IV. 2. 74), *Chandrabhāga* (IV .1. 45) and many other rivers in the *Gaṇapātha*. He also refers to Devikā ( VII. 3. 1 ) ( the river Deg in the Punjab ) the banks of which were specially suitable for growing paddy crops as hinted by Patañjali ( *Dāvika-Kulāḥ śālayaḥ*, *Bhāshya*, III. 316 ).

Pāṇini also mentions the thawing of snow on mountain tops called *himaśratha* ( VI. 4. 29 ) and also refers to glaciers ( *himānī*, IV. 1. 49 ) which were great sources of water flooding the rivers. Irrigation by lifting water from the wells must have been the most handy means available to a majority of the cultivating population. Pāṇini mentions *udañchana* ( III. 3. 123 ), meaning the large leathern bucket used for lifting well-water, and also *yuga-varatrā*, yoke and the big rope used for drawing the *udañchana* ( *Gaṇapāṭha* to IV. 2.45 ). There is no reference in the Ashṭādhyāyi to canals or improvised means of irrigation. Patañjali, however, speaks of canals for irrigating rice fields ( *sālyarthaṁ kulvaḥ* praṇīyante, *Bhāshya* 1. 82 ).

*Crops*:—Crops, broadly speaking, were of two varieties *kṛishṭa-pachya* ( III. 1. 114, ) i. e., grown by cultivation and *a-kṛishṭa-pachya*, naturally growing in the jungles as *nivāra* etc. An attempt to classify further is evident in the names of crops derived from the time of their sowing ( IV. 3. 44; 46 ) and the time of their ripening ( *pachyamāna* IV. 3. 43 ). The following evidence under the former is important.

1. *Upte cha* (IV. 3. 44 ).
2. *Āśvajujyā vuñ* ( IV. 3. 45).
3. *Grīshma-vasantād-anyatarasyām* ( IV. 3. 46 ).

Thus we know of three crops, the first sown on the full-moon day of the month Āśvayuja or Āśvina ( Sept.-Oct. ) and called *āśvajujaka*; the second sown in summer and called *graishma* or *graishmaka*; and the third sown in spring and named *vāsanta* or *vāsantaka*.

The *āśvayujaka* crops are chiefly barley and wheat and they ripen in spring. The crop sown in spring would ripen in the rains, and the third sown in summer would ripen in autumn or the month of Mārgaśīrsha.

This classification of crops in Pāṇini finds surprising confirmation from the *Arthaśāstrā*. Kauṭilya enters into a detailed discussion as to the most suitable time when a king should march for invasion (*Artha.* IX. 1). We learn there that a king should march in (a) Mārgasīrsha ( December ) in order to destroy rainy crops ( *vārshika sasya* ) and autumnal produce ( *haimana mushṭi* ); (b) in Chaitra ( March ) to destroy autumnal crops (*haimana sasya*) and vernal produce (*vāsantika mushṭi* ); (c) in Jyeshtha ( May and June ) to destroy vernal crops ( *vāsantika sasya* ) and rainy produce ( *vārshika mushṭi* ). *Sasya* and *mushṭi* in *Kautilya* correspond to *vāpa* and *Pachyamāna* in Pāṇini, i. e., the sown crops and the ripened crops. The similarity of the seasonal crops as gathered from these two authors may be clearly understood from the following comparative table.

| 1. Name of Crop ( *sasya* ) in Kauṭilya according to sowing season ( *vāpakāla* ) | 2. Name of produce ( *mushṭi* ) in Kauṭilya according to ripening or harvesting season ( *pachyamāna* ) | 3. Time of Marching for the king in Kauṭilya | 4. Corresponding names in Pāṇini for the crops according to the time of sowing ( *upte cha* ) |
|---|---|---|---|
| *1. Vārshika* | *Haimana* | *Mārgasīrsha* | *1. Graishma* and *Graishmaka* ( iv.3.46 ) |
| *2. Haimana* | *Vāsantika* | *Chaitra* | *2. Āśvayujaka* ( iv.3.45 ) |
| *3. Vāsantika* | *Vārshika* | *Jyeshtha* and *Mūla* | *3. Vāsanta and Vāsantaka* ( iv.3.46. ) |

Columns 1 and 4 reveal striking similarity. With respect to Pāṇini's *graishma* crop against which we find *vārshika* in Kauṭilya, it may be pointed out that the Arthaśāstra also knows of *graishmika* crops ( *Arth.* Text. p. 117 )*. But the raising of summer crops entails much hard labour on the part of the agriculturists, hence Kauṭilya directs that only the king who is in financial trouble and who has exhausted other means of replenishing his exchequer should prevail through his collector-general upon the peasantry to raise summer crops ( *Arth.* Tr. p. 271. ).

* Karmodaka-pramāṇena kedāraṁ haimanaṁ *graishmikam* vā *sasyaṁ sthāpayet*, Arth., II. 24.

## *AGRICULTURAL PRODUCE.*

1. Cereals ( *Dhānya* ):—Pāṇini mentions the following food grains and pulses :

*Vrīhi*:—Rice must have been an important crop in the days of Pāṇini. Special fields for growing *Vrīhi* and *śāli* are mentioned ( *Vrīhiśālyor-ḍhak*, V. 2.2) A sacrificial cake prepared from rice is called *vrīhimaya* ( IV. 3. 146 ). One who possessed a stock of rice was known as *Vrīhimān, vrīhāka* or *vrīhī*. This must have been a coveted title indicative of social status and opulence. *Bahu-vrīhi*. the name of a compound ( II. 2. 23 ) is literally synonymous with *vrīhimān*, i. e. one who has a plentiful stock of *vrīhi*. According to the *Taitt. Samhitā* (VII.2. 10. 2. ) *vrīhi* was an autumnal crop ( *Vedic Index*, Vol. I. 182 ).

The following varieties of rice are mentioned :

( i ) *Sāli* ( V. 2. 2. ):—Kauṭilya also mentions *śāli* as different from *Vrīhi* ( *Oryza Sativa* ). Mr. Dutta, author of the *Materia Medica of the Hindus* distinguished it as a crop harvested in the cold season, while *vrīhi* ripened in the rainy season. *Vrīhi* is a much older word used in the *Vājasaneyī Saṁhitā* ( XVIII. 12 ) and the *Brihadāranyaka Upanishad* (VI. 3. 13) as the first of the cultivated grains ( *grāmyadhānyas* ). Patañjali refers to a distinctive red variety of *śāli* ( *lohita-śāliman grāmaḥ* I. 403 ) and also speaks of irrigation channels specially dug to water the paddy crop.

( ii ) *Mahāvrīhi* (VI. 2. 38 ):—It seems to have been a well-known variety of rice in the days of Pāṇini, grown in Magadha. The *Taittirīya Brāhmana* III. 1. 5. 2 mentions the *mahāvrīhi* rice.

( iii ) *Hāyana* (III.1.148):—Pāṇini derives it from the root *hā*, 'to give up' in the sense of a kind of *vrīhi*. It appears that *hāyana* was that kind of paddy which was transplanted and is popularly called *Jarahana*.

( iv ) *Shaṣṭikā*:—According to Pāṇini this variety was so called because it took sixty days to ripen: *Shaṣṭikāḥ shaṣṭirātreṇa pachyante* V. 1. 90. According to Kātyayana the etymological sense of *shaṣṭika* had receded into the background, the word denoting a specific variety of rice; any other corn also taking sixty days to mature would not bear this name ( *Shaṣṭika saṁjñā-grahaṇam*; also *Bhāshya* on it II. 360 ). It is surprising that Kauṭilya does not mention crops of *shaṣṭikā* rice. Pāṇini is the earliest author not only to name it, but also to give the sound etymological explanation of its name *Sāṇṭhi* ( Hindi name of *Shaṣṭikā* rice ) was best suited to grow in the Punjab, since it does with but little water, it being sufficient if the soil is thoroughly moist after the shoots are once up. It is a coarse rice being a variety of *Oryza Glutinosa*, the grains of which agglutinate when boiled ( Watt's *Dictionary*, Vol. V. pp. 620–21 ).

( v ) *Nīvāra* ( *Nau vṛi dhānye*, III. 3. 48 ):—Of the wild or uncultivated variety of rice which was included under *a-kṛishta-pachya* class, *nīvāra* alone is mentioned by Pāṇini. The *Yajurveda* mentions both *nīvāra* and *śyāmāka* (XVIII.13.).

2. *Yava* (Barley):—Fields where barley was grown ( V. 2. 3. ) or those the soil of which was specially favourable for the cultivation of barley ( V. 1. 7. ) have already been referred to. Pāṇini also refers to special officers whose duty it was to take care of the barley fields ( *Yavapālas*, VI. 1. 78. ).

A variety of barley which Kātyāyana says must have been of inferior kind, is referred to as *Yavānī* (IV. 1. 49). *Yavaka* also appears to be one of the species of barley, for which fields were set apart ( *Yavakyam kshetram*, V. 2. 3. ). Barley must have been sown in the beginning of winter, probably on the Āśvayujī Pūrṇimā ( IV. 3. 45 ) which was a very auspicious day for scattering seeds. A ceremonial sowing of barley is still done in Hindu homes on the first bright day of the month of Āśvayuj and the young sprouts are worshipped on the tenth day of the same month. Barley ripens as a vernal crop, and the season of its harvesting is referred to by Pāṇini by about half a dozen names, such as *yavabusa* ( IV. 3. 48 ), *khaleyava*, *lūnayava*, *pūtayava pūvamānayava*, *saṁhṛika-yava saṁhṛiyamāṇa-yava* ( II. 1.17 ).

3. *Mudga* ( Phaseolus Mungo ) ( IV. 4. 25 ).

4. *Māsha* ( Phaseolus Radiatus ), ( V. 1. 7., V. 2. 4 ).

Both these pulses are considered native of India and have been cultivated for at least 3,000 years. They occur in the list of the *Vājasaneyi Saṁhitā* (XVIII. 13 ). Their cultivation has always been very extensive in the Punjab, where they are almost always sown mixed in the fields deriving their name from *māsha* and called *māshīṇa*, from which the crop is popularly known as *masīnā*. As examples of crops harvested by uprooting, the *Kāśikā* quotes *māsha* and *mudga* on Pāṇini IV. 4. 88. ( *mūlyaḥ māshaḥ*, *mūlyaḥ mudgaḥ* ). We are told by Watts that in certain districts the crop is cut, in others it is pulled out ( Watt's *Dictionary* Vol. VI, Pt.I. p. 189). Patañjali says that *mudga* also takes sixty days to ripen like the *shashṭikā* rice ( *Bhāshya* II. 360 ); in one place he also refers to *rāiamāsha* (*rāja-māshebhyo hitaṁ rājamāshyaṁ* (*kshetram*), II. 345), a variety of *māsha* grown in the Punjab.

5. *Tila* (sesamum):—It is often, in the Vedic literature as well as in Pāṇini, mentioned in connection with *māsha* ( V. 2. 4. and V. 1. 7 *tila-māsha* and *māsha* tila ). Pāṇini does not explicitly mention the two varieties of *tila*, black and white, but he refers to the use of the same in the *śrāddha* ceremony (VI. 3. 71; IV. 2. 58) where only the black grains are taken. Patañjali also refers to the black ones ( *kṛishṇatile bhyo hitaḥ kṛishṇatilyaḥ*, II. 345 ). Pāṇini would imply knowledge of the oil extracted from the *tila* seeds (IV. 3. 149 ), but later grammarians thought that there is no derivative sense attaching to the word *taila*, and therefore, it should be taken not as a word but as a suffix in such cases as *sarshapa taila* and *inguda-taila* ( *Bhāshya*, II. 376 ).

6. *Anu*–Panicum wiliaceum ( V. 2. 4 ):—A very small grain consumed mostly by the poorer people and grown as a rainy crop, is mentioned with *priyamgu* so early as the *Chamakādhyāva* of the Yajurveda ( XVIII. 13 ).

7. *Kulattha* ( Dolichos biflorus ) ( Pāṇ. IV. 4. 4. ):--Horsegram popular called *kulathi* is grown specially in the Punjab in the Trigarta region (Hoshiarpu Ambala, Simla ) as an autumnal crop. It is consumed either as pulse or groat but Pāṇini mentions it as a flavouring ingredient to other articles of diet ( *saṁs āraka dravya* cf. IV. 4. 4. ). Like *shashtikā kulattha* is for the first time mentione by Pāṇini. Kauṭilya notes it as a crop grown at the end of the rainy seas ( *Arth.* II. 24 ).

The Gaṇapāṭha of IV. 3. 134 adds a few more names to the above list cereals, e. g. *masūra* ( Ervum Hirsutum ), *godhumā* ( wheat ) and *gavīdhu* ( Coix Barbata, *Vedic Index*, Vol. I. 223 ). According to Kātyāyana *gavīdhu* formed part of the Bilvādi group ( IV. 3. 134; Bhāshya II. 323 ).

II. *FIBROUS PLANTS.*:—*Umā* (linseed) and *bhaṅgā* (hemp) are impo ant fibrous plants known to Pāṇini ( V. 2. 4 ) who mentions fields specially nam after the crops. Kauṭilya uses *atasī* and *śaṇa* in place of *umā* and *bhaṅgā*. Pāṇ also mentions cloth made from linen called *auma* and from wool called *au* ( *Umoṇayorvā*-IV. 3. 158 ). For Pāṇini's acquaintance with *Karpāsa* or cott we have to depend on the reading of the *Bilvādi-gaṇa* ( IV. 3. 134 ). He, howev knows *tūla* ( III. 1. 25 ) which may denote cotton.

Patañjali raises an interesting discussion on Pāṇini V. 2. 4. as to whet *umā* ( linseed ) and *bhaṅgā* ( hemp ) come under the category of *dhānyas* (cor or not, and sums up by saying that there is no difficulty in including *umā* a *bhaṅga* in the list of *dhānyas* for purposes of *sūtra* V. 2. 1, because the w *dhānya* ( from the root *dhinv* to please ) means 'that which pleases', and si linseed and hemp afford as much pleasure as any other crop, they have an equa good claim to be looked upon as *dhānyas*. Or, better, still, the number of *dhān* is seventeen*, a list in which *śaṇa* i. e. *bhaṅgā* is also included, hence there sho be no objection to treating *umā* and *bhaṅgā* as *dhānyas* for purposes Pāṇini's rules.

III. CANE ( *IKSHU* ).:—It is mentioned in *sūtra* VIII. 4. 5. and manufacture of *guḍa* from sugarcane is implied in rule IV. 4. 103 ( *Guḍādi bh ṭhañ* ) on which the illustration *gauḍika* meaning 'excellent for making *gu* presumes sugarcane. @

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* Kaiyaṭa refers the quotation to an unknown Smriti work. Probably sutra *śaṇa-sapta-daśāni dhanyani* belonged to a Dharma-sūtra book. Mukuta in his commentary on Amara gives the list of 17 grain 1. *vrīhi*, 2. *yava*, 3. *masūra*, 4. *godhūma*, 5. *mudga*, 6. *māsha*. 7. *tila*, 8. *chaṇaka*, 9. *aṇu*, ( Panicum Miliacum ), 10. *priyaṅgu*, 11. *kodrava*, 12. *makushṭaka*, (Phaseolus Aconitifolius ), 13. *kalaya* ( a pea ), 14. *kulattha* ( Dolichos Biflorus ), 15. *śaṇa* 16. *sarshapa*, 17. *atasī* ( linseed ).

@ Several *gaṇas* include *ikshu* as *ikshubhāra* in V.1.50; *nadādi*, IV.2.1, and its *antargana bkāvādi*, VI.4.153; *blivadi*, IV.3.134. *Kātyāyana* prescribes *śākaṭa* and *śkina* suffixes to denote a field of sugarcane: ( *Bhavane kshetre ikshvadibhyah śākaṭa-śākinau, Bhāshya*, on V. 2. 29).

IV. KUSTUMBURU ( VI. 1. 143 ):-This *sūtra* refers to the spice coriander ( Coriandum Sativum ). Kauṭilya includes it among pungent substances ( *kaṭuka varga*). The modern name *dhānyaka* is not used in the *Arthaśāstra*. In the South Indian languages the words for coriander bear a closer affinity to Sanskrit *kustumburu*, e.g. *kotamalli* ( Tamil ), *kotimiri* ( Telgu ) and *kotambari* (Kanarese). It is possibly a loan word in Sanskrit from these languages.

V. Pāṇini refers to two of the principal dye-products, viz. madder ( VIII. 3. 97 ) and indigo ( IV. 1. 42 ). *Mañjishṭhā* ( Indian madder, Rubia Munjista, ) is also mentioned in the *Aitareya* ( III. 2. 4) and *Sānkhayana* ( VIII. 7 ) *Aranyakas*. Pāṇini treats *mañjishṭha* as a derivative word formed from *mañji* and *sthā*, where *manji* may mean a cluster of flower blossoms. The permanent dye made from madder has always been highly prized for its deep tinctorial qualities. The great part of the madder used in the Punjab is that imported by the Lohani Afghans from the hills of North Baluchistan, Kabul and Khorasan to Multan and Peshawar ( Watt's *Dictionary*, Vol. VI. pt. I, p. 574 ).

*NĪLĪ* or indigo is referred to in sūtra IV. 1. 42. Kātyāyana explicitly tells us that *nīlī* was the name of the indigo plant.

In Pāṇini's time *nīḷā* was a kind of cloth ( *āchchādanā*, IV. 1. 42. ) dyed with indigo blue, while the plant itself was called *nīli*. According to Mc. Crindle: "It appears pretty certain that the culture of the indigo plant and the preparation of the drug have been practised in India from a very remote epoch" ( *Periplus*, p. 17 ). In the post-Vedic language *nīla* describes the colour of dark blue objects such as indigo, sapphire, etc. ( *Vedic Index*, Vol. II. 246, foot-note ). In Pāṇini the indigo plant as the source of this colour was undoubtedly known.

# Increased Production of Pulses Through Breeding, Introduction and Cultural Methods *

By

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## INTRODUCTION

PULSES form a very important source of protein in the vegetarian diet to which quite a large section of the Indian population is accustomed. Most of our people depend on rice as their food to a greater or lesser extent. As is well known, rice is very deficient in protein and, its continuous consumption after polishing, brings about the ' Beriberi ' disease. Even those that are non-vegetarians cannot either afford or secure flesh and other animal products in adequate quantities. Therefore, it is only through the liberal use of pulses that the essential proteins and vitamins can be made up. It may be of interest to mention that even in the U. S. A. where very balanced food is available to the people interest is developing in the use of pulses, e. g., *mug*, as a source of protein; Smith, F. L. ( 1948 ).

The frequent use of the words, e. g., *Masha* ( Udid ), *Mugdha* ( Mug ) and *Chanaka* ( Bengal gram ) in Sanskrit literature shows that the cultivation of pulses had been in vogue in this country since very ancient times. According to the findings of the Russian geneticist, Vavilov, and his colleagues, India and the Middle East countries form the primary centre of origin of most of the main legumes; Huxley, J. (1940). It is only a few beans like the French bean, Lima bean and Broad bean which have been introduced from the tropical parts of America. Therefore, our country is rich in species, varieties and forms of pulses.

The genus Phaseolus alone is known to contain as many as 150 to 250 different species. But, only the following few pulses are known to be under cultivation to an appreciable extent in India.

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**List of Pulses under cultivation in India**

| *Botanical Name* | *English Name* | *Indian Name* |
|---|---|---|
| Cicer arietinum, L | Bengal gram, chickpea | Chana, Harbara. |
| Dolichos biflorus, L | Horse gram | Kulthi. |
| Cajanus indicus, Spreng | Red gram, Pigeon pea | Arhar, Rahar, Tur. |
| Phaseolus mungo, L | Black gram | Urd, Udid. |
| Phaseolus aureus, Roxb | Green gram | Mung, Mug. |
| „ aconitifolius, L | Mat bean | Mot, Mout, Moth, Math. |
| Dolichos lablab, L | Hyacinth or Lablab bean | Wal. |
| Lens esculenta, Moench | Lentils | Masur. |
| Lathyrus sativus, L | Chickling Vetch | Teora, Kesari, Lakh, Lang. |
| Pisum sativum, L | Field pea | Vathana. |
| Vigna sinensis, Endb | Cow pea | Chavali. |

Almost all of them, except perhaps the Bengal gram, are grown as subsidiary crops; either as catch crops or as mixtures or sprinklings in cereal crops. The important reason for which they are not grown on a large scale is probably that their yields ars usually very low as compared to those of cereal crops. Also, the heavy losses occurring due to insect pests, which are many in the case of pulse crops, and the fear of damage by cattle and wild animals has prevented them from assuming a major role in the agricultural economy of the country. Their analysis from the point of nutrition made by the Nutritional Research Laboratories, Coonoor, show that they are rich in proteins and vitamins, particularly anti-Beriberi vitamins, Health Bull. Nos. 23 & 28, Govt. Ind. Press, Simla. From the point of mineral and vitamin contents, the Bengal gram and black gram stand very high, next come green gram, lentil and probably cowpeas; Pal, R. K. ( 1939 ).

It is worth noting that the Soya bean which was once thought to be unexcelled in point of nutrition has not become popular in most parts of India and particularly in Bombay owing to its peculiar disagreable flavour and odour. Though it is rich in proteins, the part of it that is available has been found to be small and, therefore, it does not possess any special advantages over gram, udid, mug or lentil. The crop occupies the land for two seasons and may suffer either due to water logging or deficiency of moisture; Woodhouse, E. J. & Taylor, C.S. ( 1913 ).

The plant parts of pulses make a good fodder for cattle. They are not only relished by them very much but are also rich in proteins. The pulse plants, being bushy herbs, cover the soils, suppress weeds, prevent the evaporation of soil moisture and supply humus to the soil by shedding their leaves. They form excellent cover crops on slopy lands and are ideally suited for strip cropping to prevent soil erosion. Most of them are good rotation and green manure crops and are also useful as ' honey ' crops. Being of short duration many of them can be grown in either the kharif or the rabi season or in both.

The most important point in favour of pulses is, as well known, their capacity to fertilise the soil by fixing Nitrogen from the atmosphere and to convert the plant food in the soil to an available form. The first work is extremely important and is accomplished through the agency of the bacteria present in the nodules on their roots. These bacteria are known to be specific i. e. each variety and strain of them can work on only particular type of plant. The prolificacy of nodule formation depends on the two important factors, viz., ( 1 ) the availability of the requisite type of bacteria and ( 2 ) the availability of conditions suitable for the work, i. e. appropriate amount of moisture, temperature, lime, phosphorus etc. The value of this work that they do will be realised from the fact that the amount of Nitrogen fixed per acre can be modestly estimated as 50 to 200 lbs., depending upon the conditions mentioned above; Varadarajan, S. ( 1948 ).

For all the above reasons, pulses are very important in the agricultural and food economy of the country and should deserve the maximum attention.

Unfortunately, their cultivation is so limited that even precise statistics about them are not available. Those that are at hand presented in Table 1 tell what they are worth.

TABLE-1

**Statistics about the areas and production of pulses in ( the formerly undivided ) India 1932 - 33**

| Province | Area | | | Grain yield tons. | |
|---|---|---|---|---|---|
| | | Gram | other food grains & pulses. | | |
| Madras | (a) | 89,802 | 7,435,987 | (e) | 20,000 |
| Bombay | | 981,015 | 3,146,938 | | 186,000 |
| Bengal | | 176,600 | 1,009,900 | | 54,000 |
| U. P. | | 5,398,572 | 6,773,358 | | 1,398,000 |
| Punjab | | 3,893,785 | 1,449,077 | | 804,000 |
| Bihar & Orissa | | 1,499,200 | 4,609,900 | | 503,000 |
| C. P. & Berar | | 1,365,165 | 5,117,860 | | 250,000 |
| Assam | (b) | . | 212,726 | | (a) |
| Ajmer-Merwar | | 16,977 | 43,664 | | 2,000 |
| Coorg | (a) | 180 | 1,268 | | (c) |
| Delhi | | 80,156 | 7,975 | | 9,000 |

*Area* :— (a) Refers to Bengal gram
(b) Included under " other food grains and pulses "

*Yield* :— (a) Not available
(c) Less than 500 tons.
(e) figure refers to Bengal gram.

It will be seen that Madras, U. P., Bihar, C. P. and Bombay grow more of ulses than other provinces do.

Various ways are open for improving the production of pulses. These fall nder two different categories, i. e. (I) methods of long term improvement and II) methods of short term or cultural improvement. The methods under the rst category are of Breeding and Introduction which form the topic of this paper. nder the second, there are the following methods :—

Extension of areas.
Intensive cultivation under irrigation.
Manuring the crops with Nirtogen and Phosphates.
Treating with bacterial cultures.
Growing tur and beans as perennial crops wherever possible.
Growing suitable mixtures of cereals & pulses.

Control of flower bud shedding by spraying with hormones. Photoperiodic treatment.

It must be empasised here that from the point of the problem before our country today, i.e. the immediate stepping up of food production, the methods under the second category would be much more important and effective. Therefore, it has not been thought inappropriate to include discussion on them also in this note.

## BREEDING AND INTRODUCTION

Breeding problems in pulses are not very different from those in other crops. In general they are :-(i) increase in yield (ii) improvement in size, colour and lustre of grain (iii) earliness (iv) increase in protein and vitamin content (v) drought and frost resistance (vi) resistance to diseases and pests (vii) efficiency in Nitrogen fixation and (viii) fertility and nonshedding of flowerbuds. Of these, the first four are of primary importance and, more particularly, yield and earliness.

As mentioned above, low yield is one of the factors limiting the cultivation of pulses. Since our food grains are not priced in the market today according to their food value nor are they likely to be so valued in the near future it is but natural that cultivators will not be induced to grow them on a larger scale unless their yields are high. The fact that the average out-turns per acre vary from province to province and from tract to tract within each province, shows that there must be considerable amount of variability in each of the crops with regard to

the potency for yield, even though the differences may also be largely the result of soil and climatic differences. Yield is dependent upon factors, e. g., branching of the plant, number of pods per branch, number of grains per pod and the grain size. It should, therefore, be obvious that one has to concentrate on these characters for purposes of selection. Resistance to diseases and pests being a character directly determining yield it is also important to evolve types which are resistant to diseases e. g. wilt which are of common occurrence in these crops. Earliness is also a point to be highly valued because most of the pulses are often taken as catch crops. Leafiness is desirable both from the point of value of the fodder as well as from the point of conservation of moisture in the soil.

As pulse crops were not very extensive in cultivation and as commercial crops like cotton and sugarcane occupied most of their time, plant breeders did not pay serious attention to the economic improvement of these crops till recent years. All that was done in the various provinces and by the Indian Council of Agricultural Research was in the nature of classification of types, study of anthesis and pollination, study of diseases and evolving a couple of high yielding and disease resistant types here and there by selection.

In the year 1937 Sir John Russell in his report on the work of the then Imperial Council of Agricultural Research, stressed the need for scientific research work on pulse crop improvement particularly in view of their importance as a source of protein. Accordingly, the then Imperial Council of Agricultural Research took up a co-ordinated scheme for research in almost all provinces and states on gram, horse gram, *tur*, *urd*, *mung*, peas, *guar* and other pulses.

Almost all the pulses mentioned above except *tur* are very highly self pollinated. The arrangement of their floral parts is such that some amount of cross pollination could take place if self pollination did not occur. But, it has been found by various workers that there is hardly any cross pollination in nature. Even high amount ( as much as 46 per cent ) of cleistogamy has been reported in *Udid* and *Mug* by Narasinham ( 1929 ). Only in *tur* cross pollination to the extent of even 5 to 8 percent has been reported by Shaw et al ( 1933 ).

The general prevalence of self pollination in pulse crops makes their breeding simple. Any plants found with desirable characters can be depended upon to be almost certainly pure for them and only need multiplication to cover the areas to be put under them. The search for these plants can be conducted in the two ways usually employed in plant breeding work.

The first method is to collect a number of representative bulk samples from areas to be served, growing them on a large scale and selecting the desired types of plants. The second method is to make an exhaustive collection of varieties and pure strains from outside tracts, provinces and countries and grow them under observation with repeated checks of the best local types. From the fact that several different types of *mug*, *udid*, *tur* and lentils have been isolated and classified by plant

breeders; Bose, R. D. ( 1932 a & b ); Shaw & Bose ( 1928 ); Shaw *et al* ( 1933 ) it appears that one may hope to come across innumerable varieties, types and sub types even within a single species. The gram crop is so mutable that one may easily find one or two new types in the course of a season if one is in search for them. There are several allied species of phaseolus already under stray cultivation. As examples may be mentioned. Ph. angularis—Aduski bean, Ph. calcaratus–Rice bean, and Ph. ricciardianus–Meth bean; Kennedy, P. B. ( 1925 ). Also, one comes across in high altitudes of Deccan a few wild types, e.g., Ph. trilobus, Ph. dalzelli, Ph. gigas and Ph. sublobatus. It is very probable that similar types would be found even in other provinces, particularly in Bengal, U. P., the Punjab and Kashmere which are bordering the lower heights of the Himalayas. India and the Middle East countries being the home of pulse crops, a collection of several different species, each consisting of a large number of varieties may be possible if the work is organised on a sound basis. Though it is less likely that any of the foreign or wild types will suit any particular tract, the possibilities of their adaptation cannot be excluded. It is also highly probable that at least some of them will possess certain desirable characters that are absent in the local material, in which case they will be useful for purposes of hybridisation.

As is well known, the work being done in India at present is in the preliminary stages and, therefore, the breeding programmes are based largely on the first method. Collection of foreign material is casual and random; introductions are rare and hybridisation almost limited to intra and inter varietal hybridisation. A few important problems have, no doubt, been solved even through these limited efforts. For example, gram strains resistant to wilt have been produced in Madras and Bombay. The Bombay Department of Agriculture has also succeeded in evolving wilt resistant *tur*, virus resistant *kulthi* and a type of gram, named Gulab, eminently suited for parching. Much ground can yet be covered in evolving high yielding superior strains of pulses through these methods alone. Even so, we need not stop from taking further and more difficult steps in tackling the various kinds of specialised problems that exist in different pulse crops.

The following are a few such problems :—

Drought resistance, earliness and hardiness in poor land crops, e. g. *Kulthi matki* and *china mug;* resistance to virus diseases in *Kulthi*, *matki*, *mug* and *wal;* resistance to wilt in *tur* and gram; hardiness and freedom from lathyrism in *lang;* resistance to storepests in all pulses.

Pulses with higher protein and vitamin content; gram and peas suitable for canning and parching; quickly cooking *tur* and gram; *mug* varieties suitable for growing in both kharif and rabi seasons. Leafy types of *udid* and *mug* suitable for green manuring; quickly growing bushy types for green fodder; salt tolerant pulse crops etc.

All these are problems that await solution and, if solved, will surely lead to increased production and improvement of the qualities of pulses. Some of these problems may have to take recourse to wide crossing. It is, therefore, evident that the strength of the pulse breeder would depend upon the strength of his collection. An example of what may be possible to be achieved in pulses through wide crosses is provided in the report of work being done at the Institute for Cereal Production of South Eastern U. S. S. R. Fantastic as may the Russian attainments appear, it is proposed to quote this as an example; [ Godunova, P. M. ( 1944 ) ] to indicate the lines along which our efforts may be directed.

" In order to obtain non-lodging and non-shedding peas and lentils intergeneric crosses have been made with gram whose stem is strong and suited even to combine-harvesting. Moreover, gram pods do not split even when left standing. Gram is also drought resistant and has a more vigorous root system than either peas or lentils. The combination of all these features in a single variety of peas or lentils would be of great practical interest. Special mention is made of peas Shambovyi ( erect ) and Nos. 54, 62 and 63 with erect habit. Even when lodging occurred the upper portion of their stems remained erect and was thus saved from decay in bad weather and could be harvested with the machine.

Gram, Driepropetrovskii No. 6 showed the best yield and shortest cooking time. "

Examples of how even introductions, simple as they may seem, may prove to be extraordinarily useful are provided by the popularity gained by *china mug* in the Bombay Province and the *mat* Bean, Ph. acomitifolius, in California Kennedy, P. B. ( 1925 ).

The *China mug* is a very short timed crop maturing in only about two months. It can be taken after the failure of a crop like *bajri*; Pennisetum typhoides Stapf and Hubbard, or even after the harvest of a kharif crop like rice or before sowing a rabi crop like wheat. Besides yielding the grain it also fertilises the soil for the succeeding crop. Naturally, therefore, the cultivator thinks of it as a god-send.

Similar is the case with the *mat* bean which, it is learnt, is being taken up as a cover crop in California.

It, therefore, appears to be high time that we organise our collection of foreign plant material efficiently. Besides arranging for a free exchange of material within the country itself it is also worth while to organise expeditions of trained botanists to the various Middle East Countries for such collection in the near future

A great amount of hybrid vigour, ranging from 59.58 to 394.37 per cent has been reported in the soya been by Went and Stuart ( 1924 ); Ashton, T (1946 and heterosis may possibly be found even in crosses in other crops. However

the exploitation of this phenomenon in improving yield is not possible due to the great difficulties involved in mass emasculation and crossing.

Colchicine treatment has been found to increase the grain size in gram, *tur*, *mug* and *udid* through autopolyploidy; Ramanujam, S. & Joshi, A. B. (1941); Kumar, L. S. S. & Abraham, A. (1942); Pal, B. P. & Ramanujam, S. (1944). But, most of the progenies being wholly or partially sterile, it has not been possible to secure fully fertile types which are at the same time large seeded. Continuous selection for fertility is being practiced in Bombay to attain the desired object. Though this is a tedious process and one cannot be very sure of securing the desired type, one may get at least material to serve as a foundation stock to build up fertile and stable polyploids.

It may also be possible to obtain economic mutants through irradiation. Such mutants have been reported to have been produced in soya beans in the U. S. S. R., U. S. A., and Germany.

So much about the long term aspect of improvement of the pulse crops. It is now proposed to discuss, in brief, the short term aspects which are no less important at the present juncture.

## EXTENSION OF AREA UNDER THE CROPS

Different complementary methods can be used to extend the area under the pulse crops. Firstly, pulses of short duration and, among them early varieties, could be grown advantageously as sole crops in either of the seasons. As sole crops they can best be grown as catch crops either after a *kharif* crop like rice or before a *rabi* crop like wheat. Now that insecticides, e. g., D. D T. and Gammaxane are available for the effective control of many pests a great impediment before the cultivator has been removed. The problem of depradation by stray cattle may be solved through co-operative arrangements for watching the village cattle and constructing cheap hedges around the fields. Secondly, inferior lands can be utilised for growing crops like *kulthi, china mug, matki* etc. This will not only supply grain but will also improve the soil gradually. Thirdly, it is worth while to review and revise the various crop rotations in the country from the point of maintaining the soil fertility. Such a revision is bound to increase automatically the area under the pulse crops. The importance attached to rotating cereals with legumes in foreign countries can be seen from the method adopted in Italy where in a seven year rotation, wheat is followed by two years' meadow land and four years' rice, only a portion of the land being occupied by rice at a time. This practice has been found to enrich the soil fertility and increase the yield to nearly double of what could be had by continuous cultivation of rice alone; Varadarajan, S. ( 1948 ).

## INTENSIVE CULTIVATION UNDER IRRIGATION

Intensive cultivation under irrigation, wherever possible, is another method of improving production. Pulses have been found to respond liberally to

irrigation. For example the chafa gram of Niphad ( Bombay ), which gives not more than about 500 lbs. per acre under dry conditions has been found to give as high a yield as 1300 lbs. under canal irrigation. Even other pulses like *tur* have been found to benefit a great deal by irrigation.

## MANURING

Legumes are voracious feeders of lime and phosphorus. Moreover, the bacteria in their nodules have been found to fix Nitrogen better in the presence of these elements. It is therefore essential to manure legumes with substances like superphosphate and bonemeal. Also, experiments have shown that the manuring with Nitrogenous substances at flowering time benefits these crops.

## TREATING WITH BACTERIAL CULTURES

It has been mentioned above that Nitrogen fixing bacteria are specific, i. e. the bacteria residing in the nodules of, say, the gram crop are able to fix Nitrogen only when that crop is grown and not any other pulse crop. Sometimes, when the land is taken up newly for cultivation under the crop, or after a very long interval, the requisite bacteria may either be absent totally or may be very few in number. Therefore, nodule development may be very sparse. Under such circumstances, it has been found expedient to inoculate the soil with the requisite type of bacteria. It has been reported that such inoculation increases the vegetative growth of the crop tremendously; Madhok, M. R. ( 1941 ).

## GROWING TUR AND BEANS AS PERENNIAL CROPS

Tur and certain of the beans have perennial varieties which could be grown on and along the bunds and water channels.

## GROWING SUITABLE MIXTURE OF CEREALS & PULSES

Mixing pulses with cereals in suitable proportions and not in the present indifferent fashion, may be helpful in increasing the production of pulses without affecting that of cereals. It has also been found that mixtures reduce the incidence of diseases of either of the crops in the mixture. It has been reported, for example that when *tur* was grown mixed with Jowar it suffered about 32 per cent mortality by wilt but when grown as a whole crop 88 per cent of the plants died due to the disease. It has also been similarly reported that the nutritive value of cereals increased when they included mixtures of pulse crops.

## CONTROL OF FLOWER BUD SHEDDING BY SPRAYING WITH HORMONES

Flower bud shedding, especially during cloudy weather, is a special problem in *tur*. The shedding is considerable and, if prevented, may increase the yield of the crop very substantially. In addition to searching for types which do not shed flower buds for hybridisation it may be worth trying several different hormones as sprays.

## PHOTO-PERIODIC TREATMENT

There is an account of photo-periodic vernalisation having been tried on several different Phaseolus and other pulse varieties which exhibited differential responses; U. S. D. A. Techn. Bull. No. 867. It may therefore be possible to render certain late maturing varieties early, and also to make the rabi varieties grow in the kharif season and vice versa. Moreover one may be able to grow even the *tur* or the gram crop before wheat comes in the field.

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# Art of Gardening in India

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Practice of Gardening in India is as old as Indian Culture. It is neither a modern fad nor a thing of fossilised past to be admired in the archives of Historical collections. The Art of Gardening has progressed from century to century like a mighty Banyan tree, which lost its main trunk but produced millions of aerial roots and handed them over to posterity as gigantic trees to carry on the eternal functions of life and multiplication.

Father Time has erased the original traces of Garden design and planting of the past, but hereditary religious and social practices, Sanskrit scriptures and old architecture stand witness to love of human beings for delicate, sweet-scented flowers and nourishing lucious fruits. Above all, the urge to master Nature and to bring the precious things of wild forests to homes and villages or cities, have done more than enough to keep alive the art of gardening in all ages and all countries.

It is not possible to say who laid out the first garden or who made the first lotus pond for the pining "Naika" of Kalidas and Bana, to drown her sorrow in the pool of red and white lilies. But one can easily follow intersting referances to large gardens and water reservoirs in Mahavansa a book written in Pali language in Ceylon. As a matter of fact, the year 563 B. C., the year of Lord Buddha's birth, may be taken as a starting point for the recorded history of gardening. The symbolic Lotus of Buddha, displayed in its thousand petals is another example of gardening, taking an important place in religious life of India. The old ruins of Buddhist monastaries of Runaveli in Ceylon, the wall paintings in ancient temples in Java, and also the teachings of Ashoka inscribed on rocks, show how important the trees, the flowers, and the water courses were in old days when people of this country sought Peace and Happiness in the preachings of Lord Buddha.

But, let us turn our footsteps from the land of Nirvana to that of Romance where Kalidas, Bhas, Shree Harsha, Bana and Bhavbhuti, the giants of Sanskrit literature poured out a continuous stream of immortal poetry and prose. As many know, the date of Kalidas is a matter of controversy. However many students of literature agree that Kalidas wrote his plays during the reign of King Vikrama of Ujjaini about 57 B. C. It is also believed that he was a contemporary of Horace and Virgil. Abhijnan Shakuntalam, a precious jewel amongst Sanskrit plays written by Kalidas is full of word pictures of many exquisite gardens, where young girls used to water their favourite plants and where large lotus leaves used to float amongst dancing lilies agitated by the cool evening breeze over a pond of

artistic design. The garden popularly known as Udyana, Upavana, or Pushpa Karandaka, was invariably a favourite rendezvours of young lovers, as is it now. Bowers of flowering creepers covered the marble seats ( shila pattakam ) so conveniently placed in the nooks and corners of an old garden in a king's palace compound, where the lovely maidens of Sanskrit poets used to fan away their anxious moments by means of lotus leaves bigger than the full moon! Very often the keeper of these gardens would be a woman, who took keen interest in the welfare of trees, birds and pets like deer.

People planted their trees in rows, as they do now, forming long shady avenues, and laid out orchards of Mango trees (Amra Vana and Amra Kunja) and other fruits like plantain and cocoanuts, and took great care to irrigate, and manure them. We find similar references in Meghaduta by Kalidas, and Svapana Vasavdattam and Pratimanatakam, by Bhasa, who thrived in those days in Northern India. During that period of culture and refinement the art of gardening was not necessarily confined to the North. In South, King Shudraka mentions some interesting developments in garden craft. Mrichhakatikum by the same author is full of references to ingenious devices for lifting, spraying and distributing water in the gardens. Very probably they were the fore runners of water wheels and fountains of the modern age.

Skipping over five centuries after king Shudraka, we come across the works of Shree Harsha, Bana and Bhavbhuti. Priyadarshika and Naganandam and Harsha give us greater details of garden design. The trees were grouped and creepers were segregated and the places were named according to tne plant matetial grown there or the purpose for which they were utilised. Thus, in those days places like Chandana Lata griha (bower of Sandal wood), Manmathodyan (garden of Cupid) or Samudragrihakam (sea-side pavilion), became popular haunts for the people and the princes alike.

Bana, the prolific writer, gifted with great descriptive talent, who flourished between the end of the sixth century and middle of the seventh century has given us many picturesque accounts of gardens, pleasant rockeries, artificial water courses, ever revolving peacock fountains, and unending Tamala avenues. While mentioning the superb constructions of Shower houses (Dharagriha) and Arctic pavilions (Himagriha) Bana bewitches his readers with his masterly descriptions.

After Bana, between 745 to 1150 A. D. the Sanskrit literature gathered unprecedented momentum and Sanskrit plays, poetry and prose appeared in great bulk penned by various wellknown and obscure writers. Almost all the works contained some reference to one or the other phase and aspect of gardening.

But, the art of gardening was finally crystalised and cornered in an academic frame by King Somdev of South India, in his "Abhilashitartha Chintamani" during eleventh century. Eventually in the 13th century, Sarangadhar who lived in the North, while king Hamira reigned, classified and placed this interesting art on an independent footing. He devoted a separate section to this craft and called

it "Vrikshayurveda" in his useful treatise named "Sarangadhar paddhati". It may be that whatever Sarangadhar propounded in this book, may not wholly be true in the light of the latest botanical researches, and may not fit in the elastic theory and practice of modern Landscape designing. Yet, one should not underrate the importance of such an illuminating legacy.

When we think of present day gardens in India, we instinctively feel the foreign influence in their design and layout. This influence is not attributed exclusively to any one European school of Landscape gardening.

In the year 1494 A. D. Babar arrived in rich and prosperous India to establish his Moghul Empire. He did not come to loot and plunder the country as his predecessors Taimur Lang, Mohmad of Gazni or Shahbuddin Ghori did. As Babar was anxious to develop his new home, he brought some of the nicest things of Art and Culture from his country. The art of gardening was one of them. The gardens laid out from the beginning of his reign to the end of the Moghul Empire were more or less, repetitions or rellections of Persian gardens, with changes in the plant material to suit the climatic and geoligical conditions of this country, though, in many instances the layout rarely suited the topographical features of the place. This treatment for new gardens gave birth to an individualistic design in garden art which came to be known later on as the Moghul gardening.

The Moghul gardens were invariably enclosed by a wall. Water flowed in the canals more to please the eyes than to nourish the plants. Generally paths ran parallel to the canal so that the person walking there could see and admire the beauty of the coloured pavement, of marble, through the crystal clear water. The entrance through the gates of the enclousers though big was artistically constructed. Through them one could see the long water courses terminating at a pavilion with marble seats. These were generally used by people to observe the play of sparkling fountains in the twilight. The Moghul gardens in those days were not considered complete without a few Jasmine creepers, or roses. People, then went in more for scented flowers rather than for decorative ones. Some of these gardens contained grape wines pomagranates, mangoes and even sugarcane, growing luxuriently. Thus, they had an aesthetic as well as an utilitarian aspect. Curiously enough, certain of these Moghal gardens were related to the Tudar garden in their scheme for planting, building of towers on the garden wall or designating the summer houses. Usually the permanently built flower beds were of geometrical patterns, popularly known as parterres, which were constructed nearer the main building or along the water channels. The trees ran right across the whole area till their branches swung over the walls exciting the curiosity of the passers-by.

It will not be out of place to mention few of the famous gardens created by the Moghal Emperors from 1494 to 1707 A. D. Babar (1494–1531) built Ram Bagh and Zora Bagh at Agra, besides two gardens Bagh-i-Wafa and Bagh-i-Kilan near Kabul. Only one garden at Delhi goes to the credit of Emperor Humayun

(1531–1556). During almost half a centnry of Akbar's reign (1505–1605) gardens at Fatehpur Sikri and Sikandra were constructed and a garden named Nisim Bagh was laid out in Kashmir. Jehangir (1605–1628) had more vision and imagination than his predecessors in selecting his garden sites. He laid out famous Nishat and Shalimar and much less known Acchibal and Verinag Gardens in Kashmir. Moreover he built a good garden called Dil-khush Bagh at Lahore and another, near the tomb of I'tomed-ud-doulah at Agra. Shahjehan, the most romantic of the Moghal Emperors (1628–1658) following in his father's footsteps constructed Shalimar Bagh at Lahore and Delhi. He was the creator of Taj Gardens at Agra and Fort gardens of Delhi. He a'so created the Dara Shukoh garden at Delhi. Aurangzaib (1658–1707) having a relegious turn of mind got a garden prepared in the main mosque at Lahore, besides Cho Burj Bagh, Nawa Kot and Pinjore gardens. Many of these gardens exist till today but that ancient glory, splendour and beauty of form have become a thing of the past, excepting in some of the gardens in Kashmir. Kashmir the natural garden of India, with its lakes and rivulets and wealth of scenic beauty has continued to nourish the one and only Shalimar, the child of Jehangir's fancy, which earned for itself the oft quoted phrase "Gar Firdos bar rube Zaminast, Haminast, Haminast, Haminast." The usual trend of people to imitate the ruler was as strong in those days as it is today and it is no wonder if old gardens of Moghals were imitated by small states like Jaipur, Udaipur and Jodhpur in Rajputana. The inquisitive amongst us need not go farther than Shanwar Wada in our home town, to find the traces of Moghal design in gardening.

The modern English gardens emerged successfully from the imbroglios of Italian, Dutch, French, German and even Chinese and Japanese style of Landscape Gardening. Laurels for the latest and consistent method of Informal or Naturalistic and artistic garden designing go to a coach painter named William Kent ( 1700 ) who not being very successful in his own line, took to priesthood for some time. Another gardener Joseph Praxstone, improved and developed this art of gardening in 1826 A. D. Many other landscape designers continued to carry on the work of creating tasteful gardens till the end of 19th century. From the beginning of this century, an eminent landscape architect Thomas Mawson, has been preaching and practising this art remarkably well. It is not surprising that enthusiastic students of this art have tried to influence the present day gardening in India.

The landscape architect Sir Edward Lutyen of the Viceregal House at New Delhi, while modernising the frontage, has tried to imbibe the exquisiteness of the Moghal art. Thus, the rear of the main building overlooks a modified and perhaps a better version of the Moghal garden, but, somehow or other it is wanting in that spirit which floats about imperceptibly in any of the old gardens of the Great Moghals. " Vrindavan " gardens at Mysore, also, manifest the importance of running water in garden, and the electrically illuminated sprays of innumerable fountains present the charm of a dream land.

In many places the tendency of the present day gardener is to lay out gardens irrespective of any thought for a definite style or method of gardening. He would borrow the idea of a pool from here, of a statue from there, of bower design or a path way from Mr. X's garden, seat or a gate post from Mrs. Y's compound. The result is a confusion of ideas and clash of styles. This chaotic and painful picture does not end here, it goes farther. The planting material is equally inharmonious. Sheth A insists on having the "Fountain tree under his bed room window. Mrs. B likes to see the red roses planted in the pink geranium beds, and Rao Bahadur or Khan Saheb C, must have tuberoses on his terraces on the second floor! Thus the poor piper has to play to his master's tune! There are exceptions also to this state of affairs and well-laid, sensible and sometimes artistically created gardens give us a pleasant surprise.

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# Pineapple Culture in Western India

By

S. R. GANDHI, M. Ag. (Bombay) *

The pineapple is one of the finest and most delicious fruits that is widely cultivated throughout the moist tropical regions of the world. It takes an unusually high rank amongst the fruits as an all round source of vitamins. Its juice being rich in sugar is able to furnish a food of high energy value. It also contains mineral salts and acids of great importance to human health.

**Climate:**— In India, pineapples are grown on a very small scale especially in wet tropical regions of Assam, Bengal and on the west and east coast of the peninsula. In Bombay Province its cultivation is found in Konkan and South Gujerat on the coast on a narrow strip of country within 10 miles from the sea where the climate is warm and humid. The further inland climate is unsuitable. It does not stand low temperatures and is killed outright by frost. It thrives well in coastal tracts of Konkan receiving 50 to 125 inches of rainfall and where the temperatures range from 70° to 90° F. On South Gujerat Coast where the climate is more severe and less humid than in Konkan, pineapples are required to be

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grown under the shade of mango trees. In addition to furnishing to the plants marked protection from cold, the shade prevents excessive evaporation from the soil and the foilage of the plants, thus conserving the moisture which is so essential for the well-being of the plant especially in the hot weather. In parts of the tropics such as the Hawiian islands and the Malaya ( Singapore ) where the pineapple is extensively grown and canned for export, the rain is very uniformly distributed throughout the year. In these conditions, it is cultivated as a rain fed crop and does not require any artificial irrigation. Parts of peninsular India, on both coasts which get the advantage of two monsoons, south-west and north-east, are more suitable for growing pineapples as a rainfed crop than the west coast of Bombay Province which gets only the South-west monsoon from June to September and where the climate remains dry from October to May. The pineapple, therefore, is necessarily an irrigated crop in Bombay Province. Unfortunately, the whole region of the sea coast in this province is notoriously deficient in underground water and probably this is one of the principal reasons why inspite of a favourable climate the pineapple cultivation has not made much headway in Konkan. The total area at present under pineapple in Bombay Province, according to the Agricultural returns of 1947 is 60 acres only, but, it is hoped that with better irrigation facilities that Government contemplates to provide to the public under " The Grow More Food Campaign ", the cultivation of this fruit will be attempted on a much larger scale in the near future.

**Structure of the pineapple plant :—**The pineapple plant is very different from other fruit trees. In fact, it is not a tree at all. It is merely a small herbaceus plant consisting of a short stout stem with roots directly attached and surrounded by a whorl of long narrow stiff leaves standing from two to three feet high. The fruit is borne on a stalk about an inch in diameter which is a prolongation of the main stem. The pineapple plant is extremely shallow-rooted and the roots do not extend more than a foot or so around the base. A peculiar characteristic of the pineapple is its second root system which develops from the leaf axils above ground. The buds in the axils of lower leaves develop into aerial roots which extend into the cuplike reservoirs made by the channel like leaves clasping the stem. It is proved that the soil roots of the pineapple seem largely for anchorage and to enable the plant to develop sufficient growth in its initial stages but later growth seems to depend largely on the axillary root system, as it is these roots which are capable of utilising the moisture in the air and also the rain to the fullest extent. The channel like leaves, catch and conduct the slightest rainfall or morning dew into the cups or reservoirs from where the axillary roots easily feed. This peculiar structure of the pineapple suggests that we can replace the expensive soil irrigation to some extent by spraying the plants lightly by means of a hand sprayer off and on during the hot weather. Also, it is possible to give manurial or remedial sprays very effectively to the pineapple by this method.

**Propagation:—** The pineapple is commonly propagated vegetatively from leafy shoots which arise on the mother plant. These leafy shoots are called ratoons, suckers, slips or crowns as described in the following illustration:—

Fig. 1.—Parts of a pineapple plant:—(1) Soil roots; (2) ratoon; (3) main plant stem with leaves stripped off to show axillary roots on the lower portion; (4) sucker; (5) fruit stalk; (6) slip; (7) fruit; (8) crown slip; (9) crown.

Ratoons are shoots formed on the stem below the soil level. Suckers are shoots produced in the axils of leaves on the stem above ground. Slips are shoots that spring up from the stem immediately below the fruit. Slips may arise just below the crown of the fruit and in that case they are called crown slips. The leafy crown of the fruit can itself be severed from the fruit and can be used for propagation.

For all practical purposes, however, the suckers and slips are the most common and convenient means of propagating pineapples. In Bombay Province, however, mostly suckers are used for propagation.

**Soils** :— Pineapples can be successfully grown on soils which are well-drained and have plenty of organic matter and from where iron supply to the plant is easily available. The laterite soils found all over Konkan are best suited to

the pineapple culture. Sandy, alluvial soils can also be utilised for pineapples. Sticky clay soils and soils with a high percentage of lime should be avoided. The pineapple being extremely surface rooted a soil about a foot in depth may even serve the purpose provided the subsoil is well-drained.

**Varieties :—** A local type of pineapple ( Mauritious ) belonging to the Spanish group has been long under cultivation in Konkan and South of Surat. The fruit is very small; the flesh is white, sweet but hard, fibrous and not very juicy.

The two exotic varieties recently introduced in Bombay Province are "Kew" or " Smooth Cayenne " and " Queen ".

The " Kew " or "Smooth Cayenne" is the world famous canning pineapple cultivated on an extensive scale in the Hawaiin Islands. The fruit is large, 8 to 10 lbs. in weight and on ripening assumes a very attractive golden yellow colour. The flesh is light yellow, rich in flavour and extremely juicy; the eyes are broad and flat. The leaves are spineless and hence the name " Smooth Cayenne ". The plant reproduces itself slowly and puts out very few suckers and slips.

**Queen :**—The Queen is the leading variety in Singapore. The fruit is characterised by yellowish flesh which is sweet and rich in flavour. The eyes point upwards from the sides. Leaves are spiny. The fruit does not weigh more than 4 lbs. It produces a good number of suckers and slips.

**Planting and Aftercare :**—The land should be brought to a fine tilth by ploughing and harrowing during the hot weather in April and May and divided into flat beds with proper irrigation channels and drains. The beds then should be manured with well rotted farm yard manure or leafmould at the rate of 30 cart-loads per acre. Planting may be done during or after rains. Growers especially in very heavy rainfall tracts prefer to plant after rains from September to November.

Before planting, the planting material, either suckers or slips should necessarily be cured by stripping of their basal leaves to a length of about an inch on the stem, and trimming the lower ends of the stems with a sharp knife and drying them in the sun for about three days. After trimming and stripping, the tender surfaces thus exposed are cured in the sun by standing the planting material upside down. If this curing is not done and the suckers planted with their lower leaves unstripped, they may seriously suffer from a disease called base-rot and die soon after planting. The stripping of lower leaves also facilitates the initial rooting of soil roots on the exposed stem.

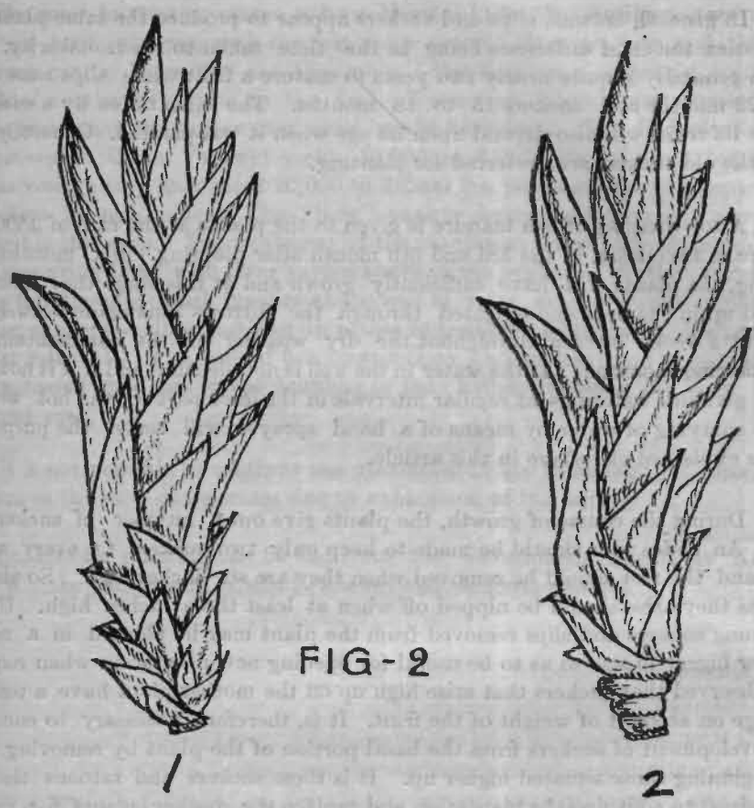


Fig. 2. How the stripping and trimming of a sucker is done. ( 1 ) An unstripped sucker; ( 2 ) a stripped and trimmed sucker.

Suckers of pineapple are planted 3 ft. apart each way. A " planting rope " with markers to show the position for each plant is stretched down the row and three to four inch deep holes are made by means of an iron hook. This planting iron is thrust into the soil with a quick push of the right hand to open up a hole and as it is withdrawn the left hand thrusts the exposed stem of the sucker into the hole so formed. The moist soil is then pressed around the stem. The suckers should never be planted too deep for if the soil should get into the centre of the plant, it would choke the apical growth which would rot and would eventually die.

An acre of land will accommodate 4,850 suckers ( Queen variety ) spaced 3 feet apart. The "Kew" or " Smooth Cayenne " being a larger variety is given 3½ ft. spacing and therefore 3,556 suckers are required per acre.

In general, crowns, slips and suckers appear to produce the same plant characteristics, the chief difference being in the time taken to reach maturity. The crowns generally require nearly two years to mature a fruit while slips take about 20 to 22 months and suckers 15 to 18 months. The time taken by a sucker to mature its fruits will also depend upon its age when it was planted. Generally 3 to 4 months old suckers are preferred for planting.

A top dressing of fish manure is given to the plants at the rate of 3500 lbs. per acre in two doses, in the 3rd and 5th month after planting. Six months after planting, the plants will have sufficiently grown and at this stage they should be earthed up in the beds and irrigated through the furrows thus made between the ridges at a weeks' interval throughout the dry weather till the commencement of the following monsoon. If the water in the well is not plentiful and if it is not possible to give full waterings at regular intervals in the later part of the hot weather, a light spraying of water by means of a hand sprayer will serve the purpose as well as explained elsewhere in this article.

During the course of growth, the plants give out a number of suckers and slips. An endeavour should be made to keep only two suckers to every mother plant and the rest should be removed when they are six inches high. So also the slips, as they arise should be nipped off when at least three inches high. Unwanted young suckers and slips removed from the plant may be planted in a nursery to grow bigger in size so as to be useful for opening new plantation when required. It is observed that suckers that arise high up on the mother plant have a tendency to lodge on account of weight of the fruit. It is, therefore, necessary to encourage the development of suckers from the basal portion of the plant by removing, from the beginning those situated higher up. It is these suckers and ratoons that will be retained to continue the plantation and replace the mother plants for yielding successive crops in the same land after the first plant-crop is harvested. Only one fruit is produced on the first or plant-crop on its main axis, and succeeding fruits must be produced by the suckers that are left behind by the mother. After the plant-crop is harvested, the stalk of the mother plant withers and the strength of the parent plant is thrown into suckers which therefore develop more rapidly than a new planting.

**Harvesting:**—It takes about 12 to 16 months for the plant-crop to produce the fruit and 3 to 4 months more to mature it. A reliable sign of ascertaining the maturity of the fruit is that the eyes which are more or less angular in the initial stages get flattened in the centre and bulged at the sides and the colour of the fruit begins to turn yellow. The fruit is harvested with 2" to 3" of the stalk attached to it otherwise it has the tendency to rot at the core. The fruit stalk is brittle and can easily be snapped from the base of the fruit by grasping the crown as a handle. After gathering the fruits, the mother plants should be cut close leaving two bottom suckers to develop and give crops in the following year.

The main harvesting season is from May to July. In Konkan, two main crops occur during the year with the first major crop in May to July and the second minor crop in November and December. The first crop is nearly to-thirds of the total number of plants in the area. From the second year onwards as many as twice that number or even more can be harvested. The first plant crop of the pineapple (Queen Variety) yields 10,000 to 12,000 lbs. of fruit per acre. Every successive crop may yield 20,000 to 25,000 lbs. per acre due to retention of two suckers in each place. The "Kew" variety being much larger in size may yield double this crop. The treatment of the plantation in subsequent years consists in manuring them with farm yard manure in the beginning of the monsoon, giving a top dressing of fish manure at the end of rains in September, removing unwanted suckers or slips, earthing up plants in October and irrigating the orchard at proper intervals. The dose of fish manure may also be increased in proportion to the increased yield due to the doubling of the number of plants per acre from the second year.

It is not possible to continue the plantation in the same land for more than five years as the crop deteriorates due to exhaustion of the soil.

Suckers for planting can be had from the Government Farms at Kumta (North Kanara), Ratnagiri, Kosbad (Thana) and Gandevi (Surat).

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# Recent Developments in the Insecticidal Control of Certain Important Insects Injurious to Fruit Crops in the Bombay Province

By

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## Introduction

The advent of new insecticides like DDT (Dichlorodiphenyl trichloroethane), BHC ( Benzene hexachloride ) and other chlorinated hydrocarbons, has marked a new era in the development of agricultural pest control. In fact, these have given a new approach to the problem of insect control and revolutionised the time

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honoured practices of controlling various pests. The experiments with these new insecticides are being carried out in all the agricultural countries of the world. In India, Bombay Province as usual has taken a lead in launching certain schemes to test the efficacy of these insecticidal chemicals against a wide range of agricultural pests, which endanger the food production, food preservation and ultimately affect the food economy of the country. At a time when the country is facing food deficit, it is all the more important to save the food crops of every kind from the ravages of insect foes. The same analogy holds true even with regard to the production of fruits, which form a part and parcel of our daily diet. Likewise, the need for saving the fruit crops from insect enemies, has intensified with the increase in the acreage under fruit trees, since the inauguration of the Deccan Canal irrigation system and also with the ceremonious "Tree Planting" on auspicious occasions like the 'Independence Day'. Thus with a view to finding out specific control of some important insect pests affecting fruit crops like mango, citrus, pomegrante, guava and grape vine, investigations with new insecticides were carried out by the present writer. The results thus obtained by him during the course of his toxicological studies are included in the following short notes on some important fruit pests along with their tentative control schedules.

## Important fruit pests and their tentative control schedules.

### 1. Mango jassid hopper ( *Idiocerus* sp. )

Major pest of mango inflorescence in all the mango growing tracts of Bombay Province particularly in Ratnagiri, Bulsar ( Surat ), Thana and Dharwar Districts. The tiny jassid hoppers are active from December to March. Both nymphs and adults feed on the sap of tender leaves and inflorescences. As a result, the flowers fall off without setting any fruits. The extent of damage may range from 20 to 30 per cent. At times, the damage is so severe that it may result in the total failure of the crop. These insects secrete a sugary substance popularly called ' Honey dew ' which later developes into sooty mould and thus imparts a black appearance to the plants.

During the recent investigations carried out by the author, it is observed that 5% DDT mixed with commercial sulphur in the proportion 1 : 1 as dust, or a spray containing 4 lbs. of 50% wettable DDT in 100 gallons of water has yielded cent per cent reduction in hopper population. Depending upon the availibility and easy access to water, spraying or dusting is to be ascertained and the control measures advocated accordingly. Normally, about $1\frac{1}{2}$ lbs. dust mixture or $2\frac{1}{2}$ gallons spary material would suffice an average sized tree of about 20 ft. height.

*Dust or spray schedule :*

( a ) ( i ) If spray is to be advocated, the first application of 0·2% DDT spray given above should be made just prior to the first flush of flowering either late in November or early in December.

( ii ) The second application should be made about three weeks after the first apraying. While giving this application, it is better to mix 4 lbs. of wettable sulphur for every 100 gallons of 0.2% DDT spray so as to safeguard against mildew attack.

( b ) ( i ) Where dust treatment is to be advocated, the first application of 5% DDT-sulphur ( 1 : 1 ) should be made thoroughly soon after the first flush of flowering is complete by the middle of December.

( ii ) The second dusting should follow at least two weeks after the first application.

**N. B.**:— Should there be any rain following any of the applications, dusting or spraying should be repeated accordingly.

2. **Mango shoot borer** ( *Chlumetia transversa* w )

Active from July to December. Major pest mostly on mango seedlings and grafts in the nursery. The caterpillars bore into the growing shoots and tender leaves. As a result the shoots wither and at times the plants may even be killed.

From the experiments conducted by the writer, application of 0.2% DDT spray prepared as in the above schedule has proved very beneficial. This spray is incidentally found to be useful in the control of the leaf webbing caterpillars and Lymantriid caterpillars infesting the mango trees.

*Spray schedule:*

( i ) As soon as the withering of tender leaves is marked on one or two plants in the nursery first application of the above spray should be made thoroughly after clipping of the withered shoots.

( ii ) The second application should be made about three weeks after the first spraying. During this application, it will be better if pyrocolloid is mixed at the rate of 1 lb. in every 100 gallons of 0.2% DDT spray. Since this mixture is not compatable, this should be prepared only at the time of application.

3. **Red ants** ( *Oecophylla smaragdina F.* )

These ants are active throughout the year. They do not cause direct damage to the plants but are indirectly troublesome to the fruit trees like mango, citrus, chickoo and guava by harbouring noxious insects like cocoids in their nests. Their enormous numbers and wanderings on the trees affect harvesting adversely.

From the insecticidal trials carried out by the author it is observed that dusting a mixture of 5% BHC, ( Gammexane or hexyclan ) in combination with sulphur in the proporation of 2 : 1 or Pyrodust 1500 or 5% DDT-sulphur ( 2 : 1 ) has yielded very encouraging results.

*Dust schedule :*

( i ) The tree trunks and the space around them upto a radius of about 5 ft. should be thoroughly dusted first with any of the above mixtures.

( ii ) The same mixture is then to be dusted all over the trees and also into the nests by piercing them open with the fore-end of the dust gun.

( iii ) The above items should be repeated after about 2 or 3 weeks in case of 5% DDT-sulphur mixture and one week in case of Pyrodust or 5% BHC-sulphur dust ( 2 : 1 ).

**4. Pomegranate fruit borer** ( *Virachola isocrates* )

Serious pest of pomegranate particularly in Dholka ( Ahmedabad ), Poona, Satara and Bijapur Districts of Bombay Province. When plants are in flower or when the fruits are about the size of pea nut, the female butterfly lays eggs on them. These eggs hatch out and one or two small darkish brown caterpillars enter the fruit by boring a hole and thus develop inside the growing fruit. The activity of the pest is almost throughout the year since there are two seasons for the crop. The extent of damage may range from 30 to 35 %.

The insecticidal trials conducted by the author signify that this pest can be very well controlled by two to three sprays containing 4 lbs. of 50% wettable DDT powder in 100 gallons of water ( i. e. 0.2 % DDT spray ).

*Spray schedule :*

( a ) Mid-June to Mid-September :

( i ) By the middle of June when the tree is in full blossom the first application of 0. 2% DDT spray should be given.

(ii) The second application should be made adout 3 weeks after the first spraying.

(iii) The third spraying should he made about 3 weeks after the second application.

( b ) Mid-December to Mid-March.

(i) The first spraying should be given by the middle of December. Care should be taken to wet all the floral parts and leaves.

(ii) The second application of spray should be made about three weeks after the first.

(iii) The third spraying should follow within 3 weeks after the second application.

**5. Lemon butterfly** (*Papilio demoleus* Linn)

Occasionally a serious pest on the leaves of different citrus varieties. Eggs are laid on the leaves and the caterpillar stage is also passed feeding on the leaves. The green caterpillars when full fed often travel long distances and pupate hanging from the branches.

From the recent experiments it is observed that a spray containing 1 lb. of pyrocolloid and 4 lbs. of 50%DDT wettable in 100 gallons of water has been found to be very effective against these caterpillars.

*Spray schedule:*

(i) The first application should be made when the young green caterpillers appear on the leaves in the nursery or in the orchard.

(ii) The second spraying should be given about 3 weeks after the first one if found necessary.

6. **Citrus leaf miner** (*Phyllocnistis citrella* S.)

A major pest of citrus leaves and twigs all over the citrus growing districts of the Bombay Province. Activity of this pest is from April to October. The larvae mine the leaves of citrus plants especially those which are young or are in the nurseries. They feed on the mesophyll leaving two epidermal layers intact and thus give rise to transparent galleries. The infected leaves get distorted, dry up and fall of and thus the vitality of the whole plant is seriously affected Sometimes the larvae mine under the epidermis of young green twigs also.

Recent insecticidal trials carried out by the author show that a spray containing 1 lb. of nicotine sulphate 40% 4 lbs. soap and 4 lbs. 50% wettable DDT in 80 gallons of water has proved very effective in controlling this pest.

*Spray schedule:*

(i) Early in April or late in May when the freshly emerged larvae are seen, the first application of the above spray should be made.

(ii) The second spraying should follow at least three weeks after the first application.

(iii) If the attack persists, subsequent sprayings should be given at an interval of 4 weeks.

7. **Citrus aphid** (*Toxoptera aurantii* B.)

One of the important major pests. Although active throughout the year its severity is marked from October to February. These aphids are mainly found on the leaves and tender shoots of citrus. Both adults and nymphs feed on the sap of growing shoots and leaves. As a result the leaves become badly curled and at times etiolated. In severe cases of attack the ripening of the fruit is slowed down.

By way of control, the recent investigation shows that a spray containing 1 lb. nicotine sulphate 40% and 4 lbs. soap in 80 gallons of water is much superior to that of new insecticides like DDT or BHC against this pest. However pyro colloid diluted 1 : 800 has also yielded a high mortality.

*Spray schedule:*

(i) By the middle of October when the aphids start appearing in a pest form, the first spray of nicotine sulphate or Pyrocolloid should be given.

( ii ) The second application should follow within a week after the first spraying.

( iii ) The subsequent sprays if required should be given at a week's interval.

### 8. Slug caterpillar ( *Parasa lepida* C )

Sporadic minor pest of citrus and mango in Ahmednagar, Poona and Dharwar Districts. The caterpillars feed on soft parts of leaves in the early stage. Later on the entire leaves are eaten up and the trees are defoliated completely. As a result of defoliation, the fruits remain undeveloped. The pest is active from mid September to mid December. Working in the infested orchards becomes an irksome job owing to the irritation caused by their hairs on the skin of the workers.

The recent insecticidal trials conducted by the author reveal that a spray containing ¼ lb. pyrocolloid and 3/4 lb. of 50% DDT wettable powder in 20 gallons of water has controlled the pest very effectively.

*Spray schedule :*

( i ) The first application of the spray should be made during September –October when the caterpillars appear sporadically.

( ii ) The subsequent sprays should range at an interval of 2 weeks, should the infestation become severe.

### 9. Guava mealy bugs ( *Pulvinaria psidii* M )

Specific pest of guava all over the Bomday province. Both adults and nymphs feed on the sap of growing shoots and in severe cases the growth of the plant is considerably checked. The pest is active practically throughout the year.

Recent experiments show that a spray containing ½ lb. fish oil rosin soap and ½ lb. 20%DDT emulsion in 4 gallons of water can control the pest very effectively. The same spray is also found to be useful in the control of mango scale insects (*Aspidiotus destructor*) and citrus scale insects ( *Chrysompholus* and *Pseudococcus* sp.).

*Spray schedule :*

( i ) Two sprayings at one week's interval should be given preferably before the monsoon sets in during July depending upon the incidence of the pest.

( ii ) Two applications at one week's interval should be given as winter sprays after November.

### 10 The shoot and bark borer ( *Arbela tetraonis* M )

Serious pest of guava, citrus, pomegranate and mango trees, found all the year round. The female moth lays eggs under loose bark or in some crevices and the freshly hatched larva bores into the stem and bark. It moves

about in a gallery of powdered bark and silk, feeds on the bark and also enters the stem. As a result, the tree puts on a sickly appearance and ultimately it may even die.

By way of control injecting the borer solution containing 2 parts of carbon bi-sulphide with one part each of chloroform and creosote, is found to kill the larvae of the borer quite effectively. The same solution is found effective against the grub of mango stem borer. ( *Batocera rubus* )

*Treatment schedule:*

( i ) Scrape off the webbings and galleries and ascertain the live burrows.

( ii ) Inject the solution only into such of the suspected crevices or holes.

( iii ) Repeat the above items at least once in a fortnight.

N. B.:— In case the solution is not available even petrol can be used.

11. **Fruit fly** ( *Chaetodacus* sp. )

Occassionally a serious pest of guava, citrus and mango. The fly lays eggs by means of its piercing ovipositor under the rind of the fruit when it is about to ripen. Within a few days the eggs hatch and the young maggots start feeding on fruit pulp. The infested fruits can be recognized even at an early stage of attack by the presence of a rotten patch round the place of oviposition. As the maggots grow, this patch extends and the fruit falls down and becomes entirely useless for human consumption.

By way of control, a spray bait containing 1 oz. tartar emetic and 24 ozs. jaggery in 20 lbs. of water can be recommended.

*Treatment schedule:*

( i ) When the fruit is about to ripen in March, spray such of the foliage that is facing the sun, with the above bait mixture.

( ii ) Destroy the fallen infested fruits by burning them into small pits.

( iii ) Repeat item No. 1 immediately after item No. 2 and also once a week.

12. **Grape vine beetle** ( *Scelodonta strigicollis* Mot )

Seasonally serious pest in the pruned vineyards of Nasik, Nagar, Poona and Bijapur districts of the Bombay Province. It is singularly monophagous on grape vine, even though it is found to scrape the lower surface of the leaves of pangara (*Erythrina indica*). The small adult flea beetle popularly known as *Udadya*, causes considerable damage to pruned vines especially after October pruning. It is active from April to November. Eggs are laid under the bark of the vine. The pest passes its grub stage feeding on the roots for 5 to 6 weeks and pupates in the soil in an earthen cell. Within a week's time the adult beetle emerges out of the pupa The adult when disturbed, falls down, lies motionless and feigns death.

This habit was therefore taken advantage of in devising the " Umbrella method " by the author. An ordinary umbrella was inverted and the inside was

wetted with kerosenised water. Vines were shaken holding this inverted umbrella underneath each vine. The beetles thus dropped into the umbrella were thrown in drums coated with sticky substance inside and half filled with kerosenised water. This method could be followed with great success in the early mornings of September before October pruning.

But the recent insecticidal trials conducted by the writer show that the pest can be brought under control by two or three sprayings of DDT-Bordeaux mixture prepared by mixing 4 lbs. of 50 % DDT wettable powder in 100 gallons of Bordeaux mixture ( 3 : 3 : 50 ) which is already used against downy mildews.

*Spray schedule:*

( i ) The first application of DDT-bordeaux mixture should be made within a week after pruning in October and also in April.

( ii ) The second spraying should follow within two weeks of the first application.

( iii ) The third application should invariably be made about two weeks after the second spraying.

N. B.:- The addition of DDT-wettable to Bordeaux mixture should be done just prior to its application. Should rain follow any of the treatments, they are to be repeated accordingly.

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# Cassava Growing in Zanzibar

By

YUSUF O. K. HASSANIA, F. Sc. (Agri.) class

Many of us in this college are unaware of the fact that cassava is one of the most valuable food products. As potatoes form the chief diet of the Irish, so does cassava form the staple food of the East Africans. Being one of the most favoured foods, it is extensively cultivated in Zanzibar and the coastal area of East Africa.

Cassava or Maniobe as it is sometimes called, was first introduced probably from Latin America by the Portugese who, soon after their conquest of the islands of Zanzibar and Pemba, found that the climatic conditions and soil were well suited for the production of this crop.

"Muhogo" is the name given to this crop by the East Africans but its Botanical name is Manihot aipi. It is a small plant attaining a heigt of 6 to 8 feet and it is in the roots that the valubale starchy food is stored. These tuberous roots are usually 1½ feet long but sometimes under favourable conditions they even attain a lenth of 3 feet.

Cassava bears small fruits, but it is propogated by cuttings of the stem. In the island of Zanzibar, the most popular mode of cultivation is "Matuta" i. e., ridges in which the cuttings of the cassava stem are planted.

It is very interesting to note that in Zanzibar people do not pay anything to the landlords or the Government for the land in which they grow their food products. Zanzibar is a country which has specialised in the cultivation of cloves and hence the landlords do not pay much attention to the production of food stuffs. The plantation owners, therefore, allow their labourers and people living in their plantations to grow cassava, sweet potatoes, banana and such other food products, without asking them to pay rent. This method seems very peculiar, however, according to the tradition it still exists.

An ordinary cultivator gets from two to ten acres of land, and with hand labour grows food products which not only provide him with every day necessities of life but even clothes and some cash.

When cassava is to be grown, the land has first to be cleared of all weeds by uprooting them with a "Jembe"—a sort of spade with a long handle. The weeds and other undesirable plants are then burnt and the ashes mixed with the soil. Sometimes they are allowed to dry and then buried under the ridges. The moist soil of the ridges causes them to rot and thereby provide manure. No other manure is used in the cultivation of cassava. When ridges are ready, the cultivator cuts from green stems of cassava six to eight inches pieces which include three to four internodes. The cuttings are then planted on the top of the ridge with a regular interval of 3 feet. In between these cuttings sweet potatoes are planted. Within 15 days the cuttings strike roots and the leaves are borne.

Usually early varieties of sweet potatoes are sown along with cassava, so that by the time the latter attains a height of about 3 feet, the sweet potatoes are ready for harvest. The first weeding is done when the crop is a month old. The second weeding is done soon after the harvest of sweet potatoes, and the third one when the crop is nine months old. Thus within twelve months the cassava crop is ready for harvest.

There are many local varieties; the most popular of which are "Muhega", "Msitu", "Kibange" and "Biti Asumani". Kibange reaches its maturity within eight months; and consequently during the last war when early crops were most essential to meet the food shortage, this variety was preferred by the cultivators.

The cassava roots which are rich in starchy foods have a thick skin which is fed to cattle with some concentrates. Roasting and cooking cassava in cocoanut

juice is the usual way in which this food is utilised. Cassava is also dried and powdered to form a flour which is used in the preparation of " Ugali " —a sort of African porridge. The flour is also used in many laundries for starching clothes. If the stem is not used for propogating the plant, it serves as fuel when dry. The leaves during early stages are used as vegetable which in " swahili " is called " Mbhoga Ya Kisambbu. " The leaves of the matured plants are fed to cattle as green fodder. Cassava has a certain percentage of sugar and is also used in the preparation of alcohol.

It is certain that if this crop is acclamatized in our province we may solve not only the food problem, but can even supply considerable amount of cattle fodder. We may also prepare industrial alcohol which would go a great way in pacifying the discontented rumbling of the dissatisfied motorists.

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# Contributions of Leibig and Haber to Agriculture.

By

G. R. KOPPIKAR, B. Sc. (Agri.) Class.

Food production is the burning problem of to-day that every person ranging from the highest to the lowest status in India is confronted with. Having clearly experienced the pinch of the deficit of food sometimes even to keep the souls alive all over India, the present Government have been forced to take certain positive steps in the direction of elevating the standard of the yields of crops which are at present below par as compared to those in most other countries. Certain measures which promise to enable us to achieve this aim are being undertaken. In this connection no tiller of the soil can pull on with his work successfully without the necessary knowledge of certain principles influencing agriculture and agricultural practices.

The relation of chemistry with agriculture and its influence on agriculture in general needs no emphasis. These two are connected with each other with so great an intimacy, that even the concept of agriculture and its practices without the application of chemistry seems to be beyond imagination. The very single fact that plants suffer fatally in the absence of the necessary chemical nutrient elements in their vicinity is quite sufficient to prove the undoubted and indisputable dominance of the knowledge of chemistry in relation to agriculture. Hence

it necessitates every son of the soil to keep himself familiar with the knowledge of agricultural chemistry. In this connection he would do well to learn, remember and bring into actual practice the contributions made by scientists which will guide him throughout his career as a farmer and enable him to achieve his goal of growing more food as well as preventing the waste of any of the resources available to him as a farmer.

One of the leading scientists whose achievements and discoveries have been useful to agriculture, is the German chemist Baron Leibig. Among the various of his achievements in chemistry in general, a few which stand in good stead to the farmer are enumerated as below.

Of all those who are notable in their efforts to find out the nutritional requirements of plants in general and of economic crops in particular, Leibig shares probably the largest amount of credit. His notions and theories in this respect came to the light in the name of his Mineral Hypothesis. As a result of his experiments he came to the conclusion that " plants need to be supplied with minerals in order to provide for normal growth". The earlier views held by scientists were that humus as such was directly absorbed by plants and that it was synthesized into plant tissues. Leibig further went on to advocate that through the physiological process of photosynthesis, plants obtained their carbon requirements from the atmosphere and, therefore, they need certain other elements commonly known as ash or ash-constituents which they can absorb from the soil. Hence it would be enough to supply the nutrient medium with the required minerals only to plants for their necessary growth.

But this hypothesis suffers from certain limitations and drawbacks as are und by actual practices. In the culture solutions composed of the necessary utrient elements for a series of plants, it has been observed that the plants hibit a marked deterioration if they are grown through a number of genera- ons from the seed obtained from the culture plants. This is mainly attributed the absence of certain essential phyto-hormones which are largely and com- only found in humic manures and soil organic matter. Low residual effect of ch mineral mixtures and their inability to serve as a complete manure, low food lue and low keeping quality of the produce due to an increased amount of oisture content in the produce obtained in such cultures have greatly been sponsible for the restriction of this hypothesis in actual practice. However, in e history of the development of agriculture the hypothesis has attained an portant position due to its suggesting a successful attempt towards an increased oduction of food, especially of such a nature as can be comsumed early.

The second achievement advocated by him in an important cultural opera- on is known as Leibig's Law of Minimum. It claims to be the very base on hich the important practice of manuring stands. Soil, the reservoir of the utritional elements of plants, is found to contain various of the principle ele- ents exhibiting a range in their individual amount. In such a condition (always

found mostly in all soils ) the crop growth is determined by that particular element which is minimum in amount in the whole lot of the elements. Thus, supposing a patch of soil contains nitrates to the tune of 0.6 %, phosphate 0.2 %, and potash 0.15 %, it is the potash that influences the growth of the crop taken on that patch of soil. Thus one should expect to find the growth and the yield of the crop in proportion to the amount of potash rather than that of nitrates or phosphates. Hence, the right policy in manuring such a plot would be to add such a manure as would increase the amount of potash therein because in such cases, an increase in the element or elements most deficient in the soil will be followed by a proportionate increase in the yield of the crop grown on the soil.

This principle as put forth by Leibig, should find an important place in the practice of manuring. Before starting the cultivation of a particular soil its chemical analysis would reveal its actual position and quality regarding the various principle elements in it. Accordingly, the choice of such manures as can supply the elements present in the soil in the minimum amount can be determined and the right and economical policy can be persued in manuring the soil without any wastage of such elements as are already present there in sufficient quantities.

The third principle advanced by Leibig is his theory of Rotation of Crops, though Leibig is little known as the originator of this theory. Before Leibig, D'Candol had interpreted the cause of the lowering of yields in the same crop cultivated every year on the same land. According to him plants secreted certain materials through their roots in soil every year, and the material after being accumulated beyond a certain limit, would prove to be detrimental to the same plants or to the plants of the same nature in their botanical structures. As opposed to this, Leibig explained his own theory which has been accepted as more desirable than that of D'Candol. According to Leibig, the cause in the lessening of yields in such cases, is due to lack of a particular kind of food or particular facilities in obtaining the food. The facilities mentioned by him are associated with the depth at which the food is stored in soil. Consequently it follows that the plants or crops which are similar botanically in their nature of growth and structures should be properly distributed year after year and they should be replaced by such crops as can create proper conditions for the former ones in connection with the availability of nutrition in such a manner that all these crops will find no difficulty in showing a normal growth and in yielding the proper amount of produce.

The significance of the Principle of Rotation of Crops is well established and well-known to-day, not only for the advantages that have been put forth by Leibig but for many others also. Thus, it will be of an immense benefit to every farmer in carrying on his profession with the desired advantages.

Another German scientist who came to the help of the farmer in his profession, though indirectly, but who is very little known to the agriculturist is Fritz Haber. As a chemist his services were mainly sought for by Germany in the first world war during 1914–18. Sometime after the war broke out, the

headache of the pressing need for sodium nitrate used for the preparation of explosives, drove the German scientists towards finding out a method of the preparation of the chemical, and but for the valuable and successful efforts on the part of Haber in this direction, Germany would have had to sue for peace within the first six montns of the war.

Haber synthesised the chemical by the fixation of the unlimited amount of atmospheric nitrogen by means of hydrogen, to form ammonia. The requirements for achieving this, as sought for by Haber are:—

1) a thoroughly purified mixture of 1 volume of nitrogen and 3 volumes of hydrogen,

2) a pressure of 300 to 500 atmospheres under which the mixture is compressed,

3) a temperature of 500° C at which the process is carried on, and

4) a suitable catalyser ( finely divided iron containing a little molybdanum ).

This method has been found to be the cheapest one. The ammonia thus formed was made to react with suitable chemicals to synthesise the desired chemicals.

Through the agriculturist's glasses, the importance of the process lies in the ammonia being converted into useful chemicals like ammonium sulphate, and ammonium nitrate which can be of an immense use in agriculture as fertilisers in bringing about a fovourable effect in bringing forth an immediate growth and large yields. Thus, the credit of utilising the unlimited treasures of the atmospheric nitrogen in the synthesis of the fertilisers for the first time and thus the credit of bringing of the nonavailable form of atmospheric nitrogen into an easily available form for plants goes to Haber.

In this way, among the host of scientists all over the world these two eminent scientists have come to limelight in the achievements in the arena of agriculture. It is to be hoped that the agriculturists all over India, engrossed in pulling their nation out of the present difficult food situation will study the significance and the utility underlying the above mentioned discoveries and inventions, and that with the help of such useful facts, they will go a long way in leading the nation to success in its goal of improving the present food situation.

# Gymkhana Activities

The Gymkhana activities started just after the election of various secretaries, for various departments.

Our college has participated in all items of the inter-collegiate sports except swimming, atyapatya and basket ball. This year our foot-ball team was excellent. We played many matches. Our college participated in the " Poona District Foot-ball Association " tournaments and achieved a remarkable success by standing runners up. We were hoping to have a good chance in Inter-collegiate sports but it was not to be due to some unfortunate circumstances. Messrs F. F. Pinto, M. B. Rana, and S. R. Ambekar, gave admirable show in all the matches.

This year our cricket and volley-ball teams played the semifinal matches against S. P. College but we lost these due to insufficient and scientific practice. Messrs M. B. Rana, C. B. Pande, played the semifinal match in badmington doubles.

Indian games and gymnasium is the only department which has scored all the points in Inter-collegiate sports. The department was in full swing and majority of the students took interest in its activity. We stood runners up in khokho. Mr. S. B. Brahme put up an admirable show in Khokho. This year we had a number of good wrestlers. We were hoping to get the wrestling championship but some of our wrestlers were injured previously. Mr. A. N. Shinde and Mr. B. N. Bhosale got the championship in 135 to 145 lbs. and below 100 lbs. respectively. In weight lifting we could have done well but we were not able to practice as the weight lifting set is incomplete. Mr. V. P. Dalaya and Mr. J. G. Patil achieved the championships in 135–145 lbs. and below 110 lbs. respectively. It is all the more praiseworthy that Mr. J. G. Patil not only got the championship but he has broken the previous records and established a new good record.

Reading room was run with great enthusiasm. The most striking item was the introduction of foreign magazines like ' Sports ', ' Life ', ' Strength & Health ' and ' British Farm Mechanization '.

In the first term of the acedemic year, we had very good chances to attend the lectures of many eminent personages like, Mr. Annasaheb Sahasrabudhye ( President Maharashtra Charakha Sangh ), Dr. Ghatage, Deputy Director, Grow More Food Campaign, Dr. Khankhoje, Adviser to Central Government, and Dr. J. C. Kumarappa, President of All India Village Industry Association. This year Agricultural Association and Debating Society Department is running very smoothly.

We hope to have a good performance in sports in II term of the academic year.

— A. N. Shinde,
*Hon. Gen. Secretary.*

# Book Review

## Reconstruction of Land Tenure *

**Problems of Zamindari and Land Tenure Reconstruction in India-by Peshotan N. Driver, Professor of Agricultural Economics, College of Agriculture, Poona : Published by New Book Co. Ltd., 188, 190, Hornby Road, Bombay, 1949, Pp xx and 310; Rs. 12-8.**

No review however exhaustive, can do full justice to this remarkable publication which is the result of comprehensive studies. It is throughout marked by refreshing originality and a brilliant analysis of the extremely difficult problems of Zamindari abolition and land tenure reconstruction. While discussing a multitude of related problems, the author reveals a mastery of detail which is truly amazing. Prof. Driver is frankly iconoclastic and his book should serve to upset the calm complacency of moderate political leaders and profoundly disturb the conscience of the rentier and landlord classes.

The six outstanding features of this brilliant treatise are : (1) an exhaustive examination ' In our own time of relative over-population ' of the relation between land tenure and agricultural productivity in our country– a delicate but essential examination which researchers in agricultural economics have till now shirked for fear of undermining ' our traditional ideas about the private ownership of agricultural land ', (2) a forthright and well-reasoned indictment of all forms of parasitic landlordism; (3) a realistic treatment of the problem of compensation rightly stressing " the great danger of a legalistic approach leading to unfairly liberal compensation '; (4) a detailed examination of the " economic disasters of ordinary peasant proprietorship " followed by an attack on " the dangerous belief commonly held in India that the abolition of Zamindari should or will lead to the establishment of a society of peasant proprietorship " (5) an evalcation, without the least trace of political prejudice of the economic and social benefits or collectivisation in Russia; and (6) a bold radical plan for nationalising land and for collectivised agriculture on co-operative lines, which however, is not entirely Russian in inspiration.

Starting with an account of the origin and history of Zamindari, Prof. Driver deals exhaustively with the different aspects of the system and its abolition and covers a vast ground including land taxation and peasant proprietorship before he outlines his plan of reconstruction. The main arguments of the author leading up to his advocacy of state-ownership of land may be briefly summarised as follows :– By creating " the institution of agricultural landlordism based on private property rights in their modern forms ", British rulers separated us from "the tradition of agriculture blended with industrious and that of agriculture

* Review from Indian Express Magazine Section, Madras, dated 4th September 1949.

based on the 'common' possession of land" Although private cultivation of land in ancient India is not questioned, it is conclusively proved that the Hindu land system never made the right of cultivating land "a property right in the sense of right to sell land as a transferable marketable commodity". The theoretical advantages of good landlordism remain only theoretical; the increase in the number of rent-receivers and non-cultivating owners as also in the number of landless labourers has created a dangerous class division in society; the iniquitous distribution of land is as much a feature of Zamindari as of Ryotwari areas - all these factors underline the necessity for abolishing all forms of landlordism. As "the total land available is much less than necessary for a proper redistribution in the form of prosperous individualistic peasant farms, all forms of private ownership of land too should be abolished. Arguing that the Indian "peasant's love of the land is not so uncontrolled or uncontrollable as we imagine", the author suggests that "the best solution of the difficulty is a psychological change which will convince both our tenants and the proprietors of to-day that it is not economical to keep on clinging to their ancestral holdings". Then will follow "a system of nationalisation of land which will both guide as well as be guided by co-operative influences and which will be neither ordinary State landlordism of a loose type nor even State farming of a closely centralised type".

The logic behind the author's arguments is so impaccable that their refutation will be neither easy nor pleasant for even the most well-informed critics.

V. R.

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# Gleanings

— Some U. S. A. scientists state that the fresh water seaweed botanically known as Chlorella has immense possibilities as a food material. This unicellular alga, which forms a green scum on still water in summar, is very efficient photosynthetically, catching sunlight and utilising it to convert inorganic materials into food. Its growth is accelerated by increasing carbon dioxide in it environmment. An extra supply of nitrogen causes it to produce large quantities of protein. By reducing the supply of nitrogen it tends to store up more fat and oils in the cell. It can thus be induced to produce either proteins or fat and oils at will. The scientists emphasize that it is most likely to get into the human food cycle by way of livestock and poultry feed.

— "American Newsfile," Sept. 14-49.

— Earthworms are an asset for productive agriculture. Experiments conducted in America have shown an average increase in crop yields by 81 per cent by dead earthworms. By adding live worms the yields were even higher — 8 per cent!

— "American Newsfeature," 14th Sept. 49

— In some parts of Hawaiian Islands occupied by livestock enterprises flies are found to be responsible for soil erosion. During certain seasons of the year vicious horn flies attacked the sheep and drove the animals to the open faces of the island. In order to keep off the flies the animals stamped the ground and kicked the dust, which was carried away by wind and rain causing serious soil erosion.

— "Soil Conservation," August 49.

— The Hawaiian farmers who were at a loss to know what to do with the heavy stumps remaining after pineappie harvest, are now using them as a mulch for soil conservation.

— "Soil Conservation," August 49.

— In a suger refinery in Hawaii a large settling tank has been constructed to catch water used for washing out soil from the freshly harvested cane. A large amount of silt deposits in the tank. A huge rotating arm takes out the sludge therefrom and deposits it in an adjacent basin, from where it is carefully returned by truck to portions of fields most seriously damaged by erosion.

— "Soil Conservation," August 49.

— The term, harmone, is derived from a Greek word, meaning "I arouse activity". Bayliss and Staring while working on pancreatic secretion in 1902–03, coined this term.

— "Times of India," 5th August 49.

— Heavy down-pour of rain and cyclonic storms are causes of immense damage to a standing paddy crop in India. It is estimated that the Indian agriculture has to bear a loss of millions of rupees under such conditions. As soon as a paddy crop lodges the earheads come in contaet with the wet soils and then rot. Japanese farmers have devised an ingenious method to check the damage to a rice crop by heavy downpour of rain. Poles 8' to 10' high are fixed in the field at intervals, strings are tied to the poles so as to form a sort of lattice-work. These strings support the earheads and prevent them from lodging and coming in contact with the soil.

— "Mauli" 9 th October 1949.

— Rice hulls ( a waste material so far ) mixed with forage seeds are now used in U. S. A. for facilitating the sowing of mixtures of different kinds of seeds in one operation and obtain their uniform distribution irrespective of their size, shape and weight. Usually heavy seeds rush out of the drill spouts and lighter seeds are left behind, resulting in a spotty, uneven growth of the crop. Each of the rice hull in the seed mixture acts as a cup and holds a small quantity of the different seeds in the mixture and passes out of drilling spouts taking the seed along with it.

— "Soil Conservation," July, 1949.

— The total area under cultivation in India at present is only 82,00,000 acres. It is estimated that if India is to be self-sufficient in food supply an area of 1.15 acres per adult per year would be required to be under cultivation. This means that an area of 84,00,000 acres must be under food crops only if India has to pass over the present crisis.

— " The Mysore Economic Review."
( Vol. No. 1, No. 1 )

— Average yield of paddy in Karwar district is 1700 lbs. But it has been proved experimentally that this can be stepped up to 4000 lbs. A farmer in Korlakate obtained a paddy yield of 5400 lbs. this year.

— " Shetkari " June 1949.

— In June, 1948 newspapers gave publicity to a warning from Prof. Einstein against modern methods of agriculture. It was stated in the warning that with the use of huge tractors, machinery and chemical fertilizers, production could be forced up for a time but in the long run they would result in the loss of fertility and incalculable and irreparable damage.

Mr. A. Kumar Dutt of Panihati subsequently corresponded with Prof. Einstein in this connection and obtained the following elucidation. Prof. Einstein, it appears, in his conversation with Dr. Jha referred to the book " Our Plundered Planet " by Fairfield Obborne, which convincingly shows that indiscriminate exploitation of the soil by technical means can become dangerous and lead to speedy deterioration. Prof. Einstein's opinion was based on the above-mentioned book.

One can infer from this that fertilizers and machinery, if used in the right manner, in the right place and at the right time, would not cause the injury referred to above. Properly used, they would be similar to a medical and surgical treatment in case of human diseases. Indiscriminate use may create evil effects.

—" Amrita Bazar Patrika " 26th August, 1948.

# Obituary

It is with deepest regret and poignant sorrow that we have to record the untimely death of Mr. B. Nazareth, late Assistant Horticulturist to Government, B. P., Poona, which occurred on 22nd October 1949. The irony of fate is that it was never expected that an ordinary illness would snatch him a way from our midst so suddenly. His personality and work were so blended that it is very difficult to fill his place and the Horticultural Section is poorer by his death.

Mr. Nazareth ushered his career in the Department of Agriculture in the year 1923 and was posted in the Plant Breeding Section and the training and experience he gained there stood him in good stead in his later independent work in the field of plant breeding in which he acquitted himself very well, as judged from his research papers. For nine years he worked as Superintendent of the Wheat Breeding Stations at Ganeshkhind and at Niphad. In 1932 he was taken up in the Horticultural Section and since then he officiated as Superintendent of the Ganeshkhind Fruit Experiment Station, Kirkee, and Modibag Gardens, College of Agriculture, Poona, which positions he ably filled. During this period his work on vegetable breeding is worthy of mention in as much as a couple of brinjal and chilli selections are now widely cultivated as improved types. During the world-war II, his previous training in the University Training Corps urged him to volunteer his services for active service and in 1942 he was taken up as a Commissioned officer in the Bombay Provincial Unit, Civil Pioneer Force, which office he efficiently held for over three years. On release from the active service in 1946 he was appointed as Assistant Horticulturist to Government in B.A.S. Cl. II.

On the social side, Mr. Nazareth during his college career distinguished himself as a first class sportsman and an all-round athlete. His was an ever jovial and amiable personality. He was very popular with whomever he came in contact. It was his genial personality that made him a successful propagandist during his office as Assistant Horticulturist.

Mr. Nazareth leaves behind a large family and a large circle of friends to mourn his death and we offer our heartfelt sympathies and condolence to his bereaved family.

May God in His mercy lend him grace. May his soul rest in peace.

— S. R. G.

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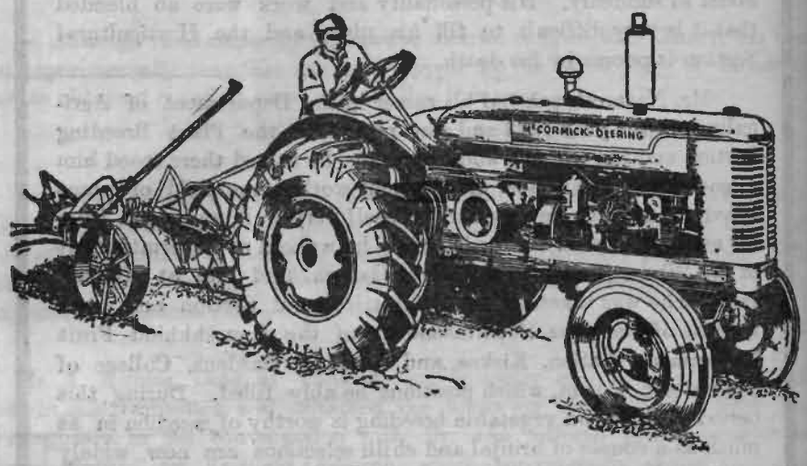


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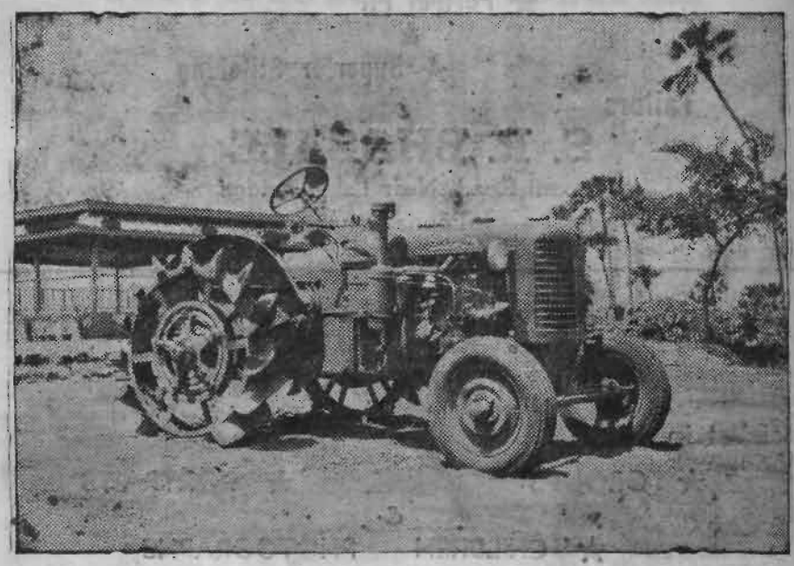

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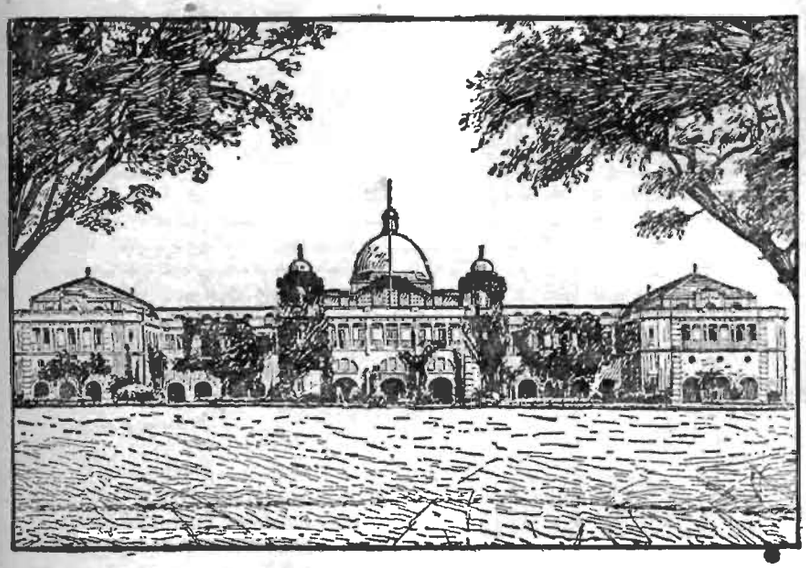
VOL. XL, NO. 4] THE [FEBRUARY, 1950

# Poona Agricultural College Magazine



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# THE POONA
# AGRICULTURAL COLLEGE MAGAZINE

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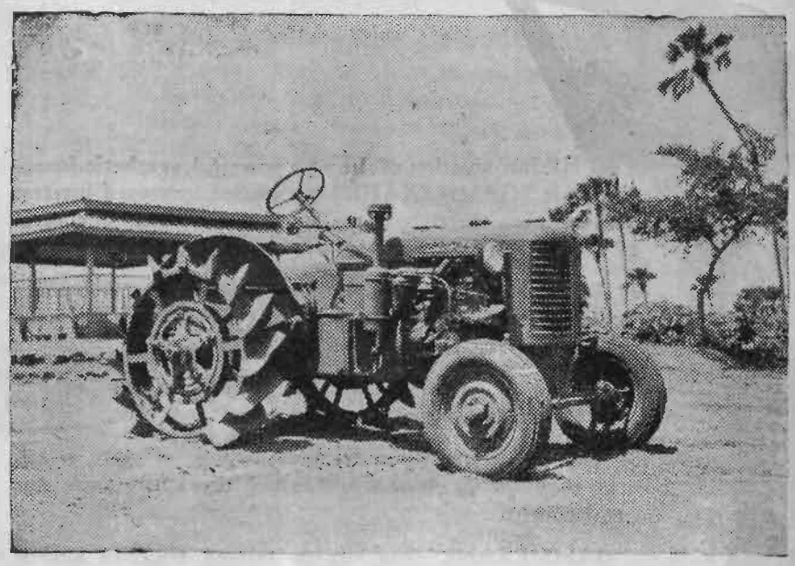

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# COLLEGE OF AGRICULTURE, POONA 5

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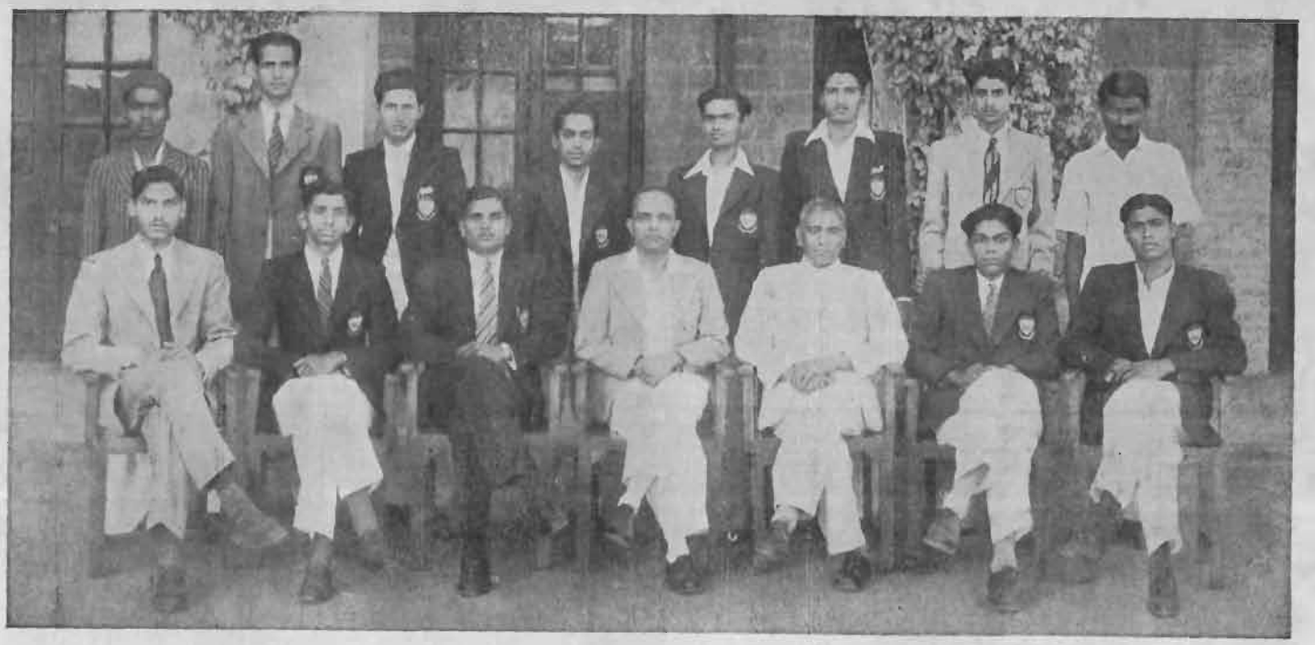
1949—50



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# COLLEGE OF AGRICULTURE, POONA

## The 41st Annual Social Gathering, 1949

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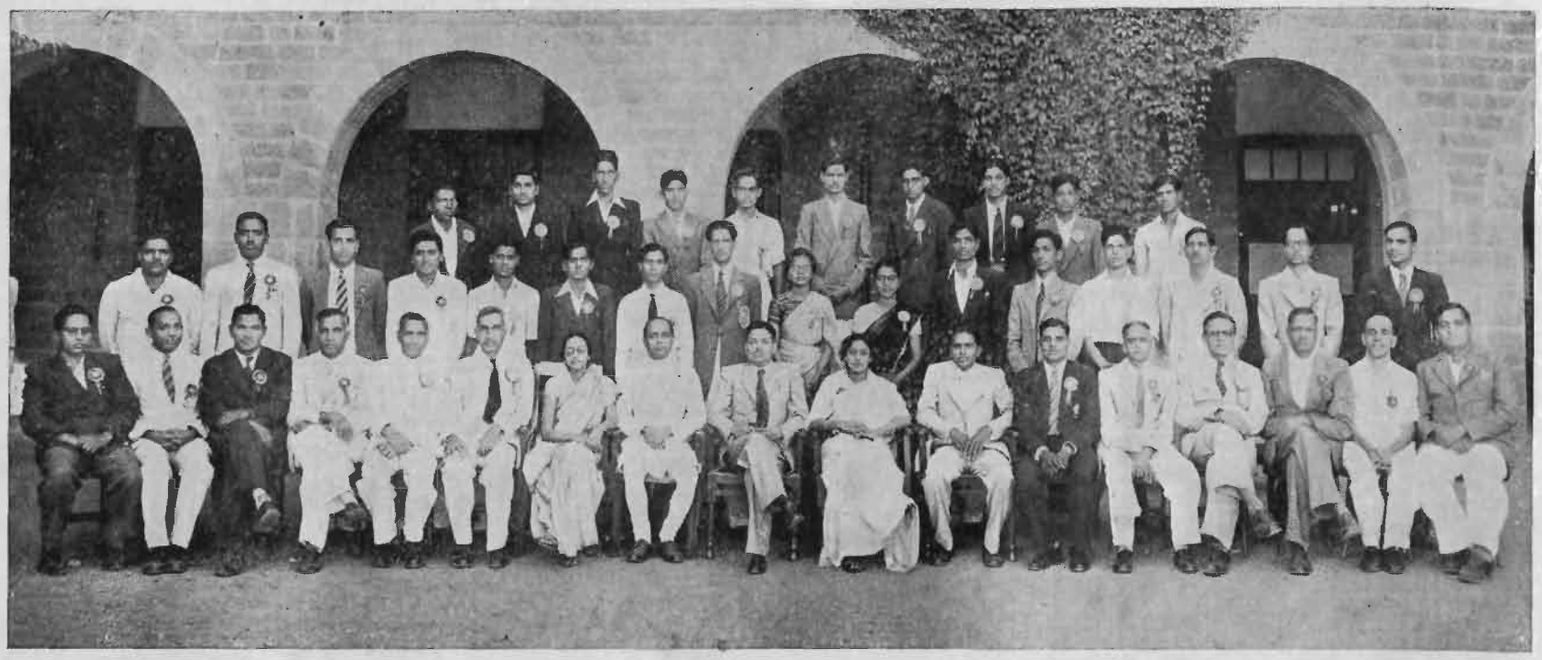

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# Inauguration of the Republic

The dawn of the auspicious day of 26th January 1950 saw the fulfilment of a dream of 20 years standing. The day was a great day in the history of India that is Bharat when India became a sovereign Independent Republic. The day was all the more significant as India attained the unique republican status as a federal and secular state for the first time in its history. A homogeneous and united India now possesses a Government of the People, for the people instead of a monarchy. Our country has thus advanced in its march of political progress and attained a status similar to other republican nations in the world. The sons of India have hammered out its federal constitution for the past three years and decided the destiny of the country and India now possesses the power of full self expression amongst the nations of the world.

The new existance of our country as a republic imposes on us a great burden of responsibility as a free people. It is now the bounden duty of the people of India to maintain its dignity and liberty newly attained. Everybody has to strive his utmost to uphold the honour of the country and be loyal to the country. All our thoughts and actions should lead to the elevation of the country's status and dignity. This is all the more necessary as an economic cloud overhangs the country. We are faced with food shortage. We have to be self sufficient in many other directions. We are backward in industries and have to achieve a quick advancement to obtain an equal footing with other advanced countries in the world. Our path is strewn with thorns and it should be the holy duty of every citizen of India to unite and co-operate fully with the Government so as to enable us to uphold our newly attained freedom to make it everlasting and to establish an era of peace and prosperity in the future. Let every one of us, therefore, pledge ourselves to do our utmost for our country

शुभास्ते पन्थानः सन्तु।

जयहिंद

* * * * *

The inauguration of the Indian Republic was celebrated at our college on Thursday, the 26th January 1950. The Director of Agriculture, all heads of several sections situated on the college estate and their staff, the college students, farm school children and farm staff were present in full strength, when the hoisting and salutation ceremony of the flag of Republic was performed. Principal L. S. S. Kumar hoisted the flag. N. C. C. guard from the college presented arms to the flag and everybody present at the ceremony paid his homage to the national flag. The heart of every single soul in the gathering was overflowing with joy on this solemn occassion of attainment of full freedom. Each individual felt the responsibility of the new spirit befitting the occassion. After salutation the Principal addressed the gathering, which dispersed thereafter.

# Message of the Principal, College of Agriculture, Poona on the Indian Republic Day (26th January, 1950)

This is a day of great significance in the history of our Motherland. The freedom that this country had enjoyed centuries back and which had been lost for a time is now regained. This newly won freedom is in a way very different from what it had ever been before. For, the unification of the country into such a vast and homogeneous whole could never before have been possible except under the benign rule of the Great Emperor Asoka, whose *chakra* and the lion capital have most appropriately been adopted as the symbol and seal of our freedom.

On the 15th of August, 1947, our country declared its independence and our statesmen and representatives have since then deliberated upon the framing of a charter of freedom for the country which is now written and adopted. This new constitution is a synthesis of the best democratic principles that are to be found in the constitutions of other great republics and democratic countries of the world. The constitution embodies equal rights for all, equality of expression and speech and conviction, freedom to follow any faith, personal liberty and other rights of a citizen of a republic. From today the nation will be governed according to these rights of the people.

It is, therefore, our solemn duty on this day to vow allegiance and loyalty to the new constitution and to pledge ourselves to uphold and implement the people's rights. It is expected of each one of us to do his or her duty as a citizen of a great republic which stands for the freedom and peace of all, which is against aggression and force and which strives for unity and goodwill amongst all nations without distinction of any sort.

Our leaders have pointed out that the real responsibility commences with the winning of freedom and the establishment of a republic. Provision of food, shelter and clothing, promotion of health, education and culture, development of agriculture, commerce and industry, encouragement of arts and science, protection of women, children and the aged and the defence of the nation against agressive attack from outside or inside are responsibilities that have to be discharged. Beginnings in respect of all these have been made and given sufficient time and with the goodwill and co-operation of all, the country should be able to fulfill all obligations for the benefit of its greatest number.

In the future progress of the country each and every citizen has a role to play. Whether this role be large or small, if it is done conscientiously, none need despair of success or have misgivings about the fulfillment of the ideals aimed at.

On this solemn occasion we should be failing in our duty if we forget to remember our revered father of the nation, Gandhiji, who though no longer with us in body is ever present in spirit. This day of our freedom should be consecrated to his sacred memory as it was he that led the country from slavery to freedom.

Let us pray that this freedom won would be guarded zealously by our posterity and it may never be lost to the people of this land.

JAI HIND.

THE POONA
AGRICULTURAL COLLEGE MAGAZINE

Vol. XL ] FEBRUARY, 1950 [ No. 4

# Editorial

Last October the Prime Minister of India Pandit Jawaharlal Nehru went round the United States of America and Canada. In his journey, a triumphal one, he met with a rousing reception everywhere. He has left a deep impression on the minds of peoples of America and one can be sure that his contacts will enable a better and fuller understanding between the two hemispheres which may be expected to result in active co-operation and partnership in cultural, scientific, industrial and other fields with a view to bring about the well-being of the several nations. We may count upon the mutual understanding established to help our country progress in every direction. We feel certain that the Prime Minister's message of peace and goodwill will bear good fruit.

* * * *

The food drive which we have referred to in our former issues, is being maintained in its tempo. In our province, Captain S. P. Mohite has been appointed the Provincial Director of Food Production. His experience and contacts with people, while serving in the revenue department as a Collector, will lead to better co-ordination between Government Departments and the non-official agencies. He has announced his plan of laying more stress on minor irrigation works, co-operative effort in agriculture and reclamation of waste land.

The Government of India will shortly take a forward step in this direction by introducing legislation leading to the formation of economic holdings. An economic unit would certainly lead to avoidance of wasteful practices, saving of labour and in increasing production. It is envisaged that the step will lead to Co-operative and Collective farming. The Government of Bombay have instructed the Collectors to take over the management of all cultivated lands which have remained fallow for two years. The lands will be leased out to adjacent cultivators. Our national army has put in an all out effort by bringing more than 30,000 acres under cultivation. The Government of India and the several Governments are taking every possible step to increase the food production. Although this year, there are promises of good results, the public and the peasantry should

not rest satisfied with what may be achieved. We have to strain still more and adopt all possible methods of improvements to get much further ahead of the present achievement.

* * * *

Devaluation has hit a hard blow to our country's economy. We have now to pay more for all things bought from United States of America and other countries who have maintained the old rate of exchange. This adverse condition has necessitated the Government of India and the Provincial Governments to put a check on their activities of providing increased irrigation facilities within the proposed time limit. Schemes like the Damodar valley, Hirakund and Bhakra dams and several other important projects have to be cut, to adjust the economy of the several Governments. The weilding of the axe will result in drastic cuts and the programme of recovery in food production will suffer. We hope that these schemes will be expedited with a view to obtain early results in building up a granary.

* * * *

The F. A. O. Census Committee has reported to the effect that the data bearing on agricultural statistics and the system of its collection are not upto the mark. The whole system of collection of such data requires careful planning, organisation and co-ordination. Further, we have been dealing with figures which were incomplete and as such our judgments and inferences based thereon could not be upto mark. The committee has recommended methods to place the agricultural statistics on a sounder footing. If these methods are adopted, we will be on firmer ground as regards our out-turns of food and other agricultural requirements. We feel sure that accuracy of agricultural statistics will lead to better future planning.

* * * *

The pilot survey of the average income of a farm labourer carried out by Government Bureau of Economics and Statistics in Ahmednagar, Bijapur and Sholapur districts shows that the average income of a farm labourer in the rural areas of the province is Rs. 4/- per week. Although unemployment ( only 10% are out of work ) is not widely prevalent in this class of labour, the annual average income of Rs. 220/- is extremely low for a living of the lowest calibre. Everybody can well realise that such a person will have to live in permanent discontent and indebtedness to enable himself and his family to meet his needs of food, clothing and other requirements of life. One can very well imagine that he cannot afford medical relief nor can he save anything for enjoyment or for his progeny. The investigation exposes an extremely sorry state of affairs and needs immediate remedying.

* * * *

United States of America and Mexico are shortly beginning a joint con-
uction of a multi-purpose river project for water conservation, flood control
l generation of electric energy. The river Rio Grande which serves as
oundary line between the two countries is to be dammed for the purpose. The
roject will be in charge of the International Boundary and Water Commission.
Such a joint and co-operative effort is both praiseworthy and beneficial to both the
nations. Without it neither of the two nations would singly be able to achieve
the sum-total of the expected result. It is noteworthy that the mutual spirit of
good-will and understanding on the part of the two neighbour nations will lead
benefitting a large area and the peoples of the two nations living thereon.

* * * *

One of the outstanding events in the second term was the celebration of the
41st Annual Social Gathering on 11th November, 1949 with Shri. S. G. Barve,
I. C. S., the popular Municipal Commissioner of Poona, as chief guest. This year
so the gathering was held in the Drawing Hall, which was nicely decorated for
the occasion. The otherwise drab premises of the Drawing Hall were enlivened
by an artistic arrangement of huge palm leaves and pot plants. Shri. & Shrimati
S. G. Barve were received on arrival by the Principal L. S. S. Kumar, Shrimati
Kumar and members of the reception committee. Principal Kumar introduced
the various heads of sections to the chief guest. The students and the staff repre-
sentatives of the Gathering Managing Committee were then photographed along
with the guests. Principal Kumar and the General Secretary Shri. D. S. Narkhede
introduced and welcomed the chief guest. After the report of the sports acti-
vities read by Shri. A. N. Shinde, General Secretary, College Gymkhana, Shrimati
S. G. Barve distributed prizes to the several winners. The chief guest then
addressed ( synopsis printed elsewhere ) the audience and referred to some out-
standing problems on the economics of agriculture. After a vote of thanks to the
chief and other guests everybody was treated to sweet drinks. The gathering
programme which consisted of sports, dramas etc., lasted two days. The event
was thoroughly enjoyed by all, except for the limited accommodation in the draw-
ing hall, which requires widening by removing the central pillars. The gathering
was a great success.

* * * *

The representatives of the Food and Agriculture Organization of the U.N.O.
visited the college on 25th October, 1949. They were taken round the college and
were shown the working of the various sections.

* * * *

Prof. A. W. Ashby, a well-known English Agricultural Economist and the
Director of Agricultural Economics, Research Institute, University of Oxford,
visited the college and delivered an interesting and thought-provoking lecture on
the " Place of Agricultural Economics and Rural Sociology in the agricultural
education and research ", on 21st December, 1949.

The 37th session of the Indian Science Congress was held in Poona during the first week of the year when the public of Poona were regaled with a feast of intellectual treat, the like of which had not happened before. Not only almost all the distinguished men of science of India were present for the session but there were also nearly a dozen foreign delegates of International repute from such distant countries like U. S. S. R., U. S. A., Sweden, Denmark, England, France, Canada etc. We could see in flesh and blood the scientists about whom we had only read in text books. It was an inspiring occasion and the public of Poona took advantage of the opportunity in thousands. The President was Prof. P. C. Mahalanobis, F. R. S., the well known statistician from Bengal. The Session was opened by the Governor of Bombay, inaugurated by Hon. Dr. Shyamaprasad Mukherji, the Union Minister for Industries and Supply and addressed by the Hon. Shri. Kher, the Premier of Bombay and the Hon. Pandit Jawaharlal Nehru, the Prime Minister of India.

The Governor of Bombay stressed the need for the promotion of peaceful ends in scientific inquiry and research. Prof Mahalanobis in his presidential address deplored that the Co-ordination between Science and Industry was neither as close nor as intelligent as the situation demands. Inadequate statistics on food production have made nonsense of administrative calculations. " It is best to confess that India really does not know the actual ( agricultural ) position." The President further pleaded for the mobilization of India's man power of which at least she has sufficient; Pandit Nehru appealed to the Scientists to concentrate on humanity's primary needs which are of vital importance than the atomic bombs. The fact that nations, however impoverishod, can always find money and material for the waging of war is a significant comment on the madness of the world to-day.

There were 13 sections representing the various sciences and to us agriculturists, the most interesting was the section of agricultural sciences presided over by Shri. R. L. Sethi, Agricultural Commissioner to the Government of India Under its auspices three symposia, were held — Rice, Grow More Food Campaign and Soil Conservation — all of which were interesting.

In addition to the Sectional Sessions, there were special and popular lectures by the distinguished scientists both indigenous and foreign. They were very popular and were attended by the public in large numbers.

In connection with the Congress, an agricultural exhibition was held in Agricultural College on 5th and 6th January 1950. The research work carried out by the various sections of the department was exhibited. The variety and diversity of subjects that go to make agriculture and scientific art could be collected in one place and was very informative.

The 3rd annual session of the Society of Agricultural Statistics of India was held at our college premises prior to the Indian Science Congress. It was inaugurated by the Hon. Shri. M. P. Patil, our popular Minister for Agriculture and Forests. The presidential address of Sir Datarsingh was read by Shri Sethi. The meeting was held under the presidentship of Dr. Sukhatme and Mr. Krishnaswami and a very interesting symposium on Crops and Weather was held. The proceedings were wound up with a popular lecture on " Science at the Countryside " by Noble laureate Sir C. V. Raman.

# Brief Synopsis of Mr. S. G. Barve's Address to the Forty-First Annual Social Gathering of the Agricultural College, Poona

The importance of Agriculture in the economy of India can hardly be exaggerated. Some 85 to 90 per cent. of the Indian population lives in villages. The living of some three-quarters of the entirs population comes out of agriculture, and agriculture and allied industries are far and away the most important single occupation in the country. The central problem of Indian economics is the problem of Indian poverty. A satisfactory solution of this problem would not be available unless the problem of Agriculture and all that it implies in Indian economy is satisfactorily solved.

It behoves us, therefore, to enquire how this principal industry of the country, namely, Agriculture and allied pursuits, is conducted. The picture is very depressing. If you compare the figures of production per acre of the principal crops of the country, you will find that they compare very unfavourably with similar figures of other countries where agriculture is on a sounder footing. Thus, our production of wheat per acre is less than one-third that of America or Australia, our production of rice bears about the same proportion to the average production per acre in Japan or Italy; and the same is true of sugarcane, cotton, maize, etc. We have a very large portion of the entire livestock in the world; something like one-third of the entire cattle population in the world is from India The milk production of an average Indian cow, however, is something like one-eighth that of an average British cow. All these instances would show that while Agriculture is our most important occupation, the industry judged by standards of production is run on extremely unsatisfactory lines.

The problem of Indian agriculture is not less nor more than the entire problem of India's rural economy. The solution of one would not be available without the solution of the other. Numerous important questions arise in this connection. It is impossible to do more than merely to state them in a short talk. There is the problem of consolidation of holdings; then there is the question of mechanisation of agriculture and how far such mechanisation would be desirable in the Indian circumstances. The average unit of production in India is at present so small that the introduction of fullfledged mechanisation is bound to create several social problems by throwing out of employment several hundreds of thousands of people, who at present find their livelihood, be it on a meagre scale, in agriculture and connected pursuits. Whether the increased productivity that would be available with mechanisation is worth securing at this expense is a point which requires close consideration. Unless steps are taken for the absorption of the manpower thus released, such mechanisation could scarcely be undertaken. Then there are problems like the supply of adequate manure of the land, prevention of erosion, expansion of irrigation facilities so that crops are secured to

the maximum extent against the notorious vagaries of the monsoon, the era cation of pests and pestilences, the improvement of livestock, the production a distribution of good seed, making available to the cultivator credit facilities cheap rates and in a convenient fashion, organisation of co-operative sale a purchase arrangements and elimination of the profits to the intermediary, e All these problems together constitute a whole nexus the resolution of wh would not be available without a complete reorganisation of the entire ru economy.

It is the business of students of Agriculture and their instructors to br to bear on the agricultural problems of the country the leaven of a scientific a enlightened outlook in all these respects. Whatever solutions to these proble are ultimately adopted by our country as a matter of National policy, their imp mentation would call for a high degree of skill, technical knowledge and abil on the part of the Agricultural Graduates who would have to play an import part in the working out of these policies. The students of the Agricultural Coll must therefore consider themselves as very important units in the countr rehabilitation and must resolve to conduct themselves in a manner worthy of t cause and the opportunity which are presented to the present generation.

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# Control of Plant Diseases Through Disease Resistance in Bombay *

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True Resistance to a disease, a Mendelian character, is governed in acc with the " Law of Inheritance " enunciated by Mendel. Since the disease its is a complex phenomenon—result of interaction between the host, the paras and the environment—disease resistance in plant, as in the animals and m exhibits complexities, not always easy to interpret. " Disease resistance ' confused many times with " disease endurance " and " disease escape " due misconception and mistaken understanding about these phenomena. T discovery, in recent years, of physiologic specialisation, presence of varyi

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types of virulent strains among micro-organisms, their different behaviour and reaction under varying conditions has paved the way to a better understanding of such complexities found in nature and has explained the true nature of the seemingly conflicting disease situations that occur from time to time. A proper understanding of the role of environment in relation to disease is of prime importance in evaluating disease-resistance in plants, since the same plant material is apt to exhibit different reactions under different sets of environments. Such results, therefore, obtained without reference to the three main factors referred to above as constituting " disease ", may naturally lead us to erroneous conclusions. Experience has shown that what is resistance under one set of factors is susceptibility under another set and that the disease situation in a locality may change from year to year in accord with the virulent strains of a parasite occuring in that locality.

It is, thus, essential that plant breeders and plant pathologists alike must carry out their work of evolving disease-resistant varieties of crops with full understanding of factors such as etiology, physiologic specialisation in and phenological relations of the parasite.

The experience of scientific workers in relation to the ever changing disease situations in reference to cotton wilt caused by *Fusarium vasinfectum* in the cotton belts of this province and the very recent complexities in the wheat rust situation that occurred during the two successive years of rust epidemic ( 1947 and 1948 ) are too fresh to require any detailed consideration. While the different behaviour in wilt-sitution in cotton can be attributed to seasonal changes in soil temperatures, the rust situation in wheat was primarily due to the differential predominance of the various races of stem rust prevalent in the two rust years. It is, therefore, essential to define resistance in plants with reference to the changing environmental factors on the one hand and the presence of virulent strains on the other. Thus " Standard " Resistance must be measured in terms of " Standard " environment and " Standard " set of virulent strains.

It has been argued in certain quarters, that, although complete immunity to disease in plants is the ideal to be aimed at, selection for resistance under field conditions is a sufficiently satisfactory basis for the isolation of resistant strains. Experience with Pusa 4 and Pusa 12 wheat with reference to rust resistance, Pusa 80 and other field-resistant strains of *tur*, and cotton in Bombay to Fusarium wilts has clearly shown that such an argument is fallacious. Such a view-point is the result of a wrong assumption that field selection provides as uniform a basis for testing crop plants for their resistance to disease as either pot culture or disease nurseries. Thus, while Pusa 80 *tur* was found highly resistant to wilt under field conditions at Pusa, it failed miserably and showed 40 to 60 % mortality under uniformly infected wilt-sick soil at Arbhavi. The same fate attended the welknown " *jarila* " cotton which had no permanent value, as, such a selection carried out without reference to standard environment and parasitic strains did not provide a real basis for distinction between " disease

resistance" and " disease escape ". Under the circumstances, isolation and selections made in this manner lead to perpetuation of " mixture " of heterogenous constitution and consequently varying in degrees of resistance.

It is, thus, obvious that in any breeding programme for disease resistance, there is a great need of approved technique whereby comparable results may be obtained at different times. Such techniques have been developed by the Bombay Plant Pathology section at the College of Agriculture, Poona, the pioneers in this line of work in India. The Wisconsin Soil temperature tanks used by Jones and his co-workers in U. S. A. for wilt research work have been a model, suitably modified to suit local conditions.

In the development of wilt-resistant varieties, as in other disease-resistance work, it is essential to have an intimate knowledge of the presence or otherwise of physiologic specialisation of the parasite. Isolations of and cross inoculations with *Fusarium* spp. from cotton and sann hemp obtained from different tracts of the Bombay Province have failed to reveal any such variability in pathogenicity and thus have greatly simplified the problem.

## Method of Testing

The technique built up for the purpose of studying soil-borne diseases, mainly *Fusarium* wilts, consists of growing plants in standard " pots " filled with sterilised soil uniformly infected with wilt culture ( at a dosage of one part of inoculum to 16 parts of soil ). The work is carried out in specially built glasshouses where the soil temperatures are uniform and adjusted by devices such as closing or opening of glass-pan windows and shutters, provision of cloth screens and curtains; the wilt-index of the infected soil in pots is then determined by preliminary sowing of a highly susceptible strain of the crop before the actual work of testing is started. The organism is grown in pure culture on a mass scale in 1000 C. C. erlenmeyer flasks containing crushed cotton meal.

The actual work of testing and isolation of wilt-immune types of crops is done in four stages :—

Stage I. *Field Selection in Disease Nursery Plot* :- The importance of this stage needs no emphasis. The work of initial field selection must be carried out in a uniformly infected wilt-sick plot in order to be able to obtain reliable and as nearly a homogeneous material as possible ; this tends to eliminate disease-escapers and makes the further process of testing and isolation comparatively easy and quick.

Stage II. *Pot-tests*:—Such field selections are then subjected to a rigorous pot-tests in a glasshouse specially constructed to maintain optimum temperature of 24 to 27° C. The actual method of testing under these conditions has already been described above. The progeny of the field selections is tested seperately in standard 6" pots. Plants showing symptoms of partial infection and complete

wilting are eliminated at this stage while those showing high degree of resistance are allowed to grow for the next stage. Partially infected plants show varying degrees of mottling on their cotyledons and other leaves depending upon the degree of resistance. For such a purpose, the degree of resistance, as expressed by the degree of mottling, was classified into five grades ranging from 100 % resistance to 100 % susceptibility. Such a classification was very helpful and made the task of elimination and isolation easier.

These grades may be described as follows :—

1. Complete absence of mottling.
2. Mottling of cotyledons only.
3. Shedding of mottled cotyledons accompanied by a slight mottle of the first leaves.
4. Mottling extending to upper leaves.
5. Shedding of the mottled leaves.
6. Mottling and drying extending to three or more leaves and shedding of many mottled leaves.

The process of testing and elimination is continued for about six weeks or more when only such plants as appear perfectly normal with "0" type of resistance are carried to the next stage.

Stage III. *Mature Plant Resistance:*— Such of those plants that survived the rigorous pot-tests under stage II above and show "0" type of resistance are transplanted in a disease nursery plot, specially maintained for the purpose; all the plants are selfed and at the end of the growing period such of the plants that show vascular discolouration in their roots are rejected while seed from the absolutely healthy plants is collected for further test.

Stage IV:— The process of pot tests with the selfed-seed is repeated over several seasons until a completely homozygous wilt-resistant strain is obtained.

The process is laborious but admits of no " short cuts " if reliable results are desired. Highly promising results have been obtained by Dr. Uppal and his co-workers at Poona in sann hemp, cotton, lang ( *Lathyrus sativus* ), *tur* ( *Cajanus cajan* ) and gram. The process is being utilised recently for obtaining brinjals resistant to *Verticillium* wilt.

## Cotton Wilt

The work has been in progress for the last thirteen years and is financed partly by the Indian Central Cotton Committee. It aims primarily at assisting the Plant Breeders of Khandesh, Broach, Surat, Dharwar and Hyderabad areas in the isolation of wilt-resistant types of cotton suitable to their respective tracts. The achievements so far obtained may be summarised as follows:-

1. *Gujarat Section:*— A selection from the indigenous Deshi cotton known as B. D. 8 has given a high degree of resistance but possesses comparatively lo ginning percentage. This has been replaced by " Vijay ". Very recently a bac cross ( B. D. × 8Ghogari ) × B. D. 8 and a cross ( Vijay × 1027 A. L. F. ) hav been evolved which possess desirable agronomic characters and wilt-resistance.

*Khandesh Section:*— With the introduction of Virum selections from C. I rigorous field selection has brought out " Jarila ". This cotton, however, show high mortality and has recently been crossed with 197-3 with great promis Dokras, also Virum selections, with high degree of resistance have been cross with 197-3 in order to combine wilt-resistance and desirable agronomic characte New Million Dollar, though of very high value from the point of view of wil resistance possesses very low agronomic characters and experience has shown th it is not possible to segregate these characters in hybrid material due probab to linkage.

*Hyderabad Section:*— Under glasshouse conditions at Poona, Gaor 6838-2-6-10 and 6107-11-4-5-7 with high degree of wilt resistance ha been evolved.

### Wilt in Sann Hemp ( *Crotolaria juncea* )

Sann hemp wilt caused by *F vasinfectum* var. *crotolariae* has also be successfully overcome by evolving highly wilt immune variety D. IX. The crop was, indeed, difficult to deal with, being highly cross fertilized and self-sterile. The breeding programme and technique had to be accordingly suitably modified and cross breeding within pure lines grown in a compact and isolated plot covered by a muslin cage had to be resorted to obtain hybrid vigour and to avoid sterility. The plants surviving the pot tests were grown in the enclosure and sib-pollination effected with the help of *Apis* and *Megachile* bees.

### Wilt in lang ( *Lathyrus sativus* )

*Lang*, an important pulse crop grown in Broach district is highly susceptible to wilt caused by *Fusarium orthoceras* var. *lathyri*. Highly wilt resistant types combining high yielding and early maturing characters have been obtained within a short period of 6 years. Of these two varieties, viz. Indore T 2-1 and Indore T 2-12, the latter has given the best results in several village trials and being early by 7 days escapes pod-borer attack.

### Wilt in tur and gram

In *tur*, prior to the introduction of the present technique, much reliance was placed on *field resistance*. Pot-tests under uniform conditions at Poona, however, have shown high percentage of mortality in such material and emphasised once again the absolute need for standardisation of the breeding technique.

## Stem Rust of Wheat

While testing for rust-resistance, the technique described above has been reoriented to suit the wind-borne character of the disease on the one hand and the presence of extreme specialisation and parasitic strains on the other. This technique which was evolved by Stakman and his co-workers in U. S. A. is well known to students of phytopathology and needs no repetition.

The actual testing work is done at Mahableshwar, where the most favorable environments for the rapid development of the disease for most part of the year exist. This work is carried out in five stages to be described in another paper.

It is neither expedient nor desirable to mention all the details of this investigation. Suffice it to say that the special technique has been instrumental in this case too, as in wilt, to discriminate between "true resistance" and "disease escape"; valuable strains combining high degree of rust-resistance and desirable agronomic characters have been obtained by crossing indigenous susceptible types with exotic resistant material. The well known Bombay Niphad 4 and Mondhya have been crossed with exotic Kenya E 144 and Hofed to obtain highly rust-resistant strains with all the desired combinations. The most hopeful feature of the present situation is the discovery of an exotic *durum* wheat, Gaza, imported from Canada which exhibits all the desirable characters of resistance to stem rust and will no doubt form a good parent material for future work in evolving rust-resistant *durum* wheat occupying very large area in Bombay Province. This forms a co-operative scheme between the Plant Pathologist and the Deputy Director of Agriculture, (Crop Research), Poona.

## Blast of Rice

The disease caused by *Piricularia oryzae* has recently been a menace to rice cultivation in this Province. It was possibly imported into this province from Madras and made its first appearance in southern borders of the Province in 1946, since when it has assumed serious proportion in all rice growing areas. Experience gained in Madras has shown that the only effective method of control of this serious disease lies in evolving resistant varieties.

Investigation on this line has recently been started and will naturally consist of testing exotic and indigenous varieties of rice under standard conditions. The technique, for the present, is being developed in the glasshouse and attempts will be made to extend its scope to the fields in due course. It will, therefore, be premature to mention any details for the present. The work is carried out in close co-operation with the Deputy Director of Agriculture (Crop Research), Poona.

# Relation of the Gestation Period with the Sex of Calf and its Live Weight at Birth in the Sindhi Breed of Cows

By

C. N. DAVE, B. Ag., A. I. D. I.

It is natural for a dairyman or a cattle breeder to be anxious to know wh his animal is likely to come in milk by giving birth to mature calf. They are bo interested to know the length of and variations in the gestation period togeth with its relation with the sex of the calf and its live-weight at birth. It is ger rally believed that a longer gestation period means a male calf. In order the fore to get some information on the above points the following problems we studied by the writer in detail at the Agricultural College Dairy, Poona, wh the Sindhi breed is systematically maintained.

I :— Gestation period and sex of the calf.

II :— Sex ratio.

III :— Gestation period, and the live-weight of calf at birth.

IV :— Time of calving and sex of calf.

I :— *Gestation period and the sex of calf.*

For calculating the gestation period, both the breeding and parturiti dates have been taken into account. Cases whose gestation period was bel 269 days and above 303 days have been eliminated. The total number of ca examined was 406 as detailed below.

**Table I.**

Showing the mean gestation period, standard deviation–probable error and standard error for female and male births :

| S. No. | Items. | For female birth. | For male birth. |
|---|---|---|---|
| 1 | Number of cases. | 197 | 209 |
| 2 | Mean gestation period in days. | 282.156 | 284.088 |
| 3 | Probable error of the mean gestation period. | $\pm$ 0.249 | $\pm$ 0.259 |
| 4 | Standard deviation. | 5.264 | 5.568 |
| 5 | Probable error of the standard deviation. | $\pm$ 0.178 | $\pm$ 0.183 |
| 6 | General mean for both sexes. | 283.150 | days. |

Table I shows that on an average of 406 cases, the mean difference in the gestation period for male and female births, is 1.932 days or in other words it can be said that a male calf is carried by the dam longer than the female one by about 2 days.

The results are significant since the actual value comes to 5.38 which is considerably greater than the theoretical value viz. 3. This indicates that there is a natural tendency on the part of males to take longer gestation period than that of females by about 2 days.

II : *Sex ratio.*

The total number of animals examined was 124 giving 497 cases for the study of sex ratio. This when further examined showed that there were 246 female births and 251 male births. The sex ratio is therefore almost equal i.e. 1 : 1.

III : *Relation of gestation period and the live weight of calf at birth.*

The total number of cases examined, the live weight of whose calves at birth was available, was 163—83 female births and 80 male births. The mean live weight of calf at birth works out as under:—

**Table II.**

Showing the relation of gestation period with live weight of calf at birt sex by sex separately:-

| Class centre of gestation days. | Female births. | | Male births. | | Mean for both th sexes combined |
|---|---|---|---|---|---|
| | Mean live weight in lbs. | Frequency. | Mean live weight in lbs. | Frequency. | |
| 270.5 | 34.50 | 1 | 46.5 | 1 | |
| 274.5 | 36.50 | 8 | 38.5 | 6 | |
| 278.5 | 41.64 | 14 | 38.5 | 15 | |
| 282.5 | 40.58 | 26 | 43.3 | 19 | |
| 286.5 | 40.34 | 26 | 45.8 | 18 | |
| 290.5 | 42.50 | 5 | 47.3 | 14 | |
| 294.5 | Nil | Nil | 48.5 | 6 | |
| 298.5 | 42.5 | 2 | Nil | Nil | |
| 302.5 | 34.5 | 1 | 42.5 | 1 | |
| Total of frequency | | 83 | — | 80 | |
| Mean live weight 40.29 | | — | 43.72 | | 41.97 lbs. |
| Mean gestation days | | 283.27 | 284.45 | | 283.84 days. |

Table II indicates :

( 1 ) that the mean gestation period for male births is more than that of the female births by 1.18 days or in other words a male calf is carried by the dam longer than the female one by about 1.18 days,

( 2 ) that the male calf weighs about 8.5 percent more than that of the female one,

( 3 ) that the mean live weight of a Sindhi calf at Birth, works out at abou 42 lbs. maximum being 62 and 58 lbs. and minimum 31 and 29 lbs. fo a male and a female calf respectively,

(4) that the mean gestation period and the mean live weight of calf at birth in Sindhi cows work out at 283.2 and 284.4 days and 40.3 and 43.7 lbs. for female and male births respectively,

(5) there appears to be a clear tendency for the steady increase in the weight of male calves viz. 38 to 47 lbs. as the gestation period increases from 278 to 290 days; while in the case of female calves, their weights are almost steady, viz. 41 to 42 lbs. during the corresponding period of gestation.

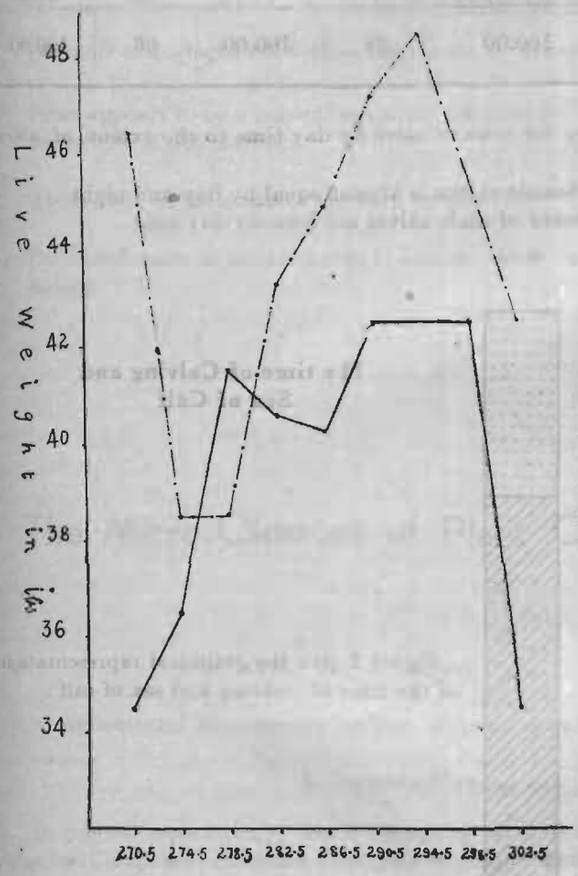



Figure 1 gives the graphical representation of the relation of the gestation period and live weight of calf at birth sex by sex separately.

IV *Time of calving and sex of calf.*

With a view to study the general tendency of cows to calve-by day time or night time-137 cases whose time of mature calving was available have been examined as under:-

**Table III.**

Showing the time of calving in relation to the sex of calf.

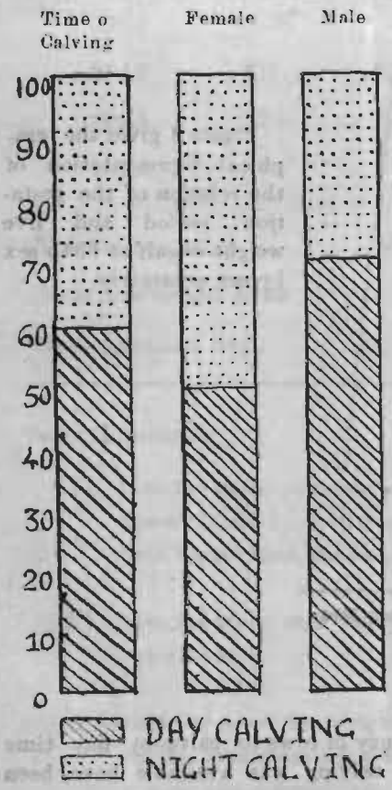
| Time of calving | No. of cases | | Sex of calf born | | | |
|---|---|---|---|---|---|---|
| | | | Female | | Male | |
| | No. | Percentage | No. | Percentage | No. | Percentage |
| Day-calving | 82 | 59.86 | 36 | 50.70 | 46 | 69.69 |
| Night calving | 52 | 40.14 | 35 | 49.30 | 20 | 30.31 |
| Total | 137 | 100.00 | 71 | 100.00 | 66 | 100.00 |

This shows that :

( 1 ) there is a tendency for cows to calve by day time to the extent of about 60 percent.

( 2 ) that the birth of female calves is almost equal by day and night.

( 3 ) that about 70 percent of male calves are born by day time.




**The time of Calving and Sex of Calf**

Figure 2 give the graphical representation of the time of calving and sex of calf :

**Summary**

1. The mean gestation period in Sindhi cows works out at about 283 days.

2. On an average of 406 cases under observation, the male calf is carried by the dam longer than the female calf by about 2 days, the significant ratio being 5.38.

   The sex ratio of the birth of calves, is almost equal.

4. The mean live weight of a Sindhi calf at birth, works out at about 42 lbs.

5. The male calf weighs more than female one by about 8%.

6. There appears to be a general tendency for cows to calve by day time to the extent of about 60%.

7. About 70% of male calves are born by day time.

8. The distribution of female births is almost equal both by day and night calving.

# The Micro-Climates of Plant Communities §

By

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## I. Introduction.

In general meteorology, one is concerned with the climatic conditions in an open, well-exposed, bare and level plot of ground which is situated in an area representative of the particular part of the country. In synoptic meteorology, where one is mainly concerned with weather forecasting, the disturbing influence of the ground surface is avoided as far as possible by recording air temperature,

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humidity, wind velocity, etc., at some distance above ground, usually 4 ft. and above. The meteorological elements recorded at these weather reporting observatories indicate what is called the general of 'macro-climate' of the area. In agricultural meteorology, however, it is precisely the air and soil layers near the ground surface which assume special importance. Investigations carried out at Poona and a few agricultural research stations in India show that if one records the air temperature, humidity, wind velocity, evaporation etc., inside environments like standing crops and orchards and compares these with the observations recorded simultaneously in a neighbouring open space, the micro-climates of these environments show significant and typical deviations from the conditions in the open space ( 2, 4, 5, 6 ).

In Europe the subject of micro-climatology has made many notable advances in the hands of Schmidt, Geiger and others (1) particularly in regard to the influence of cities, topography and forest cover. The present position of the subject will be briefly summarised in this paper.

## II Types of Micro-Climate

Type A:—During clear weather when winds are feeble and the sun shines on a level stretch of bare soil, insolation and its disposal at the ground surface by conductive, convective and radiative processes account for the large variations of temperature and humidity with time of day as well as with height above ground

Type B:—We may then consider the case in which the surface of the ground is covered with an un-irrigated crop. Here the solar radiation falls partly on the foliage which acts like a secondary surface for the disposal of solar energy The surface of the ground would retain its original importance in proportion to the fraction of solar radiation falling directly in patches, whenever the vegetation fails to obstruct its path. This would depend, again, upon the density of the plant population, the height of the crop and the amount and the vertical and horizontal distribution of the foliage. Thus, the taller the crop, the more abundant its foliage and the denser the plant population, the greater is the deviation of the climate of the crop from that of the ' open '.

Type C :— We may next consider the influence of a horizontal flow of air on Types A and B. The resulting types may be called AC and BC respectively

Type D. :- The micro-climate becomes more complex when in types A, B and C the soil is irrigated. This gives rise to types like AD, BD, ACD and BCD.

Type E. :- Lastly there are complicated cases associated with the incidence of cloudiness, rainfall etc. Types like AE, BE, ACE and BCE will fall under this group.

For studying the effect of environment on climate the standard instrument used at Poona is the smaller sized Assmann psychrometer. The variation of air temperature and humidity with height above ground is studied by taking observations at fixed times daily which include the maximum temperature epoch ( 2 P. M. ) and the minimum temperature epoch ( 6 A.M. ). In the open space of the Central Agricultural Meteorological Observatory at Poona, the observations are taken at various levels from the surface upto 35 ft. above ground with the help of a specially constructed tower. Inside crops observations are taken upto 6 or 8 ft. above ground and occasionally on higher levels. We may first of all describe some of the main features shown by the psychrometric data in different environments before discussing the wind and evaporation data which have also been recorded recently.

### III. Type A :-Micro-Climate of the 'Open' during the winter season.

The importance of Type A is obvious as it is the standard type with which to compare the climates of different environments. The winter season at Poona, of which January is typical, is dominated by warming up of the ground due to insolation by day and cooling down due to nocturnal radiation. The air movements are feeble varying between 4.5 m.p.h. near the ground to 7.6 m.p.h. at 35 ft. during the afternoon ( X epoch ) when convective mixing is maximum ; during night when the air layers cool and stratify, the mean wind velocities come down very much ; at 6 A.M. ( N epoch ) the velocity is 0.3 m. p. h. near the ground and 1.0 m.p. h. at 35 ft. Long intervals of calm at night are punctuated by occasional light winds of the Katabatic or down-slope type. Table 1 shows the variation with height of the dry bulb temperature in °C, vapour tension mm. of Hg. and the percentage relative humidity at maximum and minimum temperature epochs during January.

There is an accumulation of heat at and near the ground in the afternoon ( 2 P.M. ). The maximum temperature rises to 51.6°C at the surface and decreases rapidly to 30.1°C at a height of 1 ft. and then gradually to 27.0°C at 35 ft. On the other hand at night, owing to nocturnal cooling, the thermal structure of the air layers is very different. Even at 6 A.M. ( minimum temperature epoch ) there is a thin but feebly convective layer about 1 ft. in thickness within which the temperature decreases with height as during day time but less conspicuously ( a remuant of the convective layer characteristic of day time ). Above this layer we have the stratified inversion layer extending upwards beyond 35 ft. In the inversion layer the coldest air ( 10.3°C ) is at the bottom ( 1st above ground ) and the temperature increases with height upto a few hundred feet ( as is shown by sounding balloon records ). At 35 ft. the temperature is 13.4°C, about 3°C warmer than at 1 ft. The inversion layer persists upto about 10 A.M. when convection sets in and rapidly destroys it.

If we consider the differenee between the 2 P.M. ( X ) and the 6 A.M. ( N ) observations the " diurnal range ", as it is called, is as high as 40.8°C at the

surface ; it decreases rapidly to 19.8°C at 1 ft. and thereafter slowly to 13.6°C at 35 ft.

The vapour pressure indicates the amount of water vapour present in the air layers, one cubic metre of air in which the pressure of water vapour is 1 mm. of Hg. containing very nearly 1 gr. of precipitable water vapour. If the actual vapour pressure is x mm. the water content would be x grs. per cubic metre. In

**Table 1 ( January )**

| Height | D. B. Temperature | | | Vapour pressure in mm. of Hg. | | | Humidity % | | |
|---|---|---|---|---|---|---|---|---|---|
| | X | N | X–N | X | N | X–N | N | X | N–X |
| O-Tg. | 51.6 | 10.8 | 40.8 | | | | | | |
| 0.3" | 34.6 | 10.9 | 23.7 | 10.9 | 8.0 | 2.9 | 78 | 29 | 49 |
| 1.0" | 33.8 | 10.6 | 23.2 | 10.3 | 7 8 | 2.5 | 77 | 29 | 48 |
| 3" | 31.9 | 10.5 | 21.4 | 9.8 | 7.7 | 2.1 | 77 | 29 | 48 |
| 6" | 30.9 | 10.4 | 20.5 | 9.3 | 7.7 | 1.6 | 77 | 29 | 48 |
| 1 ft. | 30.1 | 10.3 | 19.8 | 9.0 | 7.7 | 1.3 | 78 | 30 | 48 |
| 2 ft. | 29.4 | 10.5 | 18.9 | 8.8 | 7.8 | 1.0 | 78 | 30 | 48 |
| 3 ft. | 28.8 | 10.7 | 18.1 | 8.6 | 7.9 | 0.7 | 79 | 31 | 48 |
| 4 ft. | 28.4 | 10.9 | 17.5 | 8.6 | 8.4 | 0.2 | 79 | 31 | 48 |
| 6 ft. | 28.1 | 11.3 | 16.8 | 8.6 | 8.4 | 0.2 | 79 | 31 | 48 |
| 8 ft. | 27.7 | 11.6 | 16.1 | 8.5 | 8.5 | 0.0 | 80 | 31 | 49 |
| 10 ft. | 27.5 | 11.9 | 15.6 | 8.4 | 8.7 | -0.3 | 80 | 32 | 48 |
| 15 ft. | 27.3 | 12.2 | 15.1 | 8.3 | 9.0 | -0.7 | 81 | 31 | 50 |
| 20 ft. | 27.0 | 12.6 | 14.4 | 8.2 | 9.1 | -0.9 | 81 | 32 | 49 |
| 25 ft. | 26.9 | 12 9 | 14.0 | 8.1 | 9.2 | -1.1 | 80 | 31 | 49 |
| 30 ft. | 26.9 | 13.1 | 13.8 | 8.1 | 9.2 | -1.1 | 79 | 31 | 48 |
| 35 ft. | 27.0 | 13.4 | 13.6 | 7.9 | 9.3 | -1.4 | 79 | 31 | 48 |

previous papers ( 7, 8, 9 ) it has been shown that during the day when insolation is present the vapour pressure decreases with height above ground ; during night until insolation begins next morning the vapour pressure increases with height above ground. Thus the 2 P. M. and 6 A. M. observations would be more or less typical of the day and night conditions respectively. Table 1 shows that at 2 P.M. the vertical gradient of vapour pressure favours an upward flow of water vapour, whereas at 6 A.M. this flow will be towards the ground. These movements of water vapour are to a large extent controlled by the hygroscopic property of the soil surface, which is very marked in the case of the black cotton soils of India.

As regards the relative humidity the variation with height is small compared to the diurnal variation which is nearly 50% as is shown by the differences between the morning and the afternoon values in the last colum of Table 1.

### IV. Type AC : Micro-Climate of the "Open" during summer.

Type AC stands for type A as modified by winds which are stronger than in winter. These conditions prevail during March, April and May in the Deccan.

Insolation by day is stronger than during winter so that convective winds of the forenoon & afternoon are also stronger than during the winter. Again, owing to the proximity to the Arabian Sea, the westerly sea-breeze* comes inland as a layer of about ½ Km. in thickness and replaces the drier land air temporarily during the afternoon and night and is later diluted with the land air by the convective winds of the next day. In April which is a typical summer month, the wind velocity varies from 6 to 8 m.p.h. in the afternoon and from 0.8 to 1.8 m.p.h. in the morning between ground level and 35 ft. respectively. Table 2 gives the mean temperature and humidity data at various levels above ground at 2 P. M. and 6 A. M. during the month of April. In the afternoon the temperature goes up to 64. 1°C at the surface, decreases rapidly to 40. 1°C at 1 ft. and thereafter gradually to 35. 6°C at 35 ft. Owing to increased air movements at night, the feeble

**Table 2** ( April )

| Height | D. B. Temperature °C | | | Vapour pressure in mm. of Hg. | | | Humidity % | | |
|---|---|---|---|---|---|---|---|---|---|
| | X | N | X-N | X | N | X-N | N | X | N-X |
| 0-Tg. | 64.1 | 18.7 | 45.4 | | | | | | |
| 0.3" | 44.0 | 19.8 | 24.2 | 8.7 | 9.2 | -0.5 | 51 | 13 | 38 |
| 1. 0" | 42.7 | 19.6 | 23.1 | 8.2 | 9.0 | -0.8 | 51 | 13 | 38 |
| 3" | 41.9 | 19.6 | 22.3 | 7.8 | 8.9 | -1.1 | 50 | 13 | 37 |
| 6" | 40.9 | 19.6 | 21.3 | 7.5 | 9.0 | -1,5 | 51 | 13 | 38 |
| 1 ft. | 40.1 | 19.6 | 20.5 | 7.2 | 9.1 | -1.9 | 51 | 13 | 38 |
| 2 ft. | 39.3 | 19.6 | 19.7 | 7.1 | 9.4 | -2.3 | 53 | 14 | 39 |
| 3 ft. | 38.5 | 19.7 | 18.8 | 6.8 | 9.6 | -2.8 | 54 | 14 | 40 |
| 4 ft. | 37.9 | 19.9 | 18.0 | 6.7 | 9.8 | -3.1 | 54 | 14 | 40 |
| 6 ft. | 37.4 | 20.1 | 17.3 | 6.5 | 10.1 | -3.6 | 56 | 14 | 42 |
| 8 ft. | 36.9 | 20.3 | 16.6 | 6.5 | 10.4 | -3.9 | 57 | 14 | 43 |
| 10 ft. | 36.5 | 20.4 | 16.1 | 6.3 | 10.6 | -4.3 | 57 | 14 | 43 |
| 15 ft, | 36.2 | 20.6 | 15.6 | 6.2 | 10.7 | -4.5 | 57 | 14 | 43 |
| 20 ft. | 35.8 | 20.9 | 14.9 | 6.2 | 10.7 | -4.5 | 56 | 14 | 42 |
| 25 ft. | 35.8 | 21.1 | 14.7 | 6.3 | 10.8 | -4.5 | 56 | 15 | 41 |
| 30 ft. | 35.6 | 21.3 | 14.3 | 6.4 | 10.8 | -4.4 | 56 | 15 | 41 |
| 35 ft. | 35.6 | 21,5 | 14.1 | 6.7 | 10.7 | -4.0 | 54 | 15 | 39 |

convective layer up to 1 ft. of the winter season is practically wiped out and the effect of nocturnal cooling is diluted over a thicker layer of the atmosphere so that inversion rate is less than it is in winter perticularly in the lower layers. The temperature falls to 18.7°C at the surface in the early morning, the corresponding value at 35 ft. being 21.5°C. The diurnal range is as high as 45.4°C at the surface, decreases rapidly to 20.5°C at 1 ft. and slowly thereafter to 14.1°C at 35 ft.

* The time of onset is as late as 1930 or 2000 hrs. I. S. T. on some days in late winter [February ] but the sea-breeze comes earlier and more frequently as the summer approaches. In April, May and June, the time of onset is often as early as 1400 or 1500 hrs. I. S. T.

The vapour pressure decreases with height by day and increases with height at night as in January but there is also a general increase in vapour pressure in the evening due to sea-breeze which comes in the afternoon and stagnates over the country until next morning as is shown by the 6 A. M. (N) observations ; this more humid air is later mixed up with the drier atmosphere when the convective winds are set up by insolation. The relative humidity increases slightly with height at the X and N epochs but the diurnal variation from X to N epochs is conspicuous at all levels.

## V. Type ACE :-Micro-climate during the south-west monsoon season with cloudy, rainy and windy weather.

With the onset of the south-west monsoon the climate changes from the continental type ( A, AC ) to one of the maritime type ACE with continuous and vigorous air movement day and night and cloudy and wet weather. There is very little insolation by day and nocturnal cooling is negligible. In July the mean wind velocity ranges in the afternoon from 7 m. p. h. near the ground to 15 m. p. h. at 35 ft.; even in the morning the values come down only to 4.5 m. p. h. and 10.2 m. p. h. respectively. Table 3 gives the mean air temperature, vapour pressure and relative humidity in July at different levels and at the X and N epochs. The air temperatures vary in the afternoon from 32.0°C at the surface to 25.3°C at 35 ft. and in the early morning from 21.8°C at the surface to 22.9°C at 35 ft. The diurnal range is only 10.2°C at the surface and 2.4°C at 35 ft.

In contrast to the summer conditions, the vapour pressure in July is 21.1 mm. and 18.3 mm. at the surface and at 35 ft. respectively in the afternoon; in the early morning also the variation with height is similar to though smaller than that during day, the values at the surface and at 35 ft. being 18.4 mm. and 17.9 mm. respectively. The diurnal range of vapour pressure (X-N) varies from 2.7 at the surface to 0.4 at 35 ft. The relative humidity decreases with height at both the X and N epochs; the values at the N epoch. are about 10% lower than those at the X epoch. During the monsoon the soil surface is always moist and often saturated with water so that the above results are easily understood.

**Table 3 (July)**

| Height | Dry bulb temperature in °C | | | Vapour pressure in mm. of Hg. | | | Humidity % | | |
|---|---|---|---|---|---|---|---|---|---|
| 0-Tg. | 32.0 | 21.8 | 10.2 | | | | | | |
| 0.3" | 27.1 | 22.7 | 4.4 | 21.1 | 18.4 | 2.7 | 89 | 79 | 10 |
| 1.0" | 27.0 | 22.6 | 4.4 | 20.8 | 18.4 | 2.4 | 89 | 79 | 10 |
| 3" | 26.9 | 22.6 | 4.3 | 20.4 | 18.4 | 2.0 | 89 | 78 | 11 |
| 6" | 26.8 | 22.6 | 4.2 | 20.1 | 18.3 | 1.8 | 89 | 77 | 12 |
| 1 ft. | 26.6 | 22.6 | 4.0 | 19.8 | 18.3 | 1.5 | 89 | 77 | 12 |
| 2 ft. | 26.5 | 22.6 | 3.9 | 19.6 | 18.2 | 1.4 | 89 | 77 | 12 |
| 4 ft. | 26.3 | 22.7 | 3.6 | 19.4 | 18.2 | 1.2 | 88 | 76 | 12 |
| 6 ft. | 26.1 | 22.7 | 3.4 | 19.2 | 18.2 | 1.0 | 88 | 76 | 12 |
| 4 ft. | 26.0 | 22.8 | 3.2 | 19.0 | 18.1 | 0.9 | 87 | 76 | 11 |
| 8 ft. | 25.8 | 22.8 | 3.0 | 18.9 | 18.1 | 0.7 | 87 | 76 | 11 |
| 10 ft. | 25.6 | 22.8 | 2.8 | 18.7 | 18.0 | 0.7 | 87 | 76 | 11 |
| 15 ft. | 25.5 | 22.9 | 2.6 | 18.6 | 18.0 | 0.6 | 86 | 76 | 10 |
| 20 ft. | 25.5 | 22.9 | 2.6 | 18.5 | 18.0 | 0.5 | 86 | 76 | 10 |
| 25 ft. | 25.4 | 22.9 | 2.5 | 18.4 | 18.0 | 0.4 | 86 | 76 | 10 |
| 30 ft. | 25.4 | 22.9 | 2.5 | 18.3 | 17.9 | 0.4 | 86 | 76 | 10 |
| 35 ft. | 25.3 | 22.9 | 2.4 | 18.3 | 17.9 | 0.4 | 85 | 76 | 9 |

## VI. Types B and BD : Micro-Climates of Crops.

As mentioned by Geiger (1) the influence of vegetation on micro-climate varies with the height and density of the vegetation and it is possible to distinguish four stages.

Stage 1.:- The plants have just germinated and the growth is small both in height and density so that the bare ground is covered only to a small extent. The micro-climate varies little from that above the bare ground. In this early stage the small plants have to withstand the extremes of temperature characteristic of Type A and the mortality is high. The utility of taller plants and shade trees in reducing such mortality is shown by the great care taken in plantations of tea, cardamoms, etc., for providing a net-work of shade trees.

Stage 2:— The plants reach the stage of "lateral stoppage". By spreading laterally while grwoing vertically, they cover the ground more uniformly than in Stage 1. The micro-climate is now appreciably affected by the Vegetation. The diurnal range of temperature is reduced and the air layers upto the height of the vegetation and the soil below are more humid than in Stage 1. Owing to these more favourable conditions young plants often show a sudden spurt of growth in height at the time when the stage of lateral stoppage is reached.

Stage 3:— In the first two stages the seat of the diurnal transfer of heat was at the ground surface. When plants grow close together and attain great

heights there will be interspace between the surfaces of the ground and of the vegetation. If the crown of the plants forms an effective canopy completely shutting off insolation from the ground, it is the former which absorbs solar radiation during the day and radiates heat during night. Woeikof (11) calls it the "external active surface". It must be remembered, however, that the plant canopy does not form a simple surface like the ground but has necessarily a certain vertical range in its action. Between the external active surface and the ground surface there is a sheltered region in which, owing to the action of the plants, there is great calm, high um humidity, protection from radiation, moderate temperatures by day and greater warmth than in the 'open' at night.

Stage 4:- In this case the plants have grown into a tall forest with three zones, viz.:-

( i ) the stem region in which there is some possibility of air motion.

( ii ) the foliage region which forms a barrier to air movements and

(iii) the air space above the foliage and merging into the free atmosphere.

In stages 3 and 4, if the plant density is low, there will be gaps through which sunshine will be able to reach the ground. We then have two active surfaces, viz., the ground and the upper boundary of the plant cover.

Figure 1 is a diagram given by Geiger ( 1 ) showing the transition from the second to the third stage in the variation of temperature with height in a winter rye field at Munich. The daily temperature maxima obtained from Six's thermometers are averaged for the different seasons and the height of the crop corresponding to these maxima are represented in the diagram. In April the local temperature maximum was at the surface although the surface was covered with the young rye plants upto a height of several cms ( Stage 2 ). Towards the end of May, however, the maximum had left the ground surface and the highest temperatures were recorded at about 50 cms. above ground, the height of the crop itself being 120 cms.

While dealing with crops one should compare the micro-climate of the crop with that of the open. In India the 'rabi' or 'winter' crops which are unirrigated would fall under Type B while those which are irrigated would come under Type BD, so long, however, as the skies are clear and the winds are light. The winter season at Poona gives rise to these two types.*

* During the monsoon with high winds, cloudy skies and rainy weather the change with environment will be small, i. e., type BE will approach type AE.

Table 4 gives the mean dry bulb temperature in °C and the vapour pressure in mm. of Hg. at various levels upto 6 ft. in the 'open' and inside sugarcane, jowar, cotton and tobacco crops* growing at Poona near the Central Agricultural Meteorological Observatory in December 1936. The data are given both for the maximum temperature (X) and the minimum temperature (N) epochs. An inspection of this Table will show that the systematic deviations of the crop climate from that of an 'open' space are most marked in the case of an irrigated tall crop like the sugarcane ( Type BD ). There are also significant though smaller deviations when the crop is tall but unirrigated, e. g., in jowar. A short crop does show deviations, though small, if there is sufficient foliage to allow the formation of a local climate underneath, e. g., in tobacco. In the case of another short crop like cotton the deviations from the climate of the 'open' are not significant except, later in March when sufficient foliage develops. In general, the air inside a crop contains more moisture than outside. Further, during night, the temperature inside a crop is warmer than that in the 'open'.

**Table 4**

Dry bulb °C – December 1936.

| Height | Open | Sugar-cane | Jowar | Cotton | Tobacco | Open | Sugar-cane | Jowar | Cotton | Tobacco |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.3" | 33.6 | 24.9 | 31.2 | 32.6 | 34.6 | 9.0 | 10.5 | 9.9 | 8.8 | 8.7 |
| 1" | 32.0 | 25.0 | 30.7 | 31.9 | 33.5 | 8.9 | 10.4 | 9.9 | 8.8 | 8.7 |
| 3" | 31.4 | 25.1 | 30.6 | 31.5 | 32.4 | 8.8 | 10.3 | 9.8 | 8.8 | 8.7 |
| 6" | 30.9 | 25.4 | 30.5 | 31.0 | 31.9 | 8.9 | 10.2 | 9.8 | 9.0 | 8,7 |
| 1 ft. | 30.4 | 25.9 | 30.3 | 30.5 | 31.2 | 9.0 | 10.1 | 9.7 | 9.1 | 8.8 |
| 2 ft. | 30.0 | 26.4 | 30.1 | 30.1 | 30.6 | 9.2 | 10.1 | 9.7 | 9.2 | 9.0 |
| 3 ft. | 29.4 | 26.9 | 29.7 | 29.5 | 30.0 | 9.4 | 10.0 | 9.5 | 9.4 | 9.2 |
| 4 ft. | 29.0 | 27.1 | 29.4 | 29.2 | 29.5 | 9.7 | 10.1 | 9.8 | 9.5 | 9.5 |
| 6 ft. | 28.6 | 27.4 | 29.1 | 28.9 | 29.0 | 9.9 | 10.1 | 9.9 | 9.7 | 9.6 |
| | | | | | Vapour pressure | | | | | |
| 0.3" | 9.0 | 13.6 | 10.1 | 9.7 | 9.9 | 7.1 | 8.8 | 8.0 | 6.9 | 7.3 |
| 1" | 8.8 | 13.1 | 9.9 | 9.5 | 9.4 | 7.2 | 8.7 | 8.0 | 6.9 | 7.3 |
| 3" | 8.6 | 12.5 | 9.6 | 9.2 | 8.9 | 7.2 | 8.6 | 7.9 | 7.0 | 7.3 |
| 6" | 8.4 | 12.0 | 9.5 | 8.9 | 8.7 | 7.3 | 8.6 | 7.9 | 7.1 | 7.3 |
| 1 ft. | 8.3 | 11.4 | 9.3 | 8.7 | 8.6 | 7.4 | 8.5 | 7.9 | 7.2 | 7.4 |
| 2 ft. | 8.1 | 10.8 | 9.0 | 8.6 | 8.4 | 7.6 | 8.4 | 8.0 | 7.3 | 7.5 |
| 3 ft. | 8.0 | 10.4 | 8.9 | 8.5 | 8.2 | 7.7 | 8.4 | 8.0 | 7.5 | 7.5 |
| 4 ft. | 8.1 | 10.1 | 8.7 | 8.4 | 8.2 | 7.9 | 8.4 | 8.1 | 7.6 | 7.7 |
| 6 ft. | 8.0 | 9.9 | 8.9 | 8.2 | 8.2 | 8.0 | 8.4 | 8.1 | 7.7 | 7.8 |

* The heights of these crops were 9 ft, 7 ft, 3½ ft, and 1½ ft, respectively,

Fig. 2 shows curves of air temperature and vapour pressure at 2 P.M. on the 9th October 1934 in a number of environments at different levels above ground. Here Jowar, ( Andropogon Sorghum Brot ), sugarcane and yams ( Dioscorea Batatas Dcne ), are tall crops, the first alone being unirrigated; suran ( Amorphophalus companulatus Blume ), and sweet potato are short crops with a certain amount of foliage spreading laterally. The heights of the crops are 3 ft., 4 ft., 7 ft., 2 ft., and 2 ft. respectively. It is interesting to see the variation of temperature and vapour pressure with environment. We have at one end the curve A representing the extreme conditions in the open with a rapid fall of temperature with height. At the other end we have the sugarcane and yam fields, both irrigated, with temperature low near the ground and rising with height as in a nocturnal inversion.

## VII The Micro-Climate of the Sugarcane crop.

The micro-climate of sugarcane is of special interest. When fully developed this crop has a form of canopy. Conditions inside sugarcane would therefore give some idea of what may be expected inside a forest with canopy.

It is very interesting to compare the conditions in the 'open' at the maximum temperature epoch with those inside sugarcane in flower. The over-all height of the crop is then of the order of 14 to 15 ft. in November at Poona ( cf. Fig. 3 ). The stems are almost bare from ground upto 4 ft.; above this the foliage increases rapidly and extends up to about 11½ ft. The crop is crowned by flowers from 11½ ft, to 14½ ft. The wind-break effect of the crop ( vide Section II ), i. e , its ability to reduce air movement, may be expressed as:—

$$\frac{\text{Velocity in the open} - \text{Velocity inside crop}}{\text{Velocity in the open}} \times 100$$

This "breaking" effect is 90% or more in the height interval from 4 to 14½ ft. where the foliage is thick. The crop forms a dense stand with the foliage forming an effective canopy except for very small openings through which sunshine can reach the ground in patches. While the ground is the "active" surface in the open "active" because it is the source of heating by day and cooling by night for the adjacent air and soil layers), in a sugarcane crop the ground is much less active, whereas the canopy which has a certain vertical extent is more "active". Under these conditions, in marked contrast to the "open" air, the air temperature inside the crop (Fig. 3) at the maximum temperature epoch increases with height forming an inversion. Thus we have relatively stable conditions during the day inside the crop (such conditions prevail in the open only at night due to radiative cooling). As may be expected, the pressure of water vapour is maximum near the wet surface of the ground, decreases with height up to 7 ft., and increases from 7 to 13 ft. owing to the water vapour transpired by the foliage. These details are

brought out in Fig. 3 where the dotted curves refer to the 'open'. The lowering of air temperature, the development of stability (inversion) and increased humidity inside the crop may be noted. Above the crop, free air conditions prevail. Inside tropical or sub-tropical forests with "canopy" the conditions are more or less as described above.

Observations on the movements of smoke inside a sugarcane field during day time show that, as compared to the turbulent conditions outside, the air movement or turbulence inside the crop is negligible. It is not completely absent but very supressed or subdued. The random movements are very sluggish, the horizontal drift being more in evidence. The day time inversion inside a plant community with a canopy is a "forced" inversion, to coin a new phrase, due to heating of the canopy by solar radiation to a greater extent than the ground which is practically shaded. The air layers in an environment showing "forced inversion" will not be as stratified and extremely quiet as in the " static inversion" layer which develops in the "open" during night, when the general air movement is itself small. The "wind-break" effect of the crop or forest combined with the heating of a continuous canopy are responsible for the forced inversion inside the crop or forest.

### VIII. Climate of a Vineyard (Type B changing to BD when irrigated).

Fig. 4 shows the mean hourly variation of air temperature in °F and the percentage relative humidity in the 'open' and inside a vineyard at Nasik at a level of 4 ft. above ground during the period 6th January to 2nd March 1935. The data were obtained from thermographs and hygrographs exposed in Stevenson screens kept in these two environments. The air temperature is higher in the 'open' during day time and lower at night than that inside the garden. The epochs of maximum and minimum temperature occur in the garden some time later than in the 'open'. The percentage humidity is higher in the garden than in the 'open' at all hours of the day. The epoch of maximum and minimum saturation occur in the garden a little later than in the 'open'.

### IX Type BCD.

Effect of wind on the Micro-climate of a Betel-vine ( Piper Betle Linn ) plantation at Poona.

We may now give an example of the effect of wind on the micro-climate. At Poona, in winter when the air movements are feeble, the deviations from the climate of the "open" are large as mentioned earlier. With the advance of the season the air movement becomes stronger gradually. The effect of the increase in wind velocity on the micro-climate of a crop of betel-vine (periodically irrigated) is shown by the Figs. 5 (a), (b), (c) and (d). These show the mean hourly variation of air temperature (measured by thermographs exposed inside Stevenson

screens in °F, at 4 ft. above ground in the open and inside the betel-vine plot December 1936 and January, February and March 1937. As in Fig. 4 the te perature in the open is higher during day and lower during night than inside crop, the X and N epochs in the crop showing a lag, as is to be expected. December the diurnal range of temperature is 36°F in the open and 27°F inside crop. In January also the curves show similar variations. In February when winds increase in velocity the curves begin to approach each other and by Ma when the winds are still stronger the temperatures inside the crop and out approach still closer. Thus, the effect of strong air movement during c weather is to decrease the difference in the temperatures of the two environme In this particular instance we have an example of the clear weather Type changing to Type BCD under conditions where little or no sunshine actu reached the surface of ground owing to the presence of dense vegetation.

## X. Type BCE changing gradually to BD.

We have another example shown in the curves of Figs. 6 (a), (b), (c), (e) and (f). These show the hourly variation of air temperature (at Poona 4 ft. in the "open" and inside a banana plantation, where the rows of plants and plants in row were 6 ft. apart. The plants were about 6 ft. in height. The te erature records were obtained from thermographs during the months of June, J August, September, October and November 1937.

The weather during June to September is of type BCE, with mainly o cast skies, precipitation at intervals and moderate to strong winds. In Oct the weather improved but there were a few thunderstorms. November, a t month, would bring about the micro-climate of Type A in the "open" and Ty changing to BD in the banana plantation during irrigation. One notable dif nce between the banana plantation and the betel-vine crop referred to earli that in former sunshine falls on the ground in the interspace between plants v this does not happen in the latter. There is a certain accumulation of heat in banana plantation which is not dissipated at the same rate as in the 'open', o to the wind-break effect of the crop and the neighbouring trees. This localis of warmth during the afternoon was small in June and July when the skies overcast and the average wind velocity was 8 miles per hour. Later the wind creased from 7.8 m.p.h. in August (cloudy) to 2.0 m.p.h. in October (occasion cloudy, mainly clear). In November with no rain and little cloudiness, alth the wind velocity was as low as 1.3 m.p.h. the excess of temperature inside crop was smaller than in October, owing presumably to the decrease in the inte of insolation with the approach of winter.

## XI. The effect of vegetation on wind velocity.

Having examined the effect of vegetation on the air temperature and h idity, we may now pass on to the wind-breaking effect of different environm

For studying in detail the vertical structure of the wind velocity and its variation with time of day and with environment the handy portable hot-wire anemometer is an ideal instrument, particularly when observations are desired at very short height intervals close to the ground. Measurements were made at Poona with this instrument at heights of 3", 6", 1', 2', 3', 4', 6' and 8' in the 'open' and in different crops. During the last few years a general survey has been made inside a number of crops. Table 5 gives the mean velocity in miles per hour during the period of 17th November to 11th December 1937 in the "open" and inside jowar, suran (Elephant foot) and sugarcane crops.

**Table 5.**

Mean wind velocity in miles per hour from 17-11-37 to 11-12-37.

| Height above ground | Minimum temperature epoch | | | | Maximum temperature epoch | | | |
|---|---|---|---|---|---|---|---|---|
| | *Open* | *Jowar* | *Suran* | *Sugarcane* | *Open* | *Jowar* | *Suran* | *Sugarcane* |
| 3" | .49 | .38 | .31 | .31 | 2.37 | .78 | 1.25 | .38 |
| 6" | .58 | .36 | .34 | .31 | 2.73 | .65 | 1.28 | .40 |
| 1 ft. | .47 | .34 | .25 | .29 | 2.91 | .76 | 1.32 | .45 |
| 2 ft. | .60 | .25 | .27 | .25 | 2.98 | .72 | 1.81 | .38 |
| 3 ft. | .78 | .25 | .34 | .25 | 3.87 | .92 | 2.17 | .56 |
| 4 ft. | 1.01 | .27 | .38 | .25 | 3.49 | .98 | 2.15 | .47 |
| 6 ft. | 1.10 | .25 | .47 | .22 | 4.85 | 1.25 | 3.11 | .56 |
| 8 ft. | 1.16 | | | | 5.30 | | | |

( i ) The jowar covered an area of $\frac{1}{4}$ acre with 52 rows, each 110 ft. long, there being one plant per ft. in each row on the average. The mean height of the crop was about 6 ft.; ( ii ) The 'suran' field was $\frac{1}{2}$ acre in area with 37 rows of plants, each 110 ft. long. The distance between rows was 4 ft. and that between plants in the row 3 ft. The average height of the crop was 3 ft., the leaves spreading out at the top to a diameter of 2 ft.; ( iii ) the sugarcane field was $\frac{1}{4}$ acre in area and had 20 rows, each 110 ft. long, the rows being 3 ft. apart. There were 3 to 4 clumps of canes per foot. The plants had reached the flowering stage.

At the minimum temperature epoch, when the air layers are more or less stratified, the air flow is feeble and laminar. The increase of velocity with height is typical in the open. Inside the sugarcane, jowar and suran fields there is a decrease of wind velocity with height as the wind-break effect tends to increase with height owing to the foliage becoming denser. In suran which is only about 2 ft. high, the wind velocity begins to increase with height above the crop. The velocities at the minimum temperature epoch are generally between 0.2 to 1.2 m.p.h. and are often too feeble to be measured with the ordinary cup anemometer.

At the maximum temperature epoch there is a general increase in wind velocity. The difference in the wind-break effect of different crops is seen more clearly in the afternoon, the maximum effect being inside sugarcane, jowar coming next in order. The reduction of wind velocity above the suran crop ( 2 ft. high ) persists even upto 6 ft. In the 'open' the wind velocity approaches 5.5 miles per hour at 8 ft.

The lowering of wind velocity by standing crops offers a certain degree of self-protection for the plants away from the borders of the field. The wind-breaking capacity of different crops within their respective heights may be seen in Table 6, where the mean wind velocity at different levels above ground inside different crops is expressed as a percentage of the wind velocity at corresponding levels in the 'open'. The data summarise the information obtained in a number of crops during the last few years and refer to afternoon conditions.

**Table 6.**

Mean wind velocity in the afternoon in different environments expressed as percentages of the velocity at corresponding heights in the ' open '.

| Height above ground | Percentnge wind velocity in | | | | | | |
|---|---|---|---|---|---|---|---|
| | Jowar | Suran | Sugarcane | Cotton | Wheat | Tobaco | Double-beans |
| 3" | 29 | 52 | 18 | 32 | 20 | 51 | 30 |
| 6" | 24 | 47 | 17 | 29 | 17 | 50 | 29 |
| 1 ft. | 28 | 46 | 20 | 26 | 15 | 48 | 24 |
| 2 ft. | 26 | 60 | 16 | 34 | 21 | 52 | 25 |
| 3 ft. | 29 | 56 | 17 | 50 | 40 | 58 | 28 |
| 4 ft. | 39 | 62 | 18 | 64 | 57 | 68 | 29 |
| 6 ft. | 47 | 64 | 16 | 75 | 75 | 79 | 36 |
| 8 ft. | 60 | ... | 16 | 78 | ... | ... | 52 |

The ability to reduce air movements is in the order of sugarcane, wheat, jowar, double-beans, cotton, suran and tobacco. A more detailed discussion of this problem will be found in the paper by Raman (3).

### XII. Air movement inside an Oak Forest in Austria.

We may quote here the results of measurements made by Geiger ( 1 ) in a thin oak forest with an undergrowth of beech. In a closed forest space even the large air masses which have fairly good freedom of motion between trunks remain very calm. In fig. 7 the oak is drawn to scale. The three curves represent the change of wind velocity with height above the source of the forest during hours of strong wind. The curves represent measurements ( a ) in autumn 1928, ( mean of 12 hours ), ( b ) in spring 1928 ( mean of 17 hours )

when oak was in foliage and ( c ) in spring 1928 ( mean of 28 hours ) before the sprouting of the foliage. In all the three cases the highest wind velocity occurs over the top of the trees while it is almost calm throughout between the trunks. This calm is most marked when the trees are in leaf but even the bare trunks, branches and twigs ( Curve C ) form a powerful obstruction to the wind.

Recently in India the forest departments in the Central Provinces and Bihar have begun to take some interest in the meteorological aspects of sylviculture and it may be hoped that within a few years it may be possible to extend the scope of these investigations into forest environments.

Before concluding this section, it may be mentioned that gliders experience up-rising warm currents above a forest in the evening when nocturnal cooling has already commenced in the neighbouring ' open ' spaces.

**The variation with environment of the evaporating power of the air layer near the ground.**

As a climatic factor evaporation has certain special features. It takes into account directly or indirectly the effects of several meteorological factors like wind velocity, temperature and the saturation deficit of the air stream at a particular level on the loss of moisture by evaporation from a suitable measuring device. We have, of course, to despense with instruments of large size and use the simple and handy " Piche's " evaporimeter. This instrument occupies little space and several instruments may be exposed at different levels above ground to study the variation of the factor with height in different environments.

A number of calibrated Piche's evaporimeters were exposed* in the open and inside selected crops at 1, 2 and 4 ft. above ground. The measurements of evaporation in 24 hours ending at 8 A. M. local time were recorded daily at Poona from December 1940 upto February 1941. The crops selected were jowar, double-beans, sugarcane and betel-vine.

Table 7 gives the mean values of evaporation in the different periods during the above season. The values of evaporation inside the crops have also been expressed as percentages of corresponding values in the open in the last 3 columns of the Table.

* This investigation was made by Mr. P. K. Raman

**Table 7**

Evaporation in different environments in inches.

| Environment | Evaporation in inches at heights of 4' | 2' | 1' | Evaporation as % of the open at corresponding level. 4' | 2' | 1' |
|---|---|---|---|---|---|---|
| 5-12-40 to 10-12-40 | | | | | | |
| Open ... ... | .356 | .387 | .354 | ... | ... | ... |
| Rabi Jowar ... | .209 | .163 | .120 | 59 | 42 | 34 |
| Double-bean ... | .132 | .083 | .068 | 37 | 21 | 19 |
| Sugarcane ... | .117 | .108 | .098 | 33 | 28 | 28 |
| 11-12-40 to 22-12-40 | | | | | | |
| Open ... | .341 | .366 | .329 | ... | ... | ... |
| Rabi Jowar ... | .218 | .157 | .132 | 64 | 43 | 40 |
| Double-bean ... | .160 | .086 | .083 | 47 | 24 | 25 |
| Sugarcane ... | .108 | .108 | .098 | 32 | 29 | 30 |
| Betel-vine ... | .080 | .077 | .065 | 23 | 21 | 20 |
| 23-12-40 to 6-1-41. | | | | | | |
| Open ... | .354 | .409 | .375 | ... | ... | ... |
| Sugarcane ... | .123 | .126 | .101 | 35 | 31 | 27 |
| Betel-vine ... | .098 | .089 | .074 | 28 | 22 | 20 |
| 10-1-41 to 31-1-41. | | | | | | |
| Open ... | .369 | .397 | .384 | ... | ... | ... |
| Double-bean ... | .148 | .117 | .108 | 40 | 29 | 28 |
| Sugarcane ... | .129 | .129 | .098 | 35 | 30 | 26 |
| Betel-vine ... | .092 | .083 | .077 | 25 | 21 | 20 |
| 1-2-41 to 19-2-41. | | | | | | |
| Open. ... | .492 | .556 | .516 | ... | ... | ... |
| Double-bean ... | .215 | .191 | .148 | 44 | 34 | 28 |
| Sugarcane ... | .166 | .160 | .132 | 34 | 29 | 26 |
| Betel-vine ... | .120 | .120 | .101 | 24 | 22 | 20 |

In general evaporation tends to increase with height. It is least in betel-vine where the wind velocity is least and the relative humidity maximum under the influence of irrigation coupled with the lack of ventilation. ( The betel-vine grows on some supporting structure to a height of 20 ft. and is irrigated at intervals of 10 days ). Next comes sugarcane, also a dense crop, irrigated heavily at intervals and growing up to 12 ft. in height. In sugarcane the wind velocity is

slightly higher than in betel-vine. In double-beans and jowar the increase with height is more pronounced as the crops rise upto 5 or 6 ft. only above ground. Table 8 gives the mean values of evaporation expressed as percentages of that in the open at the corresponding levels. For reference the actual values of evaporation in inches at different levels in the open are also given at the bottom of the table.

**Table 8**

| Environments | Evaporation as % of the open at corresponding level | | |
|---|---|---|---|
| | 4 ft. | 2 ft. | 1 ft. |
| Rabi Jowar ... ... ... ... | 62 | 43 | 37 |
| Double-bean ... ... ... ... | 41 | 27 | 25 |
| Sugarcane ... ... ... ... | 34 | 30 | 27 |
| Betel-vine ... ... ... ... | 25 | 21 | 20 |
| Actual evaporation in the "open" in inches. | 0.382 | 0.423 | 0.392 |

A more detailed discussion of these measurements in relation to temperature, humidity and wind velocity will be taken up when further data are collected.

## XIV. Summary.

The present report reviews broadly the results on various aspects of micro-climatology obtained at Poona and elsewhere. Systematic observations on the climates of crops and of the 'open' have been recorded at Poona during the last 10 years. A full detailed discussion of these data is beyond the scope of this paper.

While much work of an exploratory nature has already been done there is much more to be attempted before many gaps in our knowledge of local climates, particularly in large plant communities like forests can be filled in.

The author wishes to record grateful thanks to the Imperial Council of Agricultural Research for providing facilities for a section mainly devoted to these investigations over a series of years. Thanks are also due to the Director-General of Observatories for his deep interest in this new branch of meteorology.

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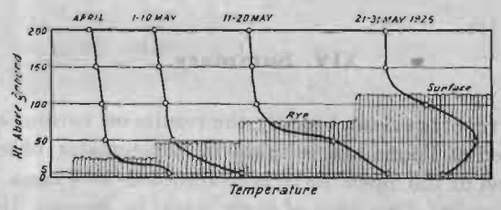


FIG.1. DAILY TEMPERATURE MAXIMA IN A GROWING CORNFIELD (AFTER R. GEIGER.)

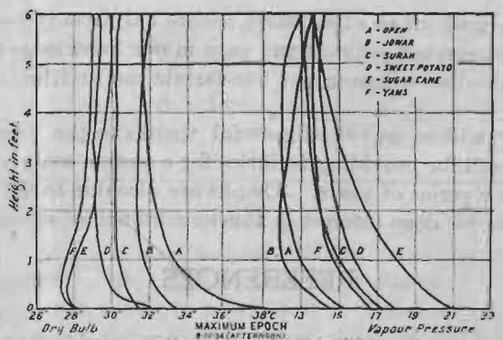


FIG. 2 VARIATION OF DRY BULB TEMPERATURE (°C) AND VAPOUR PRESSURE (mm of Hg.) WITH HEIGHT ABOVE GROUND IN DIFFERENT ENVIRONMENTS.

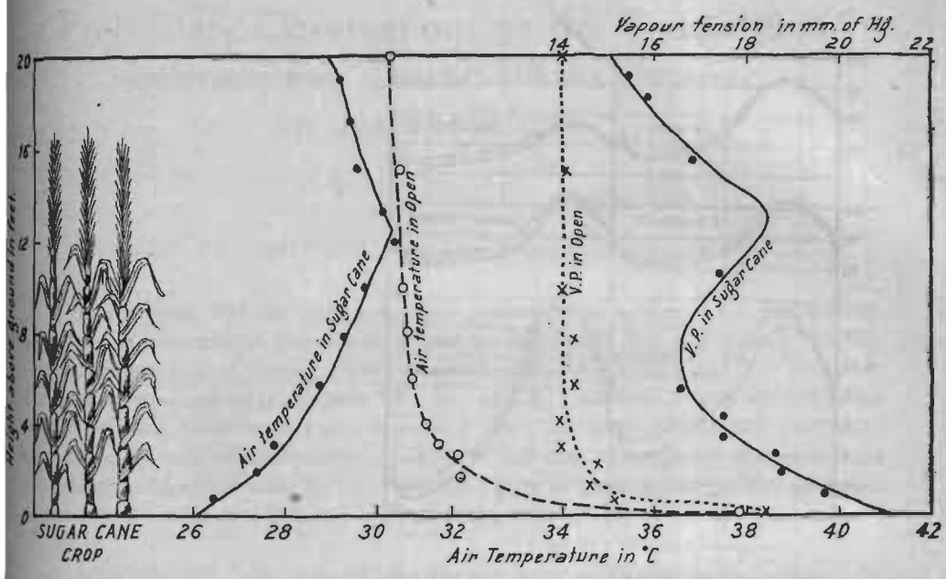


FIG. 3.

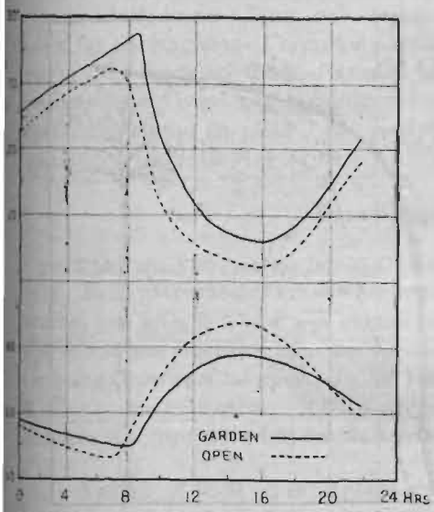


FIG 4 DIURNAL VARIATION OF AIR TEMPERATURE (°F) AND RELATIVE HUMIDITY AT 4 FT ABOVE GROUND IN THE OPEN AND INSIDE VINE-YARD AT NASIK (January)

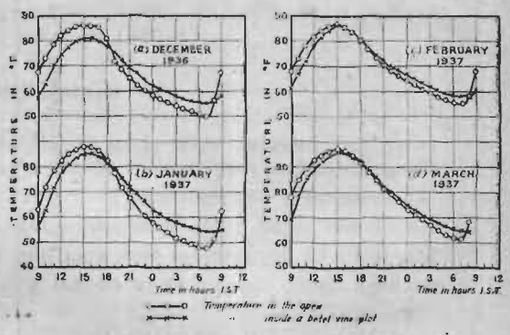


*FIG. 5. MEAN HOURLY VARIATION OF AIR TEMPERATURE

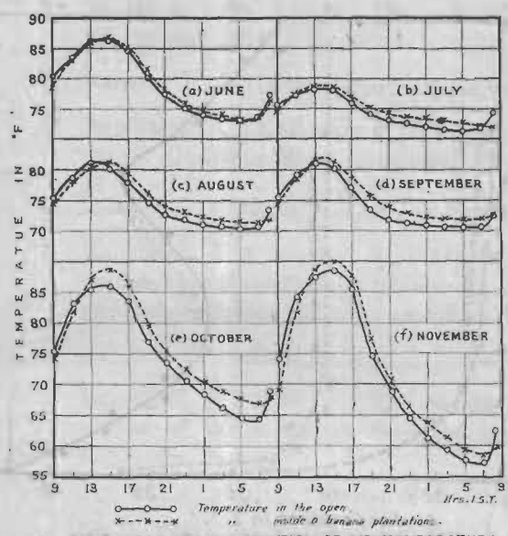


FIG. 6. MEAN HOURLY VARIATION OF AIR TEMPERATURE.

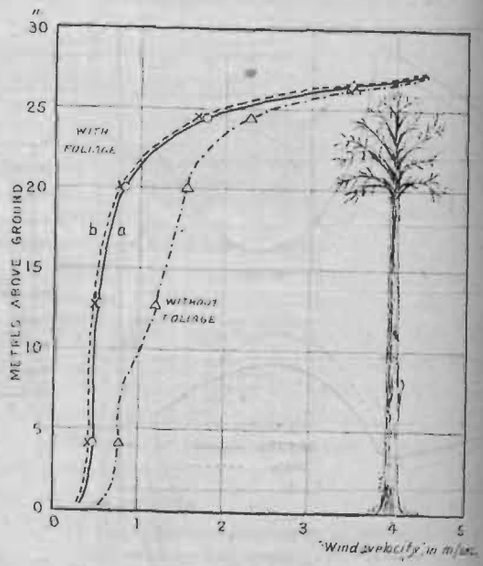


FIG. 7. AIR MOTION IN THE INTERIOR OF AN OAK FOREST (AFTER R. GEIGER).

# Preliminary Observations on the Competition between two Cotton Plants Growing in Juxtaposition.

By

T. R. KHADILKAR *

In the years 1940 to 1942 spacing experiments in cotton were undertaken : Jalgaon Experimental Farm with a view to find out if by any change in the ıltivator's practice of sowing greater yield of cotton per acre could be obtained. The various spacings adopted were 18", 24" and 30" between two rows combined with 3", 6" and 9" between two plants in a row. No single treatment proved to be statistically and consistently superior to another throughout the period of experiment. Spacings with 30" row distance gave in general low yields and treatments with 3" intra-row distance showed large fluctuations in yield.

Cultivators of Khandesh adopt 18" distance between rows and about 6" to 9" between plants. Some have recently begun to keep 24" distance between rows especially in deep and rich soils. On Jalgaon Farm, Jarila cotton seed meant for growing stage I crop for multiplication is sown with 24"×9" spacing. Two or three seeds are dibbled at each hill and about 3 to 4 weeks after, extra seedlings are removed keeping only one at a hill. In order to see what effect would be produced on yield if two seedlings were allowed to grow at a hill as against one, the following experiment was taken in 1946–47.

## Experimental Details

Plots with 20 feet length and 8 feet breadth each were marked out in a field. Each plot was grown with four rows sown 24 inches apart and the distance between two hills in a row was maintained at 9". There were two treatments 'A' and 'B' and ten replications. Each treatment consisted of four lines, the middle two being experimental ones. In 'A' two seedlings were maintained at a hill and in 'B' only one as control. *ABBA* method of layout was adopted. Two feet on each side of a plot were left out as border.

Number of bolls on each plant growing at a hill in both 'A' & 'B' treatments were counted just before harvest and the total yields of the experimental lines were also recorded plot by plot. As the number of hills available for yield in each experimental plot varied from 40 to 50, the average yield, as well as, average boll number per hill per plot were taken for statistical comparison. The following factors were compared:—

* Cotton Breeder, Jalgaon.

(i) Kapas yield per hill.

(ii) Number of bolls per hill.

(iii) Number of bolls on a high boll bearing plant at a hill in treatment '. compared with number of bolls on a plant at a hill under treatment 'B

(iv) Number of bolls on low bearing plant at a hill in treatment 'A' cor pared with number of bolls on a plant at a hill under treatment 'B'.

(v) Proportion of bolls on high boll bearing plant to those on low boll be ring plant at a hill in treatment 'A'.

Results of the statistical analysis of each factor are embodied in t table below:—

**Table 1**

| No: | Factors | Treatments 'A' : 'B' | | Mean diff. between 'A' & 'B' | S.E. of mean diff. | $\frac{M}{S.E.}$ (observed) | t (theoretic with 9 D. (at0. lev |
|---|---|---|---|---|---|---|---|
| I | Average yield of kapas per hill in tolas ( mean of 10 blocks ). | 0.90 | 0.77 | +0.13 | 0.032 | 4.06 | 2. |
| | | | | | 'A' significant over 'B'. | | |
| II | Number of bolls per hill. | 9.86 | 7.38 | +2.48 | 'A' significant over 'B' (In each block 'A' was greater than 'B'). | | |
| III | Number of bolls on high boll bearing plant at a hill in 'A' compared with a plant in 'B'. | 6.31 | 7.38 | —1.07 | 0.32 | 3.4 | 2. |
| | | | | | 'B' significant over 'A'. | | |
| IV | Number of bolls on a low boll bearing plant at a hill in 'A' compared with a plant in 'B'. | 3.55 | 7.38 | —3.83 | 'B' significant over 'A' (In each block 'B' was greater than 'A'). | | |
| V | Proportion of bolls of high boll bearing plant to those of low boll bearing plant at a hill in 'A'. | 1.81 | 1 | (Total plants observed=416). | | | |

Under the conditions of the experiment which was taken on a small scal the above statistical analysis leads to infer as follows:—

Two cotton plants grown at a hill (Treatment 'A') can give greater yield of kapas than one plant so grown (Treatment 'B'). The same relation holds good regarding the number of bolls produced at a hill. If, however, the number of bolls on two plants at a hill are compared individually with the number of bolls given by a single plant grown at a hill, then both the plants severally happen to be statistically less productive than the other. This is mainly due to the physiological competition that is set between two plants when they are made to grow quite close to each other, though jointly they are found to be more productive. On an average the number of bolls produced on one plant is nearly double that produced by its adjoining plant at the same hill, the actual proportion obtained being 1.8 : 1.

## Other observations

Besides the above findings it was also observed that in point of plant height the plants under the two treatments did not present any marked difference, nor the difference between two plants at a hill was prominent. The actual heights were not measured. It appears, therefore, that the effect of very close planting affected more the productive than the growth phase of plant development. Under both treatments the percentage of sterile hills (i. e. hills giving no bolls at all) was not more than one and under treatment 'A' the percentage of hills with one plant sterile and the other fertile was only six.

Hoyle (*) from an experiment of similar nature taken in Nyasaland opines that in a tract with short season of growth, the intra-row distance between two holes should be closer like 12 inches. He also finds that growing two plants at a hill tends to give more yield than one. The inter-row distance in his experiment was three feet as against two in the present one.

Results of this small experiment suggest that in laying out future spacing experiments in cotton under Khandesh conditions, it is worth while including a treatment wherein two or three plants per hole would be grown as against one.

## Summary

1. A small replicated trial in cotton was arranged on Jalgaon Experimental Farm in 1946–47 with a view to see what effect would be produced on yield and plant growth if two plants were grown at a hill as against one, in a common lay out where inter-row and intra-row distance is 24 inches and 9 inches respectively.

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* Hoyle S. T, Spacing of cotton in Nyasaland Emp. Cott. Grow. Rev. XV, 4 Oct. 1938, p. 306.

2. The treatment with two plants at a hill gave statistically better yield than the one with one plant at a hill. Number of bolls per hill was also greater in the first treatment. Number of bolls on an individual plant in a two plant hill was, however, significantly lower than the one on a plant of the other treatment.

3. The competitive effect between two plants at a hill was more pronounced in their boll development than in their height. Percentage of sterile hills in both the treatments was the same and small. In the two-plant treatment the percentage of hills with one plant sterile and the other fertile was six.

4. It is suggested that in any future spacing experiment in cotton in Khandesh a treatment with two to three plants at a hill may be included with advantage.

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# New Methods of Weed Control.

By

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The problem of weed control has been a nightmare to farmers all over the world since time immemorial. The amount of loss caused to the cultivator by way of decrease in yield and fertility of the soil is self-evident. The diversity in the method of propagation, seasonal appearance and spread of the weeds ensures their eternal presence in all types of soils and during all the seasons of the year. Though various methods of weed eradication are resorted to, these have been far from satisfactory. The result has been that the cultivator prefers to suffer a reduction in the yield rather than add to his cultivation charges which are hardly made good by any substantial increase in the income from the crop. Weeds which produce a prolific amount of seed like *Striga*, *Amarantus* etc., those that hibernate underground like *Cyperus rotundus* ( *Lavala* ) and those that are easily carried by wind and water like *Tridax* and *Portulaca* escape control so easily that

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their seasonal appearance is inevitable. Though cultural methods help the reduction of the ravages caused by weeds, they by no means help prevent their recurrence. The method of controlling weeds therefore must be cheap and thorough. Only will it be adopted on a wide scale.

*Methods in Vogue*:— Most of the methods in use fall under two categories, namely, the cultural or the chemical. A third, the biological method consists of using a parasite which may be an insect or a fungus or a bacillus for destroying weeds. A condition precedent to the use of this method is that the parasite should not attack plants other than the weed to be destroyed.

*Cultural methods*:— Among the existing methods of weed control, the cultural method is by far the best. It includes ploughing and turning of the soil in order to expose the dormant parts of the weed plants to the destructive effect of sunlight, inter-culturing between rows of crops to remove weeds; cutting the above ground parts to starve the plant of its stored food contents; growing green manure crops like *Sann* to smother weeds and so on. These methods are practicable in that they form a part of the routine practice in crop cultivation.

*Chemical methods*:— The chemical method of weed control consists in spraying either the weed plant or the soil by chemicals like sulphuric acid, sodium chlorate and certain copper and arsenic salts. This method has been unfortunately impracticable because of the large amounts of chemical required and the consequent high cost. For this reason, the usual method of weed control practised in this country is the cultural method.

Though the cultural method has its own advantages, one cannot fail to see the shortcomings in the method. It does not render the small weed seeds incapable of germinating and propagating their species. Many underground dormant parts of weeds may escape destruction and as a result damaged weeds may multiply vegetatively. The cost of labour for removal of weeds is often prohibitive.

*New weedicides*:— In recent years a new chemical known as 2, 4-dichlorophenoxyacetic acid has been widely used in the United States of America and on the continent of Europe. This chemical is 'selective' in its action in that it kills certain plants while certain others are unharmed. Different concentrations have different reactions on plants. This aspect therefore has been of very great advantage in weed control. '2, 4-D' as the chemical is popularly called, is harmless to most grasses and cereals like *Jowar*, *Bajari*, Wheat, sugarcane etc while non-graminaceous plants are susceptible to the destructive effect of the acid. Thus 2, 4-D could very profitably be used to eradicate the root-parasite *Striga* on *Jowar* and sugarcane. The second point of advantage is its non-toxic nature to human beings and livestock which is perhaps one of the most important factors in its favour for advocating its use to the cultivators. Its toxicity is such that seeds of susceptible weeds are rendered incapable of germination once they

come in contact with the acid. As the chemical is translocated into the body of the plant,even below ground parts are killed. Concentrations of the weedicide sufficient to kill weeds might actually stimulate growth in the regular crop as is seen in the development of brace roots in maize and abundant prop-roots in *jowar*, thereby reducing lodging and increasing the yield of the crop. Labour for removal of weeds is minimized while the control of weeds is more thorough than by any other method of weed control.

The chemical is diluted to strengths varying from 0.1 to 0.5 or 1 % before spraying. Most weeds are killed at 0.1 % strength. Those that are resistant to low strengths of the weedicide are killed at higher strengths e. g. 0.2 % and 0.3 %. Hardy bushes require to be sprayed at concentrations of 0.5 or 1%. A rate of 100 gallons per acre normally ensures good control. In case of weeds which persist, spraying is done twice with an interval of 10 days between the two sprayings. When bushy plants like *Lantana* are to be killed, the main stems are cut back till six inch stumps are left. These stumps are allowed to sprout and when the succulent sprouts are about a foot long they are sprayed with the weedkiller. It has been observed that encouraging results are obtained if the weeds are sprayed when they are about two to three weeks old. The young succulent twigs facilitate quick translocation of the chemical into the weed plant as compared to older plants which show a certain amount of resistance. The weedicide being hormonal in nature causes overstimulation of growth resulting in abnormal thickening of parts which ultimately rupture. The uneven growth causes various distortions like bending and twisting of parts. Overstimulation also causes quick exhaustion of food material thereby resulting in the starvation of the plant which ultimately dies.

Treatments are classified into two types namely the 'pre–emergence treatment' by which is meant that the soil is sprayed with the weedkiller before the appearance of weeds on the surface thereby killing the weeds in their very early stages and the 'post–emergence treatment' by which is meant that the field is sprayed when the weeds come up on the surface. The efficacy of the method used depends on the type of weeds that are prevalent in the particular soil. Where the soil is infested with weeds with subterranean storage organs, the post–emergence treatment would be more suitable than the pre-emergence treatment. A judicial combination of pre–emergence and post–emergence treatments would be best in that chances of weeds escaping the effect of the weed killer would be very slim.

Most of the modern weedkillers are known to have a soil sterilizing effect, which means that the germination of seeds of crop plants are hampered, particularly the dicotyledons. But it has been observed that this effect does not last so long as to hamper the germination of the following crop. In irrigated fields the soil sterilizing effect is lost within a month of spraying the field while in un-irrigated fields it would require about 60 days for the adverse effect to go.

Thus the use of the weedkiller does not in any way come in the way of following the normal crop rotation. The weedkiller cannot be used in fields where mixed crops are grown as in fields where cereals are grown along with legumes, because most of the legumes are susceptible to the destructive effect of the chemical. If weeds are to be eradicated in such fields by using the chemical, then, cereals alone should be grown.

The most recent discovery among weedkillers is that of Sodium Trichloroacetate ( TCA ) which is said to control the noxious grass '*Hariali*' (*Cynodon dactylon*, Pers ). Thus it is possible that in time to come even grass weeds may be controlled by modern weedkillers.

A systematic trial of the new weedkillers that are coming on the market is being carried out by the Economic Botanist's section. Below is a list of weeds found susceptible to the weedkillers and this will be added to as more results become available.

**List of local weeds susceptible to 2, 4-D**

| S. No. | Botanical Name | Common Name | Strength of 2, 4-D | Remarks |
|---|---|---|---|---|
| 1. | *Acalypha iadica*, Linn. | *Kupi* | 0.2% | Plants died in 16 days. |
| 2. | *Amarantus spinosus*, Linn. | *Kate-mat* | 0.2% | Bending of stem, yellowing of leaves, died in 20 days. |
| 3. | *Argemone mexicana*, Linn. | *Pivla-Dhatura* | 0.1% | Bending and parching of leavess, died in 12 days. |
| 4. | *Bidens pilosa*, Linn. | *Dipmal* | 0.2% | Bending and swelling of stems, died in 16 days. |
| 5. | *Caesulia axillaris*, Roxb. | *Maka* | 0.2% | Bending and swelling of stem, Chlorosis, died in 15 days. |
| 6. | *Celosia argentea*, Linn. | *Kurdu* | 0.2% | Swelling of nodes which burst; died in 16 days. |
| 7. | *Cyperus rotundus*, Linn. | *Lavala* | 0.2% | Withering of foliage; died in 15 days. |
| 8. | *Corchorus trilocularis*, Linn. | *Kadu-chinch* | 0.2% | Bending and swelling of stem, died in 18 days. |
| 9. | *Datura fastuosa*, Linn. | *Dhatura* | 0.2% | Drooping of leaves, bending and swelling of shoots, died in 14 days. |
| 10. | *Datura stramonium*, Linn. | *Dhatura* | 0.2% | —do— |
| 11. | *Eclipta alba*, Clke. | *Bhangra* | 0.2% | —do— |
| 12. | *Euphorbia geniculata*, Crt. | *Big dudhani* | 0.2% | Bending of shoots which crack later, died in 18 days. |

| S. No. | Botanical Name | Common Name | Strength of 2, 4–D | Remarks |
|---|---|---|---|---|
| 13. | *Euphorbia thymifolia*, Linn. | *Dudhani* | 0.1% | Parching of leaves: died in 12 days. |
| 14. | *Indigofera glandulosa*, Willd. | *Barbada* | 0.2% | Bending and swelling of tops. chlorosis; died in 18 days. |
| 15. | *Ipomea muricata*, Jacq. | *Bhouri* | 0.1% | Chlorosis of leaves, withering of plant: died in 12 days. |
| 16. | *Lagasca mollis*, Cav. | *Pandhri-phuli* | 0.2% | Swelling of shoot tips, died in 14 days. |
| 17. | *Leucas aspera*, Spr. | *Lucas* | 0.2% | Bending and chlorosis of leaves, died in 12 days. |
| 18. | *Lucas stricta*, Bth. | *Lucas* | 0.2% | Bending and chlorosis of leaves, died in 12 days. |
| 19. | *Nicandra phasoloides*, Gaert | *Ran-popti* | 0.2% | Bending of stem and drying of leaves, died in 18 days. |
| 20. | *Ocimum canum*, Sins. | *Ran-tulas* | 0.2% | Drooping and drying of leaves, died in 15 days. |
| 21. | *Phyllanthus Urinaria*, Linn. | — | 0.2% | Bending and swelling of stems. died in 12 days. |
| 22. | *Physalis minima*, Linn. | Gooseberry (wild) | 0.3% | Epinasty and drying of shoots. died in 15 days. |
| 23. | *Portulaca oleracea*, Linn. | *Gholu* | 0.2% | Yellowing and drying of shoots, died in 18 days. |
| 24. | *Psoralea corylifolia*, Linn. | Bavchi | 0.2% | Bending, swelling and cracking of shoots, died in 18 days. |
| 25. | *Sonchus arvensis*, Linn. | *Mahtara* | 0.2% | Twisting of shoots & chlorosis died in 15 days. |
| 26. | *Sonchus oleraceous*, Linn. | *Mahatara* | 0.2% | Bending & swelling of shoots chlorosis, died in 15 days. |
| 27. | *Solanum nigrum*, Linn. | *Kanguni* | 0.2% | Chlorosis of leaves and drying of plants, died in 15 days |
| 28. | *Striga densiflora*, Bth. | *Tarphul* | 0.1% | Curvature of shoots and leaves which wither later. |
| 29. | *Striga lutea*, Lour. | *Tarphul* | 0.1% | Died in 10 days. |
| 30. | *Tridax procumbens*, Linn. | *Ekdandi* | 0.2% | Epinasty, chlorosis and drying of leaves, died in 15 days. |
| 31. | *Xanthium strumarium*, Linn. | *Gokhru* | 0.2% | Parching of leaves and shoots, died in 15 days. |

# World Population and World food Supplies *

There is an old Egyptian saying that whoever has onee drunk of the waters of the Nile will want to go back and drink them again. I do not know if that has ever been said of the waters of the Tyne, but it is certainly true that the British Association always welcomes an invitation to Newcastle. This is our fifth visit; to no other city have we been more often.

We came first in 1838 when England was mainly an agricultural country. The 111 years that have elapsed have seen profound changes in our national life, particularly the prodigious advancement of science and of its daughter technology.

Among the many resulting achievements has been a great increase in the certainty and the length of life. The world population has risen more rapidly than ever before; it is now estimated by the Food and Agriculture Organization at about 2,300 millions, and the increase at about 20 millions a year—an average addition of two every three seconds day and night, year after year, and the two may become three or more as science advances, social services improve,and bodies such as the World Health Organisation become fully operative. Can they all be fed? The problem is complicated by the inequalities in the rate of increase, the less advanced groups multiplying more rapidly than the more advanced, and also by the unequal distribution of population over the earth's surface. Over most of the world the population is so sparse that it can produce its own food; some regions can produce surplus: but a few regions are so densely crowded that they can themselves produce only restricted dietary—England, Belgium, Egypt, India and Eastern Asia. England is the most crowded, but its highly developed export industries enable it to import food from the surplus countries, so long as they continue to have surpluses. India and Eastern Asia have fewer possibilities of imports, but their home production can be considerably intensified. Expansion of the world's food supplies depends, therefore, on extension of the food-producing area, more intensive cultivation of the area already used, and the reduction of the present heavy wastes and losses.

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* Presidential address delivered by Sir John Russell, O. B. E., F. R. S. to the British Association at Newcastle on August 31. Printed from "Nature" Vol. 164 No. 4166 of 3rd September 49, with the kind permission of the Britih Association.

## Extension of the Food-Producing Area.

The world's total land area is 35,700 million acres, but only about 11,00 million are estimated by C. B. Fawcett to be "climatically suited" to cro growth. Much of this, however, is at present impracticable for cultivation, an the area actually used is some 3,000–4,000 million acres: 7–10 per cent onl of land surface of the world. Some 85 or 90 percent of this area is used fo food production, the rest is for industrial crops. The food producing area re presents a world average of about 1½ acres per head which, at British yields would give the British pre-war diatary; much less would suffice for a vegetarian dietary. The area 'climatically suited', however, is about 5 acres per head Can any of those unused 3½ acres per head be brought into cultivation?

Agriculturists have long been engaged in widening the zone of cultivatio by converting the marginal regions of their day into farm land and then pushin out into new marginal regions. The pioneers began in the coastal regions o North America, Australia, and New Zealand, where conditions resembled ou own, using methods that had been very successful in Great Britain. Wheat wa their main crop. But in pushing inland they were brought to a standstill b the diminishing rainfall, and in Canada by the early onset of winter; everywhe their crops suffered from pests and diseases. In 1898 Sir William Crookes, i his presidential address to the British Association, startled the world by decl ring that the process of expansion was nearly over, and by the 1930's the worl would suffer hunger unless yields were raised. He showed how the necessar nitrogenous fertilizers could be prepared synthetically from the nitrogen of th air. Agriculturists did not accept his view. Lawes and Gilbert, old, but fu of vigour and Victorian pugnacity, did what many indignant Englishmen hav done before and since, wrote to the *The Times* about it. But, in fact, the addre was one of the most momentous the Association has ever heard: it founded th great nitrogen industry and everywhere stimulated agricultural investigators t fresh efforts.

The wheat problem was solved, but not in the way Crookes expecte Shortly after his address, the new science of plant genetics was founded, and f the first time it became possible systematically to transfer characters from on plant to another and so obtain new varieties possessing certain desirable qualitie Early ripening, shortness of straw and a high ratio of grain to leaf are all required in drought-and frost-resistant varieties, and all are heritable characters, as is resistance to rust and other diseases. World-wide search was made for varieties possessing the desired genes, pure line and other techniques were evolved, and new varieties were in time produced suitable for the marginal regions so that these became productive farm lands. By the 1930's Canada's 1898 wheat acreage of 4 million had risen to 27 million; Australia's 5 million to 16 million, and the Argentine's 7 million to 20 million; the world acreage and output rose far beyond the limits set by Crookes, and there was such a glut that wheat growers every-where suffered greatly and relief measures became necessary; in the Argentine wheat was burnt in the locomotives instead of coal.

The dreaded catastrophe had not eventuated, but it had been averted by means wholly unexpected; one of agriculture's many illustrations of the ancient truth:

"And the things that we looked for, the gods design not to fulfil
And the paths undiscerned of our eye, the gods unseal".

Since the 1930's, however, the wheat area of these new countries has not expanded, which has been taken to show that no more new wheat lands are available. The deduction is unjustified. Agricultural development of new lands is very costly, requiring developments of transport, storage and marketing facilities, and it is not undertaken unless a profitable market for the produce is assured. The glut of the 1930's had a restraining effect on development. Even the war has not stimulated much expansion. In 1940 Canada raised her acreage to 28.7 million in response to our urgent appeal; but the difficulties of disposal caused such discouragement that in 1941 the area fell to 21.9 million acres, and even now is only about 24 million acres, this being all that present conditions justify. All the same, Canada was able last year to supply three-quarters of British imports of wheat and flour. We owe a great debt to Canadian cerealists who made this possible—L. H. Newman, C. H. Goulden and their associates—and to the agricultural engineers who excelled themselves in devising implements for cultivating the soil, sowing and harvesting the crop with the minimum of man-power.

A new and very promising attack on the marginal lands is now being made. It is the soil-climate complex, not the climate alone, that determines agricultural use. The climate factor may be beyond our control, but the soils are being improved. Marginal lands are generally used for ranching—often many acres to one animal. Their present use is for low-productive ranching only. The more tractable are being converted into properly managed grazing land. The approach is ecological; the vegetation is surveyed, the types classified, and methods of management and conservation are worked out for each type. In South Africa more than a hundred different types of veld are recognized, each requiring its own system of management. Seeding with better grasses is being widely practised, particularly in the United States; the world is ransacked for suitable types. Canada and the United States took crested wheat grass from Russia; Australia has taken grasses from the Mediterranean countries, Africa, Turkestan and India; they are grown at experimental stations, and suitable strains are selected and multiplied. Cross-breeding has begun. Good work is in progress at Saskatoon, Swift Current and Kamloops in Western Cananda, and by Australia's vigorous Division of Plant Industry and, of course, in the United States. Unfortunately some of the good drought-resisting grasses do not easily form seed under cultivation, though they do so readily in their wild habitat. The cross-breeding of the semi-arid types has scarcely started, though collections such as that of I. B. Pole Evans in South Africa, D. C. Edwards in Kenya and others afford good material. In view of the

very great importance of grass for soil conservation in all parts of the British Commonwealth, it is highly desirable that a well-equipped Commonwealth station should be established to study existing semi-arid types and produce new ones. One of the great needs now is for leguminous plants that will do for the semi-arid and tropical regions what subterranean clover and lucerne have done for the moister regions.

Large tracts of land hitherto unfertile are gradually yielding up the secret of their barrenness. Australia has made great progress. In large parts in the south the cause was the lack of trace elements : zinc, copper, molybdenum and others ; these being supplied, the soil under proper management became productive. In the attractive Albany region are 300,000 acres to be made into 400 acre farms. For the large parts in the north, however, the secret is not yet discovered, nor has it been for the 300 million acres of peat and muck soils in Canada. But in both countries scientific workers are studying these problems under the organisation in Australia of Sir David Rivett, and in Canada of Dr. E. S. Archibald, E. S. Hopkins and others. Soil barrenness in New Zealand is ably investigated by Sir Theodore Rigg and his colleagues at the Cawthron Institute.

The wheat belt which once stopped at about the line of 18 in. of annual rainfall now stretches to the 12–15 in. line ( dependent on the evaporation ), and utilizable grass belt down to the 8–10 in. line. There are, of course, difficulties in developing regions of erratic rainfall, particularly the old Joseph problem of storing the surpluses of good years for use in bad years ; but these should not be insuperable.

The hot regions of the world present special problems because they can never be closely settled by white people. Australia's empty north has vast areas of natural grassland with adequate rainfall for beef production, and bulldozers have revolutionized the making of dams for water storage. The development problems are discussed in an excellent report by W. L. Payne and J. W. Fletcher (1937). They include land and tenure reform, pasture improvement, better living conditions for the resident workers, better abattoir facilities and transport. A chilling process based on the low temperature research at Cambridge can now replace the old unsatisfactory freezing technique whenever the quality of the beef justifies the cost. The possibilities of arable cultivation have been greatly increased by the development of the disk plough and other implements ; the Over-seas Food Corporation is proposing to develop 315,000 acres of Northern Queensland, mostly for arable crops, including sorghum varieties suited for mechanized culture.

Africa's problems are fundamentally different. The small native peasant is already in occupation with his own traditional ways of life. Yet he alone can supply some of the products vitally important to us—oil seeds, fibres, tea, coffee and cacoa. The problem is to replace his primitive methods by modern efficient

methods without too great disturbance of the best elements in the native life. We may be justly proud of the splendid pioneering work of the British agricultural officers; Great Britain has done more than any other country for the opening up of Africa. The Sudan Plantation Syndicate has for many years been highly successful in combining modern scientific cultivation methods with a way of life acceptable to the native and justifiable before the bar of civilization. In West Africa progress has gone so far that mechanization can now be introduced into the native community farming: this has been discussed in the excellent Clay-Monson report. As in Australia, the bulldozer's remarkable power of scooping out 'water holes' promises greatly to faciliate development. In Central and East Africa scientific workers at Amani and in the Departments have paved the way for the huge scheme of developing 3¼ million acres of savannah land, hitherto empty because of the tsetse fly and lack of surface water–troubles now capable of reduction. The unfortunate decision to rush this scheme through has been responsible for much costly disappointment for which, however, the scientific and technical staffs are in no way to blame. Progress would become still more rapid if a good livestock industry could be developed; this would necessitate not only better animal health but also more and better food supplies for the animals. The native problems have been lucidly discussed by Sir Alan Pym in his book "Colonial Agricultural Production" (1946). The fundamental scientific problems are investigated in Britain under Sir John Simonsen and the Colonial Office Research Council, and in East Africa by a research team under B. A. Keen. Development organised by the Colonial Office is proceeding more rapidly and systematically than ever before.

Difficult human problems are bound to arise, however. The high costs necessitate high output, and the conservation of the soil requires strict control of land use over wide areas. Close supervision by advanced white people will be essential until Africa has its own highly efficient universities, research workers and chemical and engineering industries. African students have been brought to Britain for higher training, but for some their stay has been made unprofitable by inadequate social arrangements, or even by hostile political propaganda.

The wet tropics (50 in. or more rainfall per annum) contain more unused land than any other vegetation region in the world. Sir Harold Tempany has discussed the possibilities of the British portion; the Belgians have done much useful work in the Cango; and the United Nations Educational, Scientific and Cultural Organisation proposes a survey of the vast forest basin of the Amazon. Dr. C. E. Kellog and other American experts are hopeful about the utilization of part of these regions.

At the other end of the temperature-scale lie the cold, leached soils of the northern latitudes, the podsols naturally under coniferous forest but brought into cultivation as need arises. The Finns–the most northerly farmers of the

world-the Canadians and the Russians are all studying the problems involve while the Swedes, at their incomparable station, at Svalof, have produced vari ties of arable crops well suited to the conditions.

But we need not go abroad for marginal and waste land; we have plent at home here in Britain; this also can be reclaimed by conversion first int grassland, then if need be into arable. Sir George Stapledon and his colleagu at Aberystwyth have produced suitable strains of grass and clover; their use investigated by William Davies at Drayton. R. Ellison has reclaimed much was hill-land in Montgomeryshire and estimates that 1,000 acres so reclaimed cou provide for an additional 250 store cattle. Some half million new acres we brought into cultivation in the nine years ending June 1947.

Even light sands, long abandoned as waste or left to the foresters, are no being put down to suitable grasses or lucerne and used for dairying. Norfo and Suffolk have some excellent examples of reclamations brought about enterprising farmers and landowners. *Spartina Townsendii*, shown in 1923 F. W. Oliver to Lotsy and Verhoeven as reclimer of mud flats, has proved ve successful in Holland and may yet provide much new land there and in Brita also.

In short, wherever cultivation is now practised, there are possibilities extension, and no one can say how great they may be.

## Soil Erosion

Against these potential gains, however, must be set the very seri losses due to soil erosion. This was really an old trouble to the Mediterran and Eastern peoples; but it was new to the agricultural pioneers who went from Great Britain and Western Europe, and they did not realize how greatly regions to which they were going were liable to it. Unwittingly their practi favoured it: uncontrolled felling of trees in the moister regions led to water eros while in the drier regions exclusive grain cropping with finely cultivated fallows to destroy weeds and conserve soil moisture -a false expectation based on the faulty soil physics of the time—broke down the soil crumbs into fine dust which was blown away by the scorching winds of the hot, dry summers.

In Africa great losses have long resulted from uncontrolled burning and over-grazing the grasslands, exposing the bare soil to the beating of the torrential rains characteristic of semi-arid regions, washing it away and often leaving great gullies; and matters were made worse by the success of the health and other departments in increasing the human and animal populations. It was the dust storms of the dry 1930's in the United States, and in particular a terrifying one on May 16, 1934, that made all America aware of the 'Dust Bowl' and the need

for drastic action. In the United States some 330 million acres out of 460 million acres of good arable land were estimated to have suffered, as had something like half of the wheat land of Australia, great areas in Africa, Asia and elsewhere. A useful account is given in G. V. Jacks and R. V. Whyte's "Rape of the Earth"; but there has been much sensational writing which may, however, have stimulated action.

The United States was the first to act, and set up very successful soil conservation services and a superb model: the Tennessee Valley Authority.

It is now recognized that erosion comes about through wrong use of the land, and the remedy is correct utilization, both of land and of water, applied over the whole catchment area. The problems are therefore not exclusively technical but administrative also. A vegetation plan must be drawn up to ensure continuous cover of critical areas--hilltops, slopes, etc. — with trees or grass, and the protection of arable land against soil movements and run-off of water by mechanical devices such as contouring, alternate strip cultivation, etc. For full effectiveness the plan requires the collaboration of the ecologist, the agriculturist, the forester and the plant breeder; the ecologist to asceratain what plant combinations are most appropriate, the agriculturist and forester to select those of most economic value, and the plant breeder to narrow the gap between the ideal plants and those actually available. Grass plays vitally important part; it not only covers and protects the soil, but also builds up the fine particles into crumbs by processes not yet understood; successful treatment largely depends on the selection of the right grasses, particularly rhizomatous or stoloniferous types. A large amount of successful conservation has been done and much eroded land has been rehabilitated. The United States Conservation Service under H. H. Bennett now operates over some 1,100 million acres—three--quarters of all the farm and ranch lands. The ' Dust Bowl ' States—Oklahome, Kansas and Texas--are now producing much more wheat than they did before the ' Bowl ' was heard of. The very sound Canadian prairie rehabilitation programme is in vigorous operation; in all the Australian States affected--especially New South Wales and South Australia—there are active soil conservation departments, and W. Hartley, of the Division of Plant Industry, is studying suitable grasses. Much good work has been done by I. B. Pole Evans in South Africa, W. S. Martin in East Africa, R. R. Staples in Southern Rhodesia, and by others in the Belgian Congo and elsewhere.

Soil erosion could be dealt with much more easily if the problems were solely technical; unfortunately, the need for recasting the vegetation of a whole catchment area often cuts across all sorts of social or tribal customs, personal or sectional interests, political boundaries, etc., and raises many complex administrative problems. A few recalcitrant objectors could spoil the whole plan; it must be enforceable by law, but voluntary co-operation of all concerned should be the aim. The United States soil conservation laws achieve this admirably and

have furnished models to other countries. The farmers and land-owners of th region are invited to meet the Government and State experts, and a plan for pro per land utilization is drawn up : any necessary material help is given. The far mers, feeling that the plan is at least in part their own, support it : there is no the automatic opposition given to a plan imposed from above. South Afric also has a comprehensive conservation law. The over-populated and over-graze areas of Africa present special difficulties where the remedial measures conflic with treaty rights and tribal customs ; agitators have not scrupled to stir up trou ble, and much interference with useful work has been reported in the native area of Kenya. Fortunately, the white governments concerned-the British, Soutl African, Rhodesian, French, Belgian and Portuguese-recognizing the truth o General Smuts's dictum that soil erosion in Africa transcends all political pro blems, have agreed to co-operate and to set up an information office in Paris an a soil research organisation in Africa. The many problems met with in th British Colonial Empire have recently been ably discussed by Sir Harold Tempany.

An elaborate plan has been drawn up for dealing with erosion in the U.S S. R. In most other affected countries, except perhaps China and parts of Soutl America, the need for control is recognized and the lines of action laid down.

Rehabilitation is necessarily slow, and there are no good figures to sho how far it has gone. The estimates currently quoted are those of the early 1930's when the need was just being recognized and the bias was towards all-inclusion It is therefore impossible to say whether rehabilitation has yet caught up with ero sion. But those engaged in the work are hopeful about the out-come ; the contr measures are known to be effective. Moreover, erosion is associated much mor with extensive and mono-culture systems of agriculture than with the intensiv mixed farming systems that will necessarily be more widely adopted as th demand for food increases.

## Intensification of Cropping

The most hopeful way of increasing world food supplies is by more intensiv cultivation of the land already in use. It is especially important for Asiatic an African people—sixty percent of the population of the world—for they have n prospect of emigration and very little of food imports from other continent Their present product is chiefly grain, the yeilds low and uncertain the metho inefficient. Experimental farms in India commonly obtain twice the yeild of th neighbouring peasants, and there is often no physical reason for the disparity But the difficulties of levelling-up are enormous ; they spring from the peasant poverty, their overflowing fecundity and consequent minute sub-division of th land : these can only slowly be remedied.

Meanwhile, some improvement is possible. Irrigation can still be considerably extended. The projected Nile schemes, if realized, will solve Egypt's problems for a generation, while Asia, which already has some seventy percent of the irrigated area of the world, mostly in the Himalayan region, can greatly increase the area served by tube wells as developed by Sir William Stampe.

Asia also offers vast scope for fertilizer use. Rice is the crop most affected; it is perhaps the most crucial crop in the world, for it is the main food of Asia, and its shortage is one cause of unrest there. It has been much studied in India, and improved varieties have been raised by pure-line selection; hybridization is scarcely begun. Nothing would more greatly increase its output than wider application of nitrogenous fertilizers. But rice is mainly a swamp crop, and ordinary methods of fertilizer use break down. Nitrate of soda is relatively ineffective; sulphate of ammonia often acts well but sometimes not. These puzzling complexities were resolved from a quite unexpected quarter. Prof. W. H. Pearsall, in studying marsh conditions in Cumberland, found measurable differences in oxidation—reduction potential in the water logged soils; oxidation took place at the soil water surface, but reduction lower down. Directly they heard of this, the Japanese experts saw its bearing on the rice problem. Sulphate of ammonia put on the surface of the mud in the usual fashion, at or before transplanting, was quickly oxidized to nitrate, which washed down below and was raduced to gaseous nitrogen. But if the sulphate of ammonia was pushed down through the oxidation zone into the region of reduction, it lay safely until the plant roots took it up. If nitrates, for example, ammonium or sodium nitrate, are added during the period of rapid growth, they can be absorbed quickly before they reach the reducing layer; therefore they may be used as later top dressings. The study of these oxidation and reduction zones showed also how cyanamide and other fertilizers should be applied. It gives for the first time a scientific basis to the manuring of the rice crop; another example of the far-reaching results that may come from a purely academic inquiry well carried out.

The human problems are more difficult. Will Burma under her new management retain her leading position* among rice exporters ? And can Siam and Indo-China produce as efficiently as before ? How will India fare if they do not ?

The millets are specially important as native food in the semi-arid regions of India and Africa. We have done less work on these than we should; but this is to be rectified in the East African research scheme.

The general methods of intensification of food production are the same everywhere. Land tenure and size of holding usually need modifying to encourage higher efficiency; the holding should be of such size that one man can

* Before the war Burma exported almost 3,000,000 tons of rice annually out of a total export of more than 7,000,000 tons from South and East Asia.

adequately supervise it. More productive systems must be evolved, and bare fallows replaced by tilled crops and by grasses and leguminous plants. Inevitably there comes a development of livestock. In the highest and most productive systems livestock products yield far more income than cash crops; before the war livestock accounted for 70 percent of the value of British farm produce, and according to Leitch and Godden's estimate, consumed on the average about 100 million million calories per annum—just about double the consumption of all our human population, and giving us in return less than ten million million calories. But it is only fair to say that they supply other essential needs; that most of the foodstuffs they consume are useless to humans, coming from grass, straw and various industrial and other residues; and that they greatly enhance the productiveness of the soils.

Intensification is greatly facilitated by the adoption of some form of farmers' association allowing joint and economical use of complex appliances, buying and selling operations, etc. In Denmark co-operation, and in Great Britain a variety of contract and co-operative methods, have been used with great succeess; in the U. S. S. R. collectivization is adopted. Whatever the methods, it must suit the psychology of the farmers and be freely adopted by them if it is to have much chance of success.

Chief among the intensification methods is the improvement of the soil by fertilizers, lime, drainage, etc. Fertilizer requirements are ascertained by chemical analysis and by statistically controlled field trials as used by E. M. Crowther and F. Yates at Rothamsted or by folier diognosis and plant analysis, as used by T. Wallace and his colleagues at Long Ashton, and for sugarcane by Pierre Halais in Mauritius. Trace elements are studied by spectroscopic methods developed at the Macaulay Institute, Aberdeen, the Waite Institute and the Division of Soils, Adelaide, and elsewhere, while W. A. Roach at East Malling has ingeniously tackled the problem of supplying them.

Happily the necessary fertilizers are producible in almost unlimited amounts; the nitrogen comes from the air, to which in due course it returns; the known deposits of phosphate are estimated to suffice for some thousands of years at present rates of consumption; those of potash are also abundant. So far, only Western Europe and Great Britain use much fertilizer, between them taking nearly half the world pre-war production.* The War has brought about a great increase in

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* The consumtion per acre was in the following order: Holland (highest) Belgium, Germany, Denmark and Great Britain, France, and the aggregate was 846,000 tons of nitrogen and nearly 1,500,000 tons of phosphate out of a world consumption of just over 2,000,000 tons of nitrogen and 4,000,000 tons of phoshate.

consumption; both in Great Britain and in the United States this has doubled since 1938. World consumption of nitrogen before the War was 2 million tons annually; the present declared need is for about 4 million tons, and the factory capacity is of the same order. ‡

In moist regions nitrogenous fertilizers have more than fulfilled Crookes' expectations; they saved the people of Britain from hunger in the two World Wars, and with clover and lucerne are our best source of protein equivalent necessary to produce the milk and meat we so greatly need. In drier conditions phosphates are more effective; they have greatly improved the Australian and New Zealand pastures, thus providing large quantities of much-needed lamb and butter. Much more fertilizer could advantageously be used if factory capacity and transport were available. A better fertilizer supply and more leguminous cropping would quickly raise output over large parts of the world.

Along with more fertilizer goes the need for better seeds and better varieties; here the British farmer is particularly fortunate.

But all improvements fail unless weeds—arch enemies of mankind—are adequately controlled. Their destruction is one of the chief tasks of arable farming; chemical methods are coming in, but cultivation is the standard method; this and the preparation of a seed bed are usually its main purposes. Research on implements is done at the Farm Machinery Institute at Silsoe under W. H. Cashmore, and on field effects by E. W. Russell at Oxford.

Among the most significant changes in modern farming have been the increasing mechanization and the alacrity with which the younger farmers have accepted it. Tractors are displacing working horses—perhaps too rapidly.

Before the War about 60,000 tractors and 650,000 horses were used for agriculture in Great Britain. In 1948 there were more than 260,000 tractors, mostly ranging from 12 to 40 h. p.,* a gain of more than 200,000; in the same period horses were reduced by 192,000. Assuming with the Oxford Agricultural Economics Research Institute that the effective working power of one tractor is, on the average, the equivalent of four horses, British farms had in 1948, 1½ million 'horse equivalents' compared with the pre-war 889,000, a gain of 68 percent. During the War the quantum of output per man-year rose about 10–15 percent; but the evidence available for the past five years suggests that, despite additional power and machinery, annual output has been below the war-time peak, while the total labour force on farms, allowing for changes in composition, has remained well upto war-time strength. Clearly there is room for more economical use of farm power.

‡ Excluding the U. S. S. R., Northern Korea and the Russian zone of Germany, for which no figures can be obtained. The consumption figures (F. A. O.) include technical requirements which, before the War, amounted to about 10 per cent of the total.

* The tractor statistics include market garden types of lower h. p.

It is impossile to forecast what the tractors of the future will be like; t United States already has some of 140 h. p. The limit is likely to be set by t amount of oil fuel available; the French foresee a shortage and are starti experiments on the production of methane by fermentation of straw. Tract require their own special implements, which must be generalized and mass prod ced to keep down their cost; they can no longer be made by local craftsmen suit local requirments, like the old types: their manufacture is shifting to t industrial regions of the Midlands and Yorkshire—Canadian and American firi are recognizing the possibilities.

These engineering developments are enabling farmers to cope with t ancient difficulty that Nature's production of food is by jerks, while consumpti is fairly steady. Storage is therefore necessary; usually it has to be done on t farm, and it is often attended by considerable loss. Grain crops may suffer fr rats and mice, and these are estimated to destroy 2 million tons of food annua in England and Wales alone; a single rat is said to consume 50 lbs. of grain a y and to spoil an additional 1½ cwt. Grass, a most important and for long m neglected crop, when made into hay commonly loses 30 percent or more of valuable protein equivalent, according to S. J. Watson's estimate; but, in a event, haying is inapplicable for modern intensively managed leys or lucerne t give three heavy cuts of highly nutritious material a year. Artificial dryi preserves the nutrients intact: it requires 10–15 cwt. of coke per ton of product, 3 tons of dried grass per acre can be obtained—three times the old average yield of hay. Ensilage is cheaper, but involves loss of 20–30 percent of the nutrients: lack of driers makes it at present the more practicable alternative.

Increased intensification necessitates strict measures against pest and diseases which now travel widely and are favoured by the greater crowding of crops. Resistance is fairly frequently a heritable character, and once the genes are found, resistant varieties can be produced, such as the rust resistant wheats of North America and Australia, and the potatoes bred at Cambridge and at Corstorphine. The pathogen may exist in several strains, necessitating the introduction of several genes. The work is never ending, for a relatively harmless organism may suddenly change, like the *Verticillium* which, having long lived an almost blameless life in the Kentish hop gardens, about twenty years ago suddenly produced a virulent mutation which has since done much damage there.

Measures for protecting plant and animal health are being steadily improved; they are the subject of important international conferences: if in spite of all precautions the attacks still come, counter measures can often be taken. Plant virus diseases still defeat us, but the able and persistant efforts of F. C. Bawden, N. W. Pirie, Kenneth Smith and others cannot fail to bear fruit. Against insects the new chlor-and phosphorus-insecticides are very potent, and methods of spraying have greatly improved; even wireworms, long invincible, have succumbed to hexachlorbenzene. But there are always risks in interfering with

ature; the D. D. T. which was so effective against codling moth in orchards also lled the insect that had kept in check the red spider, and this not being affected oy the D. D. T. became in its turn a pest.

Animal diseases— to which we in Britain are very liable because of our large imports of animal carcases — are steadily being brought under control. The old method was instant slaughter to avoid spread; it was effective but costly. The modern method is to apply diagnostic tests so as to catch the disease early, then to segregate and give the appropriate treatment. Vaccines are used for a number of diseases, and immunization by the appropriate serum is growingly practised. Estimates of loss are always rather speculative, but before the War the loss of milk due to disease in England and Wales was estimated at 200 million gallons per annum. More definite is the fact that the present life of a cow in the milking herd averages about 3½ lactations only; it should be 6 or 7.

Most countries could increase their food production considerably by applying known methods of improvement and raising the average performance to the level of the best.

The yield of wheat in Great Britain used to be about 8 or 10 cwt. per acre; it now averages 20, and the best farmers get 30 or 40; but the world average is only about 7. A pedigree breeder may export a bull for £ 3,000; a scrub bull may be dear at £ 30. The average milk yield of England and Wales is about 550 gallons; recorded herds average about 700, and yields of 1,000–1,200 gallons a cow for a whole herd are not uncommon. Trained adviser recently considerably augmented in number, have long been trying to reduce these gaps.

The old agriculture could be carried on by appliances, made by local craftsman. Modern intensified agriculture cannot; it demands high-grade machines, chemicals, sources of energy that only a highly developed industry can supply and, of course, corresponding standards of education among the farmers. A food producer on the old system can feed about 4 to 5 persons–this is still a very common number; on modern systems he can feed about 15 or 20, provided some of these supply him with the necessary appliances. In the self-sufficient countries of Western and Central Europe, about 20–30 percent of the population is agriculture; in Eastern Europe and in Asia the proportion is 60–70 percent or more, and the standard of living are much lower. They can still be raised, but marked improvement can be obtained only by taking some of these redundant people off the land and setting them to make the appliances for a better agriculture, and providing the necessary transport and buildings.

But this reaises new problems; it involves segregation, as seen very clearly in England where the difference in outlook between town and country is sharply marked, and konwledge of the countryside is often curiously lacking. So we hear exhortations to more food production, but at the same time the land on which

alone this can be done and the money necessary to do it are steadily taken away for other purposes. Some land reclamation, it is true, has been done; in the nine years 1939–47 the area of rough grazings in England and Wales fell by 1.4 million acres, much being brought into cultivation. But a larger area, often of better land, went out of cultivation, and the total land under crops and grass shrank by 316,000 acres, according to the official statistics. *

It is hard to find a countryman with a good word to say for planning. In the end, common sense has a way of prevailing, and we may still look for further intensification of production even in our highly cultivated lands, still more in the less developed regions elsewhere. From the present small and shrinking allocation of land in Britain we may yet raise half our food, besides improving the quality of both meat and milk. And the less developed countries can feed their people better than they now do.

## New Uses of Science in Food Production

Pure science is continuously opening up new possibilities for use in agriculture. The starting point is commonly some purely academic problem of no apparent practical interest whatsoever. R. A. Fisher's investigations on the theoretical foundations of statistics, ably developed by F. Yates, have revolutionized agricultural experimentation by enabling investigators to make valid estimates of the significance of their results. Frequently the physiologist has started the chain of inquiries, followed by the biochemist and the organic chemist, and finally the technological chemist.

One of the most fruitful series of investigations began with the old inquiry: Why do plants turn their leaves towards the light ? Went and Kogel at Utrecht showed that the response was due to minute amounts of an organic compound which operated by causing growth of the tissue where it happened to be. Several of these growth-promoters were found; they are called auxins and have a fairly simple chemical pattern–a straight-chain-acid group combined with a benzene, naphthalene or indolyl group: indole-3-acetic acid is one of the commonest.

These and similar substances were soon prepared on a large scale and were shown to promote root formation in cuttings; Zimmerman and Hitchcock at the Boyce Thompson Institute investigated the action in detail, and horticulturists used it in practice; these and other effects are being followed up at East Malling under F. G. Gregory. Later it was found that these auxins induced the setting of fruits of the tomato and cucumber family without the intervention of pollen from the male organ; workers at Wisley, Long Ashton and Wye have all been active

* Prof. L. Dudley Stamp puts the net loss at 438,954. acres after allowing for some 500,000 acres of reclamation. The difference largely turns on the definition of 'cultivation'. In the official figures for 1948 the ten year fall is given as 270,000 acres.

here. A spray of B-naphthoxyacetic acid, 40 parts per million of water, has been used considerably by commercial growers; the fruits are normal in appearance but not yet in quality, and they are seedless. Some fifty substances of this type have been tried by R. L. Wain and Dephne Osborne at Wye, and L. C. Luckwill at Long Ashton; each has some effect on the habit of the growth of the plant or the character of the fruit—not always desirable—but a considerable range of control is possible.

So far no substances have been found effective for large fruit trees except some varieties of pear.

Another important action of the auxins was discovered by W. G. Templeman, E. H. Slade and W. A. Sexton at Jealott's Hill, and somewhat later, but quite independently, by P. S. Nutman and J. H. Quaste in following up some of H. G. Thornton's work at Rothamsted. It was naturally expected that auxins might increase seeding growth; but they did not—they even killed some but not others. Cereals were much less injured than some of their common weeds, and selective weed-killing became a possibility. Chlorine atoms were introduced to give sufficient stability and greater toxicity. 2:4 dichlorophenoxy-acetic acid (called for short 2 : 4 D) is very effective and now widely used, especially in North America; some 5-10 million acres of grain were expected to be treated in Canada last year. G. E. Blackman at Oxford with a team of workers is developing this chemical control, and important practical results may be confidently expected.

Other of these compounds are used for checking growth: preventing potatoes from sprouting in storage; staggering pineapple harvest in Hawaii to fit the canning facilities; preventing the pre-harvest fall of apples, etc. Other substances change vegetative shoots into flowering shoots. No one can see the end; and, I repeat, it all started with the purely academic inquiry: Why do plants turn their leaves to the light ?

Another investigation that may have far-reaching effects is being done jointly by a team of workers under R. Brown of Leeds and A. R. Todd at Cambridge. Brown and M. Edwards had shown that the seeds of *striga*, a plant parasitic on sorghums and millets and the cause of much loss in Africa and India, germinate only when stimulated by a substance excreted from their roots. Todd found it to be apparently a sugar: D-xyloketose acted well. If the different varieties of sorghum should differ in their ability to prepare and excrete this stimulant, a chemical test might be devised that would greatly assist plant breeders searching for resistant strains.

It is possible that other parasitic fungi can live only on varieties of plants capable of producing the necessay stimulant.

The cysts of the destructive potato eelworm hatch out only when stimulated by a substance excreted by the roots of potatoes, tomatoes and other solanaceæ;

this also is being studied by A. R. Todd. When this identified and prepared on a large scale, it might be applied to the land while fallow, so that the emerging larvæ could perish of inanition before the potatoes were planted.

Various soil organisms are known to produce antibiotic substances, analogous to penicillin, highly destructive to certain other organisms. Thaysen and others have found in tropical soils bacteria with high powers of inhibiting the growth of fungi. In the absence of a good soil fungicide, it is possible that soil-borne fungal diseases such as ' take-all ' disease of wheat and Panama disease of bananas might be successfully controlled by introducing or encouraging organisms producing the appropriate antibiotic. Bacteriophages, destructive to various bacteria, are also known to exist in soils, though they have as yet found no application in agriculture. Add to this list the large number of Protozoa, Acrasieæ and giant Rhizopods found in soil by B. N. Singh and other Rothamsted workers, and shown to feed bacteria and other soil organisms, and it is clear that life within the soil is as full of risks as life on the surface. Some degree of control of this vast soil population so vitally important to soil fertility has long been sought, and the older method of partial sterilization may in due course be supplemented by newer agencies.

Some of the algae and fungi, especially the yeasts, have remarkable power of synthesizing fats and proteins. Only limited use has so far been made of this property, but the possibilities are considerable. H. A. Spoehr and his colleagues at the Plant Biological Institute at Stanford, California, showed that the composition of the dry matter of *Chlorella* could be varied widely by suitably modifying the environment; the fat could be raised to 50 per sent or the protein to 75 per cent.

Moreover, there still remain unknown possibilities in the oceans, for they carry much more vegetation than the land. Prof. Lily Newton is dealing with this matter in her presidential address to the Botany Section.

Genetical science can still do much more to help crop production. To give only one instance : wide crosses often produce sterile offspring. But treatment with colchicine in some cases doubles the chromosome number and makes the offspring fertile. New types can thus be synthesized which can be used for producing new economic forms.

Ecology is also coming in to help. The old idea that science would enable the farmer to go anywhere and produce anything has given place to the more realistic principle that every acre of land should, as far as possible, be used in the way to which it is best adapted. Extensions of the cultivated area, treatment of eroded land and improvement of wild pasture are already seen as ecological problems, but the range is much wider and the possibilities great.

Many of the vital processes in animals are, like those of plants, determined by chemical substances, and some degree of control has already been attained. H. D. Key at the National Institute for Research in dairying, Shinfield, has shown that thyroxin injected subcutaneously, or iodinated protein ( casein ) fed by mouth, increased the fat content of the milk and also raised the yield upto 20 per cent after the peak of lactation was passed. Even more dramatic was the use of a synthetic oestrogen, diethylstilbœ strol, introduced in tablets under the the skin, for inducing lactation in virgin heifere or barren cow—the first stage in making the male redundant.

Artificial insemination is already widely used, and is repidly spreading, especially for dairy cattle, as milking capacity is largely inherited from the sire. Much successful upgrading has been done in Denmark; some half-million cows were inseminated in 1946, but this is only a beginning. J. Edwards estimates that by suitable dilutions the number of cows inseminated per bull could rise to 10,000 or even 15,000 per annum. We may yet live to see bulls other than a small select aristocracy, become unwanted anachronisms. But that is not all. A cow *normally produces one ovum at each œstr. When pregnant mare serum hor*mone is injected, however, she produces a number, as shown by J. Hammond, jun., and Bhattacharya at Cambridge. Attempts are now being made to transplant these into other cows—one into each—then to fertilize them by artificial insemination, and so get a dozen or so offspring from the chosen mother in place of a solitary calf. Scrub cows, otherwise of little use, could thus become incubators of the eggs of high-grade cows, the method would be particularly valuable for beef cattle. Already the transplanting has been successfully done with rabbits. No end is in sight : one cow could potentially produce some 75,000 ova during her life-time. Nevertheless, there is always the lurking suspicion that Nature may resent being uncermoniously bundled out in this way; we can only wait and see.

For it is a fact that attempts to control natural processes without adequate knowledge are always risky and may be dangerous. So agricultural scientists have long aimed at knowledge rather than control, certain that if their knowledge is sound their control will be secure. In the great agricultural research intitutions to-day ideas and equipment are freely borrowed from the pure sciences; in studying soils, plants, animals and their relations one to the other, use is made of modern biochemical methods, of physical methods, of X-ray photography, of the electron microscope, of tracer elements to follow the processes of plant nutrition and so on. There is inevitably a time-lag between the gaining of new knowledge and its possible use; for engineering Sir Richard Southwell puts it at fifty years. For agriculture it is less, and the Agricultural Improvement Council has been recently set up to keep it to a minimum. The Royal Agricultural Society has long been working to the same end.

I shall attempt no forecast as to how much food the earth could be made to yield. The limit at any time is set by the efficiency of the plant as a transformer of radiant energy; at present this does not exceed 5 per cent, and, reckoned on the basis of the amount of food produced, it is much less. Whether this can ever be raised, whether we can ever do more than increase the proportion of assimilation products useful as food, cannot be said. But the present limitations to food production : utilization of 7–10 per cent only of the surface of the earth; conversion by the animal of 10–25 per cent only of its food into human food; and fixation by the plant of no more than 5 per cent of the radiant energy it receives; these are all challenges to agricultural science–which its workers are vigourously taking up.

No limits can be set to the possibilities of science, but it does not follow that the present rate of advance will continue. Great scientific discovery is possible only for the gifted few, and only in the atmosphere of complete intellectual freedom : subordination to political or any other dogma is utterly destructive. Nor can we praise the growing tendency to take good men of science out of the laboratory and put them into committee rooms, or to load them up with so much administrative and other detail–nowadays housework as well–that they lack the leisure for " reaping rich harvest from the mellow soil of quiet thought, mother of great deeds ", to quote the noble words of Æschylus. Then there is the ever-growing specialization against which Sir Richard Livingstone and others are tirelessly warning us. The individual suffers : Whitehead reminds us that a man may know all about the laws of light and yet miss the radiance of the sunset and the glory of the morning sky. And the loss of science may be greater ; the breadth of culture of some of our pioneers—D'Arcy Thompson, Percy Frankland, J. B. Farmer and others—had much to do with their breadth of scientific vision.

Nevertheless, remarkable success is attained by teams of highly trained specialists working under an inspiring leader—even when the team includes men who, by themselves, would easily become " lost in a gloom of uninspired research ", as Wordsworth put it.

The possibilities of food production are, however, only part of the story Food producers will labour to obtain a surplus for the outside world only on condition that they are provided with adequate appliances and incentives ; and the replacement of craftsmanship by mechanization is inducing in agriculture, as in industry, a flight from labour. In many cases now the problem is not so much to increase output as to maintain markets and reduce hours of work. Happily, inspite of modern tendencies, a strong sense of individual responsibility in regard to hungry peoples still survives among food producers. This is, indeed, the basis on which Lord Boyd Orr built up the Food and Agriculture Organisation, now doing such useful work. But it would be entirely wrong to think of the world as a Welfare State where food will be produced simply out of a sense of duty. If more food is needed, more work must be done to earn it.

The increased food production that may confidently be expected is more than ample for population increases at Western rates. But it could easily be outstripped locally where Eastern rates of increase prevail. A physiologically adequate dietary might still be attainable, but if Western standards of living are desired, Western restraints must be adopted.

These, however, are human problems, and, great as are the powers of science, it is of only limited help here. It can do much to overcome material difficulties and, better still, to satisfy man's thirst for knowledge of the universe in which he lives; and it can insist continuously on our high duty to seek out the truth fearlessly and honestly, and having found what we believe to be the truth, to proclaim it—but in all humiliy and recognizing that we may be wrong. Apart from that, science can give little guidance in those great moral and spiritual problems which lie at the root of our most serious troubles to-day. It opens up many possible ways of life, but gives no help in choosing which to follow; it deals with the facts of existence but not with the values of existence. It gives some light to them that sit in darkness, but it has little consolation for those in the shadow of death, and it does not guide our feet into the way of peace. Even if science should make large-scale fighting wars impossible, it can do little against the more subtle wars by infiltration. It offers us great possessions, but as the old aristocracy knew, great possessions imply a sound sense of values and great personal responsibilities. Democracies still have this to learn. That is one of our greatest problems to-day.

But there is no need for pessimism. Looking back to the time of the first meeting of the British Association at Newcastle, one can find much ground for hope. Those, too, were days of terrible anxiety and strain, and yet there were then born many movements and activities which, scarcely noticed at first, blossomed later into full vigour, and greatly enriched our national life. How many important centenaries have been celebrated in the past few years. It may be that, unperceived by us, new movements are now starting into life, equally full of momentous possibilities for the future. Science can help us best if we have a sustaining faith, a high purpose in life and unflinching courage to pursue it.

# Conflicting Doctrines About Soils *

CHARLES E. KELLOGG

The general public has recently discovered soil. For centuries country people have known soil—their own kind of soil. They have loved it, cursed it, sweated over it, and died for it. Their knowledge passed on from parents to children over the years. Also, few early scientists studied soil, but only a few prior to about 1900. There was another thirty years before the public generally became interested.

This is not to say that no scientific studies of soils began before 1930-not at all. The work of the famous Rothamsted Experimental Station in England devoted mainly to soil study, was begun in 1843. The great Russian school of soil science originated about 1870. The American Soil Survey will be fifty years old in 1949. Most state experiment stations in the United States were making soil studies by 1900, and several considerably before that date. But public support was meager. Much of the work consisted of simple tests directed toward immediate goals of increasing crop yields. But not all of it. A few investigators did raise fundamental questions: What is soil? Why are soils so unlike the rock beneath them? Why do soils vary so much from place to place? What account for their productivity for plants? Why are some good and remain good while others deteriorate?

The practical results of this work have more than paid for the cost--many many times more. This was always expected. Yet it is a strange thing, perhaps that people have recognized the cultural value of fundamental scientific research in what might be called the more "classical" sciences, such as astronomy, botany or physics, and support such research generously without the promise of immediate practical returns, but rarely will they do this with fundamental soil science. Soil research must promise in advance to pay its way in the garden, field, or forest and so on. But any scientist knows that applied science cannot get very far ahead of fundamental science.

Today people in the city as well as in the country are concerned about soil. They have been persuaded that the security of our country depends upon how our soils are used. Although we have had had gullies for more than a hundred and fifty years, only a few people saw them before. Now what should be done? Questions are asked about world soil resources. That is, is the area of productive soils in the world large enough to feed all the people even if, by some miracle

* From : Scientific Monthly, 1948, Vol. 66, June, 479-487.

ıtesmanship, the economic and political barriers to use could be removed? And hat of the quality of our foods grown on different soils, and with chemical rtilizers? Is it getting poorer? Gasoline motors are replacing horses. Can il be kept productive without animals? Do we plow too much with the w machines?

In highly emotional terms, many popular books and magazine artciles of ıe middle and late thirties stressed the catastrophic dangers of soil neglect. Some 'en asserted that soil deterioration was a primary cause in the decline of older vilizations. Most of these advanced some panacea, usually a simple cure for ıe "simple" problems. But since there were several panaceas, at least some of ıem must be partly wrong. Then, too, the soil is anything but simple, to say ything of the people who live on it.

These trends continue—many panic makers and corrective panaceas. But ıe public is becoming a bit wary and demands more detail. For one thing, the xperiences of victory gardeners helped. City people took the opportunity to try ıanaging a soil. Panaceas were put to test. Many found that although soils may e stubborn or yielding, they are rarely simple. American farmers increased normously their use of scientific principles during the past war. All this demand or specific facts and principles is good, even though many answers are still anting; for the first step toward wisdom is an awareness of something to e known.

Let us look at a few of the current doctrines about soils, remembering when 'e do so that each has some basis of important fact and that many of the advoca- es of each are well intentioned and sincere. Correct appraisal is made diffiicult y the extremists. Any good idea, good in its relationship to other good ideas, an become bad, even vicious, when carried to absolutism. Then, all of us are ikely to have at least some prejudices, possibly unconscious ones, hard as we ry to avoid them.

## The balance-sheet theory.

We may start with the balance-sheet theory-the-soil-is-like-a-bank idea. This doctrine is not new. Quite the reverse. It was clearly stated by the great German chemist Justus von Liebig nearly a century ago.

In reaction against the more or less mystical notions that plants can change one element into another and so on, he explained the sources of plant nutrients in straight-forward terms of the new chemistry. Plants require certain nutrients from the soil: calcium, nitrogen, potassium, and the like. If we analyze the soil and find what it contains, then, knowing the need for crops, we can calculate how many crops can be grown or what fertilizers to apply. With sarcasm and invective, Liebig swept away notions of plants feeding directly on humus or

changing one element to another. Crops will grow, he said, in direct proportion to the increase or diminution of the nutrient elements in the soil. He re-emphasized the law of the minimum: where several factors are essential, plants will grow in direct proportion to the least favourable one-the limiting factor.

Just before his death, Liebig became unhappy over his theory. For one thing, his fertilizers were not successful. Then he went down the Danube valley and saw soils which, according to his reckonings, should have long been sterile but which were producing more than before, without fertilizer. Nor could he account for the nitrogen in certain plants. This last failure was nearly a deathblow, but with the discovery of nitrogen-fixing bacteria growing on the roots of legumes, the theory recovered. Thus, it is curious that a biological discovery saved the day for a purely chemical theory.

Many people believe this theory. And why not? It is so simple and so reasonable. That is, it would be if the implied concept of soil were true.

Neither Liebig nor his followers examined real soils out of doors. They didn't need to! Once the simple idea of the balance sheet was accepted, the soil had to be a static storage bin of plant nutrients. The early geologists accepted this notion, too, and filled the storage bin with ground rock-sandstone, granite, [illegible] "granite soil", "glacial soil" and so on. A few other features were recognized. Some soils were rich in clay "heavy" soils to plow--and others rich in sand--"light" soils to plow. And, with the rise of biology, organic matter and micro-organisms were added to this mixture but without fundamentally altering the concept.

It was inevitable, of course, that it should occur to someone to look at the soil, dig into it, and see whether it was really like it had been assumed to be in the balance-sheet theory. Credit for much of the early work on the soil itself belongs to the Russians. They found that soils in nature are made of a series of layers, or soil horizons, reaching from the surface to a depth of a foot or many feet. Collectively, these horizons are called the "profile" of the soil. In Europe and the United States, soil profiles are usually 3-5 feet deep. They are shallower toward the Arctic and deeper toward the equator.

Not only that, from just one kind of rock all sorts of soils, varying widely in colour, chemical composition, productivity, and so on, were found. In fact, kinds of soil were found to be more closely related to climate and vegetation than to the kind of rock. Whereas rocks are distributed more or less promiscuously over the earth, as far as the present environment is concerned, area of individual kinds of soil occur in an orderly, discoverable geographic pattern. Each distinct combination of climate, vegetation, parent rock, relief, and time — called the five genetic factors — gives a soil with a unique set of characteristics — a soil type.

This is a far cry from a simple storage bin. As the surface horizon of a sloping soil is gradually eroded away, the upper part of the horizon beneath is gradually changed and incorporated into its lower part. In turn, the upper part of the third horizon is changed and becomes the lower part of the second, until finally new, fresh minerals from the rock beneath are incorporated into the lower part of the lowest horizon. Other soils, instead of having fresh minerals added to the bottom, have them added to the top. Silty coverings are left by the overflow of rivers onto the surface of young alluvial soils like those along the Nile (Probably a third of the people of the world get their food supply from alluvial soils). On many soils dust and volcanic ejecta fall. As air enters and leaves the soil with wetting and drying, some gases are expelled and other absorbed. Rain brings soluble materials from the air, and percolating water leaches out materials. These actions change the soil materials because the various minerals and other compounds vary in solubility and rates of decomposition.

And so it goes. These and other physical and chemical processes are modified profoundly by plants, animals, and micro-organisms. Nutrients are collected by the living matter, held against the forces of leaching, and returned gradually to the soil.

Thus, a soil is a solid, changing piece of landscape. Its upper surface is the surface of the land; its lower surface is defined by the lower limits of biological forces; and its sides are boundaries with other kinds of soil where there is a change in one or more of the five genetic factors. There are changes between day and night, from one rain to the next, from season to season, with plant successions, with shifting climate, and over periods of geological time — to say nothing of man's interference.

Thousands of distinct kinds of soil exist in the world. Each has its own set of characteristics, its own combination of environmental factors, its own dynamic, its own potentialities for response to management. Some can furnish enough calcium, potassium, phosphorus, iron, or other mineral nutrients for crops indefinitely. Others respond greatly to one, or perhaps several, nutrients when first used. In some soils, nutrients become available to plants as fast as they are withdrawn; others are soon exhausted. Nor is the ability of a soil to furnish any nutrient measured by the total amount present.

This brief recital touches very lightly on just a few of the better-known processes. And yet some people, even scientifically trained people, can still be heard to say: "A soil is like a bank. One must put in what he takes". What plants require for growth and what soils contain are relevant, but these values can help us significantly only where we know a great deal more about the soil. Because a soil in Maryland gives a good response to some fertilizer is no proof that one in Iowa ever will, regardless of how long it is cropped.

This balance-sheet theory does a lot of harm. Its superficial appearance of reasonableness delayed fundamental soil science for many years. It overshimplified the soil in terms of analytical chemistry to the neglect of the physical and biological characteristics and other qualities influencing soil productivity as much as fertility. It has delayed the recognition by farmers that difierent soils should have different fertilizers according to their nature. Even now, farmers generally are using mixed fertilizers, containing nitrogen, phosphurs, potassium, and perhaps other elements, as a sort of "shotgun" treatment on soils where only one or two of these nutrients are needed. Efficiency in the use of fertilizers demands that those nutrients be used that are needed to supplement the individual natural soil in order to make it a productive, arable soil for the plants to be grown. But a believer in the balance-sheet theory, whether fertilizer technician or farmer, avoids a lot of thought and trouble. He doesn't need to look at the soil or study it. It's like a bank. *

## The erosion menace

The followers of the bolance-sheet doctrine practically ignored soil as landscape. Many early agriculturists, like Jefferson, for example, emphasized the characteristics of soil. He invented a plow-the "plow of least resistance"-and practiced contour tillage to prevent excessive washing or erosion, on the slopes. From time to time, later agriculturists and geologists studied this problem of soil washing and directed attention to the great gullies already eating away at good soils in parts of the United States. For years, scientists in the American Soil Survey emphasized the problem in reports on many countries where it existed, hoping some action would be taken, but few people were interested.

Then, about 1926, a few popular articles on soil erosion attracted public attention. The success of these stimulated others. Soon many articles and books were appearing on the dramatic story of catastrophic erosion. Pictures of great gullies were printed along with statements of the cost of erosion to the United States. Estimates were made of the plants nutrients—phosphorus, potassium, calcium, and the like—washed as soil material into streams, lakes, and oceans. Assuming that all these are available to plants, assuming a value for the chemical nutrients equal to that of commercial fertilizer, assuming that all sediment is useless, and assuming that the material exposed by erosion is all sterile-cost figures become truly astronomical.

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* The confusion is heightened by an old fertilizer trade slogan, "Feed the plant not the soil", along with substitution of the incorrect term "plant food" for both nutrients and for that portion of a commercial fertilizer that consists of plant nutrients. Of course, the food of plants consists of organic materials synthesized by green plants from the nutrients taken from the air, water, ane soil.

On top of a bad business depression came the severe drought of the thirties and inevitable soil blowing in many parts of the Great Plains. By many this was regarded as soil erosion too—wind erosion. So to the pictures of deep gullies and washed slopes were added those of the skulls of starved cattle on windswept plains and of abandoned homes, half concealed by drifted soil.

For a time, it almost seemed that each popular writer was trying to out-do the others in dramatic statement. Some even went so far as to assert that erosion had previously swallowed whole civilizations; and others, that the League of Nations caused the great erosion catastrophe; or that we should tear up our democratic institutions and do what was necessary at once to save ourselves; or country people are too ignorant anyway to learn how to handle soil!

A few even went a little further, but not much—there wasn't any further to But today's writers are more sober. The great production record of erican farmers during the past war has had some steadying effect. But, more portant, a very large number of people are now acquainted with the problem firsthand. It is sincerely to be hoped that the period of extreme statement on erosion is nearly over, else it might stimulate some counteraction just xtreme.

Excessive erosion – accelerated soil erosion – is a serious problem in parts of our own country and in many other places in the world. Like other soil problems, it has been long neglected and it demands attention. Unless farmers are careful, there will be bad soil blowing again during drought years in the Plains. Another period of very low farm prices will almost certainly be accompanied by serious soil erosion.

Not all spectacular erosion is caused by man's use of the land. Much of it is a perfectly normal concomitant of mountain building and wearing down. Nor is it all harmful; in fact, an important part is essential to the formation of productive soils. One cannot, or should not, try to stop erosion, but rather to control it. On the other hand, some of the erosion least conspicuous to the casual observer is most harmful.

The effect of a removal of the surface soil horizons by erosion varies with the soil type. An otherwise productive soil with a massive clay pan or hardpan at 18 inches may be severely damaged by the removal of 6–12 inches of surface soil, whereas one with a deep friable profile may not be influenced at all, provided the process is stopped short of gullying. In fact, the more serious erosion injuries to soil are not chemical, not the loss of plant nutrients, but the change in structure, the loss of crumblike surface horizons and the exposure of massive clays, hardpans, or even soil rock.

Why do arable soils erods or blow ? Generally, it may be said that a thick-growing vegetation has been replaced by a weaker vegetation or by widely spaced plants, thus exposing the soil to the forces of rain, running water, and wind. This can be brought about by drought, fire, cutting, close grazing, excessive cropping, and tillage. On any one soil type, the hazard of erosion depends upon the sharpness of the rains, the force of the winds, the permeability of the soil and its capacity to take in water, its slope, and its productivity for plants. Under clean cultivation, some soil with only very gentle slopes erode badly. At the other extreme, some steep soils are so pervious and productive that they may be cultivated safely. On highly fertile soils, a protective cover grows quickly. And so we might go on. Thus, specific answers to questions of erosion hazard or effects must be worked out for the alternative management practices on specific sets of soil characteristics, or soil types; and in detail, since these practices are parts of the management plan of very small units - fields and farms.

How can erosion be controlled ? Although one should not push the analogy too far, this is like asking : How can a headache be stopped ? That is, a headache is usually a symptom of some deeper maladjustment. So it is with harmful erosion : one must get at the cause and correct it. Concentration on mechanical devices alone to control the actual erosion itself may be fruitless—even injurious to the soil—if some fundamental causal factor like phosphate deficiency is neglected. Back of the phosphate deficiency we may find any one of a dozen reasons.

Generally, when a rural population becomes poverty-stricken, it fails to maintain its soil. An exploited people pass on their suffering to the land. Low prices, disease, and wars are all important causes. Things get on a hand-to-mouth or year-to-year basis. It is hard to look ahead of the immediate income. Where farmers can take a long view of production over a period of ten years or more, there are very few instances of conflict between those practices that give most return and those that maintain the soil from loss of fertility, erosion, destruction of soil structure, or other deterioration–and not only maintain it; a large part of the arable soils of the world are made better by good farming than they were naturally.

Then, too, when people move to a new area, onto a new kind of soil, the old practices and traditions may persist too long. The new soil may deteriorate before they have learned, through trial and error, how to manage it. Fortunately modern science can shorten such periods or even eliminate them.

Thus, soil-erosion control is not an isolated problem. It is one important aspect of soil management for secure production in many places. Control must be sought within the whole management system of the land. It would be unfortunate for soil erosion to be neglected as it was in former years. It would be

unfortunate for it to be exaggerated or overemphasized at the expense of other problems of soil use. Above all, concentration on the erosion itself to the neglect of its causes could be wasteful or even harmful. Many of these causes go back to economic and institutional maladjustments between soil and people. Fortunately, the trend is now strongly in the direction of a more balanced soil-management programme in our own country, and in many others as well.

Although soil scientists may continue to regret the extreme statements about erosion, they should admit that the dramatic stories about it did much to make the public more conscious of soil problems than ever before.

## The organic schools

For years most practitioners in the fertilizer field accepted the balancesheet theory. Only recently have many of them sought an understanding of soil types. We have already seen how that doctrine viewed the relationships between plant roots and soils largely in terms of analytical chemistry. Even soil scientists themselves have given soil biology a relatively small place, except for the micro-organisms concerned with nitrogen fixation.

Partly as a reaction against the simple balance sheet, biological theories of soil productivity have arisen that lay all emphasis on living plants, soil organisms and organic matter. Greater recognition of biological factors in soil management has been long overdue. But the advocates of the organic-matter doctrine go very far. They insist that organic matter is everything, or nearly so; that the usual chemical fertilizers are downright poisonous to soils; that the liberal use of compost gives special qualities to plants–they will be free of insects and diseases; and that animals, or even people, will be ever so much more healthy by eating plants grown "the organic way".

Within the organic group are separate schools. Some derived their notions from Goethe, by way of Rudolf Steiner; others from experience with compost in tropical countries. Important as these differences may be to the devotees themselves they need not concern us now. Many of the recommended practices are excellent, although not always for the reasons given.

Organic matter in soil is a very general term. It included the living forms–roots, bacteria, and small animals; fresh remains of living matter; a more or less stable decomposition product, brown or black, called "humus"; and a host of intermediate products. The final decomposition products are, of course, water, ash, carbon dioxide, and a small amount of other gases. Perhaps the great importance of organic matter may best be realized by listing its functions in soils. The relative significance of the several items varies a great deal among different soil types. *In no soil are all important at once.*

1. Organic matter promotes granular structures and pore space in some soils. Thus, it may:—

   a ) aid root extension;

   b ) promote entry of water into soil;

   c ) reduce soil washing;

   d ) reduce soil blowing;

   e ) promote aeration or exchange of gases;

   f ) increase the water-holding capacity; and

   g ) reduce baking and crust formation.

2. It reduces the extremes of temperatures, especially high summer temperatures, when used as mulch.

3. It reduces evaporation, espcially when used in the surface or as a mulch.

4. Humus aids in maintenance of reaction ( pH ) in the soil by acting as a buffer.

5. Organic matter aids in the retention of soluble substances, including many plant nutrients, by holding them in living or nearly living fresh forms against the forces of leaching and by the base-exchange properties of the humus.

6. Part of the organic matter furnishes a food supply for micro-organisms and small animals in the soil, including forms essential for the transformation of nitrogen compounds and for other processes important in plant nutrition.

7. Organic matter furnishes directly, and indirectly by promoting bacteria and fungi, complex organic compounds which may include both growth-promoting and antibiotic substances. Very little indeed is actually known about the role of these compounds in soil productivity.

8. Additions of organic matter, espcially from normal plants, mixed types, maintain a slowly available, fairly well-balanced supply of plant nutrients, including the micronutrients. This is very important everywhere but especially so in warm humid countries where leaching is severe and fertilizers expensive.

Where organic matter is used to control temperature and evaporation, relatively fresh material is used as a mulch. When used wholly or partly as a source of nutrients, the material is often partly decomposed in advance. Such

partially rotted material, or leaf mold, may be found naturally just above the mineral soil and under the surface layer of dry leaves in the forest. Commonly, it is made as compost.

The devotees of the organic schools have made rituals out of compost making. Fine points are argued about as heatedly (and with about as much reason) as recipes for mint juleps or Virginia ham. Some add special "secret" concoctions, to encourage certain micro-organisms, it is said. These "secrets" are passed on only to the most trusted of the faithful. Most insist that at least a part of the mixture must be animal products. Although soil scientists generally advocate adding chemicals to the mixture, nearly all true believers condemn their use. The unforgivable sin is to add any "chemical" nitrogen such as ammonium sulphate or ammonium nitrate, to soil or compost. Rock phosphate may be used; but superphosphate is condemned, because it is made by treating a natural earth with sulphuric acid--a strong poison. (Even that should not be so bad as common table salt – a resultant from two strong poisons!)

At great risk, we may state that the essential features in making compost consist of piling things like leaves, grass clippings, straw, and other plant remains in heaps some 4-6 feet wide, 6-12 feet long, and 4-6 feet high, let us say. Very thin layers of soil separate layers some 6-8 inches thick of organic matter. The material is kept moist, but not soggy, and allowed to decompose. If turned occasionally, it will be improved in both chemical and physical properties. If nitrogen is added as animal manure or fertilizer, the yields of good compost will be higher. Some ground limestone and superphosphate or rock phosphate are added. Many use a little mixed fertilizer.

The principal point in the process is the reduction of the ratio of carbon to nitrogen. In normal soil, this ratio is in the neighbourhood of 10 or 12. In the fresh organic matter, it is much higher-30 or 40, or even more. If the fresh material is added to the soil directly, micro-organisms will increase enormously in the soil, using the energy-giving carbohydrates. They require nitrogen for their bodies and will compete with plants for the available supply. Of course when the carbohydrates are used up, the numbers of micro-organisms will again return to normal and the nitrogen in their bodies will be available to plants. But by compositing in advance, this initial period takes place outside the soil, and the resulting compost contains nitrogen available to plants. Further, decomposition in the soil of fresh organic matter requires more moisture than is sometimes available. The compost is in much better physical condition to use than fresh organic matter.

The ratio of nitrogen and carbohydrate, on one hand, and phosphorus, on the other, must be watched also. If both nitrogen and carbohydrate—energy material—are *high*, micro-organisms *will* greatly increase and use a *lot* of phosphorus in their bodies. If the available supplies in the soil are low, plants will suffer

phosphate deficiency. Thus, partially composted organice matter, rich in nitrogen, may give bad results unless the compost is enriched with phosphatic fertilizers or generous amounts are supplied to the soil.

Of course, the nitrogen in a chemical fertilizer is not different than the nitrogen in compost. But the organic schools have an important point, often missed because of their extreme statements: If chemical nitrogen is used as a substitute for maintaining a reasonable level of organic matter and for growing legumes, the soil may deteriorate badly through loss of structure, and the erosion hazard may be increased. Then, too, it is entirely possible to use too much nitrogen fertilizer and have an excess of soluble nitrogen in relation to the other plant nutrients. People often do so in their gardens, getting as a result tall, weak, poor-fruiting plants. Many things good for people or for soil, in moderation, are harmful in excess. Yet, if on a well-managed productive soil, one may raise the yield of corn from 30 bushels per acre to 75 bushels let us say, with a commercial nitrogen fertilizer, it would be unwise not to do it.

The organic partisans exaggerate nearly as much as the erosion enthusiasts. All sorts of claims are made for disease resistance among plants treated with compost (made according to the particular author's ritual). Plants need all the elements the scientists say they do, some admit, but go on to insist that they need also a mysterious life-giving substance, a vital principle produced only by other living matter. Much that is written is pure speculation. Although, like Berkeley's theories, one cannot prove them wrong, there is no reason to believe them.

Such exaggeration and speculations are unfortunate. A great deal that is advocated by the organic schools is sound practice, even if they do often give unbelievable reasons. Certainly their implied concept of the soil is as good as, if not better than, that of their arch-enemies, the balance-sheet advocates.

Since much work is involved these organic theories appeal most to small, hobby gardeners, especially those working with poor soil. And under such conditions, results will very likely be much better with the organic methods than with those of the balance-sheet school. But such a choice is not necessary. Both involve some good practices and some unnecessary ones. And both fail to emphasize the selection of plants best able to grow on the soil at hand. In ordinary large-scale farming, animal manure or nitrogen fertilizers may be applied along with organic matter to offsen the effects of high carbohydrate content and avoid the need for composting. In the Uuited States composting would need to show a great benefit indeed to make the method economically practicable. Considerable success is claimed in the humid tropics with "organic farming" where labour is plentiful, where organic matter is especially important, and where fertilizers are very expensive or difficult to obtatin.

The organic devotees are primarily interested in production. They have not teamed up much with the erosion enthusiasts except to use their astronomical figures of damage to "demonstrate" the evils of chemical fertilizers and of failures to farm the "organic way". They also use the statistics on human disease to show the same thing.

As with erosion problems, perhaps it takes exaggeration to bring recognition of the biological side of soil productivity, and such recognition is important. Here, too, there seems to be somewhat more reasonableness coming into the current popular articles, especially in the United States.

## Earthworms.

Enthusiasm for earthworms, among the many soil organisms, can scarcely be accounted for on scientific grounds. Perhaps it is because they are slow in their movements and large enough to be seen easily. Somehow they do seem more friendly than their quicker, many-legged associates. Most people who like the soil at all like earthworms.

For plants to get the nutrients in organic matter, it must be decomposed. Humus is the result of partial decomposition. The role of decomposer is played by a whole host of soil organisms. The large ones also mix the organic matter with the upper mineral soil, dragging bits of it down into holes in the ground. The friendly earthworm is only one among the many.

Years ago Charles Darwin wrote a whole book about earthworms and their influence in forming "vegetable mould" in the surface of the soil. It is perhaps still the best book. He measured some worms and their casts and showed that over a long period their effects were considerable. Farm and village boys digging earthworms for fish bait, look for them in fertile garden soil. But not all productive soils have earthworms, and they are sometimes found in soils of rather low productivity; still one is more likely to find them in productive soil. Even now there is no definite answer to the question: Are the earthworms present because the soil is productive, or do the earthworms make the soil productive? Probably it is some of both.

Recently, great claims have been made for soil improvement by earthworms, usually as a special phase of "organic" gardening, since they need organic matter as food. Here again the soil scientist must say that he does not know. Possibly earthworms do have some special advantages over other organisms; possibly they may be harmful where soil organic matter decomposes too fast anyway. The scientist cannot say it is bad practice to destroy them or good practice to introduce them. Yet even the scientist probably likes them in his garden—most people do.

## Plowless farming

More than two hundred years ago Jethro Tull invented a grain drill and a horse shoe. Grains were planted in rows and cultivated, and yields were increased greatly over the older broadcast sowing. Tull taught that this benefit came from the very pulverizing of the soil, making it easier for the fine earth to enter the roots. This view has been long rejected. The great benefit from Tull's system came largely from the better control of weeds, which had become very bad in English grainfields.

A tradition arose, however, among European and American farmers that it was beneficial to plow and to cultivate a great deal. The invention of the steel moldboard, or turning, plow has been regarded as a great milestone in soil management, coming as it did during the breaking of the American prairies. It made plowing easier and neater. As cultivation spread west on the dry soils of the great Plains, it was emphasized as a technique for saving water. Under the "dry-farming" system advocated at the end of the nineteenth century, crops were alternated with cultivated fallow. During the fallow year, moisture accumulated and a crop could be grown the following year. By maintaining a very loose surface soil—a "dust mulch", it was called-capillary rise of water to the surface was thought to be broken and the upward movement of water halted. But more recently it has been shown that here again the principal benefits came from killing weeds which robbed the soil of moisture. The farmers who went into the plains took their tools and methods with them, including the turning plow. They had to learn other methods.

For a long time soil scientists have been arguing against too much tillage. Obviously, unnecessary tillage wastes power. But, even more, tillage tends to distroy soil granules, to injure soil structure. The effects are, however, more striking in some soils than in others.

A few years ago came a new theory, full-blown overnight; Stop plowing altogether! It was supported by all sorts of carefully selected evidence. For one thing, how about the great dust storms of the early thirties? Had not the popular books on erosion shown that the moldboard plow was the evil instrument that had destroyed the grassland? Was it not the moldboard plow that tore up the slopes in the humid region now suffering from sheet wash and gullying? Is not the forest productive without plowing? Assertions went almost to the point of implying that all soils in America were originally productive, but that they vary from one another now because some have been plowed more than others.

Seeds can be planted and plants may be grown without plowing, or even with very little tillage of any sort. If plant remains are left on the surface, not plowed under, the soil will be protected against the forces of rain and wind.

According to the advocates of plowless farming, soil organisms thrive better, plants are healthier, yields are much higher, and of course, costs are lower. In fact, as plowless farming becomes general the really big problem will be what to do with all the great increase in farm products!

So the question arose: Why plow? Look at the bounty of nature! And does she plow? Let each farmer answer for himself: Exactly why plow?

Now, this was a good question. A lot of people, agricultural experts as well as farmers, did not have a ready answer. Most farmers had plowed because it was more or less traditional to do so. For centuries, many farmers had plowed. Most of the standard books on soil science explained how to plow and when to plow, but few explained why one should plow at all.

The truth is, however, that already many tillage machines were in use instead of the turning plow in the Great Plains—machines like the one-way disc and the duckfoot cultivator. Many bulletins had already been issued to farmers explaining the use and advantages of such machines over the turning plow. Curiously, these were ignored for a time by both advocates of plowless farming and most writers of books on soils.

In the face of such claims, and with few clear reasons against them, some farmers and gardeners in the eastern part of the United States—especially city gardeners—put the theory to test. On the whole, results have been disappointing. Some took the doctrine literally and planted corn in fields of Bermuda grass—corn that got a few inches high, turned yellow, and finally perished.

Of course, plowless farming worked successfully on a good many kinds of soil, as alert farmers had already discovered. In fact, machines were already available for controlling weeds and preparing seedbeds that would leave trash and clods on the surface to protect soils from washing and blowing. But these were different soils than those traditionally plowed in the humid regions.

The kind of tillage required depends upon the crops to be grown and especially on the kind of soil. Most soils in humid forested regions are not naturally productive for crop plants. Among the very poorest are nearly level, deep, stone-free soils with clay pans or hardpans. The term "worn-out soils of the East" often refers to these. But they aren't worn out; they never were productive. On the other hand, the black soils developed under grasses in the subhumid region are naturally productive for similar crop plants.

So, in humid forested regions like Eastern United States and Western Europe, most soils highly productive for crop plants must be made so by the farmer from relatively unproductive natural soils. Soil fertility must be

increased. Soil structure must be improved, made granular, to a considerable depth. This means micro-organisms and roots need to be encouraged. They require organic matter, lime, and fertilizers, not only in the surface horizons but also in the deeper ones. Therefore, one plows as the best way to accomplish this purpose.

There are other reasons. On many soil types, systems of tillage involving the use of the turning plow are best to control weeds, to prepare a seedbed, and to make the soil receptive to rain water. On other soils such deep turning is not necessary, or even proper, and systems that avoid the turning plow are better.

Aside from the disappointments and a few financial losses from trying plowless farming on soils where plowing is essential, the net effect of the doctrine has probably been good, absurd as its claims and reasons turned out to be. It jarred lots of people who had just taken plowing for granted into considering tillage critically. Was plowing necessary ? Tests were made, and the results of older tests and experience re-examined. The inevitable result has been that plowing is found to be necessary on many soils and not on others. Farmers generally—of course not all—had plowed and cultivated too much.

As a result of the controversies that the doctrine stimulated, at least a few more people have thought about soil and now realize a little better why they do what they do.

Apparently the extreme doctrine will disappear almost as quickly as it arose, but more quietly.

## "Balanced" minerals

Scientists in plant nutrition have been fairly well agreed for some time that at least fourteen elements are essential for plant growth. These include carbon, Hydrogen, and oxygen from the air and water; and phosphorus, potassium, nitrogen, calcium, magnesium, sulphur, iron, boron, manganese, copper, and zinc from the soil. Certain soil organisms can use nitrogen from the air. Somewhat more recently molybdenum has been added to the list, especially for clovers. Only small quantities of molybdenum, iron, manganese, copper, and zinc—often called the micronutrients—are needed, although the actual amounts required vary widely among plants. Common salt ( sodium chloride ) also stimulates the growth of certain crops on some soils when used as a fertilizer. In addition, iodine and cobalt are known to be essential for all or certain animals, and they obtain these largely from the food they eat.

Besides these, a great many other elements—in fact, most of them—may be found in plants. Some kinds of plants are especially rich in aluminium, gold, silicon, or other elements, where certain compounds of the element are present in the soil in considerable quantity. Since these and many other elements are often present, one wonders how they influence the plant, if at all.

Fertilizer practitioners have given greatest emphasis to the "big three" plant nutrients—phosphorus, nitrogen, and potassium. Calcium has been thought to be abundant in nonacid soils and usually taken care of by liming in acid soils. In recent years, however, increasing attention has been given to magnesium sulphur, and the micronutrients. In many instances, applications of one or more of these have been very beneficial.

Neither plant nor animal nutritionists can explain entirely the roles of the micronutrients that are known to be essential, let alone any possible effects of the large number of other elements (except for some of the established poisons) taken in by plants and animals. Nor are the optimum environmental conditions, including the nutritional balances, known for the synthesis of vitamins and other growth-promoting substances.

Could it be that some of these micronutrients, even those having no clearly established functions, are in some way responsible for the synthesis in plants of certain organic constituents of nutritional significance to animals and humans? Even though the scientist would hesitate to say yes, he cannot say no. He doesn't know.

What a field for speculation! Here may be the key to better health and nutrition, even to the long-sought elixir to give us perpetual youth. It is only a step from the scientist's statement that he doesn't know whether these elements have important undiscovered effects to someone's saying: "Perhaps they have"; and finally to the idea "They do have."

Some have taken this final step. The claims vary from emphasis upon the micronutrients known to have at least some definite influence on growth to an impressive list of these and many more. The evidence offered includes good production, but not significantly greater than under good nonmysterious management; the fact that plants growing naturally contain such elements; and the improved nutritional value of the plants for man and beast. This last is easier said than proved. In fact, with the very best scientific facilities, it is exceedingly difficult to make accurate comparisons of foods through feeding trials to test such plants.

Research is badly needed in this area. Not, of course, to prove or disprove the claims of extremists for balanced minerals, but to uncover the facts, to find some basic principles of prediction value. There is great danger that before the facts are found much money and effort will be wasted on special fertilizers of "complete minerals". It is known that alfalfa, sugar beet, and other crops are especially sensitive to boron deficiency; tung trees are especially sensitive to zinc, as is the pecan; and so we might go on through a very long and complicated list. But there is another list of plants according to toxicity hazards to many of the same elements; that is, on the same soil, the same amount of boron may increase the yield of one crop and lower that of another.

As important as these plant preferences are two other factors: the available amounts in the soil throughout the root zone; and the general soil-management system—green manures grown, other fertilizers applied, liming practices, manures and compost used, crop rotations, and irrigation practices.

Soil scientists are going ahead slowly. Already methods of diagnosis have been fairly well developed for some crops on some soils. But these are time-consuming and highly technical. Not with even one of the micronutrients are there methods that will work generally.

Additions of reasonably small amounts of these special mineral fertilizers will probably not do much harm, except when a soil already contains a large amount of one of the elements in available form; in some instances, the applications may do some good. But the chances of meeting the actual soil needs are remote. There is no such thing as a generally "balanced fertilizer" in the sense usually implied—balanced for plants growing in soil—for all soils or even for the soils of a considerable area. As soon as a chemical mixture is added to the soil, reactions take place within the soil. The final "balance" of nutrients is quite unlike that added in the mixture. The aim in scientific or balanced fertilization is to add what is essential to achieve a balanced nutrient supply for the plant within the soil. This often requires two entirely different fertilizers, or fertilizer mixtures, for the same kind of plants growing in adjacent fields or gardens on different soil types.

## Soil and health

Careful comparisons between soil geography and human geography show many extremely interesting and important relationships. Describing such relationships is one thing, and proving causal mechanisms quite another. In the past twenty-five years or so, several important relationships between soil conditions and nutritional diseases of animals have been fairly well established. These researches have been expanding generally throughout the world.

Questions then naturally arose as to what extent human nutrition and health might be related directly to types of soil and soil-management practices. Several soil scientists and nutritionists alike realized the possibility of important causal relationships. The problem is almost unbelievably complicated by the great number of combinations of relevant factors and the technical difficulties of the research. For dependable results, the study of relationships must begin with soil type, considering its total environment and cultural treatment, and the plants grown. Then account must be taken of how the plants are processed into food, food storage, combinations of foods used, and so on. Finally, the study must be carried into the medical clinic.

A little evidence is in-about enough to show that some highly important relationships exist but that it is very difficult to obtain principles of real prediction value.

Unfortunately, some practitioners have taken the "long jump" from these conclusions of the scientists to claims of knowledge now. Of course, assertions that certain types of soil or certain cultural practices give food of special health-promoting value stimulate the emotional interest of readers. Everyone wants to avoid sickness and be strong.

Such claims are made by some extremists of the "organic-farming" schools. Some advocates of the balanced-minerals fertilizers also promise healthful, even disease-curing, food plants. It has been said definitely that erosion lowers the nutritional quality of food plants. Extravagant claims have also been made for ordinary liming and fertilizing.

Any of this may, under certain conditions, be true. Certainly, none is generally true under most conditions. Several significant local problems of great importance to the nutrition of livestock have been worked out. But there are very few proved relationships with humans developed to a point where definite predictions can be made.

But before that happy day comes when the relationships between soil and food quality are well enough known that food can be graded according to quality based upon soil type and cultural practice, the public will doubtless be presented with many more claims. In other words, dogmatic assertions on soil and health seem to be increasing rather than diminishing. Soil scientists and their colleagues in plant and animal nutrition and medicine have already made a reasonable start on this very complicated research. The great danger to their research right now is public reaction against the claims of the extremists—claims that the scientists find hard to deal with because they do not yet know the facts.

## The common difficulties

None of the various doctrines about soils can be declared to be wholly true or wholly false. Very few, if any, soil scientists are clearly identified with any of them. Although the doctrines differ from one another—some pairs very widely indeed—they all have three difficulties in common.

In the first place, their advocates hold a firm conviction—originally from revelation or authority, it doesn't matter—based upon something besides the complete soil. In the balance-sheet theory, for example, it was a notion of plant nutrition. In others, it was some superficial appearance of the land, or even of the very upper part of the soil—the part plowed or turned in spading. After the theory was firmly believed then a concept of soil was developed to accomodate such a theory. In soil science, on the other hand, one begins with the facts about the soil itself, as well as these can be learned with the scientific tools at hand.

Second, all the doctrines imply that soil is everywhere about the same, except as modified by man's use. Because a practice seems to work well in one garden or one field, the extremist generalizes widely. Some have talked about "average depth of fertile topsoil", for example, in the United States or in the world. Naturally, unproductive soils are sometimes called "worn-out" soils. Actually, there are thousands of unique soils in the world, varying from one another in every aspect. Some have little or no "dark-coloured fertile topsoil" and never did have; others are black to more than 3 feet. Some are highly erosive even with gentle slopes, wheras others are not, even with steep slopes. Many steep, thin, stony soils always were steep, thin, and stony.) And so it is with all characteristics of significance to soil productivity and use. "Soil" is a very broad term, like "plant" or "animal".

Third, these doctrines, especially in their most extreme aspects deal with areas of the subject about which science knows the least. They nearly always seem to affirm most strongly what scientists cannot deny for lack of evidence.

## A Glimpse Ahead

All this should not be taken to mean that soil scientists have no disputes among themselves. Of course they have, as in any science where advances are being made. But such disputes are in different terms than those among the advocates of the doctrines. They deal with facts and their interpretation according to the scientific method.

Nor should it be inferred that soil science is a helpless baby—not at all. It is young and still cannot answer many important questions. But it can and does answer fairly well a great many questions about a great many kinds of soil. Until recently, farmers, gardeners, foresters, and engineers learned about the soil through trial and error, with all its costly failures and headaches. Now, every day, in many parts of the world, soil scientists are making reasonably good predictions about the behavior of soils with many kinds of practices. In the future, they will know how to make these more accurately, for a longer period, and on all important soils. They will develop many new practices and understand many more relationships between soil and use. This goal can only be approached the hard way—through painstaking fundamental research. Then comes the applied research and demonstration.

If these dotrines have helped to make the public conscious of the importance of soil and the need for fundamental research, they, too, will have helped to lay a basis for substituting scientific prediction for habit and trial and error, even if indirectly.

# E. K. 70, as New Paddy Strain for North Konkan

V. M. CHAVAN § and A. K. GUPTE *

The Rice Breeding Station, Karjat, Dist. Kolaba, has been evolving improved strains in the major varieties of paddy cultivated in North Konkan since the year 1919.

Different strains have been evolved for different levels and types of land. Of these, K. 184 is one that is best suited for cultivation in the highlying, poor lands of Thana and Surat Districts as it is early and, at the same time higher yielding than the local variety. On the Karjat farm where it was evolved by individual plant selection, it has been found to mature in about 105 days and give an average grain yield of about 1,500 lbs. per acre. This strain has become very popular with the cultivator in Thana and Surat Districts and, therefore, its seed is being supplied to them every year as part of the scheme for the multiplication and distribution of improved seeds.

As is usual with all plant breeding stations in the province the Karjat farm aims continuously at further and futher improvements through:

(i) introduction of material from other farms in the province, other provinces and other countries.

(ii) pure line selection in the naturally variable material existing in the local varieties.

(iii) hybridisation with other types for combining any superior qualities besides yield with those of the strains already evolved. Yield and quality trials are taken of any new promising material obtained according to standard methods and techniques.

In the course of recent work under item (i), E. K. 70 (Early Kolpi No 70), an early strain evolved from the 'Kolpi' variety of Nasik District by the Rice Breeding Station, Igatpuri, has been found to be very suitable for replacing K. 184. The " Kolpi " variety is almost identical with ' Kolamba ' of Kolaba and Thana districts except for its virtues of less shedding, and therefore, a strain

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from it should be welcome to cultivators growing Kolamba if it has any merits over those of a Kolamba strain with similar period of maturity. The superior characteristic of E. K. 70 is that it yields about 30 per cent higher than the Kolamba strain, K. 194. This higher yield has been observed in 3 year's large scale yield trails of the two strains on the Karjat farm. The percentage of increase has also been consistent over all the three years. It may also be mentioned that even at Igatpuri where conditions are very different from those at Karjat the relative performance of the strains has been almost similar.

As will be noted from the table below, the grain of E. K. 70 is very slightly coarser than of K. 184 due to its slightly longer grain. While this is not a demerit, its grain is more attractive on account of its slightly pinkish tinge. The new strain is also later by about 5 days than K, 184 and escapes the adverse effects of the rains late in September. Even if its lateness be considered a deficit, it is very minor and the thirty percent higher yield in favour of E. K. 70 should certainly induce cultivators to prefer it to K. 184.

Table giving a comparision between the two strains of rice viz. (i) K. 184 and (ii) E. K. 70.

| | K. 184 | E. K. 70 |
|---|---|---|
| i) Sowing time | 1st week of June | 1 st week of June. |
| ii) Days to flower from sowing | 75-77 | 80-82 |
| iii) Harvesting time | Last week of September. | 1st week of October. |
| iv) Yield per acre on the farm Average of three years without any application of manure. | 1428 lbs. | 1915 lbs. |
| v) Length of grains of rice | .59 | .60 |
| vi) Breadth of grains of rice | .19 | .19 |
| vii) No. of rice grains per gram. | 73 | 70 |
| viii) Special features. | | Attractive grain. * |

* Out of fifty randomly selected persons who were requested to give their opinion on the grains of the two strains which were shown to them without disclosing their names. 70% gave opinion in favour of E. K. 70.

# COLLEGE OF AGRICULTURE, POONA 5

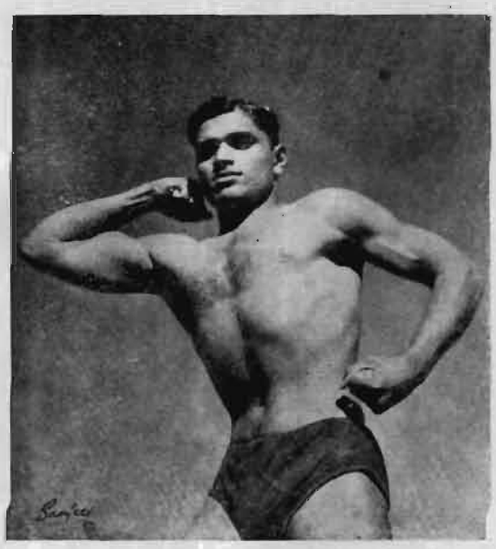
## INTERCOLLEGIATE PRIZE WINNERS

*Standing:*— Mr. J. G. Patil (*Champion in wt. lifting fly. wt.*), Mr. F F. Pinto (*Champion in Javilin throw*), Mr. B. D'souza (*Champion in Hopstep & Jump*), Mr. B. N. Bhosale (*Champion in Wrestling*)

*In Chairs:*— Mr. V. P. Dalaya (*Champion in wt. lifting*), Mr. A. N. Shinde (*Champion in wrestling & All India Interuniversity Wrestling Champion, light wt.*), Prin. L. S. S. Kumar, Prof. R. M. Chaudhari (*Chairman*), Mr. V. P. Mane (*Champion in Boxing & selected for Interuniversity wrestling fly. wt.*), Mr. K. M. Mahajan (*Champion Cross-country, Runners up in 1500 and 3000 Meters Run.*

*Champion in:*—

Body-Beautiful Competition,
College wrestling (Light weight)
Inter-Collegiate wrestling
&
All India Inter-university
Wrestling.

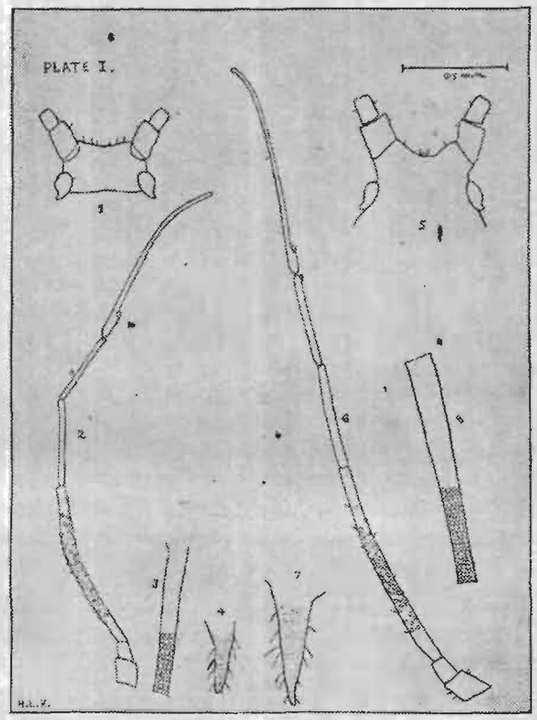


**Mr. A. N. Shinde**

## SYSTEMATICS OF *M. Jaceae.*

**Alate viviparous Female**

**Apterous viviparous Female**




1 HEAD

2 ANTENNA

3 CORNICLES

4 CAUDA

5 HEAD

6 ANTENNA

7 CAUDA

8 CORNICLES

## Weed Control

**Xanthium strumarium,** Linn. **( Gokhru )**

*Right :* Untreated plant.

*Left :* Plant treated with 0.2 % 2, 4–D, 10 days after spraying.

# Systematics of Safflower Aphids ( Macrosiphum jaceae )

By

H. L. KULKARNY, M. Sc. (Agri.) *

## INTRODUCTION

The black aphids—locally known as *mava*—are a common pest of safflower crop in the Bombay Province during October to March. Systematic studies of this aphid was taken up because of the presence of some important specific characters which did not compare well with the previous classification.

## TECHNIQUE

Aphids collected from the fields were reared on potted plants in the laboratory from where the adults were utilised for permanent mounts and compared with those collected from the fields For permanent mounts the specimens were treated with 10% KOH, washed, dehydrated with alcohol and mounted in balsam after clearing and hardening in clove oil and xylol respectively.

## SYSTEMATICS

| | | |
|---|---|---|
| Synonyms: | 1746. | *Aphis jaceae* Linnaeus Fn. Suec., 991. |
| | 1758. | *Aphis cirsii* Linn. Syst. Nat. Ed., 10 : 452. |
| | 1926. | *Macrosiphum jaceae* Linnaeus, Theobald. Brit. Aphid., 1 : 94. |

**Alate viviparous female:** Body elongate, slightly buldging at the hinder extremity, deep brown to black with a shining lustre, average length 3.15 mm. *Head* : Dark brown, deeply concave in the middle with one or two small hairs in the centre, antennal tubercles prominently developed. *Rostrum* : Long, thick, dark apically with some hairs, reaching beyond second coxae, average measurement 1.01 mm. *Antennae* : Dark brown to black, long, little shorter than the body, average measurement 2.82 mm., iii subequal to vi with 60–70 sensoria distributed irregularly; v smaller than iv with only one primary apical sensorium, vi with one compound sensorium placed at the apex of the base of flagellum. *Eyes* : Medium sized with lateral eyelets. *Legs* : Long, thin, with femur, tibia

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and whole tarsae dark, tibia hairy apically. *Wings*: Large, with thin veins and smoky stigma. *Abdomen*: With three black spots on either side before the cornicles and one behind the cornicles on either side, bases of cornicles coloured dark, presence of one median dark patch of a bigger size above the caudal plate, and some hairs distributed at random on the body. *Cornicles*: Long, cylindrical, black, imbricate, with reticulations at the distal end, slightly wide at bases, average length 0.85 mm. *Cauda*: Elongated, conicle with 4–5 long and slightly curved hairs on either side with one slightly subapical hair, average measurement 0.38 mm. Anal plate dark, rounded with some long hairs.

**Average lengths of antennal segments.**

| i | ii | iii | iv | v | vi. | Total length in mm. |
|---|---|---|---|---|---|---|
| 0.11 | 0.08 | 0.87 | 0.49 | 0.41 | 0.86 | 2.82 |

**Apterous viviparous female:** Body dark brown to black with a metallic shining coat, average length 2.81 mm. *Head:* Dark brown to black, deeply concave in the middle with some short, slightly capitate hairs, antennal tubercles very well developed. *Rostrum:* Long, thick, dark apically, extending as far as third coxae, average length 0.91 mm. *Antennae:* Black, with some hairs, basal segment large, in all six segmented, longer than body, average length 3.03 mm., iii longest with 30–32 sensoria distributed irregularly in the basal half, little smaller than vi, v smaller than iv with one normal apical sensorium, vi with one compound sensorium situated at the apex of the base of flagellum. *Eyes:* Small, black with lateral eyelets. *Legs:* Same as in alate, femur and tibia with hairs arising from tubercles. *Abdomen*: Dark brown to black, wide between the cornicles, presence of hairs arranged at random and arising from tubercled bases. *Cornicles*: Dark brown to black, long, cylindrical, slightly wide at bases, presence of hexagonal reticulations at apices, imbricate, average length 1.07 mm. *Cauda*: Elongated, conicle, slightly constricted in the middle, spinose with 5–7 long hairs on either side, average measurement 0.49 mm., nearly half the cornicles. Anal plate dark, rounded with some long hairs.

**Average lengths of antennal segments.**

| i | ii | iii | iv | v | vi | Total length in mm. |
|---|---|---|---|---|---|---|
| 0.13 | 0.08 | 0.97 | 0.49 | 0.43 | 0.91 | 3.01 |

**Systematic position:** Deshpande (1939) identified these as '*Aphis*' Spp., but since the frontal tubercles are very prominent and markedly divergent, antennae very long, cornicles long and cylindrical, cauda long and lanceolate, the author differed from him. However, the characters were identical with that of the genus *Macrosiphum*. Ghulam Ullah (1940) classified this aphid as *Macrosiphum Solidaginis* Fabricius. The author differed from his classification because of the following specific differences.

## Table No. 1

Table showing specific differences between *Macrosiphum jaceae* and *Macrosiphum solidaginis* Fabr.

| *Macrosiphum solidaginis* Fabr. | *Macrosiphum jaceae* Lin. |
|---|---|
| *Alate viviparous female.* | |
| (1) *Antennae:* Segments i, ii, and vi dark, rest pale, iii with 32–40 sensoria spread over nearly its whole length, except just at its apex. Presence of some hairs on one side only. | (1) *Antennae:* Segments i and ii comparatively less dark, rest uniformly dark. Seg. iii with some hairs and 60–70 sensoria distributed throughout its length. Presence of hairs on i, ii, iii and iv. |
| (2) *Cauda:* Black, uniformly dark long, hairy, when fully extended nearly half the length of the cornicles. | (2) *Cauda:* Black, long, with irregular constrictions in the middle, pointed and hairy. Presence of one subapical hair. |
| **Apterous viviparous female** | |
| (1) *Antennae:* Segment i, ii, & vi dark, rest pale. iii with 25–30 sensoria on the basal half and with some rather long hairs on either side. | (1) *Antennae:* Rather uniformly dark brown to black, iii with more than 25 sensoria on the basal half. Hairs on the head slightly capitate. |

*Distribution: M. jaceae* Lin. is distributed throughout Bombay province and is primarily known to be a serious pest of safflower crop in Bombay Deccan during December to February.

**Host plants:** In Poona *M. jaceae* Lin. was observed breeding on the following host plants. (1) *Carthamus tinctorius*, (2) *Arctotis grandis* (3) *Calendulla* spp. and *Guizotia abyssinica*. Host plants 2–4 were newly discovered by the author at Poona during his post-graduate studies. The host plants were confirmed by host transference experiments in the laboratory.

## Summary

The systematic studies in this aphid were taken up because of the presence of some important specific characters which did not compare well with the previous identification. The description of *M. jaceae* Lin. given by Theobald (1926) compared well with the specimens collected by the author and therefore, the aphids were renamed as *M. jaceae* Lin.

**Acknowledgements**

The author is gratefully indebted to Dr. K. N. Trehan M. SC. ( Punjab ), PH. D. ( London ), former agricultural entomologist to Govt B. P., Poona, under whom he worked as a postgraduate student. He is also thankful to Dr. E. J. Vevai for his help at the Entomological laboratory, College of Agriculture. Poona.

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*Note.* 1 The new classification was later adopted by Trehan and Halleppnwar. " Life history, Bionomics and control of safflower aphi ls. *Current Science* June 1949: 18: 211-212.

2 The present paper constituted a portion of the thesis submitted in the part fulfilment for the degree of Master of Science ( Agriculture ).

# Green Manures and Soil Fertility

By

P. V. MANE, B.SC., (AGRI.) CLASS

From times immemorial, the addition of manures to the soil. in order to increase its fertility, has been an established agricultural practice. Green manures play a very important role in increasing the organic content of the soil.

Green manuring practice is nothing but ploughing under or turning into the soil, a specially grown crop at a definite stage. Thus green manure can be defined as a living, green succulent plant tissue which can be easily decomposed, and so ploughed under the soil. This is a broad definition and may include the burying of any green tissue. The question of economy and actual gain has however to be considered. If we use a nonlegume for green manuring purpose, there is no gain as the nitrogen originally present in the soil will be turned into organic form but without any addition. On the other hand, use of a leguminous crop for green manuring purpose will increase the nitrogen quantity due to the symbiotic fixation of nitrogen. Naturally, everybody will prefer green manuring with a leguminous crop. This is why green manuring with a legume crop only is always taken for granted in common practice.

Green manuring benefits the soil in many ways. Firstly, it influences greatly the organic contents of the soil. When the plants buried decay humus is formed out of it. This humus can be said to be the foremost factor in determining the tilth of any soil. By its presence in the soil it provides conditions which are of vital necessity for the successful soil management and production of crops. It increases absorptive capacity of the soil. It binds together the sandy particles thus increasing the water holding and absorbing power of the soil. Due to humus water is retained for a much longer time. In a clayey soil, humus brings about crumb structure. Apart from this, humus tends to promote better drainage conditions and free soil acration. Granulation takes place in the soil which is very useful.

Apart from the addition of organic carbon and its effect on the soil as we have seen above, there is an addition in the nitrogen content of the soil too. The amount of nitrogen will be large or small, depending upon the conditions as well as the crop. In legume crop, the nodule organisms by symbiotic fixation increase

the nitrogen of the soil. This organic nitrogen in turn has its effects on humus content or the amount of humus. The C : N i.e. Carbon Nitrogen ratio becomes effective in the end.

The influence of green manure as we have seen above is in the form of humus and organic nitrogen on the physical condition of the soil. Now these same humus and nitrogen due to their increased amount provide plenty of food material to the next crop and the soil micro-organisms already existing in the soil. The activities of the many useful soil micro-organisms are increased and in the end prove to be useful for the crop and to increase the soil fertility.

Apart from the above major benefits, the green manuring crop has other minor benefits. A green manure crop may serve as either a catch or cover crop. We always give rest to the soil by keeping the land fallow, instead it can be used for a green manure crop. This prevents soil erosion, thus preventing loss of fine particles and useful soluble food nutrients. It also suppresses the weeds to some extent. In some cases, it is also found that some green manure crops increase the availability of some inorganic constituents of soil.

After considering the above stated benefits of taking green manuring crops. it is not out of way to study in detail how the nitrogen is increased in the soil due to the green manure crop. The increase in nitrogen content is solely due to the leguminous crop taken for green manuring purpose.

On an examination of the roots of a leguminous plants it is found that there are some nodules on it. These nodules contain bacteria, the main agents manufacturing nitrogen in the soil. The nodule bacteria are common in all leguminous plants but every species of plants has a specific relationship with the particular bacteria. This means that a legume host plant will be unable to grow in a soil which is devoid of particular nodule organisms. These nodule bacteria have their habitat in the soil when they are functionless. When the host plant is growing they enter through root hairs and cause nodules on roots. They live in the nodules, take free nitrogen from the soil air and synthesise it into complex forms. It is proved that the host plant is able to get some of the nitrogen thus fixed and thus benefit by the relationship. For this reason, this fixation is called as symbiotic fixation. These organisms are called as Rhizobium and there are different strains of Rhizobium depending on host plants.

How this nitrogen is fixed, how the host plant absorbs it and how it is liberated in the soil are all points of controversy. Different theories are put forth for each. They need not be dealt with here.

To select the proper crop for green manuring it is necessary for us to know the desirable characters of a crop to be used for the purpose.

The most important character such a crop should possess is the one of rapid growth. This is necessary so that the plants may have sufficient time for decomposition in the soil and thus we will have no difficulty for the next crop

which will get all the advantages of the buried and completely decomposed green manure crop. Naturally, the more rapid the growth of a green manure crop the better are the chances for its use as a soil improvement agent, economically.

Along with the rapid growth it is desirable that the crop should be able to grow on all types of soils. Thus it can be used on all soils and wherever required, especially on poor soils.

A crop with a spreading habit is to be desired. The rapid growth and spread will cover the soil completely and thus suppress the weeds. The control of weeds is thus automatically achieved. A spreading crop will obstruct the beating action of the rain thus preventing the digging away of the soil particles and the compaction of the soil.

The other most important characteristic of a green manure crop is that it should have maximum growth in the least possible time with abundant and succulent tops. The moisture content should be more. These characteristics are required for obtaining the maximum material in the least possible time. A large moisture content will also help in the early decomposition of the plants. These will enable the achievement of the maximum benefit.

A crop fulfilling the above requirements should definitely be preferred. No doubt this should be a leguminous crop only. Growing of non-legumes is not economical and thus not desired. Some exceptions may, however, be met with.

The main crops used for green manuring purpose in India are Sanhemp, Berseem, Chawali, Peas, Dhaincha and sometimes Sesamum which is generally found in Konkan. These are all legume crops.

In U. S. A., a much advanced country in agriculture, non-legumes are often used.

The best time to bury the crop is the one when it is at its highest or maximum growth but still immature. Thus a crop should produce the maximum material but should be quite succulent. This succulency helps in an early and satisfactory decay of plants while the maximum growth produces more humus. The moisture content of the crop helps in its decomposition and the soil moisture is not much utilised but stored for the next crop. The ploughing should be done at this time if there is sufficient water or rain. Thus a suitable green manure crop is buried at about half mature stage.

In case of San, the most common green manure crop, the maximum growth is just before flowering, between 6 to 8 weeks. This is the time when it is uprooted and buried.

Although green manuring is beneficial one has to take certain precautions as regards the general agricultural practice. It should never be indiscriminately used by interfering with the normal rotation. It should be done judiciously in order that the soil may not be packed with undecayed matter. The crop should be buried at its proper time and should have a proper moisture content in the soil for its proper decomposition. The soil should be well turned so as to get the complete decomposition of the plants. In these things drainage should never be overlooked as proper aeration plays a part of vital importance in the thorough decay of plants. Lastly it should not be taken as the whole and sole method of maintaining and increasing soil fertility. Green manure should be supplemented by adding organic manures like Farm Yard or Compost and inorganic ones like ammonium sulphate or superphosphate, whenever required. Thus, in short whatever may be the merits of green manuring, one cannot emphasise that it should be the only practice adopted to increase soil fertility. The above facts clearly indicate, how closely green manuring practice is interlinked with the maintenance of soil fertility.

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# VINEGAR MAKING AS A HOME INDUSTRY

By

N. G. Ferur *

Vinegar is a sour liquid with a peculiar aroma. It is used as a spice and preservative in domestic food preparations. Vinegar is prepared by fermentation of sugar or *gur* solution. Juices and extracts of different fruits and plants are also used for the preparation of the vinegar. Cane juice, toddy juice, *jambul* fruit juice, malt extract etc. are all used for preparing vinegar of different flavours.

Vinegar making is a quite simple process. It does not require costly appliances and large investment for raw materials. It can be practised by any farmer during his leisure hours. In some places *gur* absorbs moisture during rainy season and becomes liquid. In such places *gur* solution can profittably be

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utilised for making the vinegar. In places where fruits are grown in abundance some of the fruits are bound to become over ripe and unmarketable. These over ripe fruits can also be used for the vinegar making. Similarly juice from over-ripe or frost affected canes which cannot be used for making *gur* may with advantage be converted into vinegar.

To obtain good results and first quality vinegar, the juice or the solution to be used should contain about 18% of sugar. Fruit juices or cane juice after extraction should be filtered through a muslin cloth. If the fruit juices contain less sugar, necessary amount of sugar may be added to make up the proper percentage. The clear juice or the solution is first boiled in a tinned brass vessel and transferred to laccared earthen vats about two thirds full. Earthen vats of 40 lb. capacity would be convenient to handle. About half a pound of fermented toddy juice is added to the juice to start alcoholic fermentation. The vats are covered with a thick cloth and earthen lid to avoid entrance of insects and dust. The vats are then kept in a warm place; in winter season they may be kept in the sun. The liquid in the vats is stirred daily to ensure complete fermentation. There will be frothing and evolution of gas during the fermentation. After a week, the alcoholic fermentation will be complete and frothing ceases. Thereafter pure vinegar is added to the alcoholic liquid in the vats to start the vinegar fermentation. The vinegar may be added at the rate of 20 to 25% of the original juice. The vats are kept again in a warm place after covering with cloth and lid.

Within a week a film forms on the surface of the liquid. This film contains vinegar bacteria which are essential for successful fermentation Therefore the film should not be disturbed on any account. Within 30 days the vinegar fermentation will be complete, which is indicated by a very sour smell and absence of gas bubbles in the liquid. At this stage the juice is strained through a double folded coarse cloth. The filtered liquid is heated to boiling in a tinned brass vessel. This heating helps quick ripening of the vinegar and also produces good taste and aroma. The heated liquid is cooled and stored in stone ware jars with tight lids and is allowed to ripen for 3-4 months. The ripening process imparts proper flavour and colour to the vinegar. The vinegar during ripening becomes clear and develops attractive colour and aroma. The upper clear vinegar is decanted and sold in bottles.

The method described is quite simple and does not need technical knowledge. One can undertake this industry of vinegar making at home, with a small initial capital to start with. Also, the work can be done in leisure hours. Yield of the vinegar will be about three fourth of the original volume of the juice Good vinegar is now sold in the market at the rate of ten annas a pound. Compared with the amount to be invested in this industry, the price which the vinegar fetches in the market is really attractive. It will, therefore, be an additional income to our farmer if he takes up this cottage industry and work it during his off season.

# Possibilities of Introduction of Jute Crop in Surat District

By

M. K. DEASAI *

The cultivation of Jute *Corchorus Capsularis* and *C.Clitorius* has been mostly confined to parts of Bengal, Assam, Bihar and Orissa where it has spread over an area of over three million acres. The origin of this industry dates back to 1828 when only about 300 cwt. of Jute fibre was exported to Europe. The year 1854 saw the establishment of the first European factory at Rishra. In subsequent years, several factories sprang up round about Calcutta and the total value of the fibre handled for the manufacture of rope and bags and for export now runs into several crores of rupees.

There are two forms in cultivation *C. Clitorius* and *C. Capsularis*. *C. Capsularis* is a round fruited variety and can withstand water-logging after the plants are about 3 to 4 feet tall. The long-fruited variety *C. Clitorius* lacks in this ability and is usually grown on high land. Both these species promise to do well in Bombay Province especially on the Coastal tract of Thana, Kolaba and Ratnagiri where they are found to grow in a wild state. In Surat district only *C. Clitorius* is found growing in a wild state. Damp heat, a temperature not exceeding 100° F during the growing period and humidity varying from 60 to 90 are considered favourable for its growth.

Preliminary trials to grow Jute in Bombay Province have been reported to be unsuccessful. After the division of our country, the position of Jute industry has become precarious in that the bulk of the Jute growing area has gone to Pakistan. Attempts are, therefore, afoot to increase the area under Jute in the Indian Dominion.

Dr. B. N. Uppal, The Director of Agriculture, Bombay Province, Poona, desired that trials should be conducted to grow Jute in the Province. A preliminary trial was therefore conducted on a small plot measuring 13 gunthas at Surat during the monsoon period of the year 1948-49. The seed (*C. Clitorius*) was obtained from the Contai Beej Bhandar, Contai, District Midnapore, Bengal. The seed was broadcast in the last week of June at the rate of 3 lbs. per acre on

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* District Agricultural Officer, Surat.

the small plot measuring 13 gunthas. The land was planted to paddy in the previous season. The preparatory tillage consisted of one ploughing and two harrowings. 1½ cartloads of Farm Yard Manure and 10 lbs. of Bonemeal were given before planting. Only one weeding was done during the life of the crop.

The seed germinated well and the crop was thinned out after it was about a foot in height. Although the total rainfall in the season was only 16 inches i. e. roughly 1/3rd of the normal, the plants grew well enough attaining a height of over 6 feet.

There was a severe attack of a species of Semi-looper on the foliage when the crop was about 3-4 feet tall. This could be effectively controlled with one dusting of gammexane D. O. 34. This trial was repeated during the rainy season of 1949-50 and although the crop grew as it did last year, it is felt that if the crop could be established well before the onset of monsoon proper, it would grow still better.

**Retting:**— At about the time of podformtion the plants were cut a little above ground level and tied into bundles and were kept in a heap for about 15 days when the fibre could be seen detached from the stem in a few cases. After extraction, the fibre was washed well in clear water and tied in small bundles after being thoroughly dried. No detailed data were collected regarding the cost of cultivation and yield as this trial was designed mainly to test the possibility of growing the crop in the district.

The Director of Indian Central Jute Committee, D. B. C. Kundu, is exploring all possibilities of extending the area under Jute. According to him it is estimated that 1,00,000 acres at present not utilised for growing crops would be brought under Jute in Madras Province during the next 3 years. It would considerably help this laudable object if similar attempts in our province are made to utilise waste lands which at present are lying unused for any crop production. Efforts in this direction are already under way.

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# 'X' Rays and its Roll in Agriculture

By

S. V. TEMBE, F. Sc. (Agri.) class

Many of us have heard something about 'X'-rays, but very few of us know about their uses and functions.

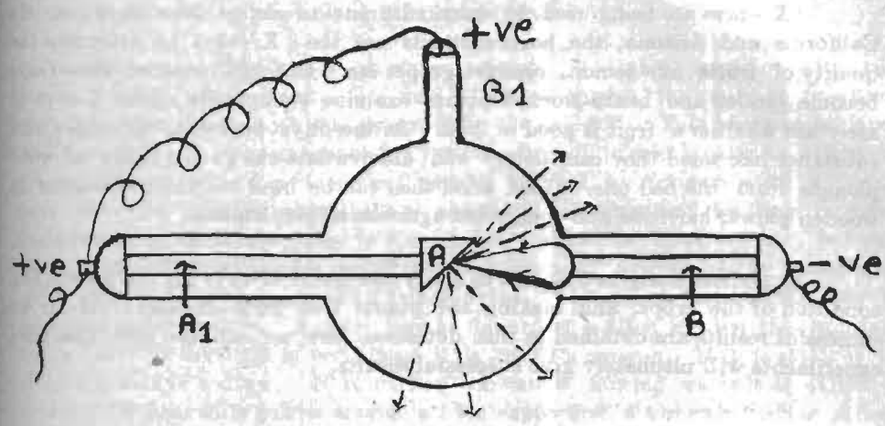
Professor Rontgen of Munich had done some experiments on discharge through gases in electricity.

The discharge of electricity through air and gases could be very well studied by producing a discharge in a closed glass tube. A glass tube about 40 cm. long and of about 4 cm. in diameter was very good for that purpose. Two wires were fused to the ends of the tube and a thin plate was attached to each end inside the tube. A small side tube was attached to this long tube so that it could be connected to a high vacuum pump. The electrodes were connected to the secondary of an induction coil. When the pressure of the gas was lowered to about 40 mm. of Hg. an electrical discharge took place inside the tube at potential difference of 10,000 volts between the two electrodes. At 10 mm pressure of Hg. of the air in the tube, the discharge was not continuous but was broken off near the cathode. A small violet coloured glow was seen near the cathode and it was separated from the remaining part of the glow by a dark gap This glow was known as the negative glow. The remaining portion of the column was called the positive column.

Professor Rontgen knew that when the pressure in the tube fell to a level of .01 mm. of Hg. the positive column completely disappeared and a stream of invisible radiation was then ejected from the cathode which struck the opposite wall of the glass tube, and gave the characteristic radiations, which were then known as cathode rays.

After this, while working with the discharge tube he discovered that photographic plates placed near the discharge tube got fogged even though they were well protected from the effects of visible light. He performed a number of experiments and proved that the fogging was due to some unknwown invisible and highly penerating radiation, coming out from the walls of the discharge tube. This radiation originates from those places of the walls of the tube where the electrons (negatively charged particles) make impacts. The radiation, which was not affected by electrostatic or magnetic field was similar to light. On account of the unknown character of the rays at that time, Professor Rontgen called them 'X'-Rays. As they discovered them they are also known as 'Rontgen rays'.

For the production of 'X'-Ray, radiation tubes of special construction are employed. In ordinary X-Ray tube three side tubes are sealed on to a large bulb as shown in the figure.




In each of these side-tubes an electrode is sealed, all these electrodes being of different forms. The tube is exhausted until the pressure of the residual gas inside the tube is about 0.0003 mm. of Hg. Anode A is kept inclined to the axis of the cathode at an angle of 45° as shown in the fig. The electrode B is connected to the negative terminal of the source of high potential differenee while A, and B, are both connected together to the positive terminal. Thus the electrode B acts as the cathode while the electrodes A, and B, serve as a double anode. The negatively charged particles viz. from B are suddenly brought to rest by impact against the body viz. A, as shown in the fig. and a bluish light is emitted from it. Such a type of radiation is termed as 'X'-rays. The greater the velocity of the impinging electrons, the more intense will be the 'X'-rays.

In gases X-rays produce intense ionization. They are invisible to the eyes. They are injurious to live tissues, if they are exposed to these rays. Nowadays 'X'-rays are used in nearly all industries. Not only they are used to examine big bridges, dams, steamers, buildings and electric poles minutely but also they detect minutely the invisible impurities on the surface of our daily food. By means of X-rays we can remove the decayed and weak electric poles.

In western countries the manufacturers examine their foods under the X-rays. As X-rays have great penetrating power they can detect thorns ; pieces of glass etc. which may be hidden in the rubber of the motor tyres. And thus they make the tyres free from danger. Faults in metallic structure like cracks and so on can be detected by using X-rays. It is also possible to investigate the flaw in pearls or its garlands by means of 'X'-rays. As the bones and metals are much more opaque to 'X'-rays than flesh, 'X'-ray photograph can clearly show

a fracture in the bones or the presence of bullets in the body. The alimentary passage can also be photographed by the 'X'-rays, by making it less transparent to these rays by administering to the patient a bismuth salt or $BaSO_4$.

'X'-rays are being used by horticulturists to detect flaw in fruits. In California and Arizona, the horticulturists use the 'X'-rays to determine the quality of fruits like lemon, orange, grapes etc. In foggy weather these fruits become spoiled and hence horticulturists examine such fruits under X-rays to ascertain whether a fruit is good or bad. As the rays penetrate through a hard substance like wood they can detect and differentiate the good quality of wood ploughs from the bad one. Good wood then can be used in the preparation of wooden plows, harrrows aud such other agricultural implements.

Experiments are in progress to study the use of X-rays for the growth and condition of the crops, and making the plants free from diseases. So far no successful results are obtained in this detection but we can be sure that these experiments will ultimately give successful results.

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# Soil Erosion And Its Control

By

J. K. GNANARATNAM, B.SC., (AGRI.) CLASS

The transport of soil particles from the place of their formation or deposition by natural agencies is technically termed as soil erosion. Soil erosion is an age old problem which the modern agriculturists are combating with. It is very disheartening to note that millions and millions of particles of soil are removed by Erosion and the land rendered unfertile for the growth of crops.

The agencies which are responsible for erosion are water, wind and waves. The latter is not common in the Deccan but more common along the coastal areas, whereas the former is responsible for removal of a considerable

portion of surface soil. The agriculturist himself contributes a great part towards the cause of soil erosion. This happens due to improper cultivation, mismanagment of the soil and deforestation. Such erosion is termed as man made or man induced or culturally induced or accelerated erosion, (1)* which differs from normal erosion taking place along the natural slopes.

There are three types of water erosion. (i) sheet erosion (ii) rill erosion (iii) gully erosion. In case of sheet erosion the soil is removed uniformly from the land ultimately exposing the sub-soil. This happens on land which are fallow. Since sheet erosion removes the soil in thin layers, its action is not easily observed and is indeed not usually noticed by farmers until it is far advanced. In extreme cases, sheet erosion is accompanied by tiny furrows scattered along the slopes, this is rill erosion; when the intensity and flow of water in the rill is more the water has a downward cutting action in the soil which ultimately are turned into a small ravine. The soil removed in this way is known as gulley erosion. A gully may be defined as a ditch cut by the running water. (2)* If the ditch is very large it is called a ganyon. If it is small it is called a ravine or a drow. If it carries constantly flowing water it is called a stream. In most soils gullies assume a 'V' shape first, a somewhat older gulley takes a 'U' shape. Vegetation is usually found on the banks of the gullies.

All erosion is detrimental but the damage caused by sheet erosion is more dangerous.

Let us turn to wind erosion. This happens only in the absence of moisture--common in dry farming areas. The menace caused by wind erosion is as detrimental as water erosion. Not only the rich soil particles are blown away from the land but the plants are either blown or their root system exposed which in course of time causes the plants to die. During severe wind erosion the sand particles removed have a tearing action on the tender leaves of the plant, which in course of time causes material loss to the farmer. Wind erosion is more prevalent in deserts, where sand dunes are formed, sand being much heavier is not carried up into the upper atmosphere with the wind, but remains on the land, where it piles up. In this manner mounds originate. The erodobility of the soil by water depends on a number of factors namely (i) natural slope of the land (ii) intensity and quantity of rainfall (iii) presence or absence of vegetation. (iv) The types of soil and sub-soil. In heavy rainfall tracts the surplus water due to heavy rains has a tendency to flow away from the land along the natural slopes; this is known as surface run off, which is not only unavoidable to the plants, but in addition carries a lot of rich surface soil along with it. This surface run off takes place where the soil has a very poor absortive power with an impervious sub-soil. The soil is not able to cope up with the rainfall due to which excess of water runs off the field. It is assumed about

* (1) A. F Gostafson "Soils & Management."

* (2) "Soil Erosion & Control" by A. E. Burges

33½% of the rain received is lost as run off. Increase in velocity of the run off doubles the quantity of soil removed, a place having a heavy annual rainfall evenly distributed throughout the year helps in conserving the soil, while a place with torrential rainfall may suffer from severe damage. The rain drops decending on the soil with tremendous force splash the soil particles round about, this is common with soils loose in nature especially the sandy soils. Next is the gradient, the greater the gradient greater is the erosion and vice versa.

The presence of vegetation is an important factor in controlling erosion. A land without any vegetation or cover crops is apt for a severe damage by soil erosion, than a covered or cultivated land. The cover crops serve the double purpose of protecting the soil from erosion and of improving the fertility of the soil when they are turned under. They also increase the absorbtive capacity of the soil by filling it with humus. The leaves of these crops intercept the beating action of the rain drops on the bare soil. The stems of these plants also prevent soil erosion by reducing the velocity of running water. The tiny roots of the plants help in holding the soil particles together. This is one of the reasons why the forest soils are never eroded away as they are kept under constant vegetation.

The type of soil also determines the rate of erosion. Soils of the granite and laterite origin allow more water to percolate into the deeper layers and thus there is no surface run off and in contrast clayey soils and loamy soils are easily eroded away due to their impervious nature. Heavy soil with impervious subsoils are easily eroded away.

## Control of Wind Erosion

In most of the dry farming tracts, to prevent wind erosion, certain forms of tillage are adopted. Deep plowing and finely pulvurised conditions of the soil are not suitable in such places, a cloddy or gritty condition should be encouraged. The land is always laid into ridges and furrows at right angles to the prevailing wind. Wind barriers are constructed on the windward side to minimize the velocity of the wind which not only blows away the soil but robs away the moisture. Wind barriers may be in the form of big trees or artificial barriers.

Strip cropping is advocated in such places alternating a soil exposing with a soil protecting crop. Before the cultivation of the soil, nature held the soil intact. In future it is only possible to hold the soil by adopting some other form of vegetative cover. Clean cultivated crops like potato, corn and cotton enhance such loss. Whereas grain crops like Bajri ( Pearl Millet ) & Jowar (sorghum) impede such loss.

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## Control of Water Erosion.

Water Erosion can be controlled to a considerable degree or extent by the methods enumerated below:—

(i) Deep plowing and surface tillage.
(ii) Gully control.
(iii) Contour farming.
(iv) Strip cropping.
(v) Pastures and grass lands.
(vi) Reforestation.

Deep plowing increases the absortive power of the soil whereas surface tillage leaves the land in corrugation or ups and downs which ultimately reduces surface run off. Deep plowing turns the soil and leaves the soil in a cloddy condition which prevents the run off of water. In case of lands which are slopy, the tillage is always done at right angles to the slope. Ridges and furrows are opened across the slep at distances depending on the slope.

## Gully Control

A gully or a small ravine not only brings about soil erosion but interferes with the tillage of the land by dividing the land into irregular strips. Temporary structures will usually be sufficient to control gully until vegetation can take charge of it. * Among the types of temporary structures used for gulley control are Logs, wooven wire, loose stone, brush, leaves and branches. Before preparing any type of obstruction the sides of the gulley are plowed to reduce the slope. An important point in gully control is the sloping of the banks to an angle such that grasses and other vegetation can grow on the bank. If the banks are not sloped they will continue to cave in. If gullies are very large they are required to be filled or covered with trash materials. * Non-eroding crops can be grown on the banks.

## Contour Farming

In contour farming, cultivation is done according to definite contours. Ridges and furrows are opened along the contour line and the cultivation is carried on in the ridges and furrows. All tillage operations are done along the contour lines and never across it. This type of farming is very common on hilly slopes especially with tea and rubber plantations where contour furrows are opened at convenient distances depending on the slope of the land. These contour furrows minimize the rate of erosion. Any surplus water that collects in the contour furrow is let into a main drain which runs along the natural slope of the land and is thus removed from the land. In such cases lock and spill system of drainage facilities are provided. This system of drainage prevents the soil from erosion.

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* (1) " Soil Erosion & Control " by A. E. Burges

## Strip Cropping

When the land is slopy and is subject to severe erosion, it may be laid out into narrow strips in straight parallel lines crosswise the general slope. In these narrow strips eroding or a soil exposing and non eroding or soil protecting crops are alternated. Water cannot attain much velocity in these narrow strips of cultivated land. Grain crops tend to check the run off. This type of cropping is known as strip cropping, and when this strip cropping is done according to definite contour, it is known as contour strip cropping.

## Pastures And Grasslands

They cover the bare soil and help in protecting the soil from the rain. The leaves of these plants protect the soil from the beating rain drops, descending on the land with certain force. Permanent grasslands afford less protection to the soil but have an effect comparable with that of the forest in that the actual erosion of the soil is checked, but the protection afforded by the grass is generally sufficient to hold the soil in place. Grasslands do the double purpose of providing ample grazing areas for the cattle as well as conserving the soil from erosion. *For this reason a covered fallow is always encouraged than a bare fallow on soils* left without any cultivation.

## Reforestation

In primitive cultivation, the forests were cut or burnt with the idea of cleaning the land for cultivation, without realising the actual loss, brought to humanity, but nowadays it has been universally realised that deforestation brings about a detrimental loss to the humanity. In natural forests, grasses and annual herbs, shrubs and trees after their life cycle die and decay to form a layer of humus which covers that soil. In addition,the humus acts as a sponge and increases the absorbtive capacity of the soil. When the rain falls gently, the whole is absorbed in the soil but torrential showers lead to surface run off due to poor absorbtive capacity of the soil. It is always beneficial to reforest the soils which are left fallow without any cultivation. In short the control of soil erosion is the restoration of the vegetative covering so as to protect the soil from the erosive action of wind and water.

# College Notes and News

The Gymkhana started its activities in right earnest from the beginning of the second term. The college annual athletic sports were held during the last week of October and large number of students took part therein. Messrs. Brahme Dalaya, Mahajan, D'souza, Pinto were the shining stars. Mr. Brahme won the individual championship and Mr. Dalaya was the runner up. A novel item in this year's activities was the institution of " Body Beautiful Competition " which naturally attracted great interest and enthusiasm among the students. Mr. A. N. Shinde and Mr. J. G. Patil won the first and second prizes respectively.

In the Inter-Collegiate Sports, Gurusahani brothers represented our college in tennis. Our hockey team was quite good and gave a good account of itself. Messrs. C. M. Ketkar and M. H. Deshpande showed great skill in the game.

It is a matter of pride that our budding boxers Messrs. V. P. Mane and S. N. Dharu were champion and runner up respectively in the boxing competition. This reflects great credit to them and the college.

Mr. Mahajan stood first in cross-country and 2nd in 3000 meters running. Mr. F. F. Pinto had a good style in Javellin throw and got the first prize. Mr. Desouza also put up good show and stood first in hop step jump.

The Indian games and athletics departments were ideal and very active during the year. It secured all the 61 points scored by the college in the inter -collegiate tournaments.

I am very glad to mention that Messrs. A. N. Shinde. F. F. Pinto and D'souza were selected to take part in the wrestling, javelin throw and hop-step jump matches respectively in the inter-group university sports. The two carried away the second and the first prize in the respective games.

Mr. A. N. Shinde who was selected to represent the Poona University in the All-India Inter-University wrestling matches, justified his selection and carried away the winner's prize in the light weight championship.

These achievements, though few and far between are of an outstanding nature. There is no doubt that given more time and leisure for practice, the students of this college can make still better contribution to this important sphere of college and university activity.

My best thanks are due to those members of the office staff and my colleagues who gave their fullest co-operation and help in the different tasks of carrying out Gymkhana activities.

Our heartful congratulations to those who won and best wishes to the rest.

**A. N. Shinde**
Hon. Gen. Secretary.

## Our Sports Achievements in 1949-1950

### Poona District Football Association Tournaments

Football:— Runners-Up.

### Inter-Collegiate Sports

1 . Khoko:—— Runners up.

2 . Weight lifting : ——

(i) Mr. V. P. Dalaya, Champion below 148 lbs.
(ii) Mr. J. G. Patil, ,, ,, 110 lbs.

3. Wrestling:—

(i) Mr. A. N. Shinde, Champion in light weight.
(ii) Mr. Bhosale, ,, in fly ,,

4. Boxing:—

(i) Mr. V. P. Mane, Champion in fly weight.
(il) Mr. S. N. Dharu, Runners-Up in fly weight.

5. Athletics:—

(i) Mr. K. M. Mahajan, First in cross-country.
(ii) Mr. ,, ;, ,, Second in 3000 meters run.
(iii) Mr. ,, ,, ,, Second in 1500 meters run.
(iv) Mr. F. F. Pinto, First in Javelin throw.
(v) Mr. J. B. D'souza First in hop step & jump.

### Intergroup University Sports.

(i) Mr. J. B. D'souza, First in hop step & jump.
(ii) Mr. F. F. Pinto, Second in Javelin throw.

### All-India Inter University Sports

Wrestling:—

(1) Mr. Anandrao N. Shinde, Champion in light weight.

**A. N. Shinde.**
Hon. Gen. Secretary.

## हिन्दी -- विभाग

# गो दुग्धका महत्व

लेखक:— ए. के द्वारकानाथ अय्यंगार, "कोविद"
(तृतीय वर्ष–खेती विज्ञान महाविद्यालय, पूना.)

आपको कदाचित विदित होगा कि जब कभी आप दूधका एक गिलास नही पीते तो आपको अंडे या आधा पक्षी या फलके रसका पूरा गिलास न लेनेसे जितनी हानि होती है, उतनी ही क्षति पहुंचती है। पोषण शक्तिके विचारसे एक पूरे मनुष्यके लिए जितना उत्तम भोजनके लिए चाहिए उसका दूधके चार गिलासों में—

१) ३६ प्रतिशत केलशियम ( 36% Ca. )
२) ३ क्वार्टर विटामिन 'जी' ( vit. G. )
३) ७ प्रतिशत ,, 'सी' ( vit. C. )
४) ६ प्रतिशत फोसफरस ( Phosphorus )
५) ४६ प्रतिशत प्रोटीन्स् ( Proteins )
६) २८ प्रतिशत विटामीन 'बी' ( vit. B. )
७) १६ प्रतिशत लौह ( Iron & Haemoglobin )

प्राप्त होता है.

सरल भाषामें यह कह सकते है कि अधिक दूध पीनेसे नित्य कृत्यमें स्वास्थ्य तथा कुशलता और डॉक्टरकी फीस आदिमें भी पर्याप्त बचत हो जाती है।

यह सब सरलतासे प्राप्त हो सकता हैं, यदि आप यह दृढनिश्चय करलें कि जो दूध का गिलास आप अभी नहीं ले रहे हैं, वह अब अवश्य लेने लगेंगे। परंतु हम भारतीय दूध पीनेके उतने प्रेमी नहीं हैं, जितना और समुन्नत देशवासियोंमें दूध पीनेका प्रचार है।

अमेरीकामें शुद्ध ५ करोड क्वार्टर दूध John Que के निवासियोंके घरोपर प्रतिदिन पहूंचा दिया जाता है। वहां प्रत्येक व्यक्ति सप्ताह ७.२ पाइन्टस ( 7.2 pints ) दूध पीता है और अनुमान यह है कि, वर्षभरके आहारका चतुर्थांश दुग्ध सेवन, खोआ, मक्खन (milk products) आदि युक्त होता है।

किन्तु इस विषयमें अमेरीका अन्य देशोंसे आगे नहीं बढ़ा हुआ है। कॅनेडा, न्यूझीलंड, स्वीट्झरलॅंड, फिनलॅंड और बर्तानिया में प्रत्येक व्यक्ति क्रमशः ५६.८, ५५.६, ४९.२, ४५.५ और ८०.७ औंस दूग्ध प्रतिदिन लेता है। किन्तु हमारे भारतमें दूधपान प्रति व्यक्तिपर लगभग ५.८ औंस पडता है। इस बातको विचारते हुए कि, दूध मनुष्यके लिए पौषक और महत्त्वपूर्ण पदार्थ है। यह अत्यन्त आवश्यक है कि, हम शीघ्रातिशीघ्र उस शेष ३५ औंस दूधको और प्राप्त करनेका उद्योग करें जो आजकल हमें नहीं मिल रहा है।

सबसे पृथ्विमे तो यही प्रतीत होता है कि, भारतमें जितना दूध होना चाहिए उतना नहीं होता। रशियाको मिलाकरभी सारे यूरोपमें जितने पशू है, उतनेही अपने यहां है पर उनके यहां जितना दूध होता है उसका पंचमांश ही यहां होता है। और कॅनेडासें भारतमें १८ गुने अधिक पशू है परन्तु दूधका उत्पादन केनेडासे केवल ५ गुना अधिक ही होता है।

और जबकि अन्य देशोंमे जितना दूध होता है, उसका ४० प्रतिशत दूधके रूपमेंही पी लिया जाता है। आपने देशमें देशके रूपमें केवल २५ प्रतिशत ही पिया जाता है। लगभग ५० प्रतिशत दूधका अपने यहां भी बनाया जाता है और कुछ भागका दही, खोआ आदि बनाया जाता है, इसमें दूधके पशू रखनेवाले व्यक्तियोंका कोइ दोष नहीं है।

अमेरीका निवासियोंने जिनसे यह प्रश्न किया गया था, बहुमतसे यही उत्तर दिया कि वे दूधको स्वाभाविक रूपमे ही लेना चाहेंगे। यही नहीं वहांकी जनताको संशय होने लगी कि, कहीं दूधमें सचमुच कमी न पडजाये और कलेवा, दोपहरके भोजन या तिसरे पहरके जलपान या रातको भोजनमेसे किसीभी समय उनका प्रिय पेय दूध न मिलातो कैसा होगा। इतनाही नहीं अमेरीकन लोगोंने बिना दूधके लोगोंकी क्या दशा होगी। इसके विषयमेंभी अपने विचार प्रकट किये है। जो लोग बालक या तरुण थे उन्होंने लिखा कि, विना दूधके जनताके स्वास्थ्यको बडा धक्का पहुंचेगा, जनता की शक्तिका स्रोतही क्षीण पड जायेगा, तपेदिकसे राष्ट्र नष्ट-भ्रष्ट हो जायेगा, आगेकी पिढीका स्वास्थ्य बहूत गिर जायेगा। (Deterioration of the future gereration) हमारे दांत जाते हेंगे। जो अधिक आयुवाले थे उनकी सम्मति इतनी उग्र नही थी पर यह तो उन लोगोंनेभी लिखा कि दूध की भारी कमी होनेपर भोजनकी व्यवस्थामें बहूत उलट-फेर करना पडेगा.

दूध की और भी कमी हो जानेके विचारसे यदि आपके दिलमें हलचल नहीं होती तो यह स्पष्ट है कि दूधका आपके भोजनमें कोइ विशेष स्थान नहीं है। मानो या न मानो किन्तु प्रकृतिका सबसे पूर्ण भोजन दूधही है। दूधके एक गिलासमें हड्डी बनानेका ( bone formation) इतना तत्व होता है, जितना रोटी के ४२ टुकडोमे।

विटामिन ए ( Vit. A ) जिसमें बहूतसे विशेष गुण होते है, अन्य पदार्थोंकी अपेक्षा इस अलौकिक दूधमे ही सबसे अधिक पाया जाता है। खानेके पदार्थोंमें यही एक पूर्णतम (Perfect) भोजन है। यदि आपको दूधकी चिन्ता न हो तो निष्कर्ष यही होगा कि दूधका आपकी दृष्टिमे कोइ महत्त्व नहीं।

यदि दूधका महत्त्व होता तो हमने उसके लिए अबतक कुछ न कुछ अवश्य किया होता। बैठे-बैठे केवल हमारे पशुओंकी दुर्दशा, चारेकी कमी, यातायातकी दुर्व्यवस्था और सरकारकी कडी आलोचना ही न करते। सच तो यह है कि, दूधकी कमी हमको अखरती ही नहीं। दूधमें मिलावर ( adulteration ) है यह जानकर भी हम कुछ नहीं करते और यदी नही यदि कदाचित दूध शुद्ध भी हूआ जिसकी अत्यल्प सम्भावना है तो चाय बनाकर हम खुद दूधमें पानीकी मिलावर कर देते है। दूधके विषयमें हमारी उपेक्षा सीमाको अतिक्रान्त कर गइ है।

आज सभी देशोंमें राष्ट्रके स्वास्थ्यकी कमीमें दूधका महत्त्व जानकर दुधकी मात्रा और गुणोंमें वृद्धि करनेका अत्यधिक प्रयास किया जा रहा है। हम ही क्यों पिछडे रहे। अब समय आ रहा है कि जिस दूधसे हम वंचित है उसके विषयमें चिन्तित होकर उसको प्राप्त करनेका उद्योग करें। यह निश्चय है कि यदि दूधके लिए हमें लगन होगी ( Mere inquisite ) जो दूध हमको अवश्य मिलने लगेगा।

— जयहिंद —

आधारभूत : —

" नवयुग " श्री. पावेरी—

# आहार की कमी का प्रभाव

लेखकः— ए. के. द्वारकानाथ अय्यंगार, "कोविद"
( तृतीय वर्ष—खेती विज्ञान महाविद्यालय, पूना. )

जो भी भोजन खाया जाए वह ऐसा होना चाहिये और उसकी प्रकार और मात्रा इतनी होकि हमारे शरीरको बनाए रखे और हमारे भारतमें कभी न होने पाए। विभिन्न वर्गके मनुष्योंको विभिन्न प्रकारके भोजनकी आवश्यकता होती है। यदि किसी भोजनमें स्वास्थ्यको स्थिर रखनेके लिए अन्य रक्षात्मक पदार्थोंका अभाव हो जाय तो परिवामतः हमारे शरीरमें खाद्य तत्त्वोंकी कमी हो जाती है। अपर्याप्त भोजनके कारण हमारी शक्तीएं स्थिर नहीं रह सकती। यदि किसी व्यक्तिके शरीरमें calories क्लोरीज आवश्यकतासे कम मात्रा में हो तो स्वास्थ्य गिर जाता है, शरीर का पोषण रुक जाता है, और शरीर दुर्बल हो जाता है। खाद्य तत्त्वोंकी कमी का प्रभाव बच्चों, गर्भवती स्त्रियों और दूध पिलानेवाली माताओ में स्पष्ट दिखाइ देता है। इन्हें ऐसे भोजनकी बडी आवश्यकता होती है जिससे उनके शरीरका पोषणहो और जो टिशू ( Tissues ) नष्ट हो गए हों वह पुनः उत्पन्न होसके।

संयुक्त राज्य अमेरीका ( U.S.A. ) में जो प्रयोग किए गए हैं उनसें विदित होता है कि खाद्य तत्त्वोंकी कमी के कारण एक व्यक्तिमें अनेक प्रकार के मनोवैज्ञानिक परिवर्तन आजाते हैं। इस विषयमें जो विशेष बातें है उन्हें संक्षेपमें नीचे दिया गया है।

भारमें कमी; शरीरका दुबलापन, त्वचाके नीचेके टीशू ( Tissues ) और पट्ठोंका शनैः शनैः क्षय, पोषणमें विलम्ब ( विशेषतः बालों और नखोंके ) सांधियोंके चढनेमें अशक्ति अनुभव गर्मीको सहन करनेकी शक्ति और सर्दीको सहन करना, नाडियों नाडियोंकी गतिमें कमी, नया शरीरांश न बनाना, अशक्तताके कारण बुढापे का अनुभव, निरुत्साह और शिथिलता, किसी प्रकार भाव न होना, ( Loss of apitite ) खिन्नता, चिडचिडापन, नेत्रोंकी ज्योतिमें कमी, आंखोंमें पीडा, आंखोके आगे धब्बे (Dots) दिखाई देना, बौद्धिक और शारीरिक परिश्रमको सहन करनेकी शक्तिका अभाव, थकावट, किसी कोलाहल परिणामपर न आना, को सहन करनेकी शक्ति रहना, किसी कार्यमें तल्लीन होनेमें कमी, कामवासनाका भडकना, दृढता और धैर्यकी भावनाओंके प्रगट करनेकी शक्तिका अभाव।

किसी कार्यसे लगाव या दिलचस्पीन होना, बौद्धिक खिन्नता, चिडाचिडापन, आलस्य और प्रमाद अन्नकी कमीके ऐसे चिन्ह है जो प्रारम्भ में पाए जातें है किन्तु इनके संबंधमें यह बताया जाता है कि इनका मुख्य कारण भोजनही है ।

किन्तु सर्व साधारणतः लोग इनसे परिचित नही है, अतः वे इनको चिकित्साके लिये डॉक्टरोंके पास जातें है, जबकि वस्तुतः इन चिन्होंकी रोक धामका साधन और उसकी औषधि उन्हीके भोजना लयमें है । —जयहिंद

आधारभूत :—
" आर्यभानु "

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## मराठी विभाग

# हिंदी ग्रामीण जीवनांतील धोंड-कर्जबाजारीपणा

लेखक—**अरविंद रघुनाथ कर्वे** B.Sc. (Agri.) Class

माती असशी, मातीत मिळशी.....हें काव्य म्हणणाऱ्यांना आपण निराशावादी असें बोधितो. पण ह्यांत जर आपण थोडा बदल केला आणि म्हटलें, हे शेतकऱ्या—कर्जात जन्मशी र्जात मरशी.....तर वस्तुस्थितीचेंच दर्शन होईल. कर्ज विमुक्त असण्याचें क्षण शेतकऱ्याच्या ायुष्यांत फार थोडे असतात. बी, बियाणाकरितां, स्वतःच्या जीवितांकरितां, दुष्काळादि आपत्ती-त तरुन जाण्याकरितां, धार्मिक कार्याकरितां वगैरे अनेक कारणासाठीं हिंदी शेतकऱ्यांस सावकाराचें य धरावे लागतात. वडिलोपार्जित धन आणि वडिलोपार्जित कर्ज या दोन्हीं गोष्टी इतक्या सहज-तें हिंदी शेतकऱ्याच्या जीवनांत रुढ होऊन बसल्या आहेत कीं, त्यांचा पगडा काढणें ही एक अशक्य ोष्ट होऊन बसली आहे.

समाजांतील दर्जासंबंधींच्या कांहीं विपरित कल्पना असल्यामुळें शेतकरी आपल्या चीजवस्तू गहाण टाकण्यास कचरतो. या वृत्तीमुळेंच तो वाटेल त्या व्याजानें कर्ज घ्यावयास तयार होतो आणि परिणामी सावकार आपल्या घरावर सोन्याची कौलें चढवितो. पिढ्यानुपिढ्या सावकारांनीं केलेल्या गळचेपीमुळें निर्माण झालेली ही कर्जबाजारी, जरी शेतकरी सावकाराच्या घरीं जन्मभर गुलाम म्हणून राहिला, तरी नाहींशी होणार नाहीं. एखाद्या इमारतीचा पायाच जर उंदीरघुशींनी पोखरून खिळखिळा केला असेल तर त्या इमारतीवर आपण कांहीं मजलें चढवावयाचे असा विचार केला तर कसें दिसेल ? तशी स्थिती आपल्या शेतकऱ्यांची झाली आहे. भारताचा आधारस्तंभ शेतकरी, तोंच जर कर्जानें पोखरला असेल तर आपण राष्ट्रीयत्वाच्या गप्पा मारण्यांत काय अर्थ आहे ?

कृषिवर्ग ह्या स्थितीस पोहोंचला त्याला अनेक कारणें आहेत. कांहीं विद्वानांचे म्हणणें असें आहे कीं, हिंदी शेतकऱ्यास उत्पादनास मदत न करणाऱ्या गोष्टीकरितां कर्ज काढावयाची संवय लागली आहे. तर कांहींचे म्हणणें असें आहे कीं, तो पूर्वजांनी केलेल्या कर्जातच गाडला गेला आहे. पावसाची अनियमितता, भाऊबंदकीमुळें पडलेले जमिनीचे लहान लहान तुकडे वगैरे अनेक कारणें निदर्शनांस आलीं आहेत. कांहीं मुख्य कारणांची चर्चा आपण अनुक्रमें करूं या.

घरांतील कर्तापुरूष निवर्तल्यानंतर त्याच्या नांवावर असलेली जमीन, हिंदुकायद्यान्वयें त्याच्या सर्व नातेवाइकांस विभागून मिळते व त्यामुळें त्यांच्यांत भांडणें होऊन, जमिनीचे तुकडे करावे लागतात. आणि अशा लहान तुकड्यांची मशागत व पीक यांचे प्रमाण कधींच फायदेशीर पडत नाहीं. आणि त्यामुळेंच अपुऱ्या उत्पन्नांवर शेतकरी हालांत राहूं लागतो आणि ओघानेंच त्याला सावकारांस जवळ करावें लागतें.

घरगुती उद्योगधंदे हें एक हिंदुस्थानचें वैशिष्ठ्य होतें. त्यामुळें हिंदुस्थान स्वावलंबी राहूं शकला होता. पण नवीन यंत्रोत्पादनामुळें, हे सर्व घरगुती उद्योगधंदे अजिबात बसून गेले व त्यामुळें शेतकऱ्याला जोडधंदा उरला नाहीं. आणि त्याला फक्त शेतीवरच अवलंबून रहावें लागलें. बैलगाडीचे एक चाक काढल्यावर जशी ती चालूं शकत नाहीं, त्याप्रमाणेंच शेतकऱ्याची आर्थिक बाजू ढासळली. मशागत करून उरलेला वेळ त्याला आळसांत काढावा लागतो, आणि त्यामुळेंच त्याचा कर्जबाजारी-पणा वाढीस लागला. थोड्याश्या जमिनींतून येणाऱ्या अपुऱ्या उत्पन्नामुळें आणि त्यांतही असंख्य वांटेकऱ्यामुळें शेतकऱ्यास सावकाराच्या घराची पायरी चढावी लागली. पैश्या येवढ्या मांसाच्या तुकड्या-करितां धडपडणाऱ्या कावळ्यासारखी आपली परिस्थिती झाली आहे.

भारतीय शेती मान्सून पावसावर अवलंबून आहे. सोंगट्यांच्या डावात "फांसाला" जितके महत्व आहे, तितकेंच महत्व आपल्याकडे पावसाला आहे. बहुतेक सर्व हिंदुस्थान पावसावांचून लागवड करूं शकत नाहीं. आणि हाय ! ज्याच्या आशेवर आपण जगतो तो मान्सून पाऊसमुद्धां अनियमितपणें पडतो. अवर्षणांत शेतकऱ्यांचे काय हाल असतात याचे वर्णन करण्याची जरुरीच नाहीं. साधारणतः दर पांच वर्षांत एक वर्ष अतिवर्षण, एक वर्ष अवर्षण व एक वर्ष समाधानकारक तर

उरलेली दोन वर्षे धड वाईटही नाहीं, आणि चांगलीही नाहीं अशा अवस्थेत जातात असें अनुमान आपल्या शास्त्रज्ञांनीं काढलें आहे. अशा नियमित अनियमितपणामुळें हिंदी शेतकरी हलाखीच्या परिस्थितीस पोहोंचला आणि त्यामुळें त्याला सावकार हा जास्त जवळचा वाटूं लागला. कारण तो अशा वेळीं त्याला द्रव्य सहाय्य करून संकटमुक्त करीत असें. दुष्काळ डोळ्यांदेखत जीव घेतो पण सावकार डोळ्यांआड हालहाल करून जीव घेतो.

हजारों जनावरें संसर्गजन्य रोगांस बळी पडली. आतांपर्यंतच्या काळांत रोग बऱ्यांच मोठ्या प्रमाणावर फैलावले आणि शेतकऱ्याची उरलेली संपत्ती हिरावून नेली. म्हाताऱ्या माणसाची काठी काढून घेतल्यावर त्याची जी अवस्था होईल तीच अवस्था त्याची झाली आणि म्हणून नवीन गुरें घेण्याकरतां त्यानें सावकारास जवळ केलें, आणि आपल्या पायावर धोंडा ओढून घेतला.

हिंवतापादि रोगांनीं शेतकऱ्यांत कमकुवतपणा उत्पन्न केला. दमट हवेच्या भागांत या रोगाचा विशेष फैलाव झाला आणि त्याची कर्तृत्वशक्ती कमी झाली. ओघानेंच धनार्जनावर परिणाम झाला आणि तो टाळण्यासाठीं सावकाराची "हांजी हांजी" करावी लागली.

हिंदी शेतकऱ्याला न्यायालयांत जाऊन खटले चालवणें यांत फार फुशारकी वाटते. किरकोळ कारणाकरितां आपली संपत्ति पणास लावून खटले चालवणें ही एक शेतकऱ्याची आवश्यक गोष्ट होऊन बसली होती. लग्न, मुंजी वगैरे सारख्या धार्मिक आणि सामाजिक कार्याकरितां फार खर्च करणें म्हणजे आपली समाजांत पत वाढवणें अशा चुकीच्या समजुती समाजांत रुढ झाल्या आणि म्हणूनच सावकारी पाश दृढ होत गेले.

इंग्रजी अमलांत, सरकारनें सावकारांची बाजू उचलून धरल्यामुळें सावकारांना शेतकऱ्यांस पिळून काढावयास संधी मिळाली. सहजतेनें मिळणारे कर्ज यामुळें तर शेतकरी लवकरच कर्ज काढावयास सवकला, आणि म्हणूनच तो एखाद्या दारुबाजासारखा अधोगतीस पोहोंचला.

सावकार वर्गाची पैसे उकळण्याची वृत्ती हें एक अधोगतीचे महत्वाचे कारण म्हणतां येईल. (सावकार वाचकमित्रहो, स्पष्ट लिहिल्याबद्दल क्षमा करा) अशिक्षित शेतकऱ्याकडून खोटे कागद करून घेणें, कोऱ्या कागदावर आंगठे अगर सह्या घेणें, चक्रवाढीनें व्याज मोजणें वगैरे अनैतिक मार्गांनीं त्यांनीं त्या गरीब वर्गाला हैराण केले.

वरील सर्व विवेचनावरून असें दिसून येईल कीं, सावकाराला जवळ करण्यांस अनेक नैसर्गिक आणि अनैसर्गिक कारणें घडली. कांहीं अर्थशास्त्रज्ञांनीं १९३० मध्यें धारवाड जिल्ह्यांतील कर्जबाजारीचें खालीलप्रमाणें विवेचन केलें. त्यांनी ३ खेड्यांची पहाणी केली. आणि प्रत्येक कारणाकरितां किती टक्के कर्ज आहे तें शोधिलें.

| | ग्राम १ | ग्राम २ | ग्राम ३ |
|---|---|---|---|
| शेतीच्या चालूं गरजा | १७·२३% | १८·६३% | १९·८% |
| शेत सुधारणा | ९·३२% | ३·८ % | ४·७% |
| घरगुती गरजा | १०·१ % | १५·७ % | १७·२% |
| व्यापार | ८·६ % | ७·० % | ०·७% |
| लग्न कार्ये | १७·१ % | २१·० % | ४५·६% |
| कोर्ट खटले | २·९ % | १८·७ % | ०·८% |
| इतर कारणें | ३·६३% | ४·६ % | ३·६% |

या कर्जाच्या ओझ्यामुळें समाजावर तीन तऱ्हेचे परिणाम झाले. आर्थिक, सामाजिक आणि नैतिक. जसजसें कर्ज वाढत गेलें तसतसें शेतकऱ्याचे मशागतीवरचे लक्ष उडून गेले. त्याला कळून येत कीं, आपण कितीही जरी कष्ट केलें तरी कांहीं विशेष फायदा होणार नाही. आणि त्यामुळें मजूरांची (स्वतःची जमीन नसतांना काम करून पैसे मिळणारांची) संख्या वाढूं लागली. सावकारी पाशामुळें जें पीक थोडें फार पिकवलें असेल ते विकण्याची कुचंबणा होऊन त्याला ते स्वस्त दरानें सावकारास विकावें लागतें. अशारितीनें कृषिवर्गानें आपली स्थिती निराशावादी करून टाकली आहे.

वर्गवारी आणि वर्गद्वेष ही वाढीस लागण्याचे कारण हेंच आहे. समाजांतील निराधार लोक असंतोष निर्माण करतात. १९२१ सालीं अशा मजूरांची संख्या २९ टक्के होती तीं १९३१ मधें ४० टक्के झाली आणि १९४१मध्यें खात्रीनें ५९ असेल.

नैतिक अधोगती तर फारच झाली आहे. पंजाबमध्यें कांहीं ठिकाणीं शेतकरी सावकाराचे अक्षरशः गुलाम झाले आहेत. किरकोळ कारणाकरितां पैसे घ्यावे आणि त्यासाठीं जन्मभर गुलामगिरी पत्करावी असें प्रकार चाललेलें आहेत.

वरील सर्व कारणें आणि परिणाम लक्षांत घेतां आपणांला हिंदी शेतकऱ्याची स्थिती सुधारणें किती आवश्यक आहे याची जाणीव होईलच. त्याकरितां आपण निरानिराळें प्रयत्न करणें आणि सरकारशीं सहमत होऊन सक्रिय मदत करणें हें किती आवश्यक आहे हें सुद्धां कळून येईल.

(आधार ग्रंथ : डॉ नारायणस्वामी व नरसिंह यांचे Economics of Indian Agriculture

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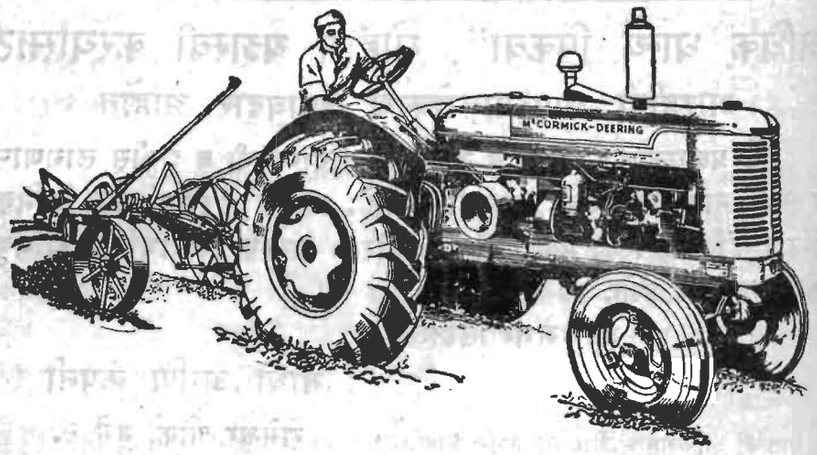


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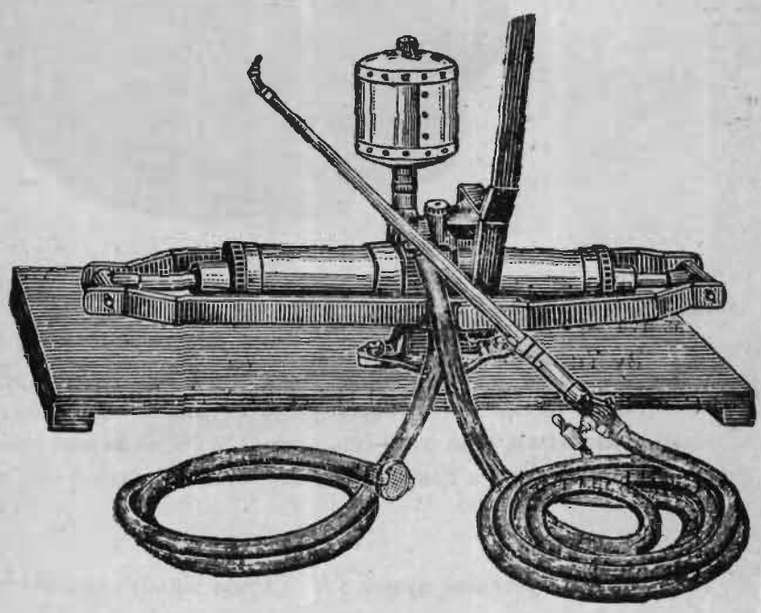

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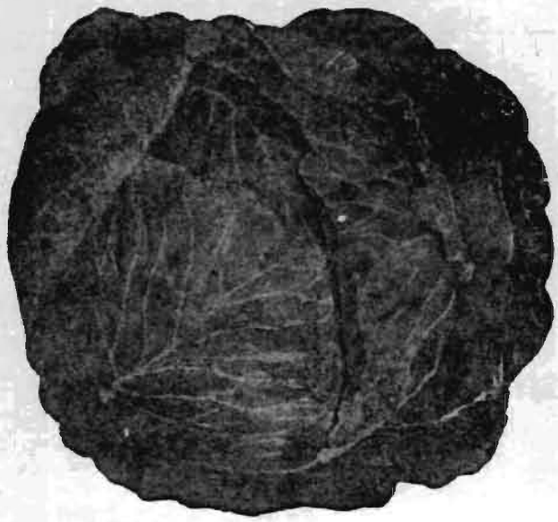

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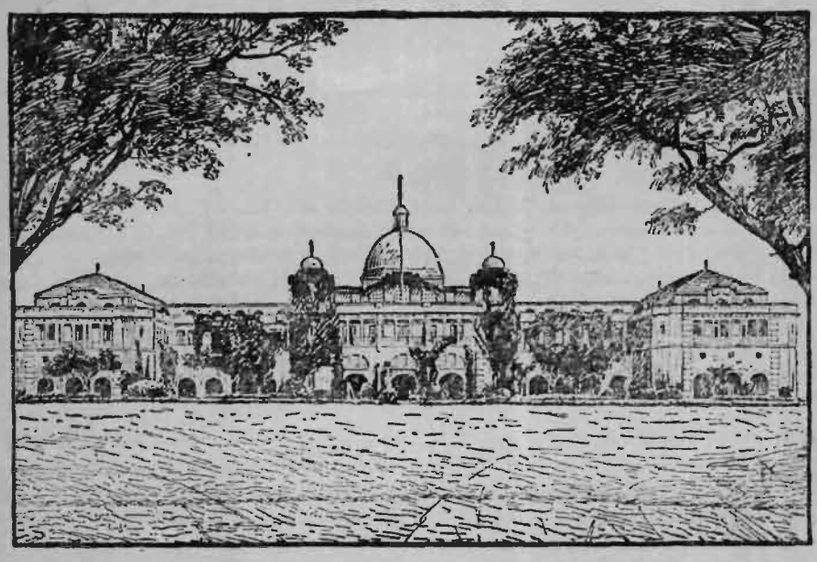
# Poona Agricultural College Magazine



It is not invariably true, however, that population pressures result in damage to the fertility of the land. Even within Italy today there are regions, notably portions of the Lombardy plains where the health of the land has been guarded for centuries. In Japan, no larger than the state of Montana but with a population one half that of the United States, the people with meticulous care, skill and intelligence have maintained the relatively limited amount of arable land that country possesses, only one fifth of its total land area, in a condition of productivity. But these instances together with but a few others, are the exception to the general rule. They are encouraging as proof of what can be done."

From—" **Our Plundered Planet** "——**by Fairfield Osborn.**

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## ERRATA

| Page | Line | Incorrect | Correct |
|---|---|---|---|
| 2 | 16 | has bright | has a bright |
| 8 | 37 | anatamo | anatomo |
| 9 | 37 | dialatometer | dilatometer |
| 10 | 14 | [illegible] | [illegible] |


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|---|---|---|---|
| 2 | 16 | has bright | has a bright |
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| 9 | 37 | dialatometer | dilatometer |
| 10 | 14 | I l jin | Iljin |
| 11 | 14 | changes | change |
| 11 | 17 | p wer | power |
| 13 | 11 | **Machine or** | **Machine fo** |
| 15 | 20 | c. | cicer |
| 19 | 21 | deteched | detached |
| 19 | 23 | is | are |
| 20 | 3 | structure | structures |
| 20 | 6 | a long | along |
| 20 | 34 | emmense | immense |
| 21 | 21 | is | are |
| 22 | 14 | a verage | average |
| 45 | 12 | pureliness | purelines |
| 45 | 28 | breeding | breeding, |
| 46 | 13 | photoperidism | photoperiodi: |
| 46 | Table I | imitation | initiation |
| 47 | Table II | lenth | length |
| 47 | ,, | Aliance | Alliance |
| 50 | 31 | uneation | uneaten |
| 50 | 32 | in | *Delete* |
| 50 | 33 | in first | in the first |
| 50 | 37 | surviors | survivors |
| 51 | 22 | two and half | two and a half |
| 51 | 23 | four and half | four and a half |
| 52 | 13 | vitability | vitality |
| 54 | 13 | lobes | lobes. |
| 55 | Graph | NRG | NR6 |
| 58 | 9 | in cool | in a cool |
| 58 | 10 | low temperature | low a temperature |
| 58 | 16 | cooler place | cooler places |
| 58 | 33 | top of pot | top of the pot |
| 60 | 21 | A. R. C. S. | A. R. C. S., |
| 61 | 16 | CARNELL | CORNELL |
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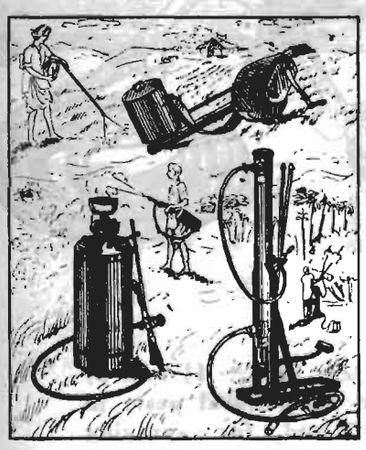

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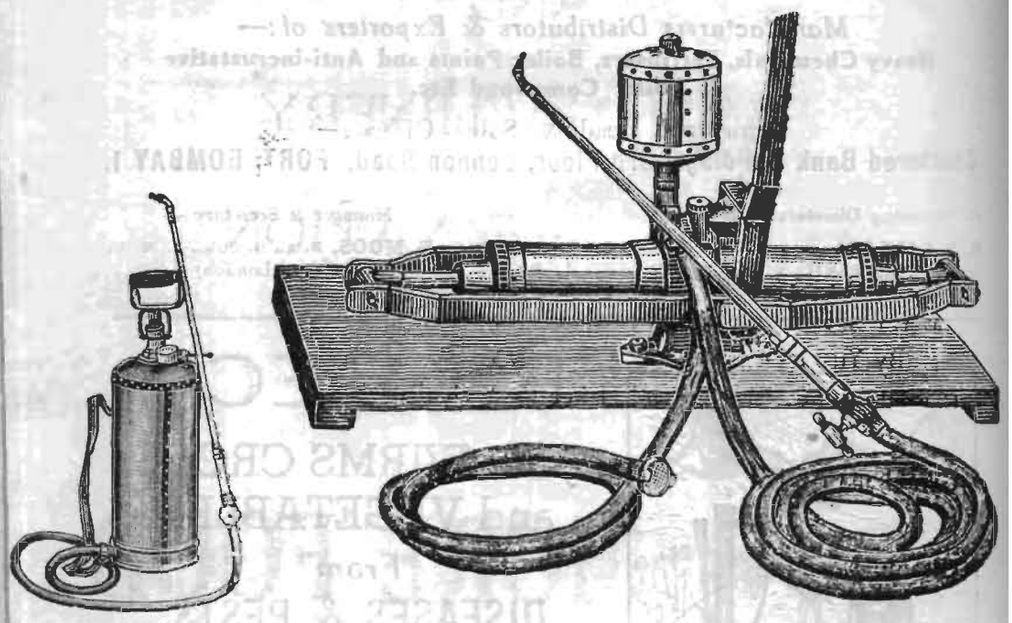

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THE POONA

# AGRICULTURAL COLLEGE MAGAZINE

VOL. XLI ] JUNE 1950 [ No. 1

## Editorial

It is but natural that we should feel strongly for the sad plight of the refugees coming to India from Eastern Pakistan. These refugees have had to leave their hearth and homes, their shelter, earnings, kith and kin and in some cases their nearest and dearest. The Government of India is doing all that is in its power to mitigate their sorry plight. It is, however, no small task to deal with such a large scale problem and it is but natural that it will be impossible to please the refugees.

Pandit Jawaharlal Nehru, Prime Minister, has, however, by his bold lead paved the way for better understanding with Pakistan. The Indo-Pak Pact concluded between the two countries should prove a turning point for millions of people who have been affected so far. Our Prime Minister, on behalf of our country, has placed his trust and faith combined with his usual charity and hope in the experiment of proper implementation of the pact. The Pakistan Prime Minister has declared and awowed his firm intention to implement the agreement in full. If the Governments and people of both the countries work the pact with a sincerity of purpose, the pact will bring about the reversal of the unfortunate happenings that have taken place so far and will establish permanent peace and goodwill between the people of the two neighbour countries. We hope and pray that good sense prevails on both sides to achieve the fulfilment of our Prime Minister's dream.

* * * *

During his tour in India last December Prof. A W. Ashby, Director of the Agricultural Economics Research Institute, forecast in a lecture at Bombay that the world's present capacity for food production was higher than it has ever been. He stated that the capacity was not, however, being fully used due to political considerations and economic barriers employed for political purposes. He

envisaged that the future trends in the world indicated plentiful food supply and lower prices. To us in India, it would be a heavenly gift when we could obtain plentiful nourishing food at cheap rates. We may hope for that day of plenty with no controls.

A more important point stressed by Prof Ashby was that the yields increased when crop and animal production were combined. The yield decreased if crop production was carried out alone. In the interests of agricultural economy and in the interest of better agriculture, it is therefore desirable that our cultivators should go in for a crop-cum-dairy programme.

* * * *

Experiments on jute cultivation in some of the districts of the State of Bombay have shown that it can be successfully grown and an area of 1000 acres will be under jute cultivation this year in the Ratnagiri, Thana, Satara, Kolaba, Karwar, Kolhapur, Belgaum and Surat districts. Ambadi fibre is known to mix well with jute in the preparation of certain articles and the proposed increase in Ambadi cultivation by about 35% will ease the jute situation appreciably. Ambadi cultivation has bright future, if the successful admixture of Ambadi and jute becomes a permanent feature in the manufacture of articles.

* * * *

The preliminary findings of the Agricultural Labour inquiry set up by the Government of India Labour Ministry to study the condition of agricultural labour in respect of the minimum wage have indicated that their standard of living has neither risen nor is there any appreciable improvement in their economic condition. The inquiry was conducted for the period of June to November 1949 at Vandalur village in Chingleput district. The average expenditure per family was Rs. 336 as against an annual income of Rs. 323. The diet was poor both in quantity and quality The investigation shows a sorry state of affairs and proves that there are just and sufficient grounds for raising the wages of agricultural labour.

* * * *

The planning commission appointed by the Government of India to coordinate and plan the development and progress of the country has started working and it is hoped that its deliberations and considered decisions will be of great value to the country. Needless to say the committee will concentrate primarily on food production. The members of the committee are well qualified for the work and with the Prime Minister as chairman of the committee, the outcome is sure to lead to considerable advancement of the country. The

success of the committee's decisions will largely depend upon the public response and cooperation. We trust that full cooperative effort and support will be forthcoming from every common man in India to fulfil the plans of the committee.

The conference on planning held at Delhi about the end of April 1950 envisages an overall balanced economy, rationalised production and a rise in the standard of living of our countrymen It is, therefore, essential to make the most of our existing resources. Enthusiasm on the part of all the workers in a project should be the key-note for the success of a scheme and the populace of India ( or at least all those who contribute directly and indirectly in fulfilling the completion of the project ) should heartily contribute their maximum effort to achieve something that is much more than the expectation of the planners. Only those schemes which deserve the highest priority should be put into force and once these have been brought to a successful fruition, the subsidiary or secondary schemes will be worked out without calling for public support. We feel that if once the public and the workers are convinced of the successful issue of a few schemes, there will be general support for all others.

* * * *

T. C. A. ( Trichloroacetic acid ) a herbicide, a small sample of which was obtained from America, is found to be an effective *hariali* ( *Cynadon dectylon* ) killer. Experiments conducted at this college have proved without doubt its capacity to eradicate *hariali*, a noxious weed. It is estimated that about 15 lacs acres of land is out of cultivation in the Bombay state at the present day because of *hariali* infestation. Its eradication by deep ploughing with tractors would require scores of years. The Honourable Minister for Agriculture and Forests has, therefore, desired to take up investigations to treat 500 acres of the *hariali* infested area with T. C. A. so as to enable it to be brought under food crops.

* * * *

To relieve the cotton shortage it is necessary to increase the area under cotton. The Government of India proposes to give land revenue concessions to enthusiastic cotton growers which would serve as incentives to them to put more area under cotton and to get a higher output thereof. It is estimated that the concessions will bring an additional four million acres under cotton yielding 8,00,000 bales of cotton.

* * * *

A publication of the Department of Agriculture, Bombay, entitled "*The Progress of Agricultural Research and Development Work in the Bombay State*" by **Dr. B. N. Uppal,** Ph. D., F. N. I., Director of Agriculture, Bombay State, is

a small booklet of 87 pages giving a comprehensive review of the agricultural activities in the State of Bombay. Dr. Uppal has taken considerable pains to present the work of the department in a clear, concise and lucid manner. All those interested in agriculture will find this booklet to be full of valuable information.

* * * *

**Announcements**

Shri M. M. Kibe has been awarded the Ph. D. degree of the University of Bombay for his thesis dealing with the black cotton soil.

* * * *

The College opened for the first session of the year 1950–51 on 15th May, 1950.

* * * *

Prof. A. A. Vasavada has been appointed Chairman of the College Gymkhana.

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## OBITUARY

We extremely regret to record the sad demise of Sri. D. R. Ghumashetti on 10th April 1950 after a brief illness at his native place. Sri. Ghumashetti passed his degree examination in agriculture in the year 1946 and was working as a Demonstrator in Animal Husbandry & Dairying at the College Dairy, after graduation. He was a hard & enthusiastic worker and was very popular amongst the students.

May God rest his soul in peace!

# DROUGHT RESISTANCE IN PLANTS

By

B. A. CHAUGULE *
B. Sc. (Agri.) Bom., M. S., Ph. D. (Calif.)

## Importance & Scope of the Subject

Of all the factors conditioning crop-production, drought or dearth of water is doubtless one of an undeniably great importance. Many crop producing regions of the world today are thrown at the mercy of nature for their success in crop-production, on account of the undefendable nature of the rainfall. Artificial irrigation is, of course, one of the few ways to combat situation, but it is too meagre to suffice the needs of the great majority of farmers in arid and semi-arid zones of the world; and whenever it is possible it is too expensive for the pockets of the farmers especially who are obliged to grow, by other limiting factors of crop production, only less paying crops. This makes it quite imperative for them to take resort to only a certain type of crop, regardless of whether it has ability to tide over periods of drought or not.

Crop improvement programmes, so far, have followed a certain path of breeding crop plants for the observable economic characters such as colour, plant height, maturity etc. But until recent years breeding projects have quite ignored one of the most outstanding and influencing aspect upon which success in crop-production depends. This aspect of breeding is 'drought resistance'.

A plant breeder may evolve a certain crop variety with an outstanding economic character. A soil scientist may recommend a certain fertilizer formula for this variety under certain conditions so as to make it yield to its utmost. But if such a variety fails to produce in unforeseen periods of drought or stress it certainly cannot command those parts of the country and those countries of the world which otherwise may be most suited to its successful cultivation. As is said earlier in these introductory remarks, observable characters like colour, height, etc. are comparatively easy to breed. Characters like drought resistance, disease resistance, etc., which are directly responsible for the ultimate yield and quality of the produce are rather difficult to handle as regards breeding. Breeding for such characters requires considerable patience, although it should not be impossible. High yield is a character which can be determined accurately only over a long period of years. It is not finally determined until the variety has been exposed to all the

* Assistant Professor of Agronomy, College of Agriculture, Poona 5.

unfavourable conditions which are likely to occur in the regions in which it is to be grown. Under these circumstances, therefore, if the plant breeder is left alone to himself he will have to wait long before he can finally find a variety integrating all the desirable characters, along with a character like drought resistance. This firstly is because natural drought in which to test a variety, is so regularly irregular in occurance and so hard to imitate artificially; and secondly because it has still not been definitely investigated what characters—morphological, anatomical and physiological—are associated with its ability to stand periods of drought. If a plant breeder knows for sure that some such factor or factors are responsible for drought resistance in plants his problem will be made far easier so as to enable him to proceed along with some definite aim in mind. It thus is one of the important responsibilities of the plant physiologist to investigate into this important basic problem of drought resistance from all its angles with a view to greatly facilitate the work of the plant breeder in his investigations. Through this co-operative effort a solution to the problem of drought resistance as a whole will be definitely reached earlier than otherwise.

In the following text, therefore, an attempt has been made to trace the course plant physiologists have followed while unveiling the nature of drought resistance in plants.

## Nature of Drought Resistance and Factors Responsible.

It was long supposed that the secret of the nature of drought resistance could be disclosed merely by a study of the morphological features of desert vegetation. Early investigators made tremendous attempts to explain drought resistance of drought enduring type of plants upon a purely morphological basis, but all have proved inadequate, although certain structural features of plants undoubtedly aid in their survival in dry habitats. ex: Many xerophytes have extensive root systems in proportion to their tops Such root systems may efficiently tap a very considerable volume of soil, hence the aerial portion of the plants my receive a fairly adequate supply of water even when the rainfall is scanty. Similarly drought resistance was attributed to characters like small leaves, thick cuticle, opening or closing of stomata so as to reduce the transpiration to its minimum, low transpiration rates, etc., idea being the economic use of water by plants. But investigations of Maximov (1929) (a) and others have shown clearly that the transpiration rates of most such species are as great as those of typical mesophytes whenever the soil water supply is adequate. The frequently observed low transpiration rates of xerophytes are due, not to any inherent peculiarities of structure of physiological behavior, but to the fact that the water content of the soil in which they are rooted is so low that little or no absorption can occur. Another misconception, long current, was that xerophytes are more efficient in reducing the soil water content than mesophytes but investigations on wilting percentage and type of plant indicate that there is no such valid evidence for such a belief.

We know that different plants and plant organs respond differently to a deficiency of water. For instance, Schroder (1886) investigated the capacity for drought resistance of various plants and plant parts—seeds and vegetative organs of higher plants, mosses, algae and fungi, etc. He found that seeds and many cryptogams readily endure desiccation even to the extent of being reduced to an air dry condition. The leaves of higher plants, on the other hand, perish before this state is reached. According to Schroder this varying capacity of different plants for drought resistance is in no way related either to the structure of the leaves or to the rate at which water is transpired. The more resistant plants, for instance, include species with thin and others with feathery leaves. The causes which bring about the death of protoplasm on drying cannot be definitely stated. Such cases as those of ripe seeds, lichens and mosses show that plant protoplasm itself may be capable of almost complete desiccation without loss of vitality. Even germinating seeds may endure desiccation provided that the embryos have not attained any considerable size, a phenomenon not infrequently observed in cereals. Schroder found that in higher plants the cells of the leaf die before the whole of the "liquid" water has disappeared from the vacuole. The injurious consequences of loss of water, therefore, might possibly be explained as due to an undue decrease of the swelling of the protoplasm, leading perhaps to a partial coagulation of its constituents.

There seems to be a close analogy between death from drought and death from freezing, so far as the final desiccation of the cells is concerned. We know that frost resistance is conditioned not only by the specific properties of the protoplasm which enable it after thawing to return to its former condition, but also by the accumulation of protective substances in the cell. Of these sugars are the most important. The question naturally arises—does the plant form substances capable of protecting it against the injurious changes occuring in the protoplasm during desiccation? Unfortunately, perhaps on account of the great experimental difficulties encountered in determining the limits of desiccation which can be endured by a cell, no work has been carried out on these lines. There is no doubt, however, that a fundamental investigation of this question would bring us appreciably nearer to a solution of the problem of drought resistance of the whole plant organism. But one important fact may be pointed out that drought may cause permanent or even irremediable injury to the plant as a whole much easier than to the cells of the leaf itself. For example, Caldwell (1913) observed permanent wilting, accompanied by destruction of root hairs, when the leaves had lost 40% of their water content. On the other hand, Schroder (1909) found that the leaf cells themselves did not usually begin to die until they had lost 70–80% of their water. Evidently the roots are injuriously affected by drought considerably earlier than the leaves, and under natural conditions a plant with desiccated roots but still living leaves is doomed to perish. It has been observed by Maximov also, that after severe wilting—utmost limit of wilting—all the leaves, with the exception of uppermost ones, died inspite of profuse watering. But the leaves when cut off and placed in water after a considerable time recovered their turgor and vitality.

Kolkunov in his various investigations on the problem of drought resistance, assumed that as a plant growing under arid conditions can only draw upon the limited supply of water in the soil, the less water it expends the better it will thrive. His first problem, therefore, was to determine the structural peculiarities which affect the rate of transpiration. He assumed that this rate depends on the degree of xeromorphy. He tried to establish various types of correlations between cell size, drought resistance and yield by working with various crops such as corn, sugar beets and spring wheat, in the light of "Brown & Escombe's (1900) hypothesis of gases diffusion through perforated membranes— " Diffusion through perforated membranes is not proportional to the area, but to the diameter of the openings". He based his investigations on the hypothesis that "the rate of gaseous exchange increases with length of stomata". But it was founded entirely on erroneous assumption and therefore the explanation he gave for drought resistance cannot be accepted. At the same time it should not lead to a total denial of the connection itself, for such a correlation does undoubtedly exist. But its explanation is not to be sought in a simultaneous decrease of the intensity of transpiration and the size of stomata.

For a clear understanding of the nature of drought resistance, therefore, we must know—Does the size of the cell as such play any important part or is it the protoplasm which, on becoming more resistant prevents further increase in size of cells ? Or, finally, are both size of the cell and the resistance of the protoplasm conditioned by some other cause, such as the accumulation of dissolved substances in the cell with a consequent increase of osmotic pressure ? In this connection it may be significant that the osmotic pressure is usually higher in small celled than in large celled organisms. The researches of Levitsky and Kusmina (1923) support the idea that the small size of the cells of resistant varieties is due to the presence of some growth-inhibiting factor. It is shown that the embryonic cells in certain varieties of beets are uniform in size, whereas in adult organs the dimensions of cells are distinctly different. In any case there appears to be a definite correlation between cell size and the power of resisting unfavourable environmental conditions. Great credit is finally due to Kolkunov for being the first to realise this correlation and to establish its existance in different plants, only that he interpreted the facts from his observations rather erroneously.

Maximov, one of the eminent investigators in this field, expressed his opinion that the basis of drought resistance is the capacity of enduring wilting without harm or with the least harm to their subsequent development. As is said before in this paper, the anatamo-morphological or physiological features generally assumed as characteristic peculiarities of xerophytes cannot be acknowledged as such, because they only allow the plant to delay as far as possible the approach of permanent wilting. Maximov examined this problem of physiological factors conditioning drought resistance from the point of view that drought resistance is first of all the capacity of enduring a permanent and intense dehydration.

That a high concentration of the cell sap is the characteristic of xerophytes was shown for the first time very definitely by Fitting (1911). Osmotic pressure in some plants is attained up to 100 atmospheres sometimes. Data surpassing this and reaching 150 atmospheres also have been obtained. But such high osmotic pressures may be due to saline nature of the external soil medium as well. It is still true that a xerophytic organization independent of the salt content of the soil, is combined with a certain increase in the concentration of the cell sap. A like influence is exerted by an increased dryness of the air, by a desiccating wind and other similar atmospheric factors. According to Maximov, Walter has rightly pointed out that the higher the osmotic pressure of the cell sap the less is the degree of swelling of the protoplasm and with a decrease in swelling the protoplasm increases its resistance in relation to external agents. From this point of view the protective significance of sugars is examined and a close analogy between endurance to frost and drought stated. But while the qualitative composition of protective substances is evidently of greatest importance for frost resistance, no such qualitative role of any group of substances has as yet been noted for drought resistance.

The role played in hardiness by hydrophyllic colloids of a carbohydrate (pento-sans) or protein nature was earlier noted in the study of drought resistance than in frost resistance. Transpiration of cacti, as opposed to that of many other plants, is decreased at day time and increased at night. Spoehr (1919) observed a considerable increase in hydrophyllic colloids—pento sans—in cacti in the dry periods and he explains the low transpiration of these plants not by some anatomical peculiarities but just by this high content in hydrophyllic colloids. Such an investigation seems to represent an extremely interesting problem with a great promising future, no doubt.

It has long been known that plants grown in a moist atmosphere are more sensitive to atmospheric drought than those grown in more severe conditions. Tumanov (1927) observed that by repeated wiltings the assimilation and growth of the plant is less and less hindered. All these observations point out that hardening in the case of drought is not mainly accomplished by external anatomical changes but due to some internal physiological ones in the cells also. According to Maximov, (1929) anatomically such hardening leads to decrease in the size of newly formed cells and in general, to the formation of a more xeromorphic structure. Decrease in the size of cells, he regards, as a decrease in the swelling of plasma. Determinations of the quantity of bound water in the tissues of hardened plants carried out by Tumanov, by means of "dialatometer" method revealed an increase in the hydrophyllic colloids. However, a detailed study of the phenomenon of hardening in relation to drought is highly imperative before drawing any final conclusions.

According to Maximov, the principal physiological peculiarity conditioning the endurance of plants to drought is the capacity of enduring without a permanent irreversible harm, a considerable withdrawal of water from the plasma of

the cells. Various authors have shown that different plants and different parts of the same plant have some sort of capacity to endure a very severe desiccation. This is not only a theoretical postulate but a firmly established fact. More than this, every plant has organs which are capable of enduring a complete or almost complete desiccation. ex: Wintering buds of trees, and to a greater degree mature seeds of almost all plants, can endure a desiccation surpassing an air dry state, and in this state they better maintain their vitality.

Every plant possesses cells capable of desiccating without harm. There thus arise the questions, what ultimately distinguishes these desiccating cells from cells of the other organs which are not capable of enduring desiccation? And, is there no possibility of artificially increasing the capacity of the cells to endure wilting just as we already have means of artificially increasing the endurance to frost?

In attempting to answer these questions Iljin (1927) carried on some experiments. He placed sections of red cabbage in solutions of different concentrations and then after wiping them with filter paper they were placed in atmospheres of different humidity percentages. He succeeded in increasing the endurance of his objects to a considerable degree.

The nature of protective action, according to Iljin, is in the plasmolysing influence of the solutions and that the degree of endurance obtained depends, first of all, on the degree of plasmolysis. A complete plasmolysis makes the cell capable of enduring desiccation. The cause of such a protective influence of plasmolysis on the protoplasm is explained in the following way: a completely plasmolysed plasma is protected from deformation and injury which may occur during desiccation in cases when the protoplasm is firmly pressed to the wall: viz. in unplasmolysed cells with the plasma lying close to the wall a further loss of water, after the wall ceases to contract, leads to a violent rupture of the protoplasm from the wall. It is understood that such a deformation and rupture of the plasma cause the death of the cells. Thus, according to Iljin, the main cause of the death of a cell during its desiccation is the decrease in volume of central vacuole *not* accompanied by a corresponding contraction of the cell wall. But Iljin's same views become too one sided when he assumes that the deposit of reserve substances in resting organs is not so much a means of providing future plantlet with sufficient quantities of nutrient, as a method for protecting these from desiccation or frost. Again he denies the direct protective influence exclusively to their plasmolysing action. He also denies absolutely the significance of hydrophyllic colloids for the increase of endurance of the plasma to desiccations which also cannot be said to be so correct. This is because the consistency of the plasma which is conditioned by its composition and its degree of swelling, may by itself have a great significance during its deformation in consequence of the contraction of the vacuole. But independently of the causes of the different endurance of various plant cells and plants to dehydration, one must admit that it is this endurance which is the main factor conditioning the resistance of plants to drought.

Apart from all the morphological or anatomical peculiarities drought resistant plants have been shown to possess another very important characteristic. Mothes (1928) showed that while plants of the mesophyte type increase, under the influence of wilting, the oxidation as well as the mobilization and translocation of proteins from the leaves which leads to a complete exhaustion and death of these organs, plants of more xerophytic character prove the more resistant in this respect. According to him, the capacity to endure permanent wilting actually proves to be not only the capacity of the plant to protect itself from coagulation in consequence of severe dehydration, but also to protect itself from the exhaustion of protein reserves beyond the limits of the indispensable minimum for life.

## Critical periods of the plant in relation to drought

We may now consider another set of phenomena that also appears to be of great importance in the study of drought resistance of plants and in the comparison of different varieties one with another. This is the changes in the capacity of enduring water loss and drought in general that plants undergo during their development.

We know that ripe seeds possess the greatest power of resisting water loss. Such seeds are not only capable of enduring practically desiccation but even require it for the process of maturation. It is indeed in an air dry condition that they preserve their vitality. This resistance to injury continues also during the earliest stages of germination. It is a well known fact that seedlings 2-3 days old (particularly those of cereals) can be again dried without losing their vitality. As development proceeds, toleration towards drying rapidly lessens and seedlings that have unfolded their first leaves are very susceptible to water loss. Even during the later stages of development the resistance of plants to water loss and therefore, to wilting—which determines their power of enduring soil drought—does not remain constant but undergoes considerable fluctuations, which again are particularly marked in cereals. Brounov (1912) applied the term ' critical periods" to those stages of development at which the plant appeared to be particularly susceptible to the action of any meteorological factor. For cereals, such a critical period in respect of soil moisture is that which precedes the "heading stage" of the crop; i.e. the period of rapid growth in length of internodes leading to the emergence of the ear from the tubes formed by the leaf sheathes. Moliboga (1927) showed, by reinvestigating the question of the critical periods of cereals, that the effect of the same degree of wilting varied according to the stage of development of the plant. The consequences of wilting at one time of tillering were transient and had practically no effect on subsequent development as on the yield. On the other hand, wilting during the period when the stems are rapidly growing in length and flowers are developing, results in a considerable decrease in both the height of the plants and the yield. Finally, wilting at a still later stage, when flowering is over, has only an insignificant effect on the plant.

## Physiological explanation for this kind of behaviour

It is during the period of maximal growth in length that the plant requires most water for the expansion of its tissues. A deficiency of water at this period leads to a sharp decrease in size of the cells and to the deflection of nutrients from the developing flowers by the energetically transpiring leaves.

From the agricultural point of view the study of the critical periods and an exact determination of the times at which they occur are of great importance. This would render it possible to evaluate the climate of a country from the point of view of its suitability for the cultivation of particular crops, and to predict from the usual time of occurance of drought the probable yield.

The study of critical periods again emphasizes the importance of exercising great care in estimating the drought resistance of plants. Reliable estimates cannot be made merely from the data indicating that in certain years, under such and such climatic conditions, particular species or varieties proved capable of resisting drought to a greater or less extent. Some plants, with an earlier critical period, may suffer most from a spring drought; others, with a later period, may be more sensitive to summer drought. It is, therefore, very desirable that more attention be paid to this question, in selecting drought resistant varieties.

## Technique of studying atmospheric drought resistance

As heretofore mentioned, various external and internal factors are put forth to explain the basis of drought resistance in plants. The aim of such scientific investigations, however, is not only to find why a certain thing happens but also to see how best these findings can have a practical application in the field of agriculture. Attempts, therefore, have been made to make use of results so far obtained in evaluating comparative drought resistance of different types of economic plants with a view to be of great help to the plant breeder in his investigations.

In regions of average precipitation like great plains of United States, drought usually occurs in the form of a few days with hot dry winds followed by a period of deficit rainfall in mid-summer. It is, therefore, necessary to consider the relative tolerance to drought and high temperature of various strains in the improvement programme of any crop. Wide variations in weather conditions from year to year make testing of relative tolerance under field conditions very uncertain as stress periods may not occur in a given year or in a succession of years even. It is, therefore, highly essential to have some simple reliable technique for testing strains under controlled conditions.

Under the circumstances described, the condition of the plants is such that they are not able to absorb water from the soil enough to compensate for the loss on account of excessive transpiration, although the moisture content of

of the soil is quite optimum. In other words, it is the atmospheric drought from which the plants suffer. The technique developed for a study of this kind, therefore, involves subjecting the plants to artificially created 'atmospheric drought'. In all investigations of this type, it has been proved quite imperative to use a method which quickly differentiates the drought resisting ability of different plants; and so far as the available information goes, "capacity to withstand permanent wilting" is the only criterion which has proved helpful for a quick eye judgment. On account of this fact, in all the following pages "capacity to withstand permanent wilting" has been the criterion upon which the results are based.

## Machine or studying atmospheric drought resistance

Various types of machines working on the same general principle have been used in the past by workers in this field. Most of them were designed to control temperature, humidity and wind velocity, as these are some of the most important factors comprising atmospheric drought. Light is also an important factor but necessity to control it has not been very acutely felt so far because majority of the tests conducted have been for durations varying from 5–10 hours only. However, the factor of light has not been ignored in all these tests.

A typical machine for the purpose of the study of atmospheric drought should consist of a drought chamber ordinarily 8' x 8' x 10' with a capacity of 60–80 4"–6" size pots. There are certain advantages in having the chamber of the size mentioned above. If the size is too small, although a better control of atmospheric conditions can be secured, the number of varieties to be included in the list becomes limited. If too large, it is difficult to have a proper control over the desired conditions in the chamber. The machine is operated by forcing air which has been heated by thermostatically controlled electric heaters. The humidity is controlled by regulating the difference between the dry bulb and wet bulb thermometers. Dampers or baffles are provided to control the flow of air and to reduce eddies. After exposing the plants for about 5–8 hours to a temperature varying from 110°F–140°F relative humidity 15–50% and air velocity 3–6 miles per hour depending upon the type of plants they are given normal conditions for growth for a certain length of time. Then, observations on injury are made From this estimated injury the plants are classified in different groups from drought resistant down to drought susceptible.

Various investigators in this field of study have met with very satisfactory results in correctly classifying varieties of crops in the order of their relative resistance to drought. Their results in the laboratory have been in close agreement with the observations in the field. Hunter, Laude and Brunson (1936) using 8 inbred lines of corn could obtain a close relative correspondence between injury of large plants in the field and injury to 14 day old seedlings in the heat chamber indicating that the latter method may be of value in testing inbred lines,

hybrids or open pollinated varieties under controlled conditions. Schultz and Hays (1938) by using three types of material--sod pieces, 60 day old seedlings of grasses transplanted and 30 day old seedlings--in their investigations, could show that alfalfa was most resistant among legumes but not so resistant as grasses and that old seedlings are hardier than younger, under the conditions of their experiment. This agreed closely with the field behaviour of their plant material. Laude (1939) working with young seedlings of wheat, corn, barley, sorghums and alfalfa discovered that there is a daily cycle of heat resistance in these plants. Daily maximum resistance in these was attained at about mid-day and continued during the afternoon. Minimum resistance was found to be early in the morning. Resistance was greater in light than when in dark. This suggests photosynthetic production of organic material as an explanation for the increased resistance of plants to heat. It is also conjectured that a photo-chemical change or some other influence of light which can be induced quickly may be responsible for the increased resistance of plants to heat, when exposed to light. Heyne and Laude (1940) in their investigations with corn seedlings and Carroll (1943), with pasture and turf grasses could classify their plant material according to a definite order of heat tolerance.

This, in short, clearly indicates that such a technique of evaluating plants is not only essential but also highly imperative to strongly bridge the gap between pure sciences like plant physiology and applied sciences like agronomy. The technique described so far, however, deserves a lot more improvement so as to enable the agronomist to exactly imitate the natural atmospheric drought in the field, and thus leaves yet a wider scope for further investigation.

## Technique for studying soil drought resistance.

Technique for studying soil drought is yet in extremely less perfected stage than the one intended for studying atmospheric drought. This is because of a great deal of difficulty encountered in maintaining the soil moisture and temperature at a desired level during the course of the experiment. It is rather easy to subject all the plants under test to the same atmospheric drought but this cannot be said of soil drought on account of the heterogenous nature of soil medium itself. Due to this and a great many other causes, studies on soil drought have not been many.

Savage and Jacobson ( 1935 ) from their observations on grasses survived through a natural drought which occurred at Hays, Kansas in 1933 - 34, obtained a direct and positive correlation between closeness of clipping for one year and survival from drought. A similar positive correlation also occurred between closeness of clipping and recovery due to watering. Mueller and Weaver ( 1942 ) working with seedlings of dominant prarie grasses, used metallic tubs for growing seedlings and subjecting them to soil drought. The main principle involved in their technique was to allow the plants to grow for a certain period with optimum

conditions for growth and then to discontinue watering at a certain stage ( generally critical for the plants ) for a period long enough to bring about permanent wilting. After this period the plants are to be watered to the optimum capacity of the soil and recovery to be noted. By using this method they could show that Blue grama is more resistant of all grasses they tried. Species characteristic of uplands or which normally occur westward in mixed prarie were more resistant and those in the lowlands or in the prarie less resistant to drought.

Carroll ( 1943 ) made a study of turf grasses with the object of determining the relative survival of a number of turf grasses under different degrees of intensities of moisture and temperature, and the effect of nitrogenous fertilizers on these responses. In his investigations soil was permitted to dry slowly by exposing the sample-plugs of sod to an air temperature of 35°C for 4 hours daily until soil moisture had gone below wilting percentage. The condition of soil moisture and air temperature chosen were such as are occasionally encountered in the fields After the percentage water in the soil of the two series had been reduced to 5% and 3% ( wilting % for the soil was 7.7% ) sufficient water was added to bring the water content to approximately 70% of its water holding capacity, and at the end of 3 weeks an estimation was made of the per cent recovery which was regarded as an index of soil drought resistance. He found that in all of the six tests he ran Pea pratensis was most resistant and c. cristatus the least.

From the few investigations, therefore, it is clear beyond doubt that the technique for studying soil drought, although yet far from being perfect, is as much an effective tool in the hands of the Plant Physiologist and the Agronomist as is the technique of the study of atmospheric drought. But further investigations alone, into the details of the technique would be of value to substantiate the hope that such a perfected technique would effect a remarkable synthesis between these two types of study to open a way towards brighter future.

## Analysis of the problem of drought resistance

The study of the problem of drought resistance is yet in a less satisfactory state. The reason lies in the greater complexity of the conception of drought as well as in the greater diversity of methods by means of which the plants avoid a too intensive loss of water. A careful analysis of the phenomenon is the first condition of success in attacking the problem of drought resistance. The important initial step, then, is to select from the miscellaneous group of plants capable of growing in dry regions those which can really endure—and don't merely escape or evade—severe drought. This is easily accomplished by such techniques as are described in the foregoing sections of this article. It is only when we have thus decided which plants are truly drought resistant that we can attack with any prospect of success the problem of determining which are the peculiarities of organization that actually confer upon the plants the faculty of enduring intense

drought. Failing such a preliminary investigation productive physiological work on the causes and factors involved in drought resistance would seem to be impossible.

The plant breeder, however, who wishes to select species or races of agricultural plants suitable for cultivation in dry regions, has many options open to him. He can, for instance,

a) Select early ripening varieties which mature early, and so escape a dry period;

b) or, he can choose forms which expend their water economically and therefore find the winter supply of soil moiture sufficient for their complete development – of grain as well as straw. But such plants are not truly drought resistant. Such plants are liable to succumb if the summer drought sets in earlier than usual, or if the winter reserves of soil water are rapidly exhausted. One may, therefore, also endeavour to select plants with an organization which will enable them successfully to withstand severe soil and atmosperic drought. Such anatomical organizations will be small cells, a dense network of veins, numerous but small stomata per unit area, a relatively great development of root system and so on. Physiologically these peculiarities are for the most part associated with intense assimilation, intense transpiration, reduced growth in height, high osmotic pressure, etc. But all these are of secondary importance as compared with the nature of true drought resistance. True drought resistance is associated with protoplasm —the capacity of protoplasm to endure considerable fluctuations in its degree of swelling, without the loss of vital activity and without the appearance of irreversible coagulation. The capacity to endure water loss may completely mask the significance of the other anatomical and physiological peculiarities and thus mystify investigators endeavouring to find a strict correlation between drought resistance and external peculiarities although these are connected with true drought resistance.

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# Role of Vegetation in Soil Conservation
## ( PART I GENERAL )

By

J. K. Basu and L. Sreeniwas

Soil erosion is a process brought about by two phenomena that occur during storms. Firstly the large soil aggregates are broken down and dispersed by the beating raindrops and then the flowing surface water carries away the dispersed soil particles lower down. In order to achieve effective control of soil erosion it is absolutely necessary that these two phenomena of the erosion process should be fully understood. For example sandy soils are highly detached and clayey soils are easily transportable. Hence the basic factors that we have to deal with to check soil erosion is—

i) to protect the large soil aggregates from the direct impact of the raindrops from being dispersed

ii) to reduce the transporting power of the flood or excess water.

The first phenomenon could be checked by using agronomical practices such as cover crops, stubble mulches, strip cropping etc. while the transporting power could be reduced by contour cultivation mechanical structure such as terraces and thick vegetation of grass and so on. This paper presents the vegetational aspect of erosion control.

Vegetation has all along been one of the main soil stabilizing factors under natural condition. This has been possible mainly because of the five important functions plants perform in conserving the soil. These functions are (i) cover or canopy effect by the foliage (ii) velocity reduction effect by the mechanical hindrance by the stems and roots (iii) soil binding effect of the roots (iv) biological effect by the adding of organic matter and (v) transpiration effect. Under natural conditions all these functions are harmoniously performed resulting in soil development and soil conservation. Results of erosion studies conducted at Sholapur under controlled runoff plots revealed that under natural vegetation the yearly loss of soil was only O. 53 tons per acre whereas in a rabi jowar plot the yearly loss was as high as 37 tons per acre. At this rate of 37 tons per acre it is estimated that 1" layer of soil would be lost in less than 4 years if rabi jowar in grown (1). This collosal loss of soil at so quick a pace should be halted and knowledge, required for the scientific and practical utilization of vegetation for conservation purposes is both essential and urgent.

Researches in this direction are being conducted at the Strip Cropping Research Centres in the scarsity parts of the Bombay State. For sustained crop production in this tract conservation farming is the only way as this tract is well characterised by the vagaries of the monsoon and severe soil erosion. While developing conservation farming practices by using vegetation the three important factors to be studied are ( i ) Precipitation characteristics of the tract ( ii ) Life periods of crops and ( iii ) Canopy development of crop-plants.

An analysis of the precipitation data collected for the last 5 years at Sholapur reveals that though over 90 per cent of the rainfall in this region occurs during the six months of June—November the hazards of erosion are more intense during the three months of August, September and October ( 1 ). Further it was found that about 75, 86 and 70 per cent of the rains that occured in August, September and October are of the order of over 49 cents. each day. These intense storms, cause emmense damage to the soil as they occur just after the soil is saturated by the early rains of June-July. Hence it is during these three months of August, September and October, " the critical period of soil Erosion ", that soil requires good protection in Bombay Deccan.

The second factor that has to be considered is the ' life period ' of various erosion resisting crops ( i. e. ) the number of days a crop would remain on the land and the period at which the crop provides its maximum canopy. Naturally,

longer the life period of the crop better it is to protect the soil. The life period of crops studied varies from 70 days for china mug to 150 days for spreading ground nut. The life periods of other crops are in the descending order of Matki (Phaseolus aconitifolium ) > Soyabean (Glycine hispida) > Wal (Dolichos lablab) > Groundnut ( Erect Arachis hypogoea ) > Hulga ( Dolichos biflorus ) > Chavli ( Vigna catiang ).

The development of canopy is another important factor that has to be taken into consideration while selecting a crop for soil cover. Crop plants could be classified for cover value into two categories ( i ) soil covering and ( ii ) soil exposing. Soil covering crops are those that spread and produce profuse vegetal canopy to protect the soil from the beating raindrops. Groundnut, Hulga, Matki etc, are some of the leguminous soil covering plants. Soil exposing ones are those that are erect and leave the land bare, exposed to the rainfall. Jowar, Bajri etc., are some of the examples of soil exposing ones.

To evaluate the canopy valve of different crops a simple technique has been developed and used. This consists of a quadret 2' X 2', made of wooden frame. The frame is divided into 144 squares by means of ordinary twine; each square having the dimensions of 2" X 2". The frame is placed at random spots above the crop on four props just touching the foliage. Four points are given to squares fully covered by vagetation, two for half covered, one for quarter covered and so on. The points scored by each crop is added up and the percentage worked out. This method provides a quantitative estimation of crop covers of various crops at different stages of their growth.

Another simple device known as "Splash-apparatus" has been used to test the efficacy of these covers in offering protection to the soil from the raindrops ( 2 ). These are installed in the field in between cover crops with the onset of the monsoon and the splashed soil collected for every rainfall for quantitative studies in the Laboratory.

Interesting data have been collected by studying the canopy and splash values of various crops. Some of the salient features obtained at Sholapur are as follows:—

**Table I.**

| | Groundnut | Matki | Hulga | Soyabean |
|---|---|---|---|---|
| Maximum % canopy achieved. | 88 | 80 | 69 | 39 |
| Average maximum % canopy-Aug. Sept. & Oct. | 37 | 38 | 27 | 18 |
| Splash value in gms. Aug. Sept. & Oct. 48-49. | 63 | 55 | 73 | 82 |

It can be seen from the results given in Table I that there is a close competition between groundnut and matki in providing a good vegetal canopy to the soil. It will also be noticed that groundnut has produced a high canopy percent of 88 yet the splash value is 63 gms, while matki with 80 per cent canopy has a lower splash value of 55. This clearly indicates that a high production of canopy alone is not enough to adequately protect the soil from the rain but the high canopy production period should also coincide with the critical period of erosion i. e. August, September and October. Further scrutiny of the data reveals that there is practically no difference in the average canopy produced in August, September and October by either groundnut or matki, but there is a difference in the splash value. This difference could be explained that in case of groundnut the ' layers ' of vegetation cover is less when compared to the bushy vegetative cover of matki. It could also be seen that there is a positive correlation between the average canopy per cent obtained for other crops during August, September and October and splash value. Soyabean which has the least average canopy value of 18 % during August, September and October has given the highest splash value of 82 and Matki which has the highest average canopy value of 38 during the same period as the least splash value of 55.

From the above results the following conclusions could be drawn. Precipitation characteristics of the Sholapur tract have been analysed and the months of August, September and October have been found to be the " critical period of erosion". Groundnut (spreading) has got the longest life period followed closely by matki. Crops could be classified as soil exposing and soil covering ones, based on the production of vegetal canopy during " critical period of erosion ". A quantitative method of evaluating crop-covers by using a quadret and their efficiency tested by using splash apparatus have been explained. It is noticed that there is a positive correlation between soil splash for August, September and October and the average maximum canopy per cent for the same period. The period of high development of canopy should synchronise with the critical period of erosion in order to effect maximum protection to the soil.

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# Effect of Buttress Grafting on Growth and Development of Orchard Trees§

By

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The rejuvenation of the tops of old and ancient historic trees by buttressing their decaying trunks by inarching (grafting by approach) young seedling rootstocks of the same family having the same genetic relationship is a well-known horticultural practice employed on a large scale in the United States of America and other civilised countries of the world (Fig. 1).

Small seedling rootstocks are planted close around the base of the old tree (scion) and when they are about half inch thick they are inarched into the trunk of the section above the injury. The rootstock to be inarched (inarch) is beheaded and its top on one side pared downwards to a slanting cut measuring about two inches in length. An inverted T (⊥) cut is then made quickly in the trunk of the scion tree and the inarch is slipped into the slit on the scion keeping the pared side snugly facing the exposed wood of the scion (Fig. 2). The operation of inarching as followed in India consists in making simple longitudinal cuts of equal dimensions on the stems of scion tree and the inarch which are made to coincide at their cambium surfaces (Fig. 3). The union between the inarch and the trunk of the old tree is effected by a new cambium ring formed through callus produced from the exposed cambium tissues of the two parts which are brought into juxtaposition in the processes described above.

As the operation when completed resembles a sort of artificial propping up of the scion trunk by a number of seedling rootstocks, it is referred to here for the sake of clarity as "buttress grafting" or "buttressing" and the seedling rootstock as "inarch".

Buttressing is also done to save orchard trees that are partly or completely girdled by footrot and such other diseases or pests.

A notable example of preservation of a diseased orchard tree by buttressing is illustrated in recent times in the saving of the original parent tree of the Washington Navel orange at Riverside, California (U. S. A.) which was originally

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planted in the year 1873 and later transplanted to a special city park in the town of Reverside. In 1917, it was observed to be declining rapidly under the influence of a pathological bark disease known as "foot root". The disease had killed the bark on a band six to eight inches wide around the trunk just above the bud union. The only way to save the tree was to supply it with a new root system and this it was decided could best be done by inarching young citrus seedlings of several citrus rootstocks into the live trunk wood above the girdled area. Nine inarches were inserted. All the inarches healed on perfectly. To-day, thirtytwo years after the operation and seventy six years after its planting, the tree is still alive and is apparently in fairly good condition and bears a fair crop of fruit annually and as a State Monument inspires faith in the great industry it established in the U. S. A. An account of this tree is published in the Citrus Industry, Vol. II, by Batchelor and Webber, University of California Press, 1948.

Apart from rejuvenating historic trees, buttressing has not been used in any part of the world as a regular orchard practice for invigorating apparently healthy and established orchard trees with a view to making them more thrifty and productive. In Bombay Province, however, this conception is recently getting a grip over the minds of mango growers of Gujerat. It is not uncommon to see quite a good number of young mango trees in the orchards of North and South Gujerat buttressed by several rootstocks planted around their bases. The object of buttressing the orchard trees in Bombay Province is however very different from that conceived for buttressing historic trees in the U. S. A. In Bombay Province, healthy young orchard trees are buttressed definitely with a view to invigorating them by giving them *additional* roots which are supposed to help the trees so buttressed in absorbing more water and mineral nutrients from the soil. In the U. S. A., old historic trees are buttressed with a view to rejuvenating their tops by *replacing* their decayed roots with a new root system.

The present investigations were carried out in order to point out the fallacy of the erroneous view that is prevailing amongst the Indian orchardists as to the effect of the rootstocks so inarched on the future growth and vigour of the scion. In Gujerat, the mango growers indiscriminately buttress their grafted mango trees in three different ways. The new rootstocks are inarched (1) to the stock trunk of the tree *below* the old graft joint (2) to the scion trunk of the tree *above* the old graft joint (3) to the main limbs or branches of the scion tree.

The investigations herein recorded were carried out in the year 1948 at the village of Chikhli, District Surat, in two separate mango orchards where fourteen young mango trees buttressed in all the above three different ways were available. Girth measurements of the parts of the scion trees as those of the inarches were taken above and below the unions in order to adjudge their mutual development as a result of buttressing. The data given in the cappended statements and the related diagrams clearly explain their ultimate reactions upon one another.

During the course of the present investigations it was observed that where the new rootstock was inarched in the stock trunk of a healthy tree below the old graft joint, it did not develop into a strong stem and only remained as a poor competitor to the original stock trunk which normally continued to maintain the scion top. (Figs. 5, 6, 7 & 9). It is only when the original root system is weak and not properly functioning right from the time the tree is planted that the inarch buttressing the stock trunk may get stronger and thicker and it may eventually take over the scion top along with the intermediate stem piece of the stock trunk to which it is attached (Fig. 8). The inarch makes an extra demand on the scion top for its stem and root development on carbohydrate supplies and thus to a certain extent reduces the supply going to the original stock trunk and roots. It is highly probable that the quantity of roots that existed before buttressing remains just the same even after the operation as the reduction in the root area of the original trunk due to less carbohydrate supplies may mean a gain for the inarch to which a part of the carbohydrate supplies is directed.

Where the buttressing rootstock is inarched to the scion top of the same age and thickness as illustrated in Fig. 4 it almost immediately takes over the scion top and the original trunk below the new graft union remains thin thereafter and does not appreciably increase in girth and with the course of time entirely loses its identity as the chief root of the original tree. Apperently, the weakening of original stock trunk of the tree as well as of the intermediate piece of the scion between the two graft joints occurs due to their inability to utilise the carbohydrates descending from the scion top. These carbohydrates are arrested at the new superimposed graft joint and are almost wholly passed on to the living tissues of the inarch which consequently begins to thicken immediately after its union has occured with the top. The original stock trunk and its roots thereafter receive comparatively very little of the carbohydrates from the top and therefore do not make any appreciable cambial growth. (Compare the development of inarches with the corresponding buttressed branches in Figs. 2, 14 and 15).

It is equally true that water supply and mineral nutrients taken by the original roots and stock trunk from the soil are interrupted at the superimposed graft joint and are unable to pass to the top which has now completely gone over to the buttressing rootstock for its nourishment. Thus, it will be seen that the scion top though still mechanically connected with the original stock trunk has now physiologically severed its connection with the latter and is totally dependent for its water supply and nutrients from the soil on the inarch. The popular belief that the scion top of a gratted tree is invigorated by inarching it with another rootstock is therefore a mere illusion. This belief seems to have originated from the healthier appearance that the tops of certain sickly trees put up soon after their union with the buttressing root-stock. Closer examination of the tops and their graft joints with the original stock trunks in such trees has shown that the poor condition of the top and sickly appearance of the leaves

was either as a result of the defective graft union or some injury caused to the root and trunk by pests and diseases and the top improved in vigour no sooner it was connected by grafting with a healthier root stock. The point is made clear that the sickly tree top is invigorated by its complete physiological change over to another rootstock and not because it draws its nourishment from two stocks—the original stock trunk as well as the buttressing rootstock.

In the circumstances described above, there is always a justification for practising buttress grafting on mango or any other orchard tree if it is intended to transfer its top from a diseased and unhealthy stock to a healthier rootstock but the practice would be superfluous, clumsy and totally wasteful if it is done on an apparently healthy tree with a view to invigorating it by providing additional source of water and mineral nutrients.

As for the time taken for the complete transfer of the scion top on to the inarch, it should be realised that the immediate transfer takes place only if the stems of both the symbionts are equal in thickness at the time of grafting but if the stem of the scion top is much thicker than that of the inarch, it takes many years for the latter to become sufficiently thick to take over the top completely. (Compare the development of inarches 1 and 2 with the corresponding buttressed branches in Fig. 16). In fact, several such seedling rootstocks are required to be inarched to the stem of the scion if it is desired to effect the transfer in the shortest time possible as in the case of the original Washington Navel orange at Riverside, California (U. S. A.) (Fig. 1). All these rootstocks after individually establishing their connections with the common top which they surround, begin to draw upon its carbohydrate supplies and thicken their stems gradually so as to fill up the empty space lying in between. When they draw too close so as to press heavily against each other in times of active cambial growth they in their turn readily inarch themselves naturally with each other so as to form one single trunk cylinder encasing the old stock trunk. The ultimate result in such cases would appear very similar to the effect produced by an operation known as bridge grafting which is employed for repairing tree wounds.

Instances are not wanting in which the buttressing rootstocks are inarched to the lowermost main branches of the scion top. When a branch so inarched is of the same thickness as the buttressing rootstock at the time of grafting, the former passes over the latter entirely immediately thus giving rise to a new tree altogether living a life quite independent of the original tree. The part of the scion branch below the union with the inarch remains undeveloped due to carbohydrate starvation as most of the carbohydrates manufactured by the branch pass to the inarch and impoverish the part of the branch connected with the original tree below the joint.

A mango tree of which five such branches were buttressed almost looked like a bunyan tree (Ficus Bengalensis) surrounded by a host of pendant root stems upholding its branches ( Fig. 14 ). In fact, it presented the site of a

veritable colony of closely spaced physiologically independent trees joined mechanically to the central axis of the original scion top which ultimately lived a truncated life, bereft of its original frame work. It is not difficult to imagine the physiological upset which this procedure of buttressing may produce on the scion top which has for all practical purposes been fragmented into so many independent units. All the buttressed branches so divided would not fruit uniformly and regularly as parts of one whole as before but they would show very irregular behaviour of flowering and fruiting according to the varied influences of different rootstocks on which they have been grafted.

If both the stock and scion parts of an orchard tree are buttressed as in Fig. 13, it would result in an unfair competition between the different inarches to draw carbohydrates from the top. The inarches applied at a higher point on the scion part arrest most of the carbohydrates and utilize them for their own thickening and the inarches down below buttressing the stock trunk get the least supply of carbohydrates and therefore remain much thinner. Nor the original trunk of the tree as a whole makes any appreciable increase in girth. Apparently, a tree buttressed in this manner would always remain poor in growth due to its energy being dissipated in developing different individual inarches who do not contribute towards the development of one common trunk.

From the observations made above, it may be concluded that.:—

(1) Buttressing by inarching is a useful means of rejuvenating the top of a large sickly tree by transfering it from its diseased trunk to those of several healthier root stocks planted around its base. The ultimate effect of buttressing is replacement of roots and not their increase.

(2) Buttressing the trunk of an apparently healthy tree is a wasteful practice which does not help in making it more thrifty or productive. It amounts to an unwarranted transfer of the top at some cost.

(3) To transfer the top of a grafted orchard tree, the inarch should be applied to the scion part of its trunk and not to the stock. If the inarch is applied to the stock, it merely creates an additional competitive root system which does not contribute towards the better development of the top.

Buttressing both the scion and stock parts at one time would result in dissipating the energy of the tree in many directions and the tree top remains permanently poor.

Buttressing the individual branches of a tree means dividing the tree in so many independent units which behave differently in growth and development.

(4) If the sickly top of a one or two year old young orchard tree is *completely* transferred by inarching on a healthier single rootstock of the same age grown by its side in situ, the process virtually means "grafting the seedling rootstock in situ". In such cases, the scion's connection with the original trunk below its new union with the inarch becomes superfluous and therefore the original trunk should be cut off

A buttressed mango tree.

Note how one of the buttressed branches (extreme left) has remained thin and impoverished below its union with inarch, whereas its part above the union has fattened and become one with the inarch.

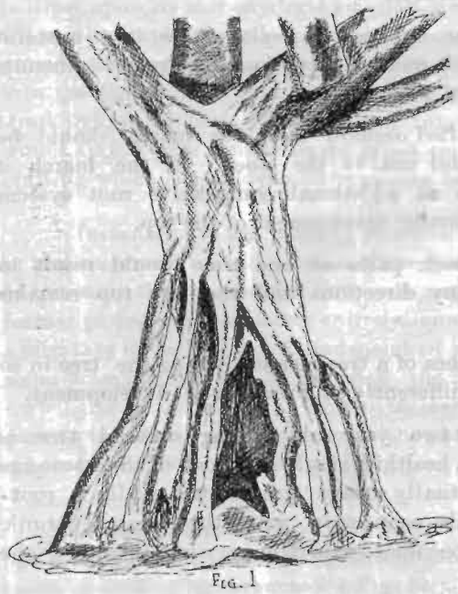

FIG. 1

Preservation of a diseased tree by buttress grafting.

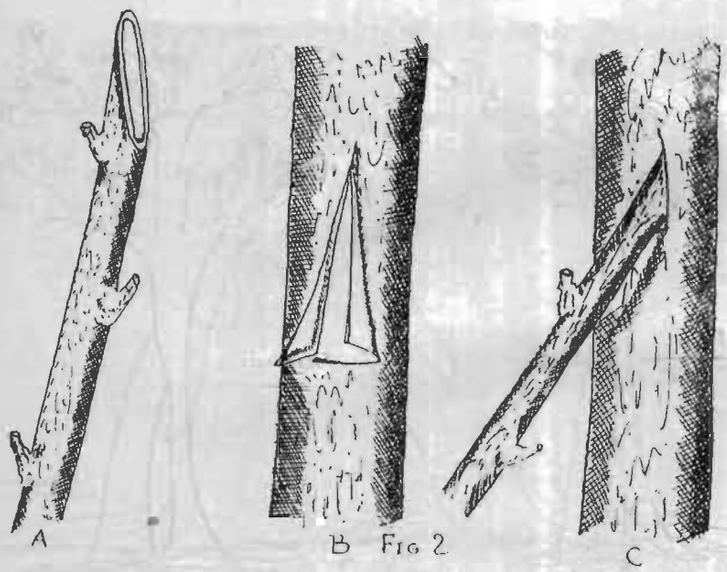


FIG 2

Inarch

Bark in trunk of the tree cut to receive inarch

Inarch inserted

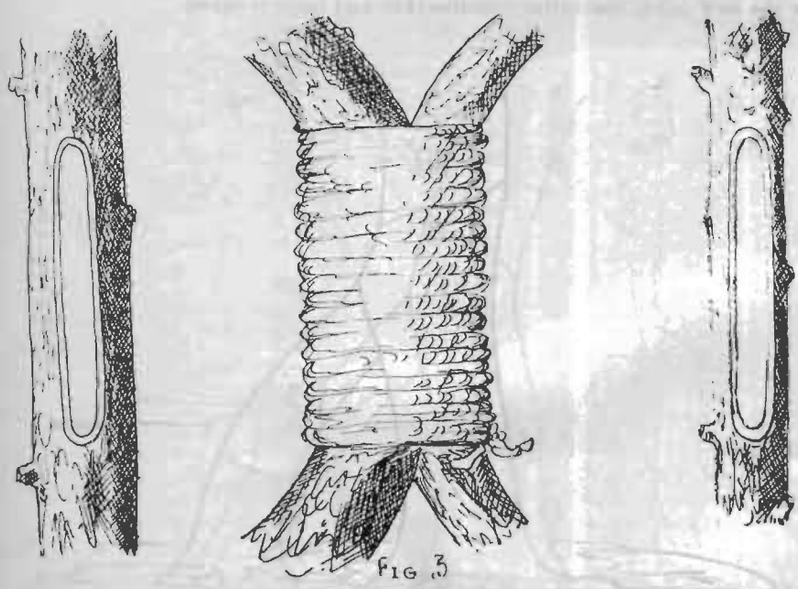

FIG 3

Scion tree

Scion tree and inarch brought into juxta position

Inarch

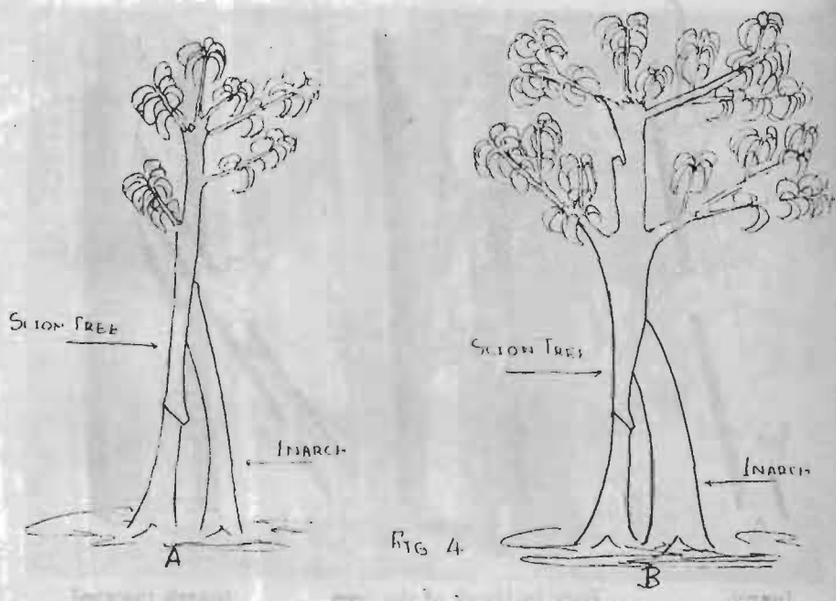


FIG 4

When an inarch of equal thickness is grafted to the scion trunk as in A, it almost immediately takes over the scion top as in B, and the original trunk below the new joint, thereafter remains thin and impoverished.

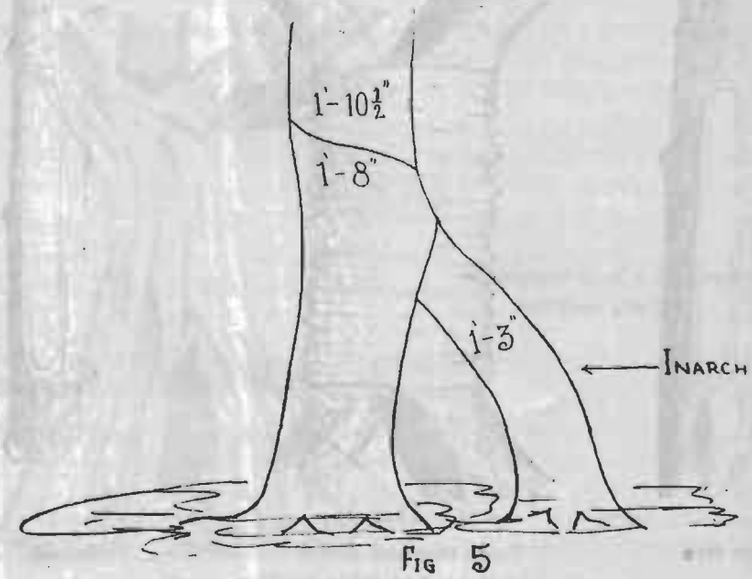


FIG 5

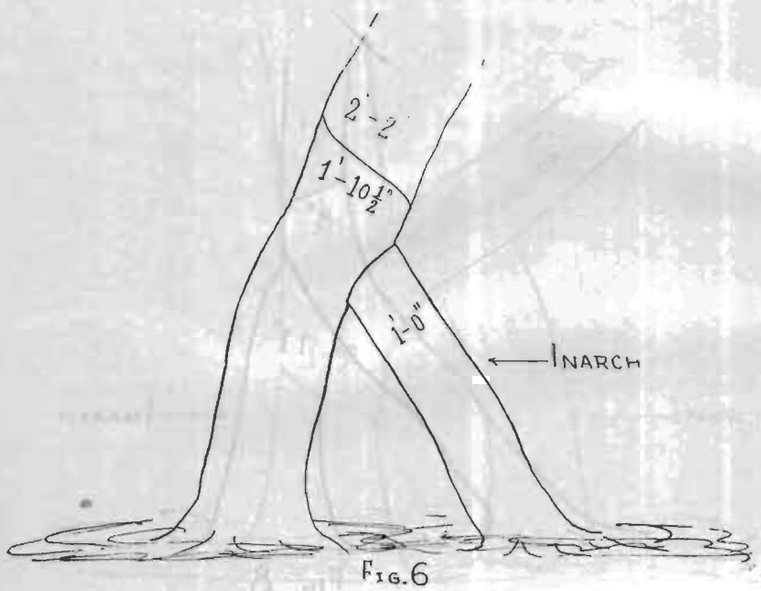


FIG. 6

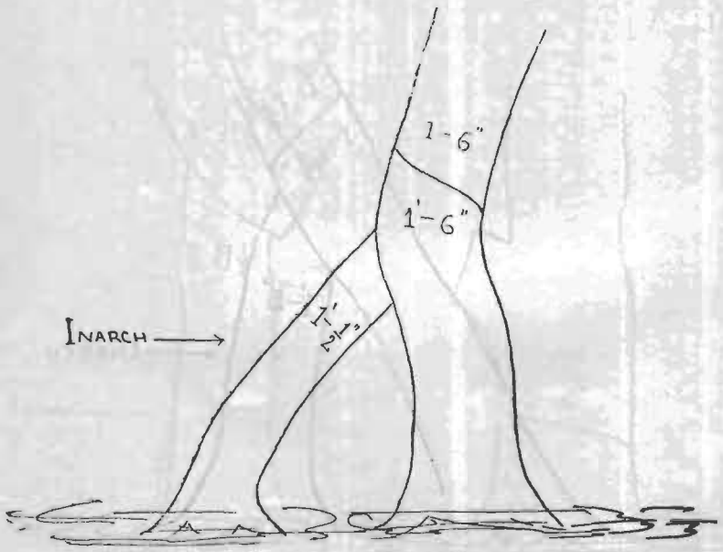


FIG. 7

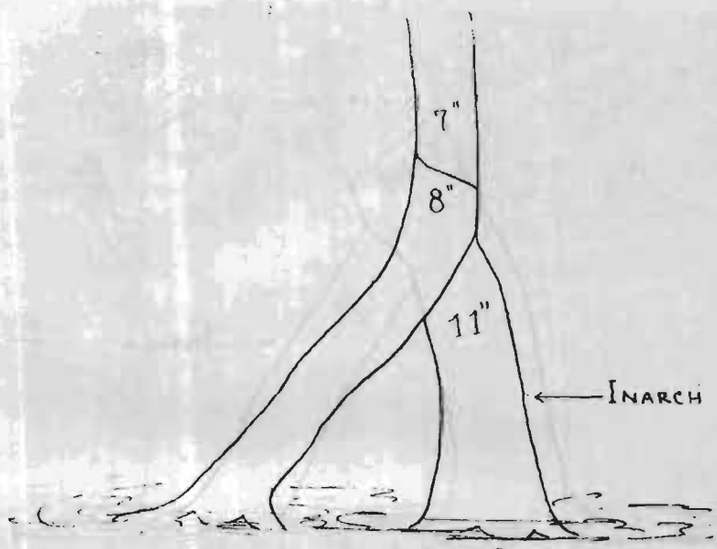


FIG. 8

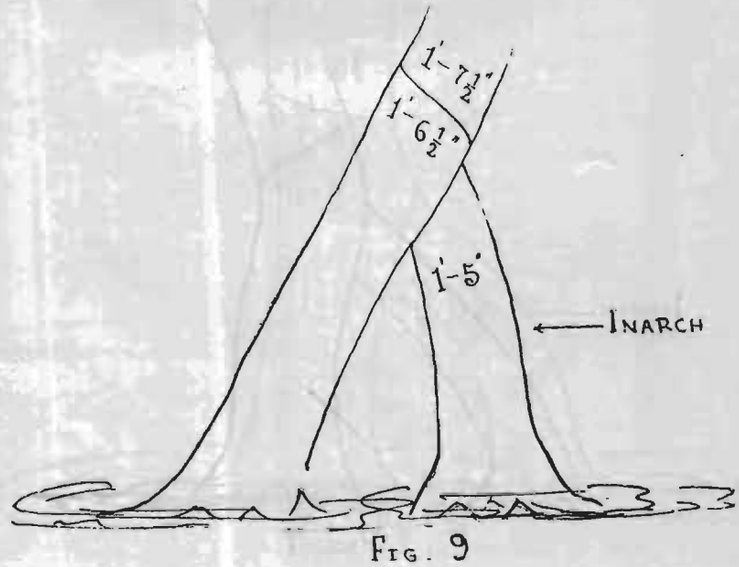


FIG. 9

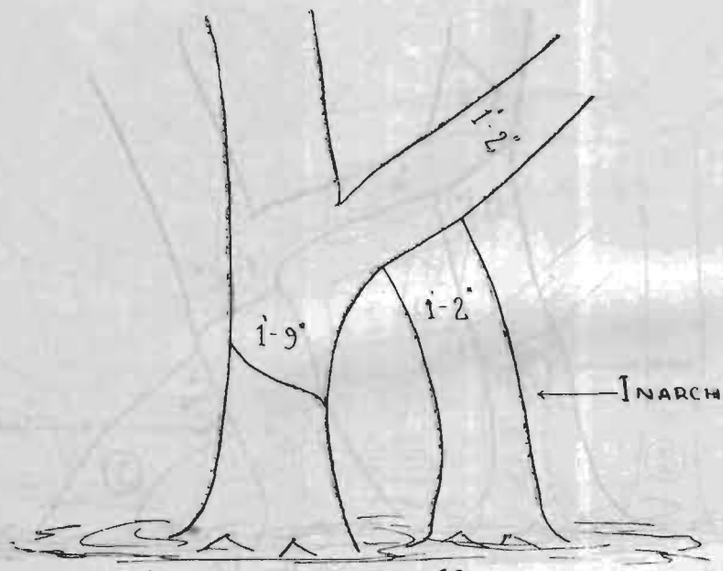


FIG. 10

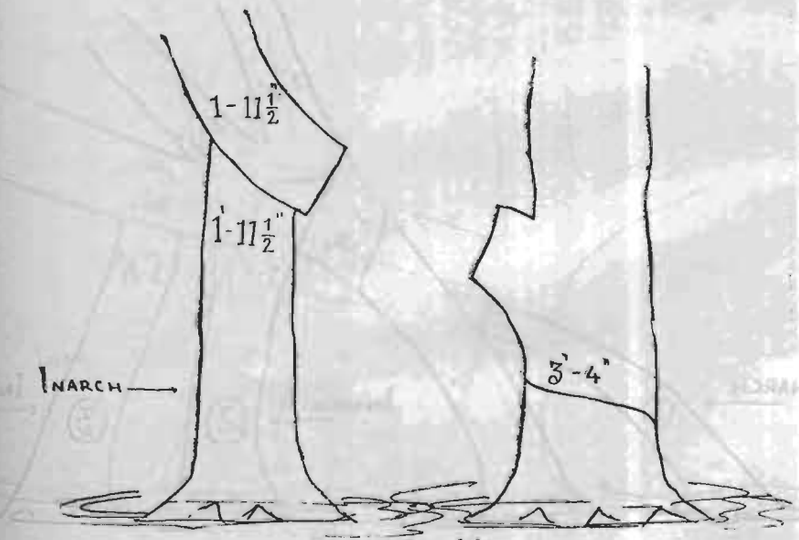


FIG 11

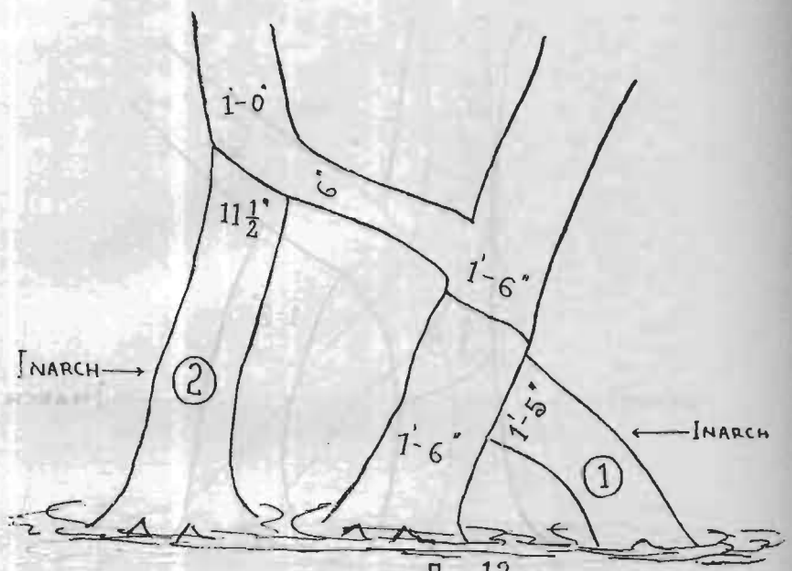
1'-0"
9"
11½"
1'-6"
INARCH
2
1'-6"
1'-5"
INARCH
1

FIG. 12

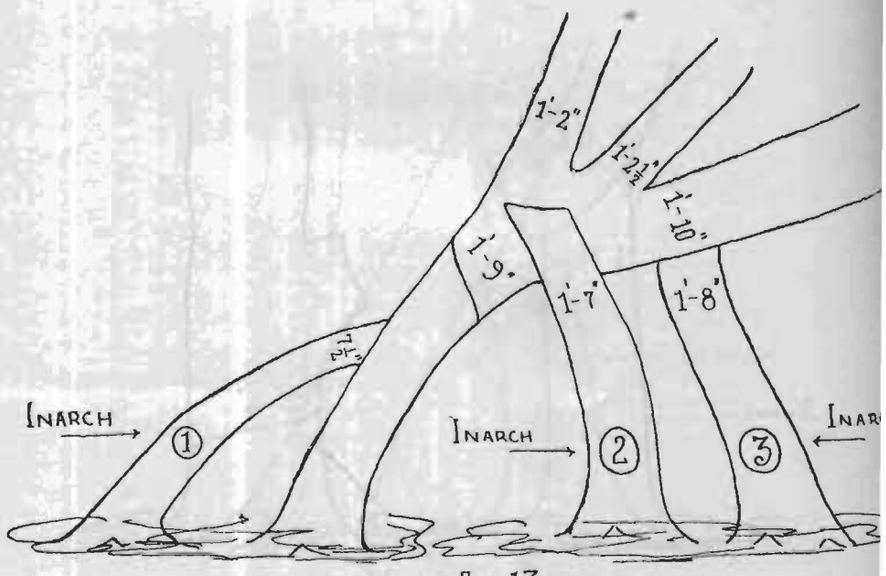
1'-2"
1'-2½"
1'-10"
1'-9"
1'-7"
1'-8"
INARCH
1
INARCH
2
3

FIG. 13

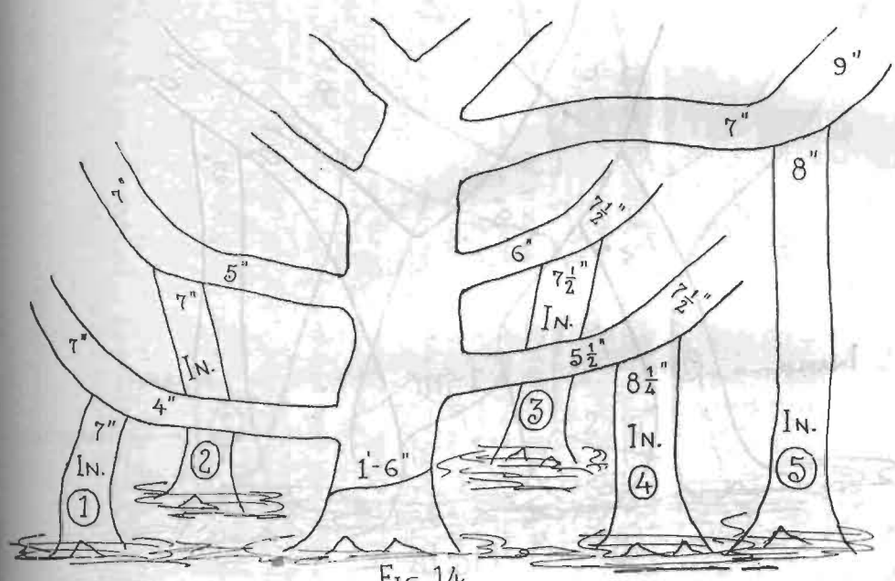
9"
7"
8"
7"
6"
7½"
7½"
7½"
5"
7"
IN.
7½"
IN.
7"
5½"
4"
8¼"
7"
IN.
3
IN.
IN.
2
1'-6"
4
5
1

FIG 14

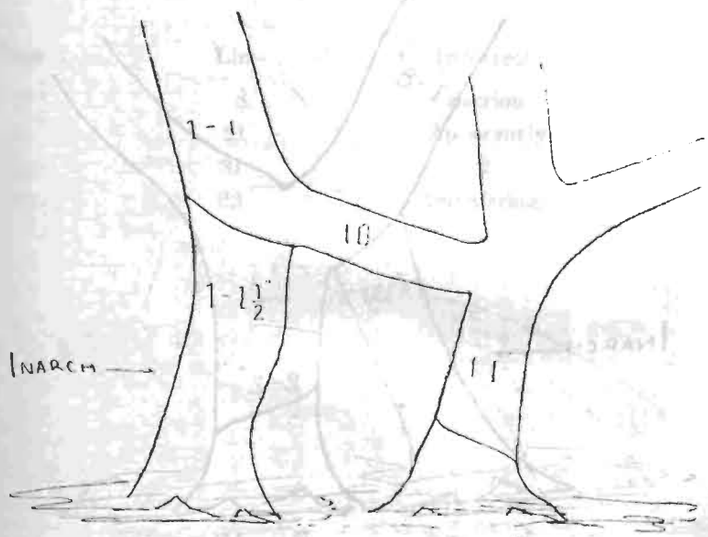
1-1
10
1-1½"
INARCH
11

FIG 15

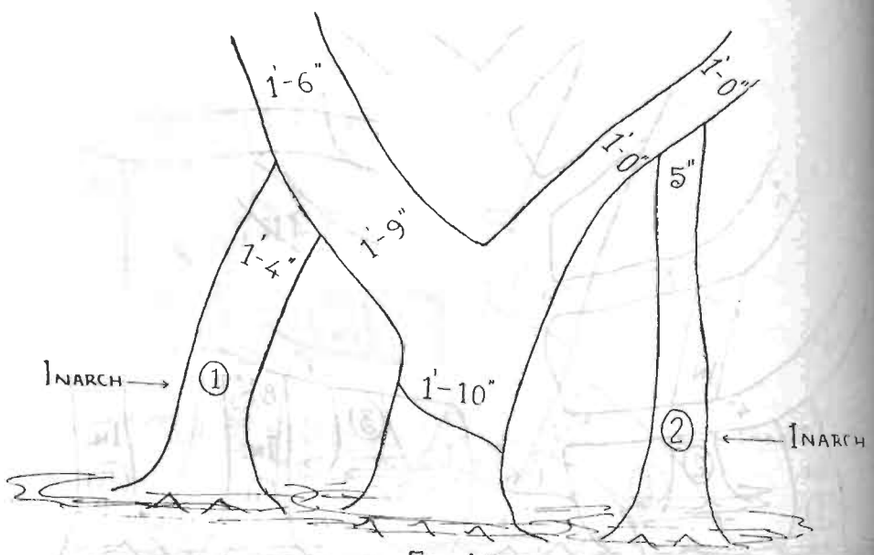


FIG. 16

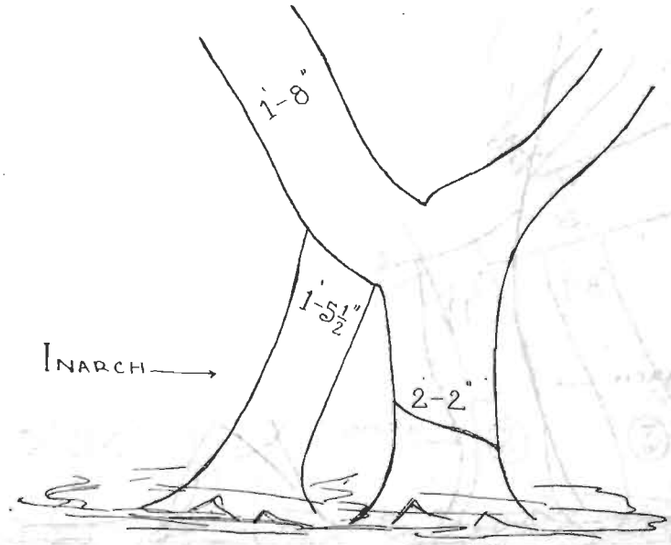


FIG 17

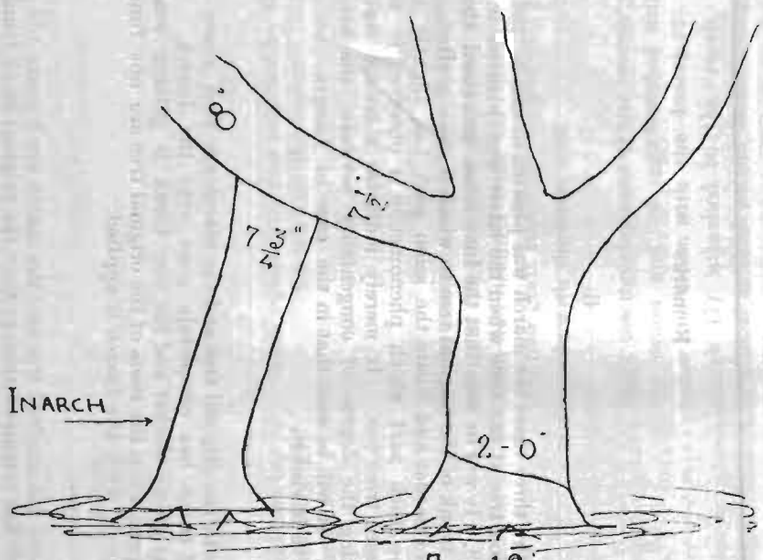


FIG 18

## Erratta

| Page | Line | Incorrect | Correct |
|---|---|---|---|
| 23 | 8 | Section | Scion |
| 25 | 21 | Apperently | Apparently |
| 25 | 31 | 2 | 12 |
| 27 | 22 | transfering | transferring |

## STATEMENT I

| Sr. No. | Name of the buttressed mango tree | Particulars of buttressing | Tree. Girth of the stock trunk. | Tree. Girth of the scion trunk. | Inarch Girth | Remarks |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 (a) | 4 (b) | 5 | 6 |
| 1. | Sardar Fig. 5. | The inarch was grafted to the stock trunk of the tree. | 1'-8" | 1'-10½" | 1'-3" | In all the three cases the inarch was planted in situ by the side of the scion tree at the time when the latter was planted in the year 1938. It will be seen that the Inarch has remained thinner than the trunk of the original tree to which it was grafted. In the case of Sardar and Nilam the scion part has slightly overgrown the stock part which phenomenon is observed in many unbuttressed trees too. It merely indicates a stionic reaction representing the degree of congeniality between the original partners. It will be seen that in the case of Langra, no such overgrowth is visible. |
| 2. | Nilam Fig. 6. | -do- | 1'-10½" | 2'-2" | 1'-0" | |
| 3. | Langra Fig. 7. | -do- | 1'-6" | 1'-6" | 1'-½" | |
| 4. | Alphonso Fig. 8. | Inarch buttressed to the stock trunk of the tree. | 8" | 7" | 11" | Here both the original tree and the inarch are four years old. The stock trunk has completely gone over the Inarch. The Inarch has grown thicker and the tree trunk is getting weaker. This happens when the roots of the original tree are not functioning properly when the Inarch is applied. |
| 5. | Alphonso Fig. 9. | -do- | 1'-6½" | 1'-7½" | 1'-5" | Here both the original tree and the inarch are 8 years old and the Inarch has remained thinner than the original stock trunk. |

## STATEMENT II.

| S. No. | Name of the buttressed mango tree | Particulars of buttressing. | Tree Girth of the scion trunk above the original graft joint | Inarch Girth of Inarch below its union with the branch | Buttressed Branch | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | | Girth of the buttressed branch **above** its union with the Inarch | Girth of the buttressed branch **below** its union with the Inarch | |
| 1. | 2. | 3. | 4. | 5. | 6. (a) | 6. (b) | 7. |
| 6. | Alphonso Fig. 10. | To a branch at its point of junction with the scion trunk | 1'-9" | 1'-2" | 1'-2" | Could not be actually measured | Mark equal thickness attained by the branch and the inarch. |
| 7. | Alphonso Fig. 11. | To a branch. | 3'-4" | 1'-11½" | 1'-11½" | | The buttressed branch was cut and separated from the scion tree sometime after its union had occured with the inarch. Mark this new graft standing independently side by side with the scion tree. |
| 8. | Sardar Fig. 12. | To a branch of the scion and also to the stock trunk. | 1'-6" | 0'-11½" | 1'-0" | 6" | Mark the development of the branch above the union and its impoverished thin end below the union with the Inarch (2). The inarch (1) attached to the stock trunk is almost as thick as the latter being 1'-5" in girth. |

**STATEMENT II.** (*Continued*)

| S. No. | Name of the buttressed mango tree | Particulars of buttressing. | **Tree** Girth of the scion trunk **above** the original graft joint | **Inarch** Girth of Inarch **below** its union with the branch | **Buttressed Branch.** Girth of the buttressed branch **above** its union with the Inarch | **Buttressed Branch.** Girth of the buttressed branch **below** its union with the Inarch | Remarks. |
|---|---|---|---|---|---|---|---|
| 1. | 2. | 3. | 4. | 5. | 6. (a) | 6. (b) | 7. |
| 9. | Alphonso Fig. 13. | On the two branches emerging from a crotch on the head of the scion trunk and also one inarch was applied to the stock trunk. | 1'-9" | (2) 1'-7"<br>(3) 1'-8" | 1'-2"<br>1'-10" | ..... | Both the tree and the inarches are 8 years old. It was not possible to measure the girth of the branches below their unions with the inarches as the latter were applied to their lowermost ends which together with a third branch formed a single crotch on the head of the trunk of the tree. Mark the poor development of the inarch (1) given to the stock trunk and the vigorous development of the inarches (2) and (3) which buttress the branches.<br>The poor development of the inarch (1) applied to the trunk is due to most of the carbohydrates arrested by the inarches (2) and (3) which are applied at the higher points on the top. |

STATEMENT II. (*Continued*)

| S. No. | Name of the buttressed mango tree | Particulars of buttressing. | **Tree** Girth of the scion trunk **above** the original graft joint | **Inarch** Girth of Inarch **below** its union with the branch | **Buttressed Branch.** Girth of the buttressed branch **above** its union with the Inarch | **Buttressed Branch.** Girth of the buttressed branch **below** its union with the Inarch | Remarks. |
|---|---|---|---|---|---|---|---|
| 1. | 2. | 3. | 4. | 5. | 6. (a) | 6. (b) | 7. |
| 10. | Rajapuri Fig. 14 | Five inarches were applied to five different branches of the tree. | 1'-6" | (1) 7"<br>(2) 7"<br>(3) 7½"<br>(4) 8¼"<br>(5) 8" | 7"<br>7"<br>7½"<br>7½"<br>9" | 4"<br>5"<br>6"<br>5½"<br>7" | Mark *the thickening* of the buttressed branches above their unions with the inarches and *their thinning* below the unions. |
| 11. | Alphonso Fig. 15 | (1) To a branch | 11" | 1'-1½" | 1'-1" | 10" | Mark the rapid development of the buttressed branch above its union with the inarch and its under development below the joint. |

**STATEMENT II.** *(Continued)*

| S. No. | Name of the buttressed mango tree | Particulars of buttressing. | **Tree** Girth of the scion trunk **above** the original graft joint | **Inarch** Girth of Inarch **below** its union with the branch | **Buttressed Branch.** Girth of the buttressed branch **above** its union with the Inarch | **Buttressed Branch.** Girth of the buttressed branch **below** its union with the Inarch | Remarks. |
|---|---|---|---|---|---|---|---|
| 1. | 2. | 3. | 4. | 5. | 6. (a) | 6. (b) | 7. |
| 12 | Alphonso<br>Fig. 16 | On two different branches of the tree | 1'-10" | (1) 1'-4"<br>(2) 5" | 1'-6"<br>1'-0" | 1'-9"<br>1'-0" | The tree is 8 years old and the inarch No. 1 was planted in situ along with it, at the same time whereas the inarch No 2 is only 3 years old having been planted at a later period. Mark the slow development of the Inarch No. 2. As it is inarched to a branch much thicker in diameter, it should take a much longer period to thicken sufficiently so as to take over the branch to which it is applied. The inarch No. 1 which is of the same age as the tree is just showing signs of taking over the branch to itself. |

**STATEMENT II** *(Continued)*

| S. No. | Name of the buttressed mango tree. | Particulars of buttressing. | **Tree.** Girth of the scion trunk **above** the original graft joint. | **Inarch.** Girth of the inarch **below** its union with the branch. | **Buttressed branch** Girth of the buttressed brach **above** its union with the inarch. | **Buttressed branch** Girth of the buttressed branch **below** its union with the inarch. | Remarks. |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 (a) | 6 (b) | 7 |
| 13. | Alphonso Fig. 17. | To one of the two branches forming a crotch on the head of the scion trunk just at the point where it emerges from the crotch. | 2'-2" | 1'-5½" | 1'-8" | Could not be precisely measured | Both the tree and the inarch are eight years old. The inarch having been awkwardly applied at the point of junction between the branch and the scion trunk, the thickening of the inarch is rather slow as compared to the point of the branch above the joint. Still quite a good quantity of carbohydrates are passing straight into the parent trunk. |

**STATEMENT II** ( *Continued* )

| S. No. | Name of the buttressed mango tree. | Particulars of buttressing. | **Tree.** Girth of the scion trunk **above** the original graft joint. | **Inarch.** Girth of the inarch **below** its union with the branch. | **Buttressed branch.** Girth of the buttressed branch **above** its union with the inarch. | **Buttressed branch.** Girth of the buttressed branch **below** its union with the inarch. | Remarks. |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 (a) | 6 (b) | 7 |
| 14. | Alphonso Fig. 18. | To a branch of the scion. | 2' | 0'–7¾" | 8" | 7½" | The tree is 8 years old and the inarch 3 years old.<br><br>The inarch was applied to a branch of equal thickness. The inarch is on the point of taking over the branch to itself. |

**Acknowledgment.**

The writer is indebted to Mr. P. M. Desai, B. Sc. (Agri ) for assisting him in measuring the various trees under observation in the course of these investigations.

# Crop Weather Studies as an Aid to the Breeding and Introduction of Crop Plants *

By

N. R. BHAT, B. Ag., Ph. D. (Cantab) ‡

It is proposed to give in this paper a connected account of a few recent ideas about the relationships between crops and weather and to show how we could utilise them in our large scale programmes of plant improvement, whether in individual countries or for the world as a whole.

In crop weather studies I include studies both of specific and general nature. By specific studies, I mean phenological studies i. e. studies of the various stages of growth and development, e. g., emergence, tillering, flowering, fruiting, ripening etc. of plant material. The studies of a general nature are all types of studies made on the relationship between crops and weather factors.

The improvement of crops is effected in the two well-known ways, viz., breeding and introduction. Considering plant breeding in the first instance, we have so long kept pureliness as our aim. We begin by selecting stock plants either from naturally varying material or material created through hybridisation and subject them to inbreeding and selection till we find them behaving more or less uniformly in respect of the desired characters. As has been recently pointed out by Harland (1949) this system of breeding works in different ways in the two categories of crops, viz. (1) those highly self-fertilised in nature, e. g. rice and wheat and (2) those slightly crossfertilised in nature, e. g. jowar and cotton. (The pureline method is out of question altogether in the case of highly crossfertilised crops like corn). In the first case, most of the loci of the original plants are homozygous and as natural selection has operated most of the time in its past on a homozygous system of genes, there is little loss of vigour or yield in the process of breeding or its continuance as a pureline. In the latter case, however, as natural selection has operated on a partially heterozygous system, the above technique results in loss of vigour of the pureline. According to Herland cotton can tolerate upto about 70 per cent of its genes in a homozygous condition and, by following the pureline technique, a loss of the order of about ten per cent results. He, therefore, advocates what he calls the "Mass Pedigree System" of breeding where slight variations in characters are not detrimental to consumption or to industry.

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* Paper read at the symposium on "CROPS AND WEATHER" arranged on behalf of the Indian Society of Agricultural Statistics, on 31st December, 1950.

‡ Statistical Officer to the Deputy Director of Agriculture (Crop Research), B. S., Poona.

Even apart from the question of deterioration, three other considerations should weigh with the plant breeder. The first is that his strain should give a better average performance than the local unselected crop. The second is that it should be capable of giving a certain minimum even in a fairly bad season. Thirdly, if possible, it should suit a fairly large area.

To satisfy the first requirement, the strain has to be tried in a series of seasons which should be representative of the climatic conditions of the place of cultivation. This requires a sound knowledge of climatic factors. For achieving the second and third objectives, it is essential to know the amplitude of expression of the genotype of the strain in varying seasons and in various places, respectively. Any plant breeder is aware of the fluctuations that occur in the yields of a pureline in different seasons. A striking instance of the pliability of gene action in places differing in latitude and therefore in photoperidism is found in the data of Quinby and Karper (1945) on certain genotypes in Milo. They are given in Table I below :—

**Table I**

The effect of photo periods upon the time of floral imitation and anthesis and number of leaves of four milo maturity genotypes.

| Photo Period. | Genotype | | | |
|---|---|---|---|---|
| | Early Ma2 | Intermediate Ma | Late Ma Ma3 | Ultra-late Ma Ma2 |
| | No. of days to floral initiation. | | | |
| 10-hour | 19 | 19 | 19 | 19 |
| 4-hour | 32 | 37 | 41 | 70 |
| | No. of days to anthesis | | | |
| 10-hour | 43.6 | 44.2 | 46.4 | 46.7 |
| 14-hour | 48.6 | 68.6 | 82.6 | 102.4 |
| | No. of leaves | | | |
| 10-hour | 12.2 | 12.3 | 12.2 | 12.6 |
| 14-hour | 16.4 | 22.0 | 23.5 | 31.5 |

It will be seen from Table I that the four genotypes behave almost as one in a ten hour photoperiod and very distinctly in the 14 hour day-length. Such pliability of gene expression has even misled people into believing that purelines may segregate when tried in different ecological conditions. Phenological studies on pureliness are, therefore, necessary in distant places and for several seasons if maximum use is to be made of the purelines. It is desirable to take up such studies on several of the best purelines and also their mixtures, if mixtures are to be recommended as advocated by Harland.

In the course of such studies, one may find such useful constants as the least variable product of 'daylength' and 'day-degree' discovered by Nuttonson (1948). By day-degree is meant the difference between the mean temperature of

the day in Fahrenheit units minus a certain empirical zero temperature in the same units. In the experiments referred to by Nuttonson, the empirical zero was taken as 30°F for wheat and flax and 40°F, for peas and egg plants. Suitable data extracted from those given by Nuttonson are presented in Tables II to IV below :-

**Table II**

Phenology of marquis wheat in a number of North American areas.

| | | From emergence to ripeness. | | | |
|---|---|---|---|---|---|
| | | Days. | Day degrees | Average length of day. | Average lenth of day multiplied by day degrees. |
| | | | | (in hours) | |
| Fairbanks | (Lat. 64°) | 78 | 2054° | 19.0 | 39.026 |
| Beaver Lodge | ( ,, 55°) | 102 | 2296° | 16.7 | 38.343 |
| Saskatoon | ( ,, 52°) | 89 | 2375° | 16.4 | 38.950 |
| Indian Head | ( ,, 51°) | 86 | 2394° | 16.4 | 39.262 |
| Portage la | ( ,, 50°) | 78 | 2398° | 16.0 | 38.368 |
| Winnipeg | ( ,, 50°) | 77 | 2448° | 16.0 | 39.168 |
| Harve | ( ,, 49°) | 85 | 2454° | 15.7 | 38,528 |
| Dickinson | ( ,, 48°) | 89 | 2540° | 15.4 | 39.116 |
| Aliance | ( ,, 42°) | 97 | 2793° | 14.7 | 41.057 |
| Lincoln | ( ,, 41°) | 86 | 2816° | 14.5 | 40,832 |
| Tlalnepantia | ( ,, 19°) | 148 | 3711° | 11.7 | 43.419 |

**Table III**

Phenology of four varieties of flax (Linota, Redwing, Bison, Rio) in a number of North American areas.

| | | From seeding to ripeness | | | |
|---|---|---|---|---|---|
| | | Days. | Day degrees. | Average length of day. | Average length of day multiplied by day degrees. |
| | | | | (in hours) | |
| Fairbanks | (Lat. 64°) | 10 | 3175° | 17.7 | 56.197 |
| Edmonton | ( ,, 53°) | 126 | 3126° | 15.7 | 49,984 |
| Saskatoon | ( , 52°) | 97 | 3019° | 16.1 | 8.606 |
| Morden | ( ,, 49°) | 96 | 2894° | 16.0 | 46,304 |
| Crookston | ( ,, 47°) | 94 | 2955° | 15.6 | 46.098 |
| Bozeman | ( ,, 46°) | 109 | 3000° | 15.1 | 48.300 |
| St. Paul | ( ,, 45°) | 89 | 3109° | 15.1 | 46 946 |
| Corvallis | ( ,, 44°) | 101 | 3125° | 14.8 | 46,250 |
| Madison | ( ,, 43°) | 96 | 3169° | 14.8 | 46.901 |
| Logan | ( ,, 41°) | 117 | 3537° | 14.5 | 51,286 |
| Fort Collins | ( ,, 40°) | 98 | 2888° | 14.6 | 42,165 |
| Manhattan | ( ,, 39°) | 100 | 3186° | 14.0 | 44.604 |
| El Centro | ( ,, 32°) | 177 | 4876° | 11.5 | 56.074 |

## Table IV

Phenology of Alaska Pass at College Park, Maryland
(Time of seeding studies during 1926)

| From emergence to harvest | | | |
|---|---|---|---|
| Days | Day degrees | Average length of day. (in hours) | Average length of day multiplied by day degrees. |
| 58 | 1279° | 14.0 | 17,906 |
| 56 | 1261° | 14.0 | 17,717 |
| 54 | 1331° | 14.1 | 18,836 |
| 51 | 1263° | 14.3 | 18,061 |
| 51 | 1267° | 14.4 | 18,245 |
| 45 | 1180° | 14.5 | 17,110 |
| 43 | 1161° | 14.6 | 17,009 |

It will be noticed from the tables that the products are least variable fo four different crops even in places of very different latitudes.

A more important question faces those who are planning introduction c plants into regions, which though agro-climatically suitable for crop productio are remaining uncultivated. Here, general studies of the relationships betwee crops and weather are of very great use. Hanson (1949) reports that it has bee found through the study of the geographic distribution of vegetation that almos identical plants are growing in widely distant parts of the globe. The study o the plants and climatic factors in these areas has led to the discovery of a fe 'homoclimes'. The fact that the areas are agro-climatic analogues has alread been verified through the performance of certain strains of crops. For exampl the strains of corn evolved in Nebraska and South Dakota in the U. S. A. hav been found to suit the Grass Land Steppe Region of the Ukraine.

The refinement and extension of the 'homoclime' technique may make i immediately possible to try in the underdeveloped and neglected regions of th world the large number of superior agrotypes already evolved in agriculturall advanced countries.

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# Control of Field Rats and Bandicoots

By

H. V. KATARKI and H. L. KULKARNY

## Introduction

Rats and bandicoots are injurious to mankind. Fieldrats cause damage to maturing crops by cutting down and feeding on cropplants such as rice, jowar, wheat, sugarcane, etc. Often the groundnut crop is attacked by rats at harvest time when they excavate the pods and feed on them. Besides, in the irrigated fields the water channels are often damaged on account of their burrows. Rats are responsible for heavy losses to stored grains on the farms, in the grain godowns, and in the houses as well. Rats spoil more foodstuffs than they actually eat. Even according to a very modest estimate the rats cause an annual loss of more than a million ton of food and seed grains. However, such losses seem negligible if one considers these ugly creatures as carriers of the germs of the dreaded plague. With the growing need of conserving crops of all kinds and efficient storage of all types of farm produce the necessity of the destruction of rats is of increasing importance. Some experimental trials in controlling the ravages of rats by poison baiting are dealt with in this paper.

## General Habits

There are several species of rats, but the most common is Ratus ratus. They are nocturnal in habit. They live in the burrows in field embankments, in the drains, in the roofs of buildings or among the crevices in the walls of old houses. The rat burrows are short but are connected with one another extensively. Each burrow has got 3-4 openings. In the fields they store grains in their burrows. Even upto 4-5 seers of grains may be stored in such burrows which generally do not open to the exterior. Observations made at Dhome, near Wai, in Satara district, in the paddy fields showed that before the earheads are produced the rats feed on the pulpy portions of the stems of paddy. When the earheads are in milk stage they feed on the milky grains. As the crop nears the harvesting stage they steal grains and store them safe in their burrows. In the grain godowns the rats enter the stores in the night, gnaw the bags and feed on the inner grains. The incidence of rats in the fields can be made out by the presence of heaps of loose soil lying at the mouths of their burrows. In the godowns and houses their activity can be made out by the presence of irregular holes in the doors and windows, bags cut at various places with loose grains lying down, etc.

## Technique of Baiting

The survey of the infested area is essential before the usage of baits in the fields. During the survey work the operator should take into account the area to be treated, the distribution of rat colonies, pest population etc. Having surveyed the area, the burrow openings should be closed with wet soil and the plot reexamined the next day with a view to ascertain the exact number of burrows having live occupants inside. Such observations will economise the wastage of poison and the base food as well. Rats are suspicious of anything that is new. This initial suspicion can be got over by supplying unpoisoned food known as Base bait ! Base baits may be given for the first two days to train the rats to come to the regular feeding points. On the third day evening the base bait mixed with the poison may be given according to the recommended doses. On the 4th day morning the treated area may be surveyed carefully with a view to ascertain the number of dead rats and collect the uneation baits. The same baits may be used for a second time in the same evening and observations may be repeated as in first instance. If again some of the baits remain uneaten they should be destroyed. The second round of baiting should be done at an interval of a fortnight, and the treatment continued further until complete control of rats has been achieved. For a regular campaign against rats two separate base baits and poisons are needed. The surviors from the first effort may be prejudiced against base baits and the poisons as well. Therefore both may have to be changed regularly to erradicate the pest.

**Zinc-phosphide**:- It is a black amorphous poisonous powder which evolves phosphine gas when it comes in contact with moisture.

Recipe:- Zinc phosphide ... ... two and a half tola
Wheat flour ... ... one lb.
Water ... ... ... ... sufficient to moisten the bait.

*Preparation*:—Moisten the wheat flour early in the morning, and keep it wet until evening. The poison is then mixed well with the flour paste and roughly about 200 pills may be prepared for distributing in the affected areas. Generally 2 pills are kept at the mouth of each burrow, in the evening.

Recipe for bandicoots:— Zinc phosphide ... ... two and half tola.
Wheat floor ... ... ... one half Pound.
Water ... ... ... ... sufficient to moisten the bait.

Prepare 100 pills only and treat the affected areas as above.

**Barium carbonate**:— It is a white amorphous and comparatively weak poison for the destruction of rats.

Recipe:— Barium carbonate ... ... One lb.
Bajri flour ... ... ... Five lbs.
Water ... ... ... ... Sufficient to moisten the bait.

*Preparation*:—Same as for zinc phosphide.

A number of laboratory trials were initially conducted at the Agricultural College Poona, with a view to fix up the optimum leathal dose of the poison to destroy adult rats. It was observed that two and half grains of zinc phosphide and four and half grains of barium carbonate per adult rat was quite sufficient to destroy it. The laboratory observations were further confirmed by conducting field trials at Dhome, in Satara district and in and round about Poona during 10-9-49 to 31-12-49. Zinc phosphide was found to be very effective in the destruction of bandicoots in human dwellings and also on agricultural farms.

### Precautions to be observed in the use of poisons

(1) Take care to put the poison baits where children and domestic animals and live stock cannot get them.

(2) Any bait left after poisoning operations are over should be destroyed.

(3) The vessels used for the preparation of baits should be washed clean after the baits are prepared.

(4) Due warning should be given to neighbouring cultivators about the treatment of affected fields with poisoned baits.

# Artificial Insemination Dairy Cooperatives in the U. S. A. *

By

N. V. NAYAK, B. A., B. SC., G. D. C. A., ‡

In 40 states of U. S. A. there were 963 Artificial Insemination Dairy Cooperatives on 1-1-1948 organised during the last ten years. 1,200,000 of dairy cows were inseminated artificially in 1947. About 7% i. e. $1\frac{3}{4}$ million dairy cows owned by 2,25,000 members are listed for service during 1948. There were 91 bull studs with an average of 19.2 bulls per stud supplying the semen to the societies of which 81 were operated by Cooperatives. The average number of cows inseminated by each bull works out at 1000. But the average maximum in one association has gone up to 2200.

The primaries were the first to come. Next they formed their federations which produced the semen in a central place and distributed it to the affiliated locals. Recently, however, a centralised form of cooperatives are organised both for production and distribution of semen. Federated structure, however, shows more vitability and success in working.

The financial structure is mostly of non-stock type. Membership fees, subscription on a decreasing sliding scale depending upon the number of cows of member's herd and capital cartificates for cash to be retired from net savings in order of their age provide the requisite capital resources and working funds. The analysis of balance sheets indicates that for a successful inseminating of about 20,000 cows a year a capital of $ 3.85 per cow is required of which $ 2 will have to be in fixed assets.

The average overall operating costs for Central Cooperatives were $ 5.69 and average receipts $ 5.87. Corresponding figures for Federal Institutions whose major activity is production of semen were $ 1.83 and $ 2.40. 70%, 37% and 90% of the total expenses represented labour costs in centralised federated and local associations respectively.

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* Abridged from 'Dairy Breeding Co-operative', F. C. Administration, N. S. Dept. of Agriculture Circular. C-133

‡ Retired Principal, Co-operative Collge, Poona.

As against the 1947 average of 200 lbs. of butter fat per cow in the U. S. A. the production of the daughters born from the semen of proved sires used by the cooperatives amounted to 430 lbs. which meant a net increased income of 200 %. Selection of good bulls, providing for the adequate care, and preserving the quality of their semen used are the three most important technical points which need attention.

The present financial policy is defective in the sense that it does not provide the adequate capital or reserves for future developments. Local organisations where the number of cows bred are under 1500 are not expected to be economic units. Associations in which at least 3000 but preferably 5000 cows can be bred are considered advisable.

Finally good working relations with members and employees who should be efficient are necessary for ensuriug the progress through times good as well as bad. It is not considered essential to employ veterinarans as managers or inseminators. Lay men trained in the technique of artificial insemination at Agricultural Colleges are found quite good. Basic minimum salary with an additional bonus on the basis of conceptions of cows inseminated is found very successful.

### Advantages of Artificial Insemination Cooperatives.

1. Farmers can secure services of outstanding sires and improve the quality of their herd and their net returns therefrom.
2. The breeding services of a good bull can be extended over a wider area and to a larger number of cows.
3. A single bull has as many as 15000 offsprings.
4. Transmission of diseases is minimised.
5. Dangers of in-breeding and cross breeding can be eliminated.
6. Microscopic examination of semen and maintenance of inception record of cows inseminated enable close watch on the sterility of the bulls.
7. Sterile bulls can be eliminated.
8. The difficulties of mating due to disparities of size and weight of male and female are eliminated.
9. Reproduction can be controlled seasonally to a greater degree as an effective means of reducing seasonality of milk production.
10. The improved breed of dairy cows will also bring better income to the dairy men.

# Graphical Representation of Khandesh Cotton Breeding Work Done During 1921 to 1948

By

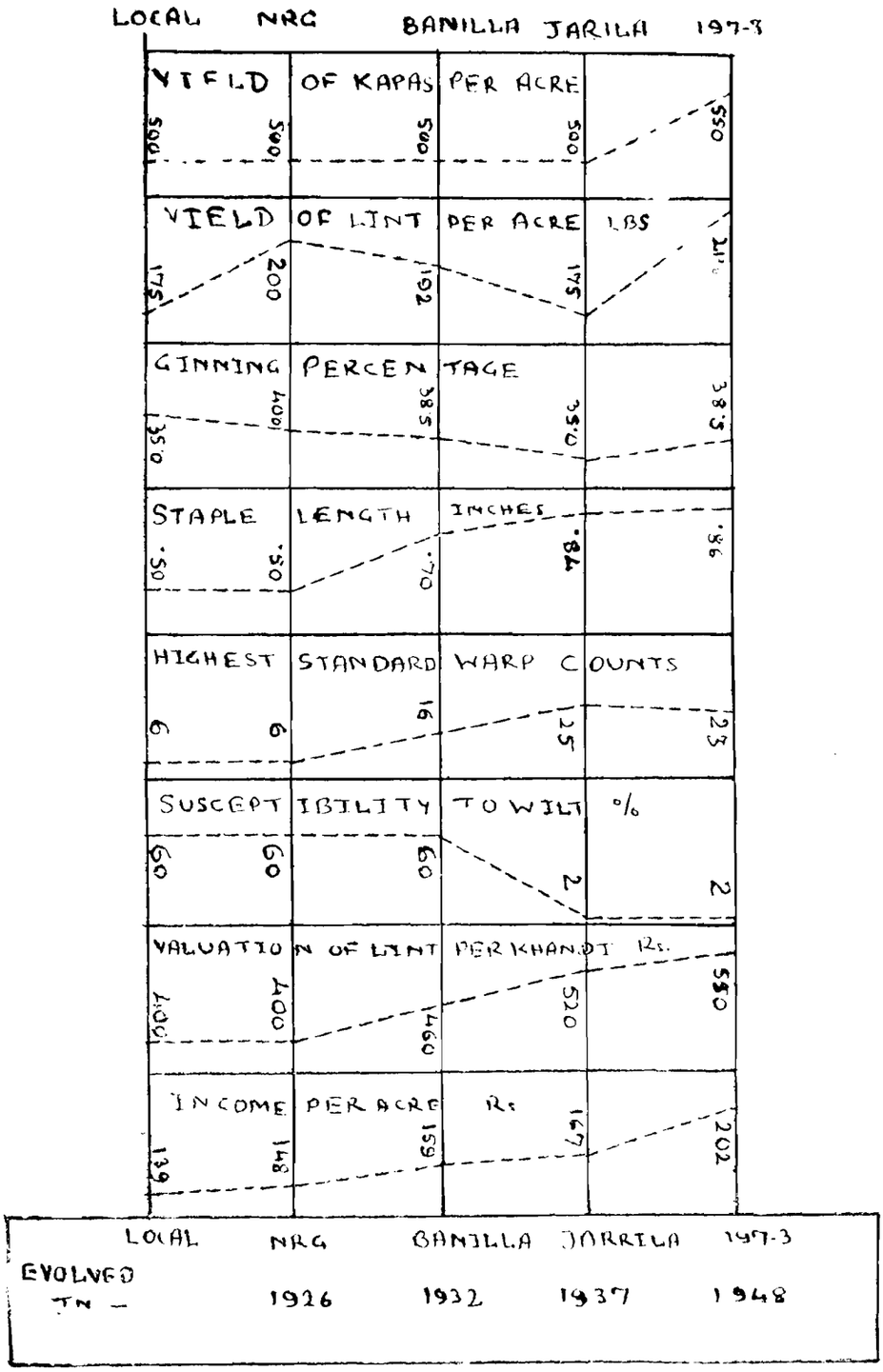
T. R. KHADILKAR, B. Ag.; M. Sc. (Cornell) *

The present note is a mere graphical representation of the trend in important economic characters of the various cotton strains evolved from time to time in Khandesh and the original prominent morphological features of the strains are given below:—

| Strain | Description |
|---|---|
| Local Cotton | It has white flowers and it belongs to the botanical class *Gossypium arboreum* L. var. *neglectum* forma *bengalensis* H. and G. |
| N. R. 6 | A selection from local cotton possessing white flowers. It was evolved in 1926. |
| Banilla. | A hybrid strain from an old cross made between Bani and Comilla cottons. It possesses sulphur yellow flowers and leaves with no sinus lobes It was evolved in 1932. |
| Jarila. | A selection from seed originally brought from Central Provinces. It has deep yellow flowers and was evolved in 1937. |
| 197–3 | A hybrid strain from a cross between N. R. 5 and Jarila. It has white flowers intermediate in size between the two parents and possesses big petal spot like Jarila and the deep green leaf colour of N. R. 5. Flowers of N. R. 5 are white. There are three foliar glands as in Jarila. They are absent in N. R. 5. The strain was evolved in 1948. |

The following graph shows the rise or fall in each economic character strain by strain to indicate whether the breeder is wending his way.

* Cotton Breeder, Jalgaon.


LOCAL NRG BANILLA JARILA 1947-3
YIELD OF KAPAS PER ACRE
500 500 500 550
YIELD OF LINT PER ACRE LBS
175 200 192 175 211
GINNING PERCENTAGE
350 400 385 350 383
STAPLE LENGTH INCHES
·50 ·50 ·70 ·84 ·86
HIGHEST STANDARD WARP COUNTS
6 6 16 25 23
SUSCEPTIBILITY TO WILT %
60 60 60 2 2
VALUATION OF LINT PER KHANDI Rs.
400 400 460 520 550
INCOME PER ACRE Rs
139 148 159 167 202
LOCAL NRG BANILLA JARILA 1947-3
EVOLVED IN — 1926 1932 1937 1948

The above graphical representation clearly indicates what could be actually achieved in spite of the desire to raise every economic character to a higher level at each stage of improvement.

The values given in the graph are comparative and taken from Indian Cotton Growing Review, Vol. I No. 4, p. 193.

The strain 197-3 has been given out in the district for the first time in 1949 for large scale cultivation over an area of about 150 acres, as it has been found to be more paying than Jarila, as evident from its income per acre shown in the graph which also shows its superiority over Jarila in many other characters.

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# QUALITY TABLE EGGS IN SUMMER

By

MR. R. M. PATIL, G. B. V. C., M. SC. (Md. U. S. A.) *

It is a general belief that eggs are a good and wholesome food in winter season, and not so good in hot season. It will be of much value to know why this nutritious food becomes unpalatable with change in temperature. If we try to save as much as 10 percent of the loss, through proper precautions and methods, we will add a sizable saving to food drive. Eggs produced by hens are of the same quality and composition in all seasons. The quality of a freshly laid egg is therefore the same at any time. It deteriorates rapidly in hot season. Low temperature in winter keeps it in a relatively good condition.

Egg contents have 64% of water. It is very essential to keep this high percentage of water to preserve the quality of egg. High temperature causes excessive loss of moisture from egg contents. This results in increase of air-cell size, which can be easily seen at broader end by candling (by holding an egg before a bright lamp in a dark room). Due to loss of moisture from egg contents,

* Poultry Research Officer, Poona

the *p*H value changes and becomes more alkaline in reaction. The white and the yolk get thin and spread out, and the white is unable to hold the yolk in the centre, which gets to one side of the egg shell. If you boil an egg and the yolk is seen extremely out of centre, it is a sign of a stale egg. In a fresh egg, yolk remains well centred even after boiling.

The accompaning pictures illustrate quality of eggs broken out.

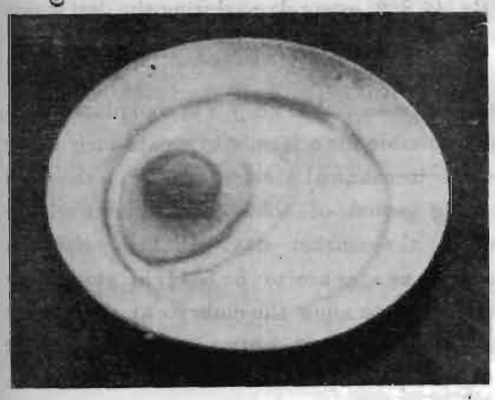
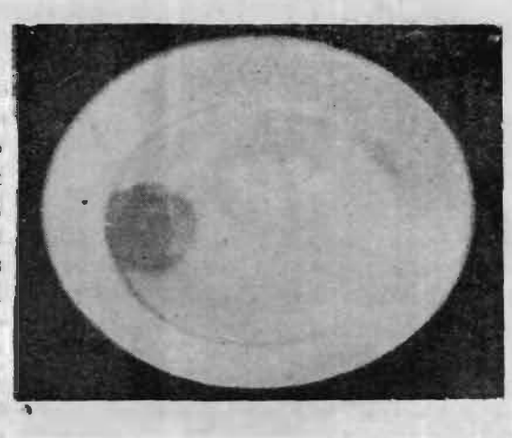


Fig. I:—

A good quality egg when opened covers a small area, with a high percentage of thick white around the yolk, but very little thin white. The yolk is round and stands well up on the white.

Fig. II:—

A poor quality egg covers a wide area. There is little or no thick white surrounding the yolk; instead a large amount of thin white, thinly spread, surrounds the yolk. The yolk is flat and enlarged.



Most of the poultry farmers and public are under an amusing impression that a hen does not lay an egg without a cock: such eggs are infertile, and do not hatch. Such eggs keep up their quality for a relatively longer time. Eggs laid by hens running with cocks are fertile eggs and are useful for hatching. Infertile eggs cannot be hatched as there is no germ cell from the male to develop it into a chicken. In fertile eggs, the quality of eggs is destroyed by the developing embryo. In an infertile egg there is no development of an embryo

and the quality can remain high for a relatively longer time than in fertile eggs under same conditions of temperature. To produce infertile eggs for consumption is a big help to preserve the valuable food.

More than 40% of eggs are wasted due to their bad quality caused by the developing germs. They are wasted because they are not used otherwise. In India eggs worth of Rs. 5.25 crores are produced every year. Therefore we lose Rs. 41, 24,000 every month or Rs. 45,822 every day, during the hot season of 3 months.

To protect the quality of an egg it is essential to keep it in cool place having as low temperature as 55°F. It is not possible for a farmer to create such a low temperature without the help of some mechanical device. 55°F is the ideal temperature for holding eggs for a long period of about two–three weeks or more. Eggs are sold once in a week on the market day. It is therefore not necessary to stick to the ideal temperature as eggs are to be held in storage for one week only. It is important therefore not to allow the embryo to develop by keeping eggs in cooler place. Embryo development begins at 70°F. All the attempt should therefore be made to keep temperature below 70°F. This is much easier with home made devices.

The picture on the left shows a device that would keep cooler by about 8°to 9°F than the atmospheric temperature. The earthen pot is burried halfway underground with half sand, and half earth mixed together to make a layer of about 3" all round and below the pot. Pour water around the pot so as to keep it fairly wet to give moisture and cold to the eggs. The pot should be buried in a good aerated room and not in a secluded corner of the house, where wind circulation is poor. The top of pot should be covered with a thin cloth to allow air and moisture from the pot to escape and thus facilitate to keep the temperature low. Keep a good bedding of clean grass at the bottom of pot to avoid eggs from coming in contact with percolated water at the bottom.

On every second day the eggs should be turned from one side to another so that the yolk will not stick to side of egg shell and get ruptured. Yolk has a tendency to float always on the upper side of egg contents, and if left unchanged in one position for long, it may stick to the shell.

The following rules will be of considerable value to keep up quality in farm eggs in hot weather: -

(1) Gather eggs frequently, say 10 a.m. and again in the afternoon.

(2) Clean the dirty eggs immediately.

(3) Cool them quickly in wire mesh basket, where room temperature is 60° F or lower.

(4) Store eggs in a cool, moist place.

(5) Keep small end down, but not until after they are thoroughly cooled.

(6) Market them often.

(7) Produce infertile eggs. Cockrels have no place in the laying flock after the breeding season is over.

# List of Gazetted Officers in the Department of Agriculture, Bombay State

( Not arranged according to Seniority )

| | Name of Officer | Appointment |
|---|---|---|
| 1 | Dr. B. N. Uppal<br>Ph. D. ( Iowa ), F. N. I. | Director of Agriculture, Bombay State, Poona. |
| 2 | *Shri D. A. Gadkary*<br>B. E., A. M. Inst. C. E. ( Lond )<br>M. I. E. ( Ind. ) B. S. E. ( I ). | *Joint Director of Agriculture, ( Engineering. )* |
| 3 | Dr. M. B. Ghatge, B. Ag., Ph. D.<br>( Wales ), F. S. S. (Lond.) | Deputy Director of Agriculture (Seed Multiplication and Extension ), Poona. |
| 4 | ,, J. A. Daji, M. Ag. B. Sc.,<br>Ph. D. ( Lond. ) | Deputy Director of Agriculture ( Research & Education ), Poona. |
| 5. | Shri V. M. Chavan, B. Ag. | Deputy Director of Agriculture Crop Research, Poona. |
| 6 | ,, A. K. B. Cazi, B. Ag.,<br>B. Sc. ( Edn ), N. D. D. ( Scot. )<br>D. I. C. ( London ). | Deputy Director of Agriculture, ( Manures Fertilizers and Rural Development ) Poona. |
| 7 | Dr. J. K. Basu, M. Sc. ( Cal. ), Ph.<br>D. ( Lond. ), F. N. I. | Soil Physicist to Government, Bombay State Poona. |
| 8 | ,, R. D. Rege, B. A., M. Sc. (Bom.)<br>Ph. D., Associate H. Sc. | Sugarcane Specialist, Sugarcane Research Scheme, Padegaon. |
| 9 | Shri R. S. Basrur, B. E. | Mechanical Cultivation Engineer to Government, Bombay State, Poona. |
| 10 | ,, P. J. Patel, B. Ag., M.Sc. (IOWA) | Agricultural Engineer to Government, Bombay State, Poona. |
| 11 | ,, L. S. S. Kumar, M. Sc. ( LOND ),<br>A. R. C. S. D. I. C. | Economic Botanist to Government and Principal, College of Agriculture, Poona. |
| 12 | Dr. M. K. Patel, M.Sc., Ph.D. (IOWA) | Plant Pathologist to Government, Bombay State Poona. |
| 13 | **Vacant** | Professor of Agronomy, College of Agriculture, Poona. |
| 14 | ,, G. A. Patel, Ph. D. | Agricultural Entomologist to Government, Bombay State, Poona. |
| 15 | Shri P. N. Driver, M. A. | Professor of Agricultural Economics, College of Agriculture, Poona. |
| 16 | ,, A. A. Vasavada, B. Ag. | Professor of Agril. Engineering Physics and Mathematics, College of Agriculture, Poona. |
| 17 | ,, S. R. Gandhi, M. Ag. | Horticulturist to Government Bombay State Poona. |
| 18 | Dr. N. N. Narayana, M. Sc., Ph. D. | Agricultural Chemist to Government, B. S., Poona. |
| 19 | Shri B. G. Oka, B. Ag. | Professor of Animal Husbandry & Dairying, Agricultural College, Poona. |

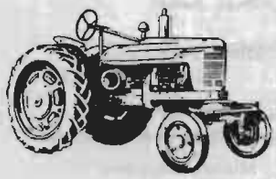
| | Name of Officer | Appointment |
|---|---|---|
| 20 | Shri J. P. Ghogale, G. B. V. C. | Professor of Veterinary Science, Agril. College, Poona. |
| 21 | Dr. S. Soloman, Ph. D. | Assistant Professor of Botany, Agril. College, Poona. |
| 22 | ,, H. G. Pandya, .Ph D. | Assistant Professor of Chemistry, Agricultural College, Poona. |
| 23 | Shri N. Gopalkrishna, B. Sc. (AGRI.) M. S. (Ill.) | Assistant Horticulturist to Government, B. S., Poona. |
| 24 | Dr. B. A. Chaugule, B. Sc. (AGRI.) Ph. D. (CALIF.) | Assistant Professor of Agronomy, Agril. College, Poona. |
| 25 | Shri M. N. Kamat, M. Sc. | Assistant Professor of Mycology, Agril. College, Poona. |
| 26 | ,, U. K. Kanitkar, M. Sc. | Assistant Professor of Plant Physiology, Agril. College, Poona. |
| 27 | ,, V. C. Pavate, B. Ag. | Principal, College of Agriculture, Dharwar. |
| 28 | Dr. M. C. Desai, B. Ag., Ph. D. (CARNELL) | Professor of Agril. Botany, Agril. College, Dharwar. |
| 29 | Shri R. F. Patil, B. E. | Professor of Agril. Enineering, Agricultural College, Dharwar. |
| 30 | Shri M. A. S. Iyengar | Professor of Agril. Chemistry, Agril. College, Dharwar. |
| 31 | Shri D. S. Rangrao B. Ag., B. Sc. | Professor of Mathematics, Statistics, Agril. College, Dharwar. |
| 32 | ,, S. A. Rajarao, M. Sc. | Professor of Entomology, Agril. College, Dharwar. |
| 33 | Dr. R. S. Deshpande, B. Sc., Ph. D. | Professor of Plant Pathology, Agril. College, Dharwar |
| 34 | ,, H. R. Arkeri, B. Ag., M. Sc., Ph. D. | Professor of Agronomy, Agril. College, Dhawar. |
| 35 | Shri S. K. Goni, B. Ag. | Professor of Animal Husbandry & Dairying, Agril. College, Dharwar, (On deputation to U. S. A. for training abroad,) |
| 36 | Dr. V. P. Bhide, B. Sc., (AGRI.) Ph. D. | Professor of Bacteriology, Agril. College, Dharwar. |
| 37 | Shri S. R. Dhareshwar, B. Ag. | Professor of Horticulture, Agril. College, Dharwar. |
| 38 | Dr. N. P. Patil, B. Sc., (AGRI) Ph. D. (BOMBAY) | Professor of Agril. Economics, Agri. College Dharwar. |
| 39 | Shri G. B. Patel, B. Ag. (BOM.) M. Sc. (CALIF.) | Cotton Botanist, Bombay State, Surat. |
| 40 | ,, S. J. Patel, M. Ag. | Cotton Breeder, Viramgaon. |
| 41 | ,, S. G. Kelkar B. Ag. | Cotton Breeder, S. M. C. Dharwar. |
| 42 | ,, P. S. Pandya, B. Ag., M. S. | Cotton Breeder, Jalgaon. |
| 43 | ,, D. S. Sheth, B. Ag., M. S. | Cotton Breeder, North Gujarat, Viramgaon. |
| 44 | ,, B. S. Thakur, B. Ag. | Cotton Breeder, Broach, (I. C. C. C. post.) |
| 45 | ,, V. V. Patel, B. Ag. | Cotton Superintendent, Surat. |
| 46 | ,, A. S. Patil, B. Ag. | Cotton Superintendent, S. M. C. Dharwar. |
| 47 | ,, J. D. Randive, B. Ag. | Cotton Superintendent, Jalgaon (I. C. C. C. post.) |
| 48 | ,, S. S. Marlihalli, B. Ag. | Plant Breeder and Officer i/c Rice Breeding Station, Bijapur. |
| 49 | ,, M. S. Pandya, M. Ag. | Plant Breeder and Officer i/c Agril. Research Station, Bhuwa. |
| 50 | ,, G. T. Babriwala, B. Sc., (AGRI.) | Plant Breeder and Officer i/c Rice Breeding Station, Dharwar. |
| 51 | ,, V. K. Patankar, B. Ag. | Officer i/c Nucleus Seed Scheme, Poona. (Pensioner Re-employed.) |
| 52 | ,, R. S. Koshal, M. Sc. | Statistician, Department of Agriculture, B. S., Poona |

| | Name of Officer | Appointment |
|---|---|---|
| 53 | Shri N. R. Bhat, B. Ag. (Bom.). Ph. D. (Cambridge) | Statistical Officer, Rice Research Scheme, under the Dy. Director of Agri. (C. R.) Bombay State. Poona. |
| 54 | ,, V. G. Sharma, M. Sc. | Statistical Survey Officer, Poona. |
| 55 | ,, K. R. Patel, B. Ag. | District Agricultural Officer, Kaira (District Nadiad.) |
| 56 | ,, V. H. Kulkarni, M.Ag. | District Agricultural Officer, Sholapur. |
| 57 | ,, V. M. Mujumdar, B. Ag. | District Agricultural Officer, Punchmahals (Godhra.) |
| 58 | ,, L. N. Patel | District Agricultural Officer, Broach. |
| 59 | ,, M. K. Desai, B. Ag. | District Agricultural Officer, Surat. |
| 60 | ,, D. H. Joshi, B. Ag. | District Agricultural Officer, Thana, B. S. D. |
| 61 | ,, P. R. Patil | District Agricultural Officer, Ahmednagar |
| 62 | ,, D. M. Kulkarni, B. Ag., Advocate | District Agricultural Officer, East Khandesh, Jalgaon. |
| 63 | ,, K. G. Kolhatkar, B. Ag. | District Agricultural Officer, W. K., Dhulia. |
| 64 | ,, G. K. Phadtare, B. Ag. | District Agricultural Officer, Nasik. |
| 65 | ,, T. B. Pawar, B. Ag. | District Agricultural Officer, Poona. |
| 66 | ,, S. V. Naikwadi, B. Ag. | District Agricultural Officer, Satara. |
| 67 | ,, B. H. Hullatti, B. Ag. | District Agricultural Officer, Belgaum. |
| 68 | ,, S. V. Kotur, B. Ag. | District Agricultural Officer, Bijapur. |
| 69 | ,, B. B. Yelligar, B. Ag. | District Agricultural Officer, Dharwar. |
| 70 | ,, V. S. Habbu, B. Ag. | District Agricultural Officer, Kanara (Pensioner Re-employed.) |
| 71 | ,, S. T. Purandare, B. Ag. | District Agricultural Officer, Kolaba, Alibag, (Pensioner Re-employed). |
| 72 | ,, S. Y. Sawant, B. Ag. | District Agricultural Officer, Ratnagiri. |
| 73 | ,, J. V. Oza, B. Ag. | District Agricultural Officer, Ahmedabad. |
| 74 | ,, S. S. Patel, B. Ag. | District Agricultural Officer, Banaskanta, Palanpur. |
| 75 | ,, B. K. Mehta, B. Ag. | District Agricultural Officer, Sabarkantha, Himatnagar. |
| 76 | ,, R. Y. Pawar, B. Ag. | District Agricultural Officer, Dangas, Bhuva. |
| 77 | ,, G. V. Wazalwar, B. Ag. | District Agricultural Officer, Kolhapur. |
| 78 | ,, G. G. Nawathe, B. Ag. | District Agricultural Officer, Mehsana. |
| 79 | ,, A. F. Patel, B. Ag. | District Agricultural Officer, Baroda. |
| 80 | ,, P. C. Mehta B. Ag. | District Agricultural Officer, Amreli. |
| 81 | ,, P. S. Kulkarni, B. Ag. | District Agricultural Officer, South Satara, Sangli. |
| 82 | ,, H. C. Patil, B. Ag. | Superintendent, Agricultural School, Manjri, Dist. Poona and Inspector of Agril. Schools (Pensioner and Re-employed) |
| 83 | ,, D. H. Gokhale, M. Ag., B. Sc. | Superintendent, Agricultural School, Sholapur. |
| 84 | ,, G. M. Badami, B. Ag. | Superintendent, Agricultural School, Bagalkot. |
| 85 | ,, G. R. Yadav, B. Ag. | Superintendent, Agricultural School, Borgaon. |
| 86 | ,, T. N. Chaugule, B. Ag. | Superintendent, Agricultural School, Dhulia. |
| 87 | ,, D. K. Desai, B. Sc. (Agri.) | Superintendent, Agricultural School, Dohad. |
| 88 | ,, K. A. Jalihal, B. Sc. (Agri.) | Superintendent, Agricultural School, Devihosur. |
| 89 | ,, P. G. Bidari, B. Ag. | Superintendent, Agricultural School, Arbhavi. |
| 90 | ,, Hari Singh, B. Sc. (Edin.) | Soil Conservation Officer, Poona. |
| 91 | ,, M. S. V. Ramrao, B. E. (Bom.) | Divisional Soil Conservation Officer, C. D., Poona and 2nd Utilisation Services Officer, Poona. |
| 92 | ,, G. V. Patel, B. E. (Bom.) | Divisional Soil Conservation Officer, N. D. Surat. |
| 93 | ,, K. D. Gumaste, B. Ag. | Divisional Soil Conservation Officer, S. D. Bijapur. |

| | Name of Officer | Appointment |
|---|---|---|
| 94 | Shri R. V. Satpute, D. C. E. | Tech. Asstt. to Soil Conservation Officer, Bombay State, Poona. |
| 95 | ,, K. C. Kalkoti, B. Sc. ( Agri. ) | Sub-Divisional Soil Conservation Officer, Dharwar. |
| 96 | ,, M. G. Shettar, B. Sc., B. E. | Sub-Divisional Soil Conservation Officer, Bagalkot. |
| 97 | ,, T. G. Yawgal, B. Sc. (Agri.) (Hons.) | Sub-Divisional Soil Conservation Officer, W. D., Bijapur. |
| 98 | ,, V. R. Kavlur, B. Ag. | Sub-Divisional Soil Conservation Officer, Belgaum. |
| 99 | ,, A. B. Phadke | Sub-Divisional Soil Conservation Officer, Satara. |
| 100 | ,, D. K. Dhekne, D. M. E. | Sub-Divisional Soil Conservation Officer, Dhulia. |
| 101 | ,, Y. A. Joshi, B. Sc. (Agri.) | Sub-Divisional Soil Conservation Officer, Pandharpur. |
| 102 | ,, Rajmane, B. Sc. ( Agri. ) | Sub-Divisional Soil Conservation Officer, North Bijapur. |
| 103 | ,, A. M. Pandya, D. C. E. | Sub-Divisional Soil Conservation Officer, Dohad. |
| 104 | ,, B. K. Shinde, B. Sc. (Agri.) | Sub-Divisional Soil Conservation Officer, Sholapur. |
| 105 | ,, N. K. Ghumare, B. Sc. ( Agri.) | Sub Divisional Soil Conservation Officer, Ahmednagar. |
| 106 | ,, S. S. Sirur, M. Ag. | Soil Survey Officer, in the Scheme for Soil Survey for Lift Irrigation Project, Sholapur. |
| 107 | ,, S. K. Biradar, B. Sc. (Agri.) | Asstt. Land Survey Officer, Belgaum. |
| 108 | ,, V. D. Tagare, B. Ag. | Alkali Soil Investigator, Sholapur. |
| 109 | ,, S. P. Patel, B. Sc. (Agri.) | Asstt. Land Survey Officer, Surat. |
| 110 | ,, E. L. Zopey, B. Sc. (Agri.) | Asstt. Land Survey Officer, C. D., Ahmednagar. |
| 111 | ,, N. S. Soman, B. E. ( Mech. ), B. E. (Elect.), Grad. I.E.E. (Lond.) | Asstt. Agril. Engineer, Lift Irrigation Scheme, Poona. |
| 112 | ,, C. K. Shah, B. E. ( Mech. ), B. E., (Elect.) (Bom.) | Asst. Agril. Engineer, Headquarters, Poona. |
| 113 | ,, R. S. Nadkarni, B. E. (Mech.) B. E. ( Elect ) | Asstt. Agril. Engineer, Lift Irrigation Scheme, Bagalkot. |
| 114 | ,, D. R. Joshipura, B. Sc. (Engg.) P. M. I. S. (India). | Asstt. Agril. Engineer, Lift Irrigation Scheme, Anand. |
| 115 | ,, R. S. Tamhane | Asstistant Mechanical Cultivation Engineer, B. S. Poona. |
| 116 | ,, R. M. Chaudhari | Superintendent, Grow More Food Campaign, ( HQ ) Poona. ( Pensioner and Re-employed. ) |
| 117 | Dr. S. W. Mensinkai, B. Sc., Ph. D. | Fibre Development Officer, Poona. |
| 118 | Shri G. S. Godbole, B. Ag., B. Sc. ( in Dairying, Reading University) | Dairy Development Officer, Poona. |
| 119 | ,, P. M. Varma, M. Sc. | Virus Entomologist, Poona. |
| 120 | Dr. S. P. Kapoor, Ph. D. | Virus Pathologist, Poona. |
| 121 | Shri R. B. Gode, M. Sc. | Compost Development Officer, Poona. |
| 122 | ,, V. P. Gokhale | Asstt. Plant Pathologist, Wheat Rust Scheme, Mahableshwar. |
| 123 | ,, R. S. Dubhashi, B. Ag. | Superintendent, Vegetable Development Scheme, Poona. |
| 124 | ,, K. I. Shaikh, B. Ag. | Potato Supply & Extension Officer, Poona. |
| 125 | ,, N. Reuben | Accounts Officer to Soil Conservation Officer, Bagalkot. |
| 126 | ,, P. V. Wagle, M. Ag. | Crop Protection Officer, Sugarcane Development Scheme, Ahmednagar. |
| 127 | ,, G. L. Patil | Improved Seed Supply Officer, (Sholapur) Poona. |
| 128 | ,, L. Shreenivas, B. Sc. ( Agri. ) (Hons), M. Sc. (Texas, U. S. A.) | Supervisor Contour Strip Cropping Scheme Sholapur. |

| | Name of Officer | Appointment |
|---|---|---|
| 129 | Shri V. S. Abhyankar, B. Ag. | Asstt. Chemist, Nutritive Analysis of Vegetable Seeds, Poona. |
| 130 | ,, P. P. Thakur, L. M. E. | Boring Engineer, Poona. |
| 131 | ,, I. A. Sayed, B. Ag. | Asstt. Horticulturist to Government, Scheme No. 15, Poona. |
| 132 | ,, P. B. Gupte, B. Com. | Accounts Officer, Poona. |
| 133 | Dr. M. M. Kibe, Ph. D. | Biochemist, Rice Research Scheme, Poona. |
| 134 | Shri A. P. Mulay | Personal Assistant to the Director of Agriculture, B. S., Poona. |
| 135 | Dr. G. B. Deodikar, B. Sc. LL. B., Ph. D. | Cytologist in the Scheme for Estt of Cytological Laboratory, Agricultural College, Poona. |
| 136 | Shri S. R. Bagal, M. Sc. (Agri.) | Entomological Officer, Combined Sugarcane Post Scheme, Walchandnagar. |
| 137 | ,, J. V. Majmudar, B. Sc. (Agri.) | Agronomist, Tobacco Breeding Station, Nipani. |
| 138 | ,, L. A. Patel, B. E. (Civil) | Executive Engineer, Minor Irrigation Division, Broach. |
| 139 | ,, B. S. Apte, B. E. (Civil), A. M. I. E. (India). | Executive Engineer, Minor Irrigation Division, Dharwar. |
| 140 | ,, A. K. Ranade, B. A., B. E. (Civil) | Executive Engineer, Minor Irrigation Division, Poona. |
| 141 | ,, R. L. Deshpande, B. E. (Civil) | Executive Engineer, Minor Irrigation Division, Belgaum. |
| 142 | ,, G. M. Vaidya, B. E. (Civil) | Dy. Engineer, Minor Irrigation Sub Division, Bijapur. |
| 143 | ,, P. A. Raj, B. E. (Civil). | Dy. Engineer, Minor Irrigation Sub-Division, Broach. |
| 144 | ,, N. B. Shimpi, B. E. A. M. I. E. (India) | Dy. Engineer, Minor Irrigation Sub-Division, Poona. |
| 145 | ,, B. S. Naik, B. E. (Civil) | Dy. Engineer, Minor Irrigation Sub-Division, Jalgaon. (E. Khandesh) |
| 146 | ,, V. M. Desai, B. E. (Civil) | Dy. Engineer, Minor Irrigation Sub-Division, Ahmedabad. |
| 147 | ,, M. R. Godke, B. E. (Civil) | Dy. Engineer, Minor Irrigation Sub-Division, Dhulia. (W. K.) |
| 148 | ,, G. R. Umrani, B. E. | Dy. Engineer, Minor Irrigation Sub-Division, Madhavnagar |
| 149 | ,, S. T. Dange, B. E. (Civil) | Dy. Engineer, Minor Irrigation Sub-Division, Nasik. |
| 150 | ,, R. B. Bhosekar, B. E. (Civil) | Dy. Engineer, Minor Irrigation Sub-Division, Sholapur. |
| 151 | ,, M. C. Khatwani, B. E. (Civil) | Dy. Engineer, Minor Irrigation Sub-Division, Ahmedabad. |
| 152 | ,, D. B. Shetwal, D. C. E. | Officiating Dy. Engineer, Minor Irrigation Sub Division, Haveri. |

| | Name of Officer | Appointment |
|---|---|---|
| 153 | ,, D. R. Aslekar, D C. E. | Officiating Dy. Engineer, Minor Irrigation Sub-Division, Surat. |
| 154 | ,, M. C. Krishnappa. | Officiating Dy. Engineer, Minor Irrigation Sub-Division, East Belgaum. |
| 155 | ,, K. M. Shelke | Officiating Dy. Engineer, Minor Irrigation Sub-Division, West Belgaum. |
| 156 | ,, S. M. Bhide, B. E. | Technical Asstt. (Civil) to the Jt. Director of Agriculture (Engineering), Bombay State, Poona. |
| 157 | ,, B. K. Chokshi, B. E. A. M. I. E. (Lond). | Executive Engineer and P. A. to the Jt. Director of Agricultural Engineering, Bombay State, Poona. |
| 158 | ,, H. R. Inamdar, B. A., (BOM.) | Superintendent, Land Records (Soil Conservation.) |



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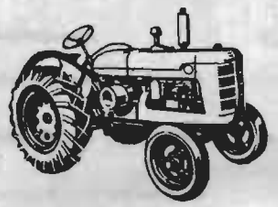
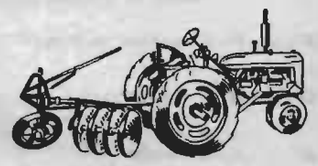
Farmall M MD 36.5 BHP



W6 & WD6 36.5 BHP
WD9 49 BHP



Farmall C 20.5 BHP
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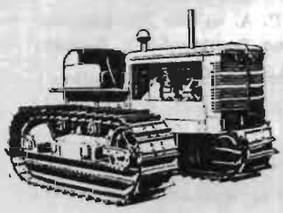

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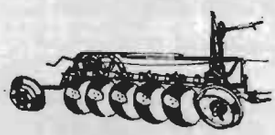

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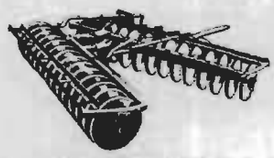

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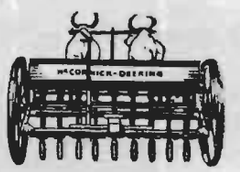

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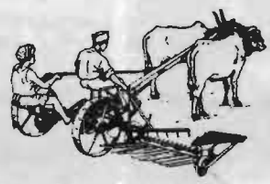

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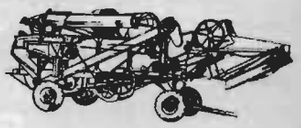
Tractor-drawn Windrowers
and Grain Binders



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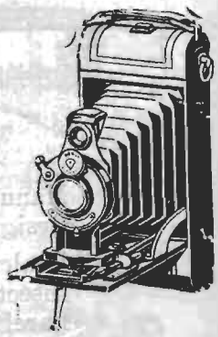

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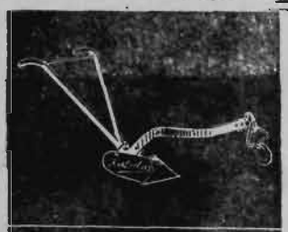

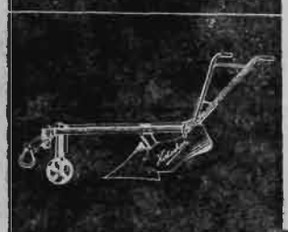

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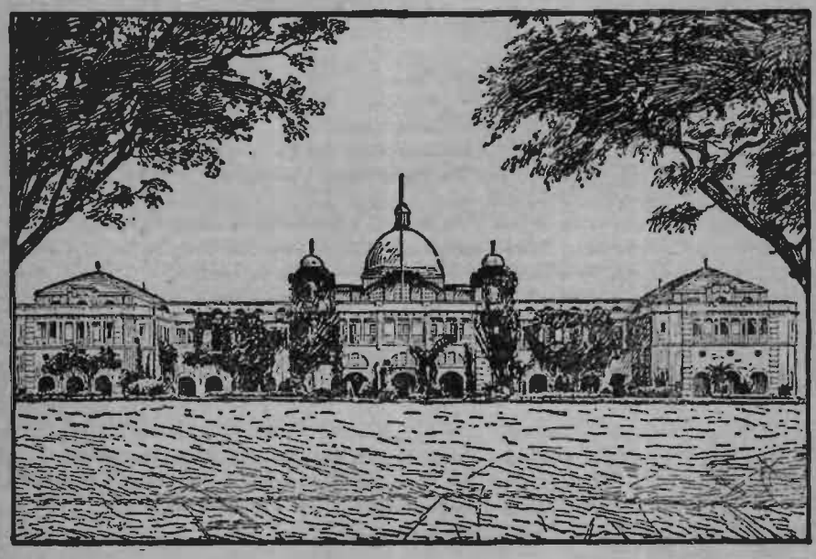
# Poona Agricultural College Magazine



यस्मिन् देशे स्निग्धनिश्छिद्रपत्राः संदृश्यन्ते वृक्षगुल्मालताश्च ।
तस्मिन् वृष्टिःशोभना संप्रदिष्टा रुक्षैश्छिद्रैरल्पमम्भः प्रादिष्टम् ॥— बृहत्संहिता

( A country, having trees, shrubs and creepers with smooth, succulent and entire leaves, receives good rain; a country, with trees, shrubs and creepers with dry and weathered leaves, receives paltry rain. — **Brihat-sanhita** )

..... For what avail the plough or sail,
or land, or life, if Freedom fail.

— **Ralph Waldo Emerson.**

# THE POONA
# AGRICULTURAL COLLEGE MAGAZINE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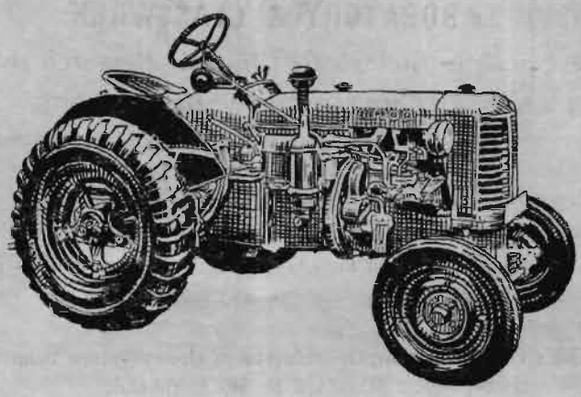

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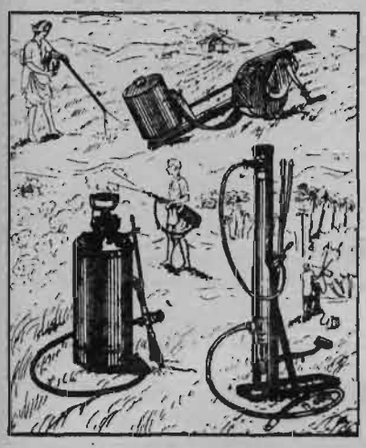

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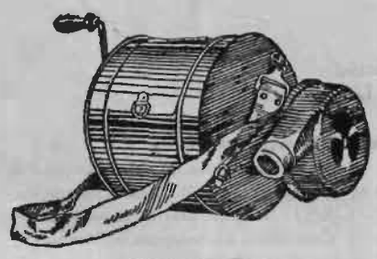

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THE POONA

# AGRICULTURAL COLLEGE MAGAZINE

VOL. 41 ] AUGUST, 1950 [ No. 2

## Editorial

This year the State of Bombay has had to face one of the worst vagaries of the mansoon. All over the State the monsoon which usually establishes in June failed to do so in spite of the signs of an early onset. As day passed day the anxiety of the people increased. The irrigation and water supply lakes in the State reached the lowest levels recorded so far. Great worry was caused both to village and city folk, as famine and water shortage seemed to stare them in the face. Luckily however the monsoon which was much delayed, did arrive about the end of the first week of July and the bursts of rain were welcomed everywhere with gladened hearts. Now that it has set in, it appears that it wants to make up for the delay with vengeance by giving heavy and continuous rains. The delayed monsoon has shortened the *kharif* season for some crops and we are afraid this may result in decreased outturns.

* * * *

Changes in the ministry of the Central cabinet were announced in May and the portfolio for food and agriculture was handed to Shri K. M. Munshi. Shri Munshi, with his usual energy, alertness and a fresh bearing on this problem, has started his activities as food minister immediately on the assumption of duties. His visit to Bombay and a conference with the Bombay officials and non-official representatives resulted in the announcement of his eight point plan. Besides discussing the ways and means for increased food production and other necessary fibre crops, the action to be taken by Government, the response of the cultivators, village panchayats etc., he stressed the need for increased irrigation facilities and increase of forest areas. He pointed out the necessity of increasing tube well irrigation and pressed for the construction of 1000 tube wells in the State of Bombay, by the end of 1951. The Government of Bombay has taken up this

matter in earnest. Shri Munshi has visited other States also and discussed the question of food supply and ways and means of increasing production in those areas. Shri Munshi announced self-sufficiency by the end of 1951 as his objective.

* * * *

Shri Munshi while at Bombay also announced that the first week of July should be observed all over India as a National Tree Festival " वनमहोत्सव ". This important suggestion for increasing forests in the country is most welcome. During the last four decades, a very large number of trees in the forests of our State as well as in private properties have been cut down for fuel and timber. There was a very heavy scale of cutting during the last war and our country has fallen extremely short of its national requirement as regards fuel and timber supply, so much so that we may have to face a timber and fuel famine in the near future. The removal of forests results in erosion, depleted water supply and ill-distributed rainfall. It also indirectly affects the manure supply by way of utilisation of animal dung for fuel instead of its proper beneficial use as a manure. So far the populace has been indifferent to the forest problem and its importance to agriculture. To supply the fuel needs of the village and to prevent overgrazing in the forest area and thereby denuding them, the village folk must take to planting as many trees round the village as possible, must raise enough fodder and prepare necessary silage for their cattle. The regeneration of forests and reafforestation and consequent water conservation, will certainly benefit agriculture also.

Our ancient culture indicates veneration for trees. The instinct though dormant is at the root of the Indian life. Shri Munshi has fixed a target of two crores of trees to be planted this year. The State of Bombay proposes to plant 25 lacs trees. The various State Governments and the populace have warmly responded to Shri Munshi's call of "Vana Mahotsav". No doubt individuals will plant their trees, but we would recommend group plantings at suitable spots in the interest of the benefits to be derived from such plantings We earnestly exhort all those who have actively taken part in tree planting to see that the trees that they have planted are properly looked after and cared for till they are well established, so as to ensure a good and stable growth of the plants and thus make the "mahotsava" a successful and permanent feature of the country. Posterity will certainly bless us for the forethought and public spirit, which impelled us to plant the trees so badly needed.

* * * *

The Rt. Hon'ble Dr. M. R. Jayakar, Vice Chancellor of the Poona University, paid his first official visit to the College of Agriculture on 4th July. This was his first visit as Vice Chancellor to a College affiliated to the Poona University. On arrival at the College at 3-0 P. M. he was received by Principal Kumar and introduced to the College Professors and Assistant Professors. He was subsequently taken round the various sections of the College, where he evinced a keen interest in the several problems affecting agriculture that were being tackled. After light tea he delivered the inaugural address of the Students' Agricultural Association and Debating Society.

During his speech the Vice-Chancellor dwelt on the ideals of the famous ancient Universities of India, whose motto, he considered should be also the motto of the Poona University. He stressed that a seeker for knowledge should have three attributes–*tapashcharya* (penance), *bhakti* ( devotion ) and *sushrusha* ( service ). He pointed out that the object of learning should be service of one's fellowmen. The learned man should be ever eager to disseminate his knowledge, should be prepared for sacrifice and should be modest. He stated that the students of the Agricultural College were peculiarly fitted for service, because they are the primary producers of the most important human necessity—food. He stressed that this fact will occupy the most important place in the thoughts of our countrymen for a number of years to come. He enjoined the students to remember these words of advice in their after life.

---

—A 1,000,000 promotional programme to increase tea drinking in the United States is to be undertaken by the "Tea Bureau, Incorporated", which represents world's big exporting tea growers—India, Ceylon, Pakistan, British Africa and the Dutch East Indies. The annual consumption of tea in the United States is 90,000,000 lbs. Ceylon now supplies the United States with 45,000,000 pounds and India with 30,000,000 pounds annually. China produces almost half of the world's tea, but consumes most of it and hence it ranks only fourth among the exporters.

The annual per capita tea consumption of the United States citizens was 10 pounds. It is now less than one pound as contrasted to 16 pounds of coffee. Though at present the United States is a predominantly coffee-drinking country, the tea interests hope that their publicity campaign will swing it again to tea.

— American New File, December 22, 1949.

# The Life Giving Water

By

A. A. VASAVADA *

आपोहिष्ठा मयोभूवस्तान ऊर्जे दधातन महेरणाय चक्षसे ।। १ ।।
योवः शिवतमो रसस्तस्य भाजयते हनः उशतीरिव मातरः ।। २ ।।
तस्मा अरंगमामवो यस्यक्षयाय जिन्वथ आपो जनयथाचनः ।। ३ ।।

1. Since Waters, you are the sources of happiness, grant to us to enjoy abundance and great and delightful perception.

2. Give us to partake in this world, of your most auspicious juice, like affectionate mothers.

3. Let us quickly have recourse to you for that your ( faculty ) of removing ( sins or diseases ) by which you gladden us. Waters bestow upon us progeny.

— **H. H Wilson.**

आपः पुनन्तु पृथिवीम् । पृथिवी पुता पुनातुमाम् ॥

Water sanctifies the earth. The sanctified earth sanctifies me.

* * * *

Water, an element of daily usage, is essential to any kind of life. It makes life possible for all the living beings in this world. From the smallest shrub to the tallest and oldest tree, vegetation of every kind must have its quota of water adequately and regularly for its healthy growth, flowering and fruiting. Animal life has to depend upon it, in season and out. We, as human beings, have sufficient experience to understand that we cannot live without water. Our bodies consist of more than 70 per cent water; wherever there is a habitable area, water must be available all the year round for growth and maintenance of life.

As water is a life-giving element to plants and animals, it is of great importance to agriculture and other industries. It is a well known fact that industries require a large quantity of water for their proper functioning. During

* Professor of Agricultural Engineering, Physics and Mathematics, College of Agriculture, Poona 5.

recent years the residents of large towns have felt the pinch of water shortage, due to increased population and increasing industrial demands. One cannot visualise agriculture without water.

Three fourths of the earth's area is water and only one fourth of it is land. Water is met with on land in its three states—in the solid state as ice or snow, in the liquid state in wells, lakes, rivers etc. and in the gaseous state all round us as water vapour forming a small part of the atmosphere all over the globe. Its presence or absence or increase or decrease in the air affects the weather and climate of a place. The increase of water vapour in air brings about sultriness during summer. Its decrease in air is due to precipitation as rain, snow or hail. Health statistics tend to indicate that during winter months when the water vapour content of the air is low, there is a large incidence of diseases like cold and Pneumonia. Water affects the climate, health and agriculture of a place and both the climate and civilisation of a country are at the mercy of water.

Water is the mainstay of agricultural practices. The rain water absorbed in the soil or water artificially applied in the form of irrigation supplies the water requirement of a crop. It is estimated that about 400 to 500 lbs. of water has to pass through the plant body to yield one lb. of dry matter from a crop. The quantity varies with the crop and in some cases may be as high as 800 lbs of water per lb. of dry matter. The plant takes up the water from the soil through its roots. It circulates in the plant body along with the fertile mineral soil ingredients in solution, nourishes the plant and is let off again in the air by way of transpiration from leaves to become vapour mixed in air.

Increase in the population of a place increases the demand on its agriculture. In the past as more food requirements needed more land under the plough, it was possible to fell forests and cultivate grass lands so as to bring such land under cultivation. Usage of lands from uncultivated regions helped the survival of human beings so far. A survey of the world landed areas indicates that very little land is left now for agricultural needs. The result is that the people of a large number of countries are facing hunger to-day —hunger due to shortage of food and nutritional caused by mineral deficiency.

If nature provided ample water in proper quantities everywhere at the right time, the earth would be a paradise to live in. There would be no famines, no arid regions, no floods and erosion. Deserts and marshes would disappear from the face of the earth. Nature, however, is erratic. Just as a small essential part of a machine when disturbed causes a breakdown of the machine, similarly disturbances in the heat, pressure and moisture conditions of the air or wind movement cause an unbalance in the weather conditions of different regions and as a result, the rainfall is delayed or ill-distributed and there are floods and famines over some regions on the earth. The rainfall and water

needs of a region should fit well for its agriculture and industries. Water is the factor which limits the growth of a population and its industries. The rainfall is a natural and variable element and cannot, therefore, be fitted to the desired agriculture and industrialisation of a place, but the water needs can be made to fit them both.

Rainfall in excess as also shortage of rainfall are both harmful to agriculture and mankind. The former accelerates soil erosion, causes floods, forms channels and gulleys, silts up river beds and reservoirs, affects the drainage of lowlying lands and indirectly causes water shortage in the soil as a large quantity of rainfall flows down to the sea in the form of floods instead of its absorption in the soil. Springs dry up early diminishing the water supply. Worst of all, however, is the loss of productive soil and fertility which go with the flood water. The removal of productive soil, on which all life depends, brings about the ultimate removal of man and beast. Ruined civilizations have resulted due to the loss of productive soil by erosion.

Droughts and famines due to shortage of rainfall affect agriculture and the nature and quantity of produce. It may be stated in this case that temporary and local shortages do not much affect a small area forming a part of a large country. The effect can be easily mitigated by internal adjustment within the country. It is only when the effect of rainfall shortage is country-wide that the pinch is really felt.

During drought or famine years there is a great scarcity of water and sometimes it becomes extremely difficult even to obtain drinking water. If the season is unfavourable, it is a natural corollary that we should make the most of every rain drop that falls on the earth's surface. Wise agricultural practice demands the prevention of the flow of rain water, so as to bring about its absorption and retention in the soil. The soil water is lost by evaporation and hence it also becomes essential to conserve it and prevent its evaporation by mulching etc. Absorption and storage of moisture in the soil will increase the water content thereof so as to increase the supply to the crops. Every bit of extra water absorbed in the soil adds a gain of so much more water for crops and helps the plants to resist the drought. Rotations, suitable cropping practices like strip cropping, raising plants of lower water requirements and efficient agricultural methods will help the drought resistance. It would also be advisable to increase the porosity and retentivity of the soil by burying all vegetative trash, by adding organic matter in the form of green manure or compost, by mixing powdered cotton or groundnut hulls, trash and such other organic roughage in the soil. Increased percolation will enable the charging of the water bearing acquifers or porous substrata and feed the underground water table. Forests help to retain moisture in the soil and keep the springs flowing for a longer time. A forest belt in high catchments would help the absorption of rainfall and its retention into the land.

The Republic of India has an area of 1246880 sq. miles with an average rainfall of 42 inches. All this rainfall uniformly spread over the republican territory and fully absorbed would enable the addition of 2799011200 cft. of water in the soil. Unfortunately the rainfall is not uniformly distributed and there are some days in the year when the shower is a few cents i.e. very negligible from the point of view of absorption by the soil. Usually about 25 to 30% is absorbed. This would mean that 93303730 cft. penetrates the Indian soil and adds 14" depth of water in the soil after allowing for the losses. But unfortunately there are regions in India, where the rainfall is considerably less than 42". If a region has an average annual rainfall of 18 to 20 inches only half a foot depth of water would penetrate the land.

In regions of low rainfall, irrigation is practiced to raise crops by lifting it from wells or perennial nalas and rivers or from tanks and canals. On account of the grow-more-food drive during recent years a large number of wells have been sunk and are still being sunk. The demand for well irrigation has increased. It is believed that pumping of water from wells will lower the subsoil water table if carried out on a large scale. If in any region the water is overdrawn i. e. pumped at a rate faster than the infiltration, the water table would be lowered. This may perhaps affect parts of a country but the whole territory may not be affected. The wells get their replenishment from acquifers ( water bearing porous layers underground ). These acquifers have a low or high rate of recharge. The ones with high rates of recharge yield plentiful water supply. Generally, deep underground acquifers get their replenishment from rain water percolation in high lying catchments. It would be most desirable and worthwhile to observe, whether the subsoil water is being depleted and if so the rate of progressive decline of the water table. If it is established that the water table is lowering, the pumping rate should be so adjusted as never to exceed the recharge.

In favourable spots where the water rushes through nalas of shallow depths for short time periods, it would be advantageous to divert the nala water on to adjacent land and to spread it over as large an area as possible This will prevent the loss of water and increase the soil moisture content wherever the water is spread.

At places where the nalas are deep or where there are depressions the water can be stored by converting the depression into a tank. The tank thus formed, however small it may be, will serve a useful purpose either by supplying drinking water for men and animals or for small scale irrigation. The percolation from the tank bed will be an addition to the subsoil water.

Large scale irrigation works with their storage reservoirs and canal systems are capable of supplying water to a large area. Water flowing in the nalas for 8 to 12 months in the year can be profitably utilised for irrigation by putting up a

diversion weir across the nala and diverting the water in canals or channels. If this is not possible, the water can be pumped and used for irrigation as in case of several lift irrigation schemes in the Bombay state.

In connection with the above, especially the nala flow and sub-soil water, it is worth while noting, that regular and adequate stream flow and subsurface replenishment dependent on large forest areas in the water shed of the nalas and rivers. In open areas the subsurface replenishment will depend upon the extent and type of vegetal cover. In our country the extent of the forest area and open land with vegetal cover is negligible. Besides large tracts of uncultivable area are barren and denuded and the percolation from such areas is very low. It is, therefore, a natural consequence that the stream flow if any is small. Many a nala and river dry up immediately after the monsoon and the water supply from these sources is extremely poor. Development of forest resources, grazing areas, and increased vegetal cover would help towards the replenishment of such sources of water.

It will be seen from above that water is the basic element for our life. If we have to live and to progress, if we want to provide a happy contented and a decent life for ourselves and our future generations, we must make the most of this element—water, presented to us by nature as an annual gift in the form of precipitation. The conservation of water is an essential to which we cannot afford to close our eyes. All possible measures to absorb the maximum rainfall in the soil must be adopted by the agriculturists everywhere. Conservation of both surface and underground water should be the main prop of our agriculture. *The water conservation programme*, if it is to succeed, should be nation-wide. *It is the only mainstay of our national economy.*

---

— Dr. Herbert Jones of California University has reported that the germination of carrot, beet, onion and tomato seeds can be speeded up through radio waves which expose the whole seeds to a uniform invigoration. The process though carried out in the laboratory, is expected to be equally applicable on field scale.

— Dr Donald H. Menzel Professor of Artrophysics at Harvard, propounded a theory that the sunspots are caused by climatic conditions, including heavy rains. He supported his views with the help of 15,000 feet of a motion-picture film, showing a rain falling on the sun from an altitude of 50,000 miles over an area of 1,000,000,000 square miles.

— A.N.F., Jan. 18, 1950.

# SOILLESS CULTIVATION OF PLANTS

By

N. NARAYANA *, M. M. KIBE § and R. R. ULLAL ‡

The subject of soilless cultivation of plants, also known as "Hydroponics" has been receiving very wide publicity in magazines and newspapers in recent years. Many of the articles on the subject are misleading and leave the reader with the impression that this new method of crop production would solve the present problem of acute food shortage, and that, in a short time, it would be possible to dispense with the age-old practice of growing crops in the soil In some of these articles, grossly exaggerated claims have been made regarding the possibilities that this method offers in the production of crops and also regarding its superiority over soil culture in the matter of economy of time, space, labour, and money. While exceptional yields may be possible under special conditions, and while certain advantages may be claimed for soilless culture, we have no definite data on the economics of this new venture either in our country, or in other countries like the U. S. A., where it has been practised on a large scale. A number of enquiries is being received from the public from time to time by the Department of Chemistry asking for advice and the possibilities of extending this method to the production of crops, both as a hobby, and as a commercial proposition. It is not possible, for want of sufficient scope, to deal with the subject in detail while replying to these queries. It is therefore proposed to give in this article the broad outlines of the method as well as the information obtained as a result of a few preliminary trials conducted with some crops at the laboratory of the Agricultural Chemist to Government, Poona.

The method of growing plants in the absence of soil, either in sand cultures, or in culture solutions, has been known to the plant physiologists for a long time, and is being extensively used for studying some of the fundamental aspects of plant nutrition. In 1669, Woodward, an English scientist first attempted to grow plants in rain water and river water, containing varying amounts of soil. He observed that the best growth occurred in the water that contained the largest amount of soil.

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In the early part of the 19th century, Boussingault, a French chemist grew plants in charcoal, and quartz sand moistened with solutions of known composition. The early research workers of the last century, from their preliminary experiment, concluded, that water was essential for the growth of plants and that, the dry matter of plants contained C, H, O, N and other mineral elements. They also concluded that the plants derived carbon and oxygen from the air, and hydrogen from the water. After establishing the possibilities of growing plants in an inert medium like sand, gravel etc. attempts were made to grow them in nutrient solutions in the absence of such a medium. Sachs and Knop accomplished this successfully in 1860. Both these scientists worked out a solution which could grow plants to maturity. The original technique developed by these workers is still in use for studying the nutritional requirements of plants. In the beginning, it was thought, that, normal growth of plants was possible if their roots were bathed in a solution containing salts of N, P, K, S, Ca, and Mg, also known as "Macro Nutrients". Later on, it was observed, that, a small amount of iron was also necessary for normal growth of plants. Further researches revealed that a number of other elements must also be present in the solution in very low concentrations, and these came to be known as "Trace Elements". These trace elements, for the present, include Fe, Mn, B, Cu, Zn and Mo, each playing a specific role in the metabolism of plants.

Although the possibility of growing plants in the absence of soil was thus established towards the close of the last century, it was not until about 1925 that the application of this new method was extended to large scale production of crops.

In its simplest sense the term Hydroponics is applied to the growing of crops in a liquid medium, but in a wider sense, and rather loosely, it is nowadays used in the case of crops grown in a litter tray containing a nutrient solution, or in an inert medium like sand or gravel which is periodically bathed with a nutrient solution in a suitable container. Other terms, like chemiculture, nutriculture and waterculture are also in use and they refer to the method of growing plants in a liquid medium using suitable plant supports. In the case of soil culture as well as soilless culture, the climatic requirements as regards temperature, sunlight and humidity are the same. The only fundamental difference in the two methods is the manner in which the nutrients required for growth are supplied to the plants.

There are three main types of soilless cultures namely (1) water culture, (2) sand culture, and (3) gravel culture Before proceeding with each of these types it would not be out of place to consider here what role the soil plays in the nutrition of plants, and how it would be possible to grow plants in the absence of soil when all the factors governing the growth of plants are supplied artificially.

Mechanically the soil provides support and anchorage to the plants. It serves as a store house for various nutrients which are necessary for the normal development of plants. These nutrients are present both in the soil solution surrounding the soil particles, as well as on the surface of soil colloids, and are taken up directly by the roots or by contact exchange between the hydrogen ions secreted by the roots and the bases held on the surface of the soil colloids. The microorganisms of the soil play an important role in releasing the nutrients into the soil solution from the soil complex. In addition to supplying adequate quantities of nutrients, the soil has to supply large quantities of water to supplement the losses due to transpiration. The presence of sufficient quantities of water in the soil helps in reducing wide fluctuations in the temperature of the soil. Finally, the soil also supplies the necessary quantities of oxygen, so essential for the respiration of microorganisms and of the roots of the plant. In the so-called fertile soils, all the factors of growth mentioned above are ideally combined and they work in harmony with each other. In the soilless culture all these factors have to be supplied artificially in order to ensure normal development of plants

## Water Culture

In this method, the plants are grown with their roots dipping in a nutrient solution contained in a shallow tank. The plants are supported above the tank by a wire-netting placed 1"-2" above the surface of the solution. Depending upon the final size to be attained by the plants, the tank may be 8"-12" deep. The tank should be filled with the solution to a height of about 4"-6" and the wire-netting should be placed in such a way that an air-space of 1"-2" is maintained between the surface of the solution and the bottom of the wire-netting. This leaves a height of about 3"-4" above the wire-netting which may be filled with a supporting medium made out of cocoanut coir or moss covered over with a layer of 2 inch of quartz sand. The tank may be of any convenient length and made of iron or concrete or wood lined with tin. It is necessary, to paint the metallic portions which come directly in contact with the solution, with asphalt paint. The bed consisting of cocoanut coir and sand serves not only as a support to the plants but it also excludes sunlight, thus preventing the development of green algae in the tank. It also serves to maintain optimum humidity above the surface of the solution. Fig. No. 1 gives the details of the tank.

The seed may be directly sown in the mulch, or in a separate seedbed, made of soil or sand, and then transplanted into the multch. It is necessary that the plants used for transplanting are sufficiently old (2-3 weeks) to withstand the injuries due to handling In the case of directly sown seeds, the mulch which is kept moist serves as a seedbed. The roots then penetrate into the mulch and later into the solution. The transplanted seedlings, however take some time to establish because of the change in their environments.*

* Fig 2 shows the Complete equip nent with plants growing in nutrient solution.

In the case of ornamental plants, like roses, individual glass containers or china-ware " baranees " ( those used for storing pickles ) with a capacity of about 1200 cc are found to be suitable. The cutting or the seedling which is first raised in the soil or sand bed, is fixed in a pith cork using non-absorbant cotton wool. Even in the case of these containers it is essential to maintain an air-space of about an inch over the surface of the nutrient solution. The seedling is so fixed in the cork that the roots just dip in the solution. The solution may be changed every 10-12 days, and the water lost by transpiration may be made up by fresh additions every 2-3 days. It is necessary to aerate the solution by means of a hand bellows for about five minutes every 3-4 days. If transparent glass jars are used, they must be painted from outside with black japan in order to prevent light from going into the solution. The plant is fixed in the pith cork resting over the collar of the " baranee " or in a metallic lid as shown in figure 3.

The solution to be used in this method may be any one of those described under ' Nutrient solutions '. The frequency of changing the solution depends upon the the density of plant population as well as on the age and type of plant. It also depends upon the season in which the plants are grown. With a tray 4' X 3' in size and crops like tomatoes, rice etc., it was noticed that a weekly change in the solution was quite enough, although during hot weather it was found necessary to add some quantity of water in order to make up the loss caused by high transpiration.

The feeding of the plants can also be carried out by continuous flow arrangement. In this method, the solution is stored in a reservoir placed at a suitable level, and it flows into the tray by gravity. After passing through the tray, it returns to another reservoir, from where it can be pumped back into the first reservoir. A continuous flow of the solution is thus maintained throughout the system. The advantage of this method of feeding is that no special contrivance is necessary for aerating the solution. In the case where such an arrangement is not possible, it is necessary to aerate the solution in the tank at least once in 2-3 days, by means of a foot bellows, in order to reduce the $CO_2$ tension in the nutrient solution as well as to supply the oxygen for the respiration of the roots.

Due to unequal absorption of different ions by the plant, the reaction of the nutrient solution changes considerably, and hence it is necessary to regulate the same by the addition of small quantities of acid or alkali, at frequent intervals. Experience with tomatoes and rice plants shows that the solution has a tendency of going to the alkaline side of neutrality when using calcium nitrate and potassium nitrate as the source of nitrogen. In such a case, it is necessary to add small quantities of a weakly dissociated acid like citric or tartaric acid in order to restore the pH to 5.5 to 6.0, which is considered to be the optimum reaction for most of the cultivated crops. On no account should the reaction of the

culture solution be allowed to go below pH 5·0 and above pH 6·5. Change in the reaction, specially on the alkaline side of neutrality brings about precipitation of certain important ions like iron and phosphate, and the plant is likely to suffer from the unavailability of these elements. The pH of the culture solution should therefore be checked up every 2-3 days using Universal Indicator and corrected as required. Heating of the culture solution is not necessary in our country, since very low atmospheric temperatures are seldom attained.

On the other hand, difficulty may be experienced in lowering the temperature of the nutrient solution. The rise in temperature of the culture medium can be reduced to a certain extent by painting the tank with red paint or any other colour which does not absorb the heat of the sun.

The advantage of water culture over the other two methods, to be described later, lies in the large volume of solution that remains in contact with the roots and which prevents the desiccation of the leaves in hot weather, which so conspicuously happens in the case of sand and aggregate culture. However, the water culture method suffers from the following draw-backs:—

(1) Considerable care and labour is necessary in fixing the plants in the system, and providing them with, adequate support. Experience with rice shows that if the rice plants are allowed to dip too much into the culture solution, they start rotting at the junction of the roots and the stem. The plants are, therefore, to be fixed in such a way that the roots just come in contact with the solution. (2) Adequate aeration has to be provided by the use of water or airpumps which add to the cost of the operation. (3) Finally the regulation of the reaction of the solution, so as to maintain proper balance between the different nutrient elements, calls for a certain amount of technical knowledge which is not possible in the case of a layman.

## Sand-Culture

In this method the plants are grown in a bed of sand or other fine aggregate moistened with the nutrient solution which is applied either from the surface or by sub-irrigation. The bed may be constructed from a wooden box waterproofed with tin lining and painted from inside with asphalt emulsion. The depth of the bed should not exceed 10" to 12" and its width may be from 2 to 3 ft. The bed may be as long as required. In the case of wooden boxes, the crevices must be filled with tape or thick asphalt emulsion. It is advisable to paint the outside of the box with a suitable paint in order to prevent attack from white ants, as well as rotting of the wood, in case the box is kept directly in contact with the soil. It is always advisable to keep the box on a raised platform made of stones or boulders, and giving it a slight slope for facilitating drainage by raising one end of the box. The bed may also be constructed from concrete either on the surface of the ground or below it, although this would entail considerable

expenditure at start. In the case of concrete tanks constructed as described above it is also necessary to paint the inner side with a coat or two of asphalt paint, and provide adequate drainage at the bottom. While filling the beds, the following procedure should be followed :—

(1) Fill the first 3"–4" from the bottom with pebbles or stones of the size of a small lemon,(about 1/2 inch diam.) and over this put a layer of pea size gravel 2"–3" in thickness. Finally, a layer of about three inch of sand (size–30 to 40 mesh) should be put on the top of the pea size gravel. This would leave a space of about two inches between the surface of the sand and the rim of the bed. It is necessary that the pebbles, gravel and the sand are thoroughly washed with water before filling in the beds.

The seeds should be directly sown in rows or broadcast in the sand layer The distance between the two rows can be considerably less (about 1 or $\frac{1}{2}$ inch) than that adapted under field condition as there is no likelihood of any competition for nutrients which are supplied in a readily available form in sufficient quantities. Until the germination is complete, the sand may be moistened every day with nutrient solution, of half the normal strength, and maintained in that condition throughout this period. When the plants are about a few inches in height, the strength of the nutrient solution may be increased to the normal and its application continued throughout the growing period of the crop.

The application of the nutrient solution can be carried out in two ways namely, from the surface as well as from below when it is known as sub-irrigation In the case of surface irrigation, it is advisable to use a watering can with a rose and water should be sprinkled through the nose of the nozzle. The even spray like action prevents the washing of the sand, and pitting of the sand bed that occurs when the solution is applied by means of a bucket. The quantity of the solution to be applied varies with the size of the tray. It is however necessary that the level of the solution in the tray is brought to within 2" from the surface of the sand, thus preventing water-logging and at the same time keeping the root-zone thoroughly moist. The nutrient solution should be removed periodically, the frequency of removal depending upon the size of tray, the density of plant-population and the type of plants. With a tray of the size of 4'X3'X8" and a variety of crops it is found that the solution may be changed every 8–10 days $2\frac{1}{2}$ to 3 buckets of solution being found to be adequate each time. This quantity is found to be quite sufficient in order to bring the level of the solution to within the feeding zone of the roots. Although the nutrient solution is removed at definite intervals, it is necessary to apply some quantity of water every day in order to make up for the losses due to transpiration, and prevent unnecessary concentration of the nutrient solution. The quantity of water to be applied between two renewals should be such that it does not cause any water-logging and it would again depend upon the size of the tray, the number and type of plants grown, and the climatic conditions. Every 15–20 days the tray should be

flooded with water and drained through an opening at the bottom, in order to remove unwanted plant excretions and excess of certain elements caused by unequal rate of absorption of different ions from the solution by plants.

## Sub-Irrigation.

In the case of subirrigation, the method of filling the tank as well as other operational details remain the same as those described under surface irrigation. The difference between the two systems lies in the way in which the nutrient solution is supplied. The tray can be constructed from sheet iron painted with asphalt or from wooden boxes made water-tight by a lining of tin. The solution is fed through iron pipe ( $\frac{1}{2}$" to $\frac{3}{4}$" diameter ) painted with asphalt on both the sides, and carrying a number of holes along its length. The holes may be 1/16" diameter or even smaller. The pipe is fixed flush with the bottom of the tray and along its length. In fig. 4 is shown a wooden tray as described above and in Fig. 5 is shown the same tray filled with pebbles of varying sizes. One of the free ends is connected with a reservoir containing the nutrient solution and the other carries a siphon which maintains a constant level of solution in the tray. Before filling in the tray with boulder, gravel and sand as described under surface irrigation, it is necessary to cover the pipe with a jacket made of sheet iron in order to prevent particles of sand from clogging the holes of the pipe. The metallic jacket is also painted with asphalt to avoid corrosion of the metal, and also contamination of the solution, with other metallic ions. The free end of the siphon rests over a funnel attached to a rubber tube, the other end of which is connected with the receiving tank. The two tanks are so arranged that the feeding tank is at a higher level than the receiving tank, and the bed carrying the seedlings occupying an intermediate position. The solution collected in the receiving tank is pumped back into the feeding tank (reservoir) as and when required. The flow of the solution from the reservoir to the tray is controlled by means of a cock flush with the bottom at the side of the reservoir. The frequency of irrigation depends upon the type of crop grown and the size of the tray. The size of the reservoir also depends upon the density of plant population and the size of the bed. With a tray 4' X 3' X 10" and a mixed crop of French beans and Lima beans, a reservoir and a receiving tank of about 18 to 20 gallons capacity is found to be quite suitable. With such an equipment and the crops mentioned above, it is enough, if the bed is bathed with the nutrient solution three times a day, by opening the cock of the reservoir tank. The solution, after it has passed through the bed, goes into the receiving tank from where it can be pumped back into the reservoir by means of a hand pump. In the absence of the pump the solution may be returned to the reservoir by means of a bucket. Every two days, it is necessary to add some quantity of water to the reservoir, in order to make up the losses by transpiration. Similarly every 3-4 weeks the bed should be flooded with water and drained in order to remove unwanted plant excretions and other elements which accumulate as a result of unequal rates of absorption of different ions from

the solution by the plants. In Fig. 6 is shown a very simple arrangement by which the bed can be flooded with the solution as often as required. In Fig. 7 are shown Lima beans and Double beans grown in a "Gravel-sand-bed" using continuous flow equipment.

Sub-irrigation can also be carried out by using two trays, one of which contains the nutrient solution and the other the gravel-sand-bed. The latter tray which carries 5-6 holes ( $\frac{1}{4}$" diameter ) at the bottom, rests over the tray containing the nutrient solution, in such a way, that the surface of the solution comes nearly half way up the gravel-sand-bed, thus maintaining a film of the solution near the feeding zone of roots. The tray containing the nutrient solution should be provided with an L-shaped side-tube which shows the level of the solution in the system in its working condition. The tray containing the nutrient solution has a drain cock at one of the corners through which the solution can be drained out. This should be done every day in order to reduce the C02 tension near the root zone, and to aerate the solution. The solution so drained is poured back on the surface of the bed by means of a "zari" or Watering Can. The concentration of the solution caused by transpiration is prevented by fresh additions of water every alternate day, so that the same volume of the nutrient solution is maintained in the tray. The nutrient solution is removed every 8—10 days. Similarly, every 3-4 weeks the growing medium should be flooded with water to remove excess of certain elements. The wash-water goes into the lower tray from where it can be drained out through the drain cock. The size of the trays will depend upon the type of plants and their number. The following sizes are found to be quite suitable for all normal crops:-

| | |
|---|---|
| Nutrient tray | 4' X 3' X 1' |
| Inner tray | 3'.10" X 2'.10" X 9" |

It is advisable not to have very deep trays, and a depth of 12" for the nutrient tray may be considered very suitable. A space of at least 3" is absolutely necessary between the bottom of the inner tray and the bottom of the outer tray. The details of the equipment are shown in Fig. 8.

Small ornamental plants can also be grown in individual containers with a similar arrangement for supplying the solution through the bottom. In such a case, one has to have two glass or chinaware containers, the outside or the bigger one containing the solution, and the inner one containing the supporting medium and the plants. The quantity of solution to be added to the outside container should be such that when the inner one is placed in it, the solution should rise into the latter through its bottom hole and reach the feeding zone of the roots. The solution in the outside container may be renewed every 8-10 days, and losses due to transpiration and evaporation should be made up by frequent additions of water in the intervening period. The drawback of this method is, that, due to the exposure of the solution to sunlight the nutrient solution develops profuse growth of algae and hence it needs to be wiped clean with a

cloth occasionally. However, this can be corrected by using an opaque container and covering the free surface of the solution by a suitable device which will also reduce the evaporation from free water surface. The reaction of the solution should be maintained between pH 5.5 to 6.0 by checking up the solution every 2-3 days with a Universal Indicator. In Fig. 9 are shown chilli plants grown with the equipment described above.

The advantage of sand culture over water-culture lies in the fact, that, it can be adapted by a beginner with a fair amount of success as it requires less skill than the latter. Secondly, one need not be very particular about the formula of the nutrient solution, as the range of tolerance is fairly wide. The third advantage is that, since sand is a porous material, it facilitates air movement which is so very essential for proper root-development. Finally, like soil, it acts as a natural support to the plants, so that no artificial contrivances are necessary.

## Gravel Culture or Coarse Aggregate Culture

Gravel culture is of comparatively recent origin, being first introduced in the U. S. A. in the year 1936. In this method, instead of using sand as the supporting medium, pebbles and gravel of various sizes are used. The operational details such as the size and kind of tank, the supply of nutrients, etc. remain more or less the same as those described under sand culture. It is, however, more advantageous to supply the nutrients to the gravel-bed at regular intervals through the bottom ( sub-irrigation ) than from above.

The tray is first filled with pebbles of the size of a small lemon ( ½" diameter ) up to a height of about 2" from the bottom. Over this should be spread a layer of 2" to 3" of bean size gravel. Finally a two inch layer of pea-size gravel should be used on the top. It is desirable that the aggregates used have rounded surface so as to avoid injury to the plants. Such gravels are usually available on river beds and they can be sifted into various sizes as per requirement. It is essential that the material is washed thoroughly with water before filling in the tank. The gravels available in the Deccan mostly consist of rounded fragments of the trap rock, and due to the very inert nature of the rock, they are ideally suitable as a bedding material. Care should be taken to avoid contamination of the material with soil since the fine particles of soil tend to clog the drainage system. Inclusion of calcareous material, such as lime nodules, when present in small amounts does no harm. In fact, their presence in small amounts, has a buffering effect in maintaining reaction of the solution at the optimum level. As in the case of sand culture, the solution may be fed by gravity, using a reservoir and a receiving tank, with a device for pumping the solution back into the reservoir, after it has passed through the bed. The solution is fed through a ½" iron pipe with holes, running along the length of the tray. Because of the coarseness of the material and consequent lack of

retentivity of moisture, it is necessary to irrigate gravel bed more often than when sand is used, taking care to see that the root zone remains constantly in contact with the nutrient solution. A double tray can also be used, one carrying the nutrient solution, and the other, the gravel bed, with holes at the bottom. It is not necessary to aerate the solution, because the coarseness of the bedding allows free circulation of air. The nutrient solution may be changed every eight to ten days and the losses due to transpiration and evaporation should be made up by frequent additions of water, so that a constant level of the solution is maintained in the gravel bed. This also prevents undue concentration of the nutrient solution in certain ions caused by the unequal absorption of the nutrients by the plants. These fresh additions of water may be made by surface irrigation.

In the case of gravel culture it is not possible to sow the seeds directly into the tray, because of the coarseness of the bedding material. Seedlings raised either in sand or soil should be used, and fixed into the bed by removing some of the fine gravel from the top. While transplanting care should be taken to see that the roots of the young seedlings are not injured by rough handling and that they go sufficiently deep so as to be in contact with the nutrient solution. The seedlings used for transplanting should be at least two to three weeks old in order that they can withstand the change in environment and easily establish themselves. It is desirable that the transplanting is done in rows preferably in the evening, using a bunch of two or three seedlings in each hole.

The only advantage of gravel culture lies in the easy availability of the material and the ease with which it can be washed and cleaned before use. The second advantage is that the circulation of air through the system is more efficient than either in water culture or in sand culture. However, it suffers from one drawback, namely, that the losses of water due to evaporation are of considerable magnitude so that replenishment with fresh additions of water has to be made more frequently.

## Nutrient Solutions

The function of the nutrient solution is to supply water, oxygen and the essential mineral elements in the proper proportions to the plants. A small amount of water is used in the formation of new tissues, whereas a large part is transpired into the air. On the other hand, the absorbed nutrients are used in the growth processes, and are largely retained by the plant. Water and mineral elements are absorbed mainly by the root tips and root hairs, the older portions of the root system chiefly acting as transporting agencies for the nutrient elements absorbed by the younger roots.

The essential macro-nutrients which need to be supplied are, nitrogen, phosphorus, sulphur, potassium, calcium, and magnesium. Amongst the micro-

nutrients which are required in small amounts and which are definitely toxic at higher concentrations are manganese, boron, zinc and molybdenum and they are considered the most essential. Excepting iron, none of the micro-nutrients should be present in concentrations higher than 1 part per million. The micro-nutrients play an important role in the enzymic systems of the plant, and a deficiency of any one or more of these causes serious physiological disorders of the plant. The nutrient elements mentioned above are supplied in the form of salts which when dissolved in water and mixed in proper proportions contitute the nutrient solution. It is essential that the water used for preparing nutrient solutions is free from salts and not alkaline in reaction. Any water which can be used for drinking purposes can be used provided it is not chlorinated.

A number of formulas for preparing nutrient solutions are in use, and any one of the following can be adopted successfully for all the types of soilless cultures discussed previously. They are arranged according to their historical development:—

(1) **Knop's formula.** (1865)

4 gms. of calcium nitrate
1 gm. of potassium nitrate
1 gm. of magnesium sulphate
1 gm of potassium mono or di-hydrogen phosphate,
1000 cc. of water.

(2) **Tottingham's formula** (1914)

5 gms. of calcium nitrate.
15 gms. of magnesium sulphate.
18 gms. of potassium di-hydrogen phosphate.
1000 cc. of water.

(3) **N. J. Agricultural Experimental Station** (1935)

Sand culture formula for fifty gallons of water.

30 gms. of ammonium sulphate.
57 gms. of potassium phosphate (monobasic)
14 gms. of magnesium sulphate.
486 gms. of calcium nitrate.

(4) **University of California, College of Agriculture,** (1937)

("T. C." Solution of Hoagland.)

| | | cc. per litre of nutrient solution. | Approximate Weight in Ozs. per 100 gallons of water. |
|---|---|---|---|
| M/1 | Calcium nitrate | 4 | 9 |
| M/1 | Potassium nitrate | 6 | 9 |
| M/1 | Ammonium hydrogen phosphate | 1 | 2 |
| M/1 | Magnesium sulphate | 2 | 3 |

To each of the solutions described above, add 1 cc. of the following solution per litre of the nutrient solution :—

(1) 2·86 gms. per litre of Boric acid.
(2) 1·81 gms per litre of Manganese chloride.
(3) 0·22 gm. per litre of Zinc sulphate.
(4) 0·08 gm. per litre of Copper sulphate.
(5) 0·02 gm. per litre of Molybdic acid.

In case commercial salts are used in the preparation of the nutrient solutions it is not necessary to add the above solution. However, it is desirable to add 2-3 cc. of 0·5% solution of iron tartarate to one litre of each of the above solutions in order to guard against any iron deficiency.

Trials conducted at the Laboratory of the Agricultural Chemist with sand, gravel, and water culture and a variety of crops like wheat, tomatoes, chillies, beans and bhendi show that the formulas devised by the late Mr. Hoagland and advocated by the University of California are very suitable and hence can be adopted for all types of cultures. Whatever the formula used for preparing the culture solution, it is necessary to check up the reaction of the solution by means of a Universal Indicator, and adjusting the reaction by addition of dilute acid (2% $H_2SO_4$) or dilute alkali (1% KOH) as the case may be. For most plants a moderately acid reaction from pH5 to pH6·5 is the most suitable, and with the formula advocated by the University of California, it is not necessary to make any addition of acid or alkali if the directions while preparing the solutions are properly followed.

## Conclusion

In India, the soilless cultivation of plants is still in its infant stage of development. The required information regarding the economics of this method for large scale cultivation is not available in this country. However, from the little experience that has been gathered from a few preliminary trials it is evident that the initial cost of equipment will be quite high, so that the method may not be profitable for the ordinary cultivator with scanty means. Secondly the success of the method depends upon how intelligently the worker understands the elementary principles governing the nutrition of plants when grown in their natural habitats and on how efficiently he is able to imitate the natural conditions artificially. The progressive citizen of the present day with the required education and the necessary financial backing may take to soilless cultivation and with a fair amount of success. As regards the possibilities of development of this method on a commercial scale, it can be said that where ordinary cultivation is not possible for want of sufficient space or good soil, and where

there is good demand for fresh produce as in the urban areas, soilless cultivation may be resorted to with advantage. In such areas the fresh produce may find ready market which may compensate for the extra initial outlay on the equipment. The trials and experiments carried out at the Poona Laboratory are two few, and the information obtained is too meagre to justify making any authoritative suggestions on the possibilities of soilless cultivation of crops and its extended use as a matter of general practice.

For more detailed information on the soilless cultivation of plants the reader is advised to refer to the books listed at the end of this article.

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Fig. 1

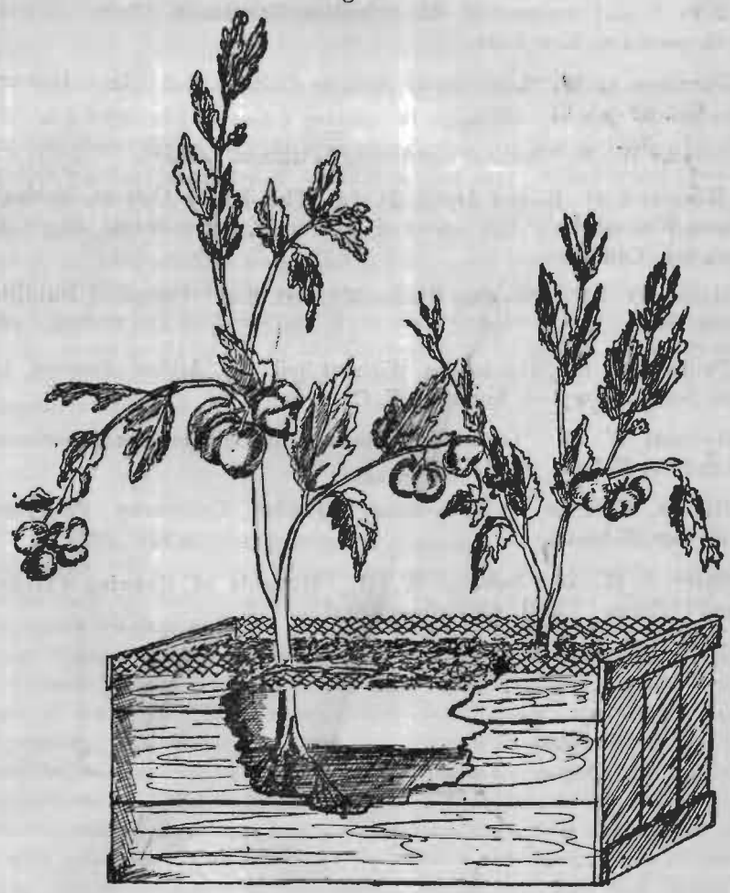


Fig. 2

Fig. 3

Fig. 4

Fig. 5

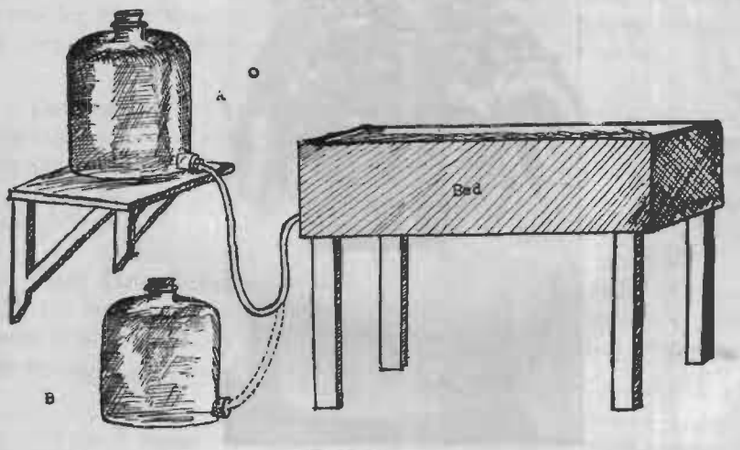
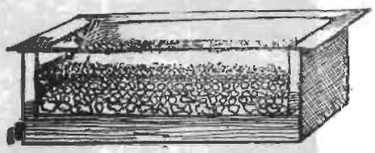



Fig. 6

Note:— When the reservoir is in position "A" the nutrient solution flows from it to the bed, and when it is in position "B" the solution flows from the bed to the reservoir.

Fig. 7



The two trays in working position.

Gravel-sand-bed

Fig. 8

Fig. 9

# Role of Vegetation in Soil Conservation

## ( Part II Strip Cropping ) *

By

J. K. BASU § and L. SREENIVAS ‡

One of the best known methods of conserving the soil resources is to resort to natural vegetation or grasses by establishing good ranges, pastures, meadows and woodlands. Most of the arable lands in this country could not be put to grass for obvious economic reasons. Adjustments, however, must be made and yet the soil conserving values of vegetation utilized to our best advantage. This could be achieved to an extent by utilizing the crop plants themselves that possess the required or the desired qualities essential for protecting the soil from the hazards of erosion. Intensive research in this direction was started in the State of Bombay since 1945 when a scheme, known as Contour Strip Cropping Research, was launched in the scarcity regions.

The technique of strip cropping is known and practiced in the United States of America and has proved to be a practice of great success. Strip cropping may be defined as a system of crop production in which long narrow strips of erosion resisting crops are alternated with erosion permitting ones. Various types of strip cropping are in vogue and they are adopted according to the needs and purposes for which they are meant. The three common types are : (1) Contour Strip Cropping (2) Field Strip Cropping (3) Wind Strip Cropping.

**Contour Strip Cropping** system recommends that the establishment of the resistant strip and other tillage practices required for the proper development of the non-resistant crops should invariably be done on the contour. This system is suitable to all topographic features and is generally known as " Strip Cropping ".

**Field Strip Cropping** is similar to that of contour strip cropping system but for the fact that it is not so rigid about strict or dead contours. This is very suitable where the land is of gentle or uniform slope. In this system the resistant strips would be laid across the slope.

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* " Part I General " has appeared in the June 1950 issue of the Magazine.

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**TABLE I**

A tentative schedule of CEREAL–Pulse combination for rotation and strip cropping for different districts.

| DISTRICTS | KHARIF | RABI |
|---|---|---|
| Sholapur | Bajri-Tur-Groundnut or Matki or Hulga. | Jowar-Groundnut or Gram. |
| Ahmednagar | Bajri-Tur-Hulga or Matki or Mug or Groundnut. | Jowar-Groundnut or Hulga. |
| Poona | Bajri-Tur-Groundnut or Mug or Matki or Hulga. | Jowar-Groundnut or Hulga. |
| Satara (North) | **Kharif Jowar**-Groundnut or Udid or Mug or Hulga.<br>**Bajri-Udid**<br>Chillies | Jowar-Groundnut or Udid. |
| Nasik | Bajri-Tur-Groundnut or Hulga or Matki. | **Jowar**.<br>**Wheat**-Groundnut or Hulga or Mug.<br>Gram |
| West-Khandesh | **Bajri**-Math-Groundnut or Mug or Math or Hulga<br>**Kharif Jowar**<br>Cotton | **Jowar**.<br>**Wheat**-Groundnut or Mug<br>Gram. |
| East-Khandesh | **Kharif Jowar**-Groundnut or Mug or Math or Hulga<br>**Bajri-Math**<br>Cotton | **Jowar**-Groundnut or Mug<br>**Wheat**<br>Gram |
| Satara (South) | **Kharif-Jowar**<br>**Kharif Bajri**-Groundnut or Matki<br>**Tobacco**<br>Chillies | **Jowar**<br>Gram-Groundnut or Udid or Matki.<br>Wheat |
| Kolhapur | **Kharif Jowar** Groundnut or Mug or Udid.<br>**Kharif Bajri**<br>**Tobacco**<br>Cotton | **Jowar**.<br>**Gram.** Groundnut, Udid or Matki |
| Belgaum | **Kharif Jowar**-Groundnut or Matki or Hulga or Udid<br>**Bajri**<br>**Cotton**<br>**Tobacco**<br>Chillies | **Jowar**<br>**Wheat**-Groundnut or Matki or Hulga<br>Gram. |
| Dharwar | **Kharif Jowar**-Groundnut or Udid or Mug<br>**Cotton**<br>Chillies | **Wheat**-Groundnut or Udid or Mug.<br>**Jowar**<br>Gram |
| Bijapur | **Kharif Jowar**-Groundnut or Mug or Matki or Hulga<br>**Bajri-Tur**<br>Cotton. | **Jowar**<br>**Wheat**-Groundnut or Hulga.<br>Gram |

**Wind Strip Cropping,** as its name indicates, is adopted in the regions where wind is the causative agent of soil erosion. Wind erosion is not yet a problem in the Deccan but this system may be useful in Rajaputana and Jodhpur regions. In this system topography is of no importance. The erosion resistant strips are laid across the direction of the wind irrespective of the direction of the land slope.

In the state of Bombay the first two systems could be used in preventing soil erosion caused by the rain water, and the results, so far, obtained indicate that there are great possibilities of adopting these systems with ease. These systems should, however, be modified to suit local requirements such as indigenous crops, climatic conditions and cropping systems

A tentative schedule of a cereal-pulse combination for rotation and strip cropping for different districts is shown in Table I. It would be noticed, that at Sholapur the main cereal crop in the Kharif season is Bajri and the erosion resistant pulse crop could be any one of groundnut (spreading), Matki or Hulga. For the Rabi crop of Jowar the resistant strips of groundnut should be established in the Kharif season reserving the lands between two resistant strips for rabi jowar sowing (Fig. 1). The resisting crops of Matki and Hulga have been found to produce efficient vegetal cover when sown with 30 lbs. seeds per acre.

Fig. 1.

Here is a resistant strip of Groundnut (spreading) at the Strip Cropping Research Centre, Sholapur. The area left in between the two resistant strips would be sown with rabi jowar.

In order to have an easy method of finding out the widths of resistant as well as the non-resistant crops and their placements the following Table II would be a very useful guide.

If the average slope of the land is 1% then it could be seen from the table that the placement of the first resistant strip would be at 150 ft. from the ridge point and the width of the resistant strip would be 30 feet. The second resistant strip would be placed at 150 feet further down and so on.

**Table II**

Proportion of widths of Erosion permitting (Cereals) and Erosion resisting (Pulses) crops for different slope conditions.

| Average slope | Width of erosion permitting crops in feet | Width of erosion resisting crop in feet |
|---|---|---|
| Between 1 per cent & below | 150 | 30 |
| ,, 1–2 per cent | 80 | 20 |
| ,, 2–3 per cent | 45 | 15 |

*Note* :—Strips of Cereals and pulses should be rotated.

The strips of erosion-permitting and erosion resisting crops are to be shifted every year so that at the end of three, four or five years' period entire area will have the rotations of cereals and pulses when the land slopes are three, two or one per cent respectively. Further, this practice ensures the production of a balanced diet of cereals and pulses for the people.

The advantages of adopting this system are thus quite obvious in that it incorporates all the improvements of crop husbandry and being easy to be adopted paves the way for sustained and lasting crop production.

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— Louisiana rice farmers have found that fallowing of rice land in the year after taking a rice crop not only gives rest to the soil but its grazing during the fallow season kills out wild rice. The practice is to take rice one year and leave the land for pasture and grazing during the next two years.

— " Furrow " Vol LIV. Sept. Oct. 1949.

# Note on Colonisations Schemes in Kanara

By

V. S. HABBU *

One of the short cuts and sure means of meeting shortage of food grains is to bring more area under such crops. That such a course is possible is seen from the large areas lying fallow and as Government Wastes. This is particularly so in Malnad tract of the Bombay State. These lands, once cultivated and flowing with honey and milk, have gone out of cultivation owing to unhealthy climate, malaria, wild animals and absence of amenities of life. Many prosperous villages are now deserted and covered with forest. Kanara which forms a major part of the Malnad tract has unfortunately lost many such villages which have now become the abodes of wild animals. Indoor, a village in Mundgod Taluka, is one of the many such villages.

**Past history of Indoor**:—This was once a very prosperous village. It had a small fort under the suzerainity of King Sond. It comprised of 12 lanes thickly populated, as can be seen from the vestige of old residential quarters. Some of the tanks and wells of masonry work show how rich the village was. But owing to malaria and its consequences the population dwindled from year to year. In 1911 it was 511 and it had come down to 132 souls in 1947, when the survey was undertaken. Of the total acreage of cultivable lands 1638 acres, about 872 were cropped in 1911. It had come down to 346 acres in 1947. Though this village was 5 miles from Mundgod and on the Mundgod-Kalghatgi road it was unapprochable during monsoon. The decay of the village had gone to such an extent, that the forest touched the last house and one could not see a few yards beyond. All the cultivated area was covered with forest growth which offered safe abodes to despondent wild animals. The residents presented an unhealthy appearance and despondency.

**Operations of the Colonisation Scheme** :—The scheme was taken up for execution in the month of February, 1948. The first thing to be done was the clearance of the area of all tree and bush growth. For this work bull-dozers were put into operation. After clearance, breaking of lands with tractors was started. In the 1st year, about 225 acres were brought under cultivation.

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* District Agricultural Officer, Karwar, N. Kanara.

As the sanitary condition of the village was of utmost importance, clearance of unhealthy spots, filling of ditches and swampy places had also to be taken up. Spraying with D. D. T. was started side by side. These had had wonderful results. Incidence of malaria went down and improvement in health was noticed. Liveliness has begun to play on the faces of village residents.

The first settlement was of the agricultural staff, entrusted with the work. To create confidence they had to stay in the village. The first settlers on the lands were displaced Sindhi families. The operations of clearance and settling of agriculturists has been going on continuously. As a result of clearance, one can now have a clear view of lands from one end to the other. Nearly 1,000 acres of cleared lands have now been made cultivable and distributed. This has added about 160 families to the existing 40. The village is now teeming with people. Owing to wide advertisement that this, the first experiment in the State, has received and also because the road has been improved upon for all weather traffic, the village which was not being visited even by the town people has now become a place of study and attraction with a view to see its transformation. It has assumed the status of a place of pilgrimage for many. This has been further facilitated by motor communication 4 times a day. This has brought the village in closer contact with Hubli, Sirsi and Karwar. No village can boast of such a facility. Lands were ideally suited for cultivation and soil very rich. The whole area is studded with a large number of tanks and diversion bunds and water channels. The number of irrigation tanks is 47. As the population dwindled the cultivated area came down, and most of the tanks went out of repairs and were covered with forests. A look at the village map shows how intelligently the villagers had planned for water supply. This is the past glory of the vallage.

When Government began to feel shortage of food supply it thought of bringing more area under cultivation. Naturally Kanara District claimed first attention. Shri M. J. Desai, then Secretary to Government, requested the Collector to find out some villages having large areas of Government waste lands Indoor was found to be the only village having such a large area and within easy reach of the Headquarters of the Taluka. The Agricultural Department was asked to prepare a scheme for bringing the whole area into cultivation. The Deputy Director of Agriculture, Konkan Division, after a detailed survey, submitted a scheme of colonisation to Government in 1946. This was sanctioned by Government in 1947. The following facilities are offered by Government.

I. **Free of cost to settlers:**— (1) Land clearance and developmen (2) Drinking water. (3) Repairs to irrigation tanks.

**II. Amounts advanced as loans**

| | | |
|---|---|---|
| (1) | For purchase of bullocks @ Rs. 500 for a pair | Rs. 75,000 |
| (2) | For deadstock | ,, 45,700 |
| (3) | Fencing with woven wire fence | ,, 75,395 |
| (4) | House Construction | ,, 75,000 |

*Note*:—Half of these to be treated as subsidy and half to be recovered from settlers.

**III. Recurring :** (1) Cultivation charges Rs. 96,000. (2) Upkeep of live-stock Rs. 54,000. (3) Upkeep of Machinery Rs. 3,500. (4) Miscellaneous Rs. 1,000.

Loans for cultivation, seed and manure will be interest free and will be recoverable after harvest. Loans for other items to be recovered from the 3rd year in 15 instalments with interest at $3\frac{1}{4}$ percent. Until the loans are paid off, the entire assets of the settlers will remain the property of Government.

New open sites have been selected for residential quarters. Every settler is provided with a *Kutcha* house having a space area of 300 to 400 square feet. As regards allotment of lands, the size of holdings ranges from 5 acres to 10 acres of paddy lands depending upon the capacity of the settlers. All loans have been advanced without any security, except the first liability on the equipment provided for by Government and on the crops grown by the settlers.

This scheme may be said to have two aspects viz , bringing additional area under cultivation and food crops and secondly rehabilitation of the landless agriculturists and labourers. From the point of administration the latter has been of utmost importance, since settlers whose antecedents and whose intentions are not fully known, had to be selected as settlers and large sums of money have been invested on them. It is a task devolving on the staff to see that they carry on cultivation satisfactorily, as recovery of loans advanced depends upon the crops produced. This necessitates individual attention. The problem does not end with an eye on the recovery of Government money, but it ultimately extends to see that the settlers stand on their own resources in course of time. Erst-while field labourers have to be turned into flourishing agriculturists. This is the goal which has been kept in view.

All that is needed for the well being of the settlers is being done. Medical Officers and a Veterinary Assistant Surgeon visit the village once a week. D. D. T.

spraying is being conducted. Fencing of the whole area with pig proof fence is in progress. Irrigation tanks are being repaired. The settlers are being financed for cultivation.

**Conclusion :**—I have been in charge of this scheme from the beginning. My impressions are not for any advertisement to attract settlers as I am getting them enough and more and there is no dearth of them. But as things stand at present most of the settlers are illiterate and have come forth because of special facilities offered, which they could not get anywhere else. They have no idea that they come here for settling permanently. The idea of improvement and development are totally absent. Even with this material, I feel that at least 50 percent of them, if not all may turn out to be good farmers. But the nation now looks upon the intellegentsia to come forward to take up nation building activities. Agriculture being the mainstay, the country cannot advance unless the intellegentsia and educated young men take it up. The Government naturally looks to the young men coming out of the Agricultural Colleges and Schools. Inspite of advertisement and propaganda, none have responded so far. Although Indoor Scheme is closed there are other schemes near about Indoor, which are yet to be taken up. A list of these is given below :—

| S. No. | Name of the Scheme | Taluka | Area in acres | Amount sanctioned |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 1 | Kuntagani | Ankola | 245·00 | Rs. 1,19,300 |
| 2 | Dongri | ,, | 361·32 | ,, 1,51,440 |
| 3 | Kusur | Mundgod | 172·13 | ,, 75,487 |
| 4 | Nyasargi | ,, | 224·14 | ,, 83,350 |
| 5 | Kop | ,, | 152·4 | ,, 66,628 |
| 6 | Hirehalli | ,, | 132·24 | ,, 61,362 |
| 7 | Tattihalli | ,, | 161·13 | ,, 70,454 |
| 8 | Kargolli, Tegginkop and Tammyankop | ,, | 387·07 | ,, 2,24,602 |
| 9 | Majjigeri | ,, | 172·29 | ,, 73,340 |
| 10 | Ugginkeri | ,, | 146·25 | ,, 65,719 |
| 11 | Hirebachanaki | ,, | 119·00 | ,, 41,966 |
| 12 | Hanmapur | ,, | 290·13 | ,, 1,04,185 |
| 13 | Arsingeri | ,, | 446·14 | ,, 1,67,200 |
| 14 | Jannkadkal | ,, | 178·00 | ,, 77,600 |

*Note* :—Scheme Nos. 1, 2, 5 and 13 have already been put into execution and all lands disposed of.

The facilities offered are more or less similar to those of Indoor Scheme. Government may extend additional facilities if agriculturally trained young men come forth in large numbers. It is an opportunity which could not be had in the past. Those intending to take up farming need not complain and fret about non-availability of lands and capital. These can be had easily.

## Summary of personal note

(1) By clearance of excessive growth of forest and spraying of D. D. T. incidence of malaria has been considerably reduced. There are few cases of malaria. General health of the people has improved. This will ultimately have its effect on the efficiency of the population.

(2) The soil is very rich and is capable of yielding 1,600 lbs. to 2,500 lbs. of paddy per acre.

(3) Large areas of *Hakkal* lands offer good scope for cultivation of mangoes and cashew-nuts. The conditions are eminently suited. The village is well connected for export.

(4) Grass grows in abundance. This offers scope for dairying. Mundgod taluka was once noted for milk and butter. Large number of nomadic tribe of *Gowlis* lived in the taluka.

(5) Most of the schemes sanctioned by Government are in Mundgod taluka and are well situated and the same conditions prevail.

(6) Large numbers are attracted by the facilities offered, but none from the educated class.

(7) The facilities offered do not throw heavy responsibilities.

(8) It is for the young and educated specially agriculturally trained to think in favour of private farming.

## My sincere and personal appeal to those trained in agriculture

Give up the trodden path of seeking for service. Take courage and strike a new path by becoming educated farmers. You will build up an estate for yourself and your posterity and become the pioneers in the line for future generations and lead the nation on its onward march of development and prosperity. By calculation, it can be shown that one can earn as much as he gets in service if he puts up the same amount of labour and attention. My young friends, gird up your loins, take courage and come forward with determination.

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— A group of American scientists have extracted another antibiotic drug, called terramycin from a new soil mold organism streptomyces rimosus. Terramycin combats successfully the bacteria causing typhus, virus pneuomonia, whooping cough, carbuncles and others When tried on animals suffering from these diseases, the disease germs were killed, the animals recovering quickly with no ill effect. Its clinical action on infectious diseases of humans is, however, still in the experimental stage.

— American Newsfeature, March 9, 1950.

# Causes for the low yields of food Crops in India and measures suggested to improve them *

By

V. M. CHAVAN § and N. R. BHAT ‡

*Almost everyone in this country is painfully aware of the fact that the* average yields of our principal food crops are very nearly the lowest in the world. In table I are given the average yields per acre of wheat, rice, maize and sorghum as obtained in the year 1946 in various countries, for which Statistics are available, in support of the fact that the efficiency of agricultural production is far too low in our land.

**TABLE I.**

Average grain yields in bushels per acre of principal food crops in the year 1946 in various countries of the world.
( Copied from Agricultural Statistics 1947 U. S. A. )

| | Country | Wheat | Rice | Maize | Sorghum |
|---|---|---|---|---|---|
| | | Bushels | | | |
| 1. | Canada | 16·2 | ... | 42·9 | ... |
| 2. | Mexico | 11·4 | 41·2 | ... | ... |
| 3. | U. S. A. | 17·2 | 45·2 | 37·1 | 15·8 |
| 4. | Trinidad | ... | 38·4 | ... | ... |
| 5. | Belgium | 42·7 | ... | ... | ... |
| 6. | Denmark | 49·4 | ... | ... | ... |
| 7. | France | 23·6 | ... | ... | ... |
| 8. | Italy | 20·4 | 86·4 | ... | ... |
| 9. | Spain | 14·1 | 76·4 | ... | ... |
| 10. | U. S. S. R. | 10·0 | 42·2 | ... | ... |

* Paper read at the 8th meeting of the Soils and Crops Wing of the I. C. A. R., New Delhi, held at Patiala, in March 1950, (With minor modifications).

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**Table I** ( *Continued* )

| Country | Wheat | Rice | Maize | Sorghum |
|---|---|---|---|---|
| | Bushels | | | |
| | (1930–34) | (1935–39) | | |
| 11. Turkey | 19·5 | 57·5 | ... | ... |
| 12. China | 15·6 | 50·6 | 21·5 | ... |
| 13. **India** | 9·6 | 25·7 | 11·7 | 9·5 |
| 14. Japan | 15·1 | 72·4 | ... | ... |
| 15. Manchuria | ... | 37·5 | ... | ... |
| 16 Netherlands Indies | ... | 28·9 | ... | ... |
| 17. Philippine Islands | ... | 20·5 | ... | ... |
| 18. Siam | ... | 26·1 | ... | ... |
| 19. Arjentina | 16·8 | 69·4 | 37·5 | ... |
| 20. Egypt | 26·0 | 70·1 | 32·6 | ... |
| 21. Australia | 9·4 | 86·0 | 22·0 | ... |
| 22. New Zealand | 32·1 | ... | 45·8 | ... |

It should not however be forgotten that in a big subcontinent such as ours with widely variable soil and climatic conditions the average rate of production is bound to be lower than in the smaller countries. It is also to be borne in mind that, in contrast, the smaller countries are often compelled, by force of circumstances, to aim at self sufficiency and, therefore, to put in maximum effort in food production.

Unfortunately, we were subject, till a couple of years ago to a foreign administration which formulated policies best suited to its own interests. Crops such as cotton, tobacco, groundnut, and sugarcane were encouraged because they were required as raw material for the mills and factories run by the ruling country. The system of Zammindari land tenure, absentee landlords and fragmentation caused neglect of the land through the indifference of both the owners and the tillers, while it was taken for granted by Government that the population could maintain itself with whatever food stuffs that were produced in the country with the supplement of imports of rice from Burma, Malaya and other countries.

The apathetic attitude towards life characteristic of the Indian philosophy and ignorance to boot made people suffer and starve under the name of fate. The real situation came to light during the Second World War when the imports from Burma and South East Asian Countries stopped and Government was forced to introduce rationing of food grains to avert ghastly tragedies such as the Bengal famine which took a heavy toll of millions of lives.

The more disconcerting feature of the present situation is the continuity of the fall in yields of the principal food-crops. In a recent article, "Increased yields of crops by breeding", Kadam ( 1949, unpublished ), has studied the trends of average production through regression of yields on years from 1911-12 to 1942-43 and has found significant decline in the case of rice, wheat, barley and bajra.

Leaving the political, economic and other extraneous considerations alone, it is worth analysing the factual causes that have been responsible for the consistently low yields of the principal food crops.

The three main factors of crop production are : ( 1 ) variety ( 2 ) soil and ( 3 ) climate. The outturn of a crop is the result of the interaction of these factors. It is, therefore, obvious that the best yields can be obtained through the availability of these factors in their optimum level.

Man has found out through experience and research of ages past that whenever any of the factors is not of the required quality, its status can be improved by artificial manipulation, and suitable cultural practices. For example, if the variety under cultivation does not respond well to the soil and climate prevalent in the tract a suitable variety that performs best under the conditions can either be introduced from outside or bred by selection from the prevalent variety by itself or by hybridisation with a foreign variety. If the soil is deficient in plant nutrients, the nutrients can be added in appropriate quantities either as manures and or as fertilisers. If it is in excess with respect to any of the elements, a suitable corrective can be used. The most important factors of climate are (i) rainfall (ii) length of day and (iii) temperature. The deficiency of rainfall can be made up through irrigation; the length of day may probably be rendered suitable by photoperiodic treatment and temperature by vernalisation.

In addition to the primary factors of agricultural production, it is necessary to evolve cultural practices which enable the producer to bring about the best interaction of the factors expected to result in the highest possible outturns.

It should be evident from the above analysis that it is the non-attendance to the various items enumerated above that has been primarily responsible for the very low average yields that we have been obtaining in our principal food crops.

Assuming, as is very well known to be a fact, that the crops being cultivated in the various parts of the country are the best suited to the soils and climates of those regions from the point of economic agricultural production, five items may be recognised as the most important from the point of its efficiency. They are, in order of importance, (1) water supply (2) manures and fertilisers (3) good seed (4) good cultural practices and (5) crop protection. It is proposed

to discuss, in this paper, the various aspects of these items, to point out how they have not been properly attended to and to suggest measures for overcoming the deficiencies that have led to the present situation.

**(1) Water Supply.** As water is the medium through which the nutrients in the Soil become available to the plants its adequate availability is the most important consideration in crop production. In all other parts of the country except the heavy rainfall tracts, e. g., the western coast, Assam, and the northern belts adjoining the Himalayas in the East Punjab and Uttara Pradesh provinces, the average annual rainfall is below about 50". In the heavy rainfall tracts, the rain comes in torrents during a short period and runs into the rivers and the sea. Much of it is useless for the crops grown in the tracts. The high rainfall in these tracts has even a harmful effect in so far as it causes soil erosion which can be prevented only through terracing, bunding, contour cropping etc. It is extremely essential to practice these preventive measures as it is estimated that about 2 per cent of surface soil is lost every year through erosion. In the low rainfall regions, except in the small areas served by the Canals, crops are anything but optimum because of the insufficiency of nutrients available to them. Firstly, on account of one or more causes, e. g., ill health, ignorance, inertia and bad economic conditions people do not apply enough manures and fertilisers to the soil and, secondly, even a large number of those that wish to apply them cannot do so for want of irrigation. As not more than about 25 per cent of the total cultivated area in the country is under irrigation manures and fertilisers, more particularly the latter, applied without irrigation not only do not profit the crops but even harm them at times. With irrigation available, large quantities of these are utilised by the crops to give heavy outturns. The most striking example is of the wheat crop which under dry conditions gives an average grain yield of only about 400 lbs. per acre in this country while its outturn is upto about 2,000 lbs. per acre under irrigation. This is true of all other crops, e. g., rice, jowar, bajri, maize, potato and Sweet potato which give far higher outturns when irrigated than when not.

The high average yields of rice in Japan, Italy and Spain are due to its cultivation under irrigation and heavy manuring In Japan about 95 percent of the area under rice is under irrigation.

The various methods of obtaining water for irrigation are (i) Large dams and irrigation projects (ii) Small dams and bandharas across nallas and rivulets, wells, and percolation tanks etc., from which water can either be simply diverted or lifted for supplying to the crops.

Of these, the large dams and irrigation projects are to be executed only by Government as the expenditure involved in such cases is very large. Items of minor irrigation can, however, be constructed by the cultivators themselves, if

necessary with the aid of Government, either individually or cooperatively. In irrigated areas care has to be taken to use water economically and proper drainage should be provided so as not to spoil the soils by stagnation of water.

There are, besides, areas which, though having rich soils, suffer from very great inadequacy of moisture in the soil. Here, apart from irrigation projects-big or small, it is even very important and pays to conserve whatever rain water that has fallen by putting bunds across the slope, repeatedly losening the upper layer of the soil and mulching to prevent evaporation and to grow the crop sparsely so as to enable it to attain full maturity with the help of the water at its disposal. This work is mostly possible for the individual farmers, though, while putting long bunds along the contour lines, cooperative efforts may be necessary.

**(2) Application of Manures & Fertilisers :** The soil is the source of food material to the crops grown thereon. As such, it should be capable of supplying the requirements of the crops in respect of their various ingredients, e. g., nitrogen, phosphoric acid, potash, lime, iron and certain minor elements in a balanced proportion year after year. The richness of a soil depends upon the parent rock from which it is formed and the transformation it has gone through. Our soils, though not generally poor have been under cultivation from very ancient times. Naturally therefore, they have been depleted of the essential plant nutrients, especially nitrogen in spite of the natural recuperation and the rather indifferent system of manuring followed in the country.

As everyone knows, the role of organic matter in the soil is very important. In decomposed state it is colloidal and forms a complex in association with the clay fraction. It improves the physical and chemical properties of the soil, supplies nitrogen to the crop and, above all, serves as a buffer in the soil ensuring even distribution of (inorganic) plant nutrients to the roots of crops. It is, therefore, very essential when applying chemical fertilisers. As our country comprises of tropical and subtropical regions, the humus in our soils is being constantly burnt away by the scorching heat of the Sun. The organic biproducts of most crops, i. e., stalks, leaves etc. are utilised as cattle feed or thatching material and are not returned to the soil except in very small proportions. The bulk of the cattle dung produced, equivalent to about 200 million tons of F. Y. M., is burnt away due to the shortage of cheap fuel and due to the insufficient realisation of its value in enhancing crop yields. Other vegetation which could be converted into compost was not utilised as such till about a couple of years ago. The old custom of preparing farm yard manure carefully has dwindled down both due to idleness and the attraction of farm labour to the industrial cities. Green manuring is not possible in most of the lands under food crops for want of the availability of water for raising the green manure crops. Poudrette is not used on account of religious and social prejudices. Thus, the humus status of the soils has been steadily going down. Owing to bad economic conditions, low prices of food grains and the nonavailability of water, inorganic fertilisers are hardly ever applied to

food crops. The importance of humus and fertilisers in our soils would be realised if the findings of Sir John Russel during his study in 1937 of the Indian experiments are taken into account. He has revealed the fact that with one maund of Ammonium Sulphate used in conjunction with a light dressing of F. Y. M. or compost, production increases by 4½ maunds of paddy, 3 maunds of wheat or 15 maunds of potatoes. The secret of the high yields of crops in countries like Japan and U. S. A. lies in heavy manuring coupled with irrigation. In China and Japan very great importance is attached to the preparation of compost and the utilisation of human excrements as manure; it is reported that as much as 67 percent of the nitrogen applied to crops is in the form of compost. Though our soils are rich in total phosphates they are present mostly in an unavailable form. The outstanding instances of phosphate deficient soils are of the tracts in North Bihar and Travancore. Application of phosphatic fertilisers fairly deep in the soil has been found to benefit the crops appreciably even in soils known to be containing enough phosphates. Potash does the important function of replacing sunshine in promoting corbohydrate formation. Though our soils do not usually need this element, its application as potassic fertilisers is known to improve the yield as well as quality of tuber crops, tobacco and fruits. At present there is a total dearth of fertilisers in the country. The state should start and or encourage the starting of factories for the production of fertilisers and also import fertilisers from other countries in the transition period.

It should be clear from the above discussion that farmers should be encouraged to prepare organic manures, both F. Y. M. and compost in a way expected to result in the maximum possible quantities of plant nutrients and apply them sufficiently to their crops. The burning of cow-dung should be stopped and the first washings by rain should be utitised to the best advantage of the crops. Green manuring should be encouraged wherever possible. Town sweepings should be utilised as compost wherever available, farmers should be induced to collect bones for manurial purposes. Moreover, artificial fertilisers and their mixtures should be advocated so as to supply the ingredients required by the crops in a balanced proportion. It would be worth while for Government in the initial stages to give them subsidies and loans for the purpose.

Besides the direct application of manures and fertilisers, there are other methods of recuperating soil fertility, e. g., by observing suitable crop rotations, particularly by including legumes in them, by fallowing and by ley farming. A good deal of soil fertility can be conserved by killing weeds with the help of weedicides, herbicides and tractors.

In certain cases, special correctives are necessary for improving the soil. Bases are removed through leaching from the soils in the heavy rainfall areas and the soils are rendered acidic. In such cases, liming is essential to improve the physical texture of the soil. Similarly, the application of gypsum or the growing of Dhaincha ( *Sesbania aculeata* ) are necessary to improve the soil

which are rendered alkaline by heavy irrigation coupled with bad drainage. There are prevalent in the country certain wasteful methods of cultivation, e. g., the 'Kumri' cultivation in the North Kanara district or the 'shifting cultivation' practised in the Khasi hills. This consists of burning and clearing the jungle and growing a crop in the cleared area. Such systems need to be stopped as they lead to soil erosion and loss of fertility.

**( 3 ) Good Seed :** There are various ways of obtaining seed capable of giving the maximum outturns of crops. They are (i) introduction of new crops unknown to the region (ii) introduction of new varieties or strains of locally cultivated crops (iii) breeding superior strains which give higher yields and are more resistant to drought and diseases than the local varieties by selection or by hybridisation with foreign types (iv) securing inbred lines of naturally cross pollinated crops which in suitable combinations exhibit hybrid vigour (v) using seed which is either vernalised or treated photoperiodically with chemicals, e. g. Colchicine, heteroauxin, or hormones.

As an example of introduction of a new crop may be mentioned the crop of China mug which has become very popular in the Bombay Province. As the crop requires only two months for maturity it can be taken in the short interval before a rabi crop like wheat. Being leguminous, it also fertilises the soil by fixing nitrogen from the air. Early varieties of groundnut have also been serving a similar purpose. Tapioca is another introduction which grows on the poorest soil and yet yields heavily.

Improvement of the local crop by selection has been found to give about 10 to 15 per cent higher yield. A large number of high yielding strains have been evolved in almost every crop in several of the provinces. Unfortunately however, they were not taken up by farmers for cultivation to any appreciable extent. Government have recently undertaken vigorous propaganda for the spread of improved seeds and have made suitable arrangements for multiplying and distributing the seed of improved strains. The enhancement of yield through this method depends upon the efficiency of the propaganda. Besides taking up strains recommended by the Agricultural Departments farmers may, with advantage, practise mass selection in their crops. This will enable them to maintain their strains and varieties at a high level of productivity.

Hybrid strains are usually an advance over simple selections. Though a few are available in some of the crops, the work of hybridisation requires to be accentuated. The work of evolving vigorous hybrids in more or less naturally cross pollinated crops like maize, bajri, jowar, tur, safflower, niger and onion is yet in the initial stages. The use of treated seed and the treating of crop with hormones to induce better pod and fruit set are yet to be tried on the experimental stations themselves. This is due to the fact that agricultural research in this country is yet in its infancy. The total expenditure on

agricultural department in all its branches is inappreciable in comparison with the total budget of the State. This state of affairs needs immediate rectification in the interest of increased food production in the country.

The improvement of quality of food crops can be attained only through a plant breeding programme and through well conducted manurial experiments attended with the chemical analysis of the treated crops.

**(4) Good Cultural Practices :** There are innumerable items going under the name of good cultural practices. They are, e. g., ploughing, harrowing, sowing or planting, seed rate, spacing, method of irrigation, interculturing, pruning, suitable time and method of harvesting etc. Cultivators have all along been following methods which they have found to be the best through their experience. These gradually deteriorated because of the lack of encouragement and protection to food production till the beginning of the Second World War and the enticement of agricultural labour to industrial cities as stated above. In several cases the existing practices require improvement. For example, wheat growers in the Bombay Province have been using seed rates varying from 40 lbs. to 120 lbs, per acre. But, it has been found through experiments conducted for 3 to 5 years on 7 different farms spread over the whole province that a seed rate of 40 lbs. is optimum for all the tracts both under dry and irrigated conditions. Similarly ridge cultivation has been found to be better than bed cultivation in irrigated tuber crops. There seems to be scope for the discovery of cultural methods superior to those in practice provided that comprehensive research is instituted in this rather difficult line.

Mechanisation of certain agricultural operations e. g. deep ploughing, water lifting etc. is likely to increase agricultural production; substantial aid to the ryots in this respect, will be valuable.

**(5) Control of Pests and Diseases:** The toll of agricultural produce taken by pests and diseases in our country is known to be very great. The total devastation by rust of the wheat crop in India in the year, 1946 is fresh within our memory. There are pests of different kinds on different crops. Locusts, wingless grasshoppers, Caterpillars, bugs beetles, Crabs, bats, birds, monkeys, wild boars and deer are among the common insect, bird and animal field pests which cause a great amount of damage to crops. Rats, moths and weevils play their part in addition during storage. Various types of diseases, e. g., wilt, mosaic, dieback, fungal and bacterial diseases etc. add to the destruction caused by pests. Unbalaneed manuring, excess of nitrogen has been found through experiments to predispose the crops to diseases.

The control of pests and diseases was not attended to seriously till very recent years, in some cases owing to social prejudices against destruction of life, but, in a large number of instances due to the unavailability of suitable control measures. The discovery of D. D. T., Gammexane, and many similar insecticides during the Second World War has provided new tools in the control of pests of several kinds. Though in some cases they are not yet found to be economic further industrial research is bound to bring them within the means of the ordinary cultivator for saving his crops. A good deal of research and trials are, however, necessary to maximise their use for the control of various kinds of insect pests. As regards animal pests, regular campaigns are necessary to exterminate them. For example, the menace of the monkeys, bats, wild boar and deer can be overcome only by organising gun clubs and Shikar clubs, and rats through suitable baits and traps. Various sprays and dust e. g., Bordeaux mixture tobacco decoction. Sulphur dusts etc., are now available for controlling diseases. As regards deficiency and toxicity diseases, proper correctives need to be adopted to balance the elements in the soil. Wherever possible, mixed cropping should be encouraged to prevent the extension and porpetuation of pests and diseases. In the case of both pests and diseases, more particularly the latter, the more sure solution lies in evolving strains resistant to them as treatment on field scale every year is not likely to prove economic. In the case of serious diseases e. g., the black stem rust, ( *Puccinia graminis tritici* ) of wheat, the blast disease ( *Piricularia oryzae* ) of rice and the wilt disease ( *fusarium* ) of cotton resistant strains have already been evolved in the various provinces. But, more plant breeding research is essential before strains resistant to most of the prevalent diseases and at least some of the serious pests become available.

The problem of weeds is no less serious. They do far more damage to crops than is usually realised, each in its own way. Generally speaking, they lower the yields of crops by depriving them of the moisture and nutrients available from the soil. Parasitic weeds, e. g. striga (*Striga densiflora and lutea*), Orobanche (*Orobanche crenua*) and loranthus (*Loranthus* species) feed directly upon the crop plants. Some of the weed seeds, e. g., (*Argemone mexicana*) are poisonous and are found to get mixed with similar oil seeds, e. g., brassicas.

Sethi (1950) gives a summarised account of the common weeds in the country and of the losses caused by them in the outturns of crops. A few important details from it are given below :—

The wild rice is a menace to rice cultivation in the C. P., Bihar and in Bombay Karnatak. According to Salimath the fall in the yield of paddy due to wild rices in Karnatak ranges from 5 to 50 per cent. The total loss caused only in Chchattisgarh division of the C. P. is estimated to be of the order of Rs. 22 lakhs annually. The destruction caused to deep water paddy in Bengal by water hyacinth (*Elichornia crassipes*) is worth about Rs. 11 crores annually.

The *Kans* weed (*Sachcharum spontaneum*) has been found to lower the yield of Cotton by about 33 per cent on the average and has laid waste millions of acres of valuable land in the C. P., the U. P., Madhya Bharat, and Vindhya Pradesh. Hariali ( *Cynodon dactylon* ), Kunda ( *Ischaemon pilosum* ) gokharu (*Xanthium stumarium*) and nut grass (*Cyperus rotundus*) are some of the pernicious weeds prevalent all over the country and causing upto about 50 percent reduction in the yields of crops. The damage caused by *striga* to *Jowar* and by *Orobanche* to tobacco is considerable.

The cultivator is usually aware of the harm done to his crops by weeds but, due to shortage of money and labour, is unable to carry out his cultivation as cleanly as is necessary for keeping the weeds in check. Recently, hormonal weedicides, e. g., 2-4-D and N: N-D, having selective lethality on dicotyledonous and monocotyledonous plants respectively, have been found. They are still in stages of trial, but are proved to be effective at least against some of the pernicious weeds like *lavala* and *striga*. However, they are not still cheap enough to be within the means of the cultivator. The Economic Botanist to Government, Bombay State, has in his recent trials, found Trichloroacetic acid (T. C. A.) to be effective against Hariali, the most persistent of the weeds. It is time that suitable practices and control measures are advocated and brought within the means of the cultivator by the Governments concerned.

Last but not the least, it is to be emphasised that the human element is the most important of all in the improvement of crop yields. Unless farmers are educated to the right type of farm practices the situation is not likely to improve very much. Such education should be imparted in agricultural schools and Colleges and also through well organised propaganda, shows, exhibitions, films, posters etc. Improvement programmes should start with the village as the unit and the full cooperation of the trusted men of the village should be availed of to guide the work of the ryots. Government should also offer prizes, as it has been doing now, to villages and farmers growing the best crops.

Fragmentation should be prevented by legislation and reasonably good prices should be assured for food grains as well as for other agricultural commodities.

Most of the suggestions given in this note are already in the programme of the " GROW MORE FOOD " Campaign in all the provinces. What is essential is to intensify the efforts on a warlike basis. That good results can be quickly attained by rendering the cultivation of food crops profitable is evident from the striking increases being realised by cultivators in the case of cash crops like Sugarcane, Cotton and Tobacco.

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— Dr. Renato Dulbecco, biologist in the California Institute of Technology, has discovered that light not only can " kill " microscopic organisms but apparently can bring them back to life. The light which " kills " is of ultraviolet type, which is invisible to human eyes, while the light that " revives " is of a longer wave length which is just barely visible to human eyes.

Submicroscopic organisms called bacteriophage were used by Dr. Dulbecco for his experiments. It is not yet known to the scientists whether bacteriophage is a virus or a virus like organism; but it is positively known that it infests and destroys the bacteria. Dr. Dulbacco found that by exposing these bacteriophage to ultraviolate light, he could " kill " them and keep them in a death like state for 24 hours, but most of the " dead " organisms could be " revived " and made active when exposed to the reviving light. This discovery of how sunlight affects life and growth is definitely imporant to man's learning.

American Newfile, Dec. 15, 1949.

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# Our National Rural Insurances Plan

By

RASHID A. MUNSHI *

## Introduction

The Crop Insurance seems decidedly a new innovation in ordinary plannings of Rural programmes. During War No. I "Grow more food/fruit campaigns" have enhanced the agricultural scientific prestige to a large extent and even now the agricultural programmes and drive form the major part of Indian New Order and Policy of Economic Nationalism in India and the States.

Apropes of this crop Insurance has become part and incorporate section of recent and modern agricultural plannings. It seems essential, nay important. to put it into vogue, wherever and whenever possible in rural areas and forest Nursery Centres.

Due to war economy and abundant pressure of new agricultural schemes projects coming in these days we are suggesting small state and divisional areas as territorial units of experimental works wherein these Insurances could be launched and worked out successfully. To be precise just recently (17-9-45), I have approached the Director of Agriculture, Bombay Government, Poona to introduce this "Insurance" project at a cost of Rs. 1,84,000 only for a territorial unit of Central Division comprising of 4/6 districts as experimental ones (Cf: 4/5 Tahsils of Dewas State Jr.). This project could if appreciated be able to secure the financial backing through the Bombay Rural Development boards or from the Indian Council of Agricultural Research, New Delhi.

With the War II (East/West) end the prospects for such types of territorial units experimental projects are bright and can easily be pushed along with other rural problems and plannings. The financial returns within 1/2 years of their (Insurance projects) state equalise initial expenses spent in propaganda work and initiations.

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* Director, N. China Cottage Industries and Education Centre, Mahableshwar.

In foreign countries, continent and even Japan/China Crop Insurance has been now and again brought into play and tackled successfully and becomes just a routine outlook in modern Agri-cum-Horticultural plannings in rural centres.

It is opined these projects, proto-types to Dewasians and Nippon be taken up for the benefit of the rural communities. They would find abundant popularity and inseparable vogue along and with our usual agricultural and post-war plannings and Economic Nationalism in particular.

**Beveridge paralled for farmers in India:** - Just recently we find National Social Insurances plan being advocated by Lord Beveridge and it seems they are abundantly popular especially those regarding sickness, old age pensions, maternity and widowhood and even unemployments. (Gr. Britain) They have also created a separate ministry.

In India Insurances with regard to fire, accidents and deaths are commonly in vogue. Just as these above Insurances have become part and parcel of civilised people and their living, so also crops, live-stock and forest nurseries. Insurances are being evisaged for vast rural agricultural plannings.

**Creating Administrative Units and Suggested Crops Insurance Schemes Bombay** :- Bombay Central Division Scheme comprising of some 6/7 districts seems a most probable one giving as it does insight into the very internal working and Government machinery setting possible.

The approximate figures and main features of Crops Insurance project Experimental and first of its kind for Central Division, B. S. (Cf: Dewas and Tahsils) a *Territorial* unit being as follows.

1. The project to be approved of by The Rural Development boards for due recommendations for grauts Rs. 1,84,000/- only from the Bombay Government or from the Indian Council of Agriculture research, New Delhi. - for initial expenses

2. The financial implications ( expenses ) Rs. 1,84,000/ - being arrived and calculated as and from say,

| | | | |
|---|---|---|---|
| a ) | Cost of 30 Rs. pamphlets per Village of 300 heads. | Rs. | 30 / - |
| | 150 Villages in a Taluka..... | ,, | 3,04,500 / - |
| | 10 Talukas to a Dist..... | ,, | 4,5000 / - |
| | 4 Dists. to a Division..... | ,, | 1,80,000 / - |

b ) There is no necessity of extra Staff, the Agricultural – Cum – Revenue operating the scheme. In special cases provision may be made for a divisional Crop– Insurance Offieer pay @ Rs. 200/ –– annually 2400 and some 4/6 District Crop – Insurance Inspectors @ 120/– annually 6000/–.

Total : Rs. 2,50,000/–

**Enhancement of State Revenue :**

**Incomes :** ( a ) Supposing the rate of insurance is 2 (two) rupees per acre for 180,000/– acres the income would be Rs. 360,000. ( b ) In 1/2 years the premium money equalises expenses leaving a balance Rs. 360,000/– minus Rs. 250,000 = 110,000/–. Thus Government gets land Taxes plus additional revenue of Rs. 110,000/– 150,000 from Division – annually.

3. This being prototype to Dewas State ( and 4 Tahsils ) same as a Division in B. P. ( with 4/6 Dists. ) for intigral and regular part and propaganda of routine farming. – Indian and abroad.

A state comprising of such 3/4 Divisions shows an increase of premium money Revenue to the tune of some Rs. 150,000 x 4 = 60,0000 yearly. Rs. 6/7 Lacks ( without Extra Staff Services ).

4. On successful termination of its experimental period, usually extending over 1/2 years only the projects should be extended to other States and even abroad with a view to establish Sino – Indian linkages and elements.

a ) If necessary, culminating into regular Crop – Insurance policy and Act through Central and Provincial Legislatures – " New Order " – New Deal and Policy of Ecomomic Nationalism – on patterns of progressive countries. E/W. (Cf : Lord Beveridge National Insurance plannings for Great Britain )

**Possibilities of Corporations Companies :** II. Insurance Act and the Security of funds with suggested Company / Sate Government. In case the projects are being undertaken by the State Governments there is no necessity for a General Insurance Company to step in the Governments managing their own affairs.

a ) The settlement of Accounts: It is proposed that every 14/17th year ending. accounts should be settled and if a company operates after account for the dividend on shares, reserve funds, expenses of " Proposed Association " concerned any profits should be passed on to the policy-holders and by bonus to the shareholders.

The question of any General Insurance Company comes in if and when such a company has been started and capital raised by shares, deposits and loans.

b) The Insurance Act 1938 provides that such funds be kept separate in the interests of the policyholders and part of the funds of and from premium collections, say 30/35%, be invested in Government or other approved securities.

c) **Banks** : The premium money collections and funds should be kept with the Imperial Bank of India or any authentic one, Ltd. concerns.

In Japan, in the vicinity of Hiroshima, Nara, Kyoto, Kone and Okayama most of the forest nurseries have been " insured " and naturally, General Insurance Companies have come forward to help and finance the projects along with consulting ACTUARY for their quinquinnial valuation of Association and liabilities.

*The classes of Policies and premiums.* In case of the agricultural crops and forest nursery plantations it is found convenient to calculate and change premium on assessment varying according to the acreage and type of lands concerned.

The policies have been reckoned under three types A/B/C showing premium varying according to the assessment. The premium is collected by Village Officers along with Land Taxes.

**Premia Basing Actuaries.**

CLASSES OF POLICIES TABLE : I

| Land Assessment per acre. | A class Premium per acre. | B class Premium per acre. | C class Premium per acre. |
|---|---|---|---|
| 8 As. to 12 As. | 0- 4-0 | 0- 3-0 | 0- 1-6 |
| 12 ,, ,, 1 Re. | 0- 5-0 | 0- 5-0 | 0- 2-0 |
| 1 Re ,, 2 Rs. | 0-10-0 | 0- 7-0 | 0- 4-0 |
| 2 Rs. ,, 3 ,, | 0-15-0 | 0-11-0 | 0- 7-0 |
| 3 ,, ,, 4 | 1- 4-0 | 0-15-0 | 0-10-0 |
| 4 ,, ,, 5 | 1- 9-0 | 1- 3-0 | 0-13-0 |
| 5 ,, ,, 7 | 1-14-0 | 1- 7-0 | 1- 0-0 |
| 7 ,, ,, 9 | 2- 3-0 | 1-11-0 | 1- 3-0 |
| 9 ,, ,, 11 | 2- 8-0 | 1-15-0 | 1- 6-0 |
| 11 ,, ,, 13 | 2-13-0 | 2- 3-0 | 1- 9-0 |
| 13 ,, ,, 15 | 3- 2-0 | 2- 7-0 | 1-12-0 |
| 15 ,, ,, 18 | 3- 7-0 | 2-11-0 | 1-15-0 |
| 18 ,, ,, 21 | 3-12-0 | 2-15-0 | 2- 2-0 |
| 21 ,, ,, 23 | 4- 2-0 | 3- 3-0 | 2- 5-0 |
| 23 ,, ,, 25 | 4- 7-0 | 3- 7-0 | 2- 8-0 |

*N. B.*:—Fraction of an acre will be considered an acre for the purpose of premium and compensation.

Japan

III. **N. China Industries / Education Deal and the article of Association. (Insurance Act Provisions).** It is found the projects can be successfully worked out if conjointly launched and planned by the Agricultural cum Revenue Staff.

'1) The articles of Association provide and enable the policy-holders to have a voice in the administration and form into an association. They have thus full knowledge of affected and damaged areas, information in respect of land records and often cognisant of the funds held.

Thus the Association (of influential land holders and financiers, Revenue members, Directors and Dy. Directors of Agriculture, N. China Education Industries Centre representative etc.) a semi-Government one and with its working committee in joint responsibility with the Government can fittingly have head and branch offices inaugurated in Central places, Districts and Tahsils (Cf: Dewas and Dewas 4/5 Tahsils )

**The Working Committee.** (Revenue-cum-Agricultural.)

1. Hon. finance member ... President
2. Hon. Revenue member ... Vice President
3. Director, Dy. Director of Agriculture.....Secretary
4. N. China Ind.-Edtn. Centre.....Representative.
5. Divisional, Dist. forest officer in case forest nurseries are covered and involved)

The decision of the Committee is final and the secretary closely collaborates with the president responsible for arranging by monthly meetings, reports, budgets etc.

(2) **Joint machinery and the moral hazards.** The Mamlatdars will send in very often crop and annewari reports and declare areas under damage due for compensation.

**Moral Hazards:**- (a) Famine, drought (Ahmednagar, Bijapur, part of Sholapur etc.)

(b) Flood, Excessive rains (M'war 230",/350.) (Tapti River floods, dated 15-10-45)

c ) Diseases, Insect pests ( Rust, Mildew, grass hoppers a टोळ धाड Cabbage-flea peas केंवरा, Mahableshwar.

d ) Hail stones, snowfall, cold waves, potato करपा, chillies wilting etc.

In Japan forest protection and preservation policies along forest Insurance Act are meant to cover damages to parks, forest, economic tree plantations caused due to wanton and careless camp fires, floods and Rly. engine charcoal.

The Association and Mamlatdars own the list of the " Pattaholders " and total acreage affected.

They are also responsible for cases of lapsed policies and general complaints of the individual farmers.

**Lapsed Policies.** It is seen that policies cannot necessarily laps on account of default in payment of premiums. The policy will lapse in case the land lapses to Government. The premiums are based on land-assessments and collections made with land taxes and naturally if any transfer of land occurs the policy also passes on to the transferee.

The mutation Register shows these changes and the policy will along with the land pass on to his or her legal heir under Revenue Code.

**In Brief :**

**The Revenue Dept.**

1. Supervise the working.
2. Would declare areas affected, send lists of " Pattaholders " with acreage of each to Association.
3. Penalty department paying Compensations.

   Premia are paid to the Rev. Officer ( Mamlatdars, Circle Inspectors, Village Talati and Patils) who will have to pass receipt for every amount of premium received by him.

**The Association.**

1. This Association shall be styled as N. China Cottage industries Edtn. Centre.

   Mahableshwar Crop ( forest nurseries ) Insurance Association ( Cf : Dewas State Crop Insurance Association ) or with any modified name according to the operational areas or Territorial units wherein the projects work.

   Cf: Central Division Bombay Crop Insurance Association. )

a) The patta-holder thus will be the policy-holder and the Insurance will be perpetual against Crop to be produced in a specified land and the benefit will go to the cultivator.

2. Receives lists from the Rev. Dept.

3. Responsible for farmer policy holders and areas being involved.

4. Semi – Govt. will Hd. / Br. Offices and its Working Committee.

**Plans of / for Assurance and Compensations paid.**

It is found that the permium figures collected should conveniently be put up with the damage claimed figures or the Compensation ones in just and fitting proportions and ratio.

In certain Native States (Cf: Dewas) the premiums are kept in equalising proportions to the compensations paid out. This is rather unjust and brings no consolation to the poverty stricken farmers.

A purpose of this-the plans of Assurance-should be popular and workable and hence it is suggested in the table below to keep compensation columns some 3/4 times the premium figures.

The compensation given when the Crop Yields (or even forest nursery plantations) go below the averages and up to the time of the destruction of crops. Vide Mr. Henry Spielman, Consul General, U. S. America (Corporations) D. O. Letters.

**Actuaries Tables**

*Compensation 3/4 times the premium.*

| Land Assessment per acre. | A class Compensations per acre of damage. | B class Compensations per acre of damage. (Three times) | C class Compensations per acre of damage. |
|---|---|---|---|
| 8 As. to 12 As. | 0-12-0 | 0- 9-0 | 0- 4-6 |
| 12 „ „ 1 Re. | 0-15-0 | 0-12-0 | 0- 6-0 |
| 1 Re. „ 2 Rs. | 1-14-0 | 1- 5-0 | 0-12-0 |
| 2 Rs. „ 3 | 2-13-0 | 2- 1-0 | 1- 5-0 |
| 3 „ „ 4 | 3-12-0 | 2-13-0 | 1-14-0 |
| 4 „ „ 6 | 4-11-0 | 3- 9-0 | 2- 7-0 |

| | | | |
|---|---|---|---|
| 5 „ „ 7 | 5-10-0 | 4- 7-0 | 3- 0-0 |
| 7 „ „ 9 | 6- 9-0 | 5- 1-0 | 3- 9-0 |
| 9 „ „ 11 | 7- 8-0 | 5-13-0 | 4- 2-0 |
| 11 „ „ 13 | 8- 7-0 | 6- 9-0 | 4-11-0 |
| 13 „ „ 15 | 9- 6-0 | 7- 5-0 | 5- 2-0 |
| 15 „ „ 18 | 10- 5-0 | 8- 1-0 | 5-13-0 |
| 18 „ „ 21 | 11- 4-0 | 8-13-0 | 6- 6-0 |
| 21 „ „ 23 | 12- 6-0 | 9- 9-0 | 6-15-0 |
| 23 „ „ 25 | 13- 5-0 | 10- 5-0 | 7- 8-0 |

*N. B.*—In case of fields forest nurseries in which Two Crops are produced in one year the amount of compensation will be half.

IV. **The Project and Propaganda.** As it would be evident from the introductory remarks as well as the main features and framework as checked out above the Crop Insurance projects are new and modern to Indian psychology and knowledge.

In foreign countries (Continent and far East) these are part and conjoint workings of any authentic agricultural plannings and programme securing freedom from want for farmers.

Apropos of this it is opined that the various State and Dist. Agril. Rural development Boards Cooperative and Rural Development sections along with Dy. Directors and Dist. Overseers would stress this modern innovation as vital and inseparable to usual agricultural plannings and drive on patterns of foreign progressive nations.

In working up the machinery both while collecting premiums and payment of compensations it is found seasonal Crop and annewari reports from Mamlatdars and Dy. Collectors are of vital importance. Generally the average crop yield is reckoned as follows:—

**Almost all crops or few selected ones commercial types**

1. **Graminaccae.**

| | |
|---|---|
| Jowar ... ... | 9 annas in rupee |
| Wheat ... ... | 9 „ „ „ |
| Maize ... ... | 7 „ „ „ |

2. **Oil Seed/fibre.**

| | |
|---|---|
| Linseed ... ... | 7 annas in rupee |

Tilli and other seeds (Sept.–Oct. Panchyani Terraces) ... ... 7 annas in rupee
Cotton ... ... 10 ,, ,, ,,

3. **Dal Crops** gram ... 8 ,, ,, ,,

4. **Irrigated Crops** ... 10 ,, ,, ,,

Sugar Cane, Tobacco, Opium (Nagar) Strawberries, Eng. Veges. (Mahableshwar) Citrus Gardens, Banana, Grapes etc.

5. **Forest Eco. Nurseries** 7 annas in rupee.

4/5 years old and below. Cachew nuts, Chandan, Cherry plants, Hirda Jambul, Phanas, Tea, Coffee etc.

V. Very often it is asked whether these and other fundamental basings figures and projects are practical and available easily to or in any locality or Dists. and Divisions (Territorial units) in a state or even for large scale zonal areas such as those envisaged in Pakistan and Hindustan Sections of India.

This is further clarified and explained drawing a paralled – say in between and as follows :— showing

A single Territorial unit – A single Division in a State – comprising of 4 / 8 Districts of 4/5 Tahsils. (Cf : Dewas Central Division B. P.) State, C. T ),

| | |
|---|---|
| 1. The Crop Insurance Projects - in Vogue and common. | 1. These are new and unknown V often. |
| 2. Gram Panchayat Systems perfect and fundamental Basings often. | 2. Coming up sparcely and recently along Village – libraries ( Cf : Old. M'war Village ) |
| 3. The Bij – Bhandars and Savan returns common ( purity seed drive and multiplication ) | 3. Not so abundant nor thought so essential. |
| 4. Malkana Hakk and State Landlordism. | 4. Landlords / Peasant – proprietorship bills. |
| 5. Debt Relieving Act and ( money lenders ) Committees. | 5. Bombay Agricultural Debt Relieving Act Start 1945 Oct. |
| 6. The State specialisations. | 6. Neglected Institutions. |
| a ) Patil Boys – Patil Boards. | |
| b ) Sardars – Sardar ,, | |
| c ) Temple pujari \| Sanskrit ,, | |

**Freedom from want** for the farmers. *Compulsory deal theory and practice*. Thus it is abundantly clear — the state unit by virtue of its being — small and

specialised institution takes up easily certain reforms and projects — suiting traditions and temperament of the people as shown above.

This may not be found in territorial units but the *progressive patterns* can easily be copied and introduced in rural centres, and life and method of livings of the agrarian communities – ( Cf : Japan ) – as such just recently the project has been placed before the Director of Agriculture, Bombay state and the results are awaited – The propaganda section adding abundantly to our modern policy of agricultural plannings and Economic Nationalism. Now that India is fast evolving it should have on equality with other Democratic Nations of the world.

In conclusion — it is expected that this Agricultural Crops — Insurance project —as being advocated by our N China Cottage Industries and Education Centre - Mahableshwar / Ahmednagar - would soon find favour and populiarity in the Indian Union, even abroad, securing ultimately freedom from want for the rural communities and individual farmers equally.

**References :** 1. Nippon Forests and Insurance Act.

2. Dewas Crop Insurance Act.

3 D. O. / Cooptive Registrars Bombay ( 13 Nov. 45 )
a) The Federal Crop Insurance programme U. S. America.

4. Bulletins / publications – The National Farmers' Union Mutual Insurance Society Ltd. Stratford – on Avon. ( England )

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# SWEET POTATO

By

G. A. PATEL *

*Natural Order* :- Convovulaceae. *Botanical Name* :- Ipomoea Batatas· *Marathi* :- Ratalu. *Gujarati* :- Sakkaria. *Kannada* :- Genasu. *Area in Bombay State* :- 13,514 acres in 1946-47.

*Area in acres of important centres* :-Belgaum 3,808, Satara 2,223, Poona 854 Sholapur 1,042, Bijapur 925, Nasik 867, Kolaba 652, Kanara 727, Kaira 382.

The chief use of sweet potatoes is for human food. The creepers are used as cattle feed; in famine it is an important crop. The crop is used in making starch, sirup and alcohol. The sweet potato contains 16% starch and 4% sugar i. e. 20% alcohol producing material. This is a very important crop in tropical and sub-tropical countries like Africa, China, Japan, India and U. S. A. The sweet potato is a native of tropical America. It is now widely distributed throughout the world where climatic conditions are favourable. The juice of both vines and roots is milky. The flowers are almost white or pale violet in colour.

**Climate :-** The sweet potato is one of the most drought resistant vegetables. It can give a fair crop without irrigation in semi-arid regions. This can be grown where 4 months in a year have warm days and nights, plenty of sunshine and moderate rainfall. The largest yield is secured when the rainfall is abundant in the early part of the growing season. Where the rainfall is 20"-25" it can be taken throughout the 3 seasons, where the rainfall is 30" to 40" it can only be taken in Rabi season.

**Soil:—** Well drained soils are necessary for highest yields. The crop thives best on sandy loam soils, with a clay sub-soil layer; but it can be grown on a wide range of soils, if the growing season is sufficiently long. On very rich soils or in heavy soils the crop produces much vegetative growth and the potatoes are likely to be very large and rough. This reduces their market value. Good drainage is important, since the crop does not thrive well where water stagnates. Planting on ridges is suitable mainly for the purpose of drainage.

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**Preparation of the Soil :—** On deep soils there is a tendency for the roots to grow long and slender, so deep ploughing is not advocated. Usually 6" depth of preparation is sufficient. Fresh manure is not applied to this crop as it produces long and rough potatoes Bulky manure is applied to the previous crop. The soil is brought into fine tilth by freguent discing and harrowing.

**Layout and Planting :—** In Gujarat ( Broach, Kaira and Ahmedabad) flat beds are prepared 6' x 12' and the vines are planted in the bed in the month of November. The crop will be ready for harvest in the month of February March after 4 months. In other parts of the state ridges and furrows are opened 2' apart by the ridger and cuttings of the vines are planted on both the sides of the ridges 9" apart. Fine cuttings are obtained from the matured vines which are free from the soil borne disease. The length of the cutting is 12" with 4-5 sound buds therein. The cuttings are planted 9" apart keeping the end buds free. The central bud which is put inside strikes the roots. The number of cuttings required is theoretically 50,000, but practically 1 lac per acre, and on weight base 600 lbs. of cuttings are required. The area for seed purpose is 6 to 8 gunthas. The seed rate depends on the variety, type of soil and the planting distance. At the time of planting the ridges are previously irrigated and the cuttings are planted in the mud.

**After Care :**—Keep the area clean by hand weeding and stirring. As this crop has got the spreading habit it covers the whole ground and minimises the weed growth.

**Top Dressing :**—If fertilizers are available a 650 lbs. mixture consisting of 2 parts bone-meal, 4 parts groundnut cake and 1 part of $K_2SO_4$ or 500 lbs. of bone-meal is applied.

**Irrigation :**—In Rabi and Hot seasons 12-14 irrigations are given at an interval of 10 days. The water requirements of the crop amount to 30–32 acre inches.

**Turning of the Vines :**—There is a difference of opinion regarding this operation. Experiments were carried out for turning the vines every week, after they were properly established. It was found that it was unsafe to disturb the vines after they had grown to a considerable length.

**Harvesting :**—When the sweet potato is grown for early market it may be harvested as soon as the tubers reach the marketable size, regardless of the stage of maturity. Generally the crop is ready within 4 months. Harvesting is done by digging out the tubers with a *Kudali* or a pick axe, by hand labour or by a light plough and collecting the tubers afterwards. The averagee yield is 8,000 to 12,000 lbs. of tubers.

**Varieties :**—There are about 100 varieties of sweet potatoes but there are three important varieties from the market point of view. They are Red, White and Ceylon Cluster white. The white variety is supposed to be less sweet and more fibrous than the red one. The 3rd variety is introduced by our department from Ceylon and it has a natural tendency to form all the tubers in clusters near the surface. The size of the tuber depends on the type of soil, cultivation and manure. It varies from a few ozs. to a couple of pounds.

**Diseases and Insect Pests**:— (i) *Black Rot:*— This affects the underground portion of the crop. The fungus produces dark and black somewhat sunken, more or less circular spots on the surface of the tuber. On the stem also the infection begins as a small black spot which generally enlarges until the whole stem rots off. The plants grown from affected tubers are likely to bear the disease. Seed from disease-free vines should therefore be used. There are many other diseases such as, leaf spot, leaf blight, root rot, soft rot etc. but they are not met with in the state of Bombay.

(ii) *Sweet Potato Weevil :*—It is a slender snout beetle about 1/4 inches long. The weevil feeds upon the leaves, stems and vines in the early stages and lays a large number of eggs at the base of the vine tuber. The young larvae on hatching eat the flesh of the potato leaving an irregular burrow lined with excrement. They feed inside the tuber upto the time of their full growth and pass the pupa stage within the sweet potato

**Remedy :**—Crop rotation and spraying with stomach poisons.

**Cost of cultivation**

| Items. | | Men. | Women. | Bullocks. |
|---|---|---|---|---|
| I. Preparatory Tillage :— | | | | |
| Ploughing. | ... | 4 | ... | 8 |
| Mixing Manure and Harrowing. | ... | 2 | 2 | 4 |
| Laying out. | ... | 4 | ... | 2 |
| II. Planting :— | ... | ... | 10 | ... |
| III. After Care :— | | | | |
| Interculturing, Weeding, Stirring, turning vines. | ... | ... | 30 | ... |
| Top Dressing. | ... | ... | 10 | ... |
| Irrigation. | ... | 10 | ... | ... |
| Harvesting. | ... | 8 | 12 | ... |
| Total Labour :- | | 32 | 44 | 14 |

**Cost of labour.**

| | | | Rs.As.Ps. |
|---|---|---|---|
| Labour. | ... | | 75-0-0 |
| Manure and fertilizers. | ... | | 60-0-0 |
| Seed. | ... | | 50-0-0 |
| Irrigation. | ... | | 5-0-0 |
| Marketing. | ... | | 2-8-0 |
| Supervision. | ... | | 12-0-0 |
| Interest @ 9% | ... | | 6-0-0 |
| Land rent. | ... | | 30-0-0 |
| Hire charges for implements. | ... | | 1-0-0 |
| | | Total | 241-8-0 |
| **Receipts :—** | | | |
| 8000 lbs. tubers, @ Re. 0-1-0 per lb. | ... | | 500-0-0 |
| **Deduct :—** | ... | | 241-8-0 |
| | | Net Profit | 258-8-0 |

—The new institute for Muscle Research in the United States, directed by Dr. A. Szent-Gyorggi, the famous discoverer of Vitamin C, is trying to solve the mystery of muscular activity. It is reported that muscle consists of a complex protein called " actomyosin ", which is a combination of " actin " and " myosin ". Molecuis of " actin " are small and round ; while those of " myosin " are long and thin. Yet another substance, known as Adenosine Triphosphate ( ATP ) is said to act as the energy exchange agent. The energy exchange is regulated by salt.

Actin molecuis unite together to form long threads when a very little salt is added. These threads form long muscle fibre and the long thin myosin molecuis unite with them giving the familiar straited appearance to the muscle. This complex structure formed, which is very sluggish, is called as actomysin. However, when a small amount of ATP is added the structure becomes amazingly reactive. The muscle contracts due to high percentage of salt and expands due to a low percentage of salt. Dr. Szent-Gyorggi says that all evidence points out, that ATP is the key substance of muscular activity and that the stiffening of muscles after death is due to loss of ATP.

— A. N. F. Dec. 29, 1949.

# Storage of Grains in Bombay State

By

S. V. PINGALE *

The main food requirements of the population in this state being satisfied by grains, grain storage has been an important practise since long. Actually a majority of the cultivators and the consumers prefer storing their grain requirements of 1–2 years. Grain unlike money, however, deteriorates in storage, the factors responsible being moisture, rats and insects and the existing conditions show that this has not been overlooked. On the other hand in the Bombay state it is observed that every possible means including insects have been harnessed in grain storage by the cultivators and the consumers to minimise damage. Besides, the methods adopted vary from tract to tract indicating that the climatic conditions are also taken into consideration. Large scale observations, however, show that these efforts do not yield complete success and some damage continues to occur. It is, therefore, intended to summarise the local methods in this article along with the suggested additions which have been worked out in the light of recent developments.

In N.Gujarat the main grains stored are wheat,bajari and pulses. For storage the cultivators and the consumers use earthen cylinders which have an opening at the top to introduce grains and an opening at the bottom to take out grains. The capacity of such cylinders varies from 500 to 3000 lbs. and they are usually kept 2 to 3 feet above ground to avoid rat and white ant trouble. Before putting in the cylinder the grains are dried in the Sun and mixed with ashes and Neem leaves. In this tract mixing of ashes is thought absolutely necessary and at any cost this is accomplished. The grains are then introduced in the cylinder with a handful of *Trogoderma granaria* larvae (locally known as *Vantri*) on top and then the opening sealed with mud and cowdung. The introduction of *T. granaria* larvae is supposed to keep other insects away and itself does not cause much damage. In the laboratory it is observed that these grubs raise the temperature of the grain considerably and this keeps other insects away. A few observations in case of grains stored this way have shown that where larvae are introduced the damage varied from 0·5 to 1·0% and was caused by *T. granaria* and where not introduced it was between 1·0 to 2·5% caused by *Calandra oryza* in case of cereals and by *Bruchus* sp. in case of pulses.

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A few persons store their stocks in bags and in such cases castor oil is applied to wheat and rice at the rate of 1·0 to 1·5% and this method is found to afford protection to grains for 5 to 6 months.

On large scale merchants store grains in bulk in half underground and hall above ground rooms. In their storage no preservative is used and considerable damage is caused by *T. granaria* and *C. oryza*.

In central Gujarat where wheat, maize and paddy are stored, in addition to the above methods, small sized above ground rooms are also used for storing these grains in bulk. In such cases the preservative used is ashes. In this tract maize suffers heavy damage within a short period from moisture and insects like *C. oryza*, *T. granaria* and *C. rugicollis*.

In Konkan where paddy is the main crop, it is stored on a small scale in cylindrical bins prepared of bamboo and these are locally known as *kanagies*. They are made airtight by applying mud and cowdung to its side. Their capacity varies from 500 to 1500 lbs. The pests damaging paddy in this area are rats and the insect, *Sitotroga cerealella*. The cultivators use Neem leaves as a preservative but inspite of it, the damage in 8 to 10 months storage goes to 3 to 5% and if the *kanagy* is opened frequently it may amount to even 10·0%. The pulses are stored in earthen pots or gunny bags with the local red soil applied to them as a preservative and this is found to protect them from *Bruchus* attack.

The merchants store their grains either in bags or in bulk in above ground rooms where, in addition to *S. cerealella*, *Rhizopertha dominica* is found responsible for damage.

In Khandesh where, kharif and rabi jowars and wheat are stored, it is observed that Kharif jowar is most susceptible to insect attack and *C. oryza* and *S. cerealella* are responsible for damage. Rabi jowar is damaged by *C. oryza* and *R. dominica* whereas, wheat by *C. oryza* and *T. granaria*. The cultivators store grains in *kanagies* or bags after using ashes and neem leaves. However, in this tract the insects take a heavy toll and in 8 to 10 months storage 3-7% damage to kharif jowar and 1-4% to other grains is not unusual.

The merchants of this tract store the grains in bags or in underground *pucca* built cellars locally called *Peva*. In the *peva* the grain is stored for 2 years in bulk without any preservative but, after storge all oxygen is removed from the *peva* by burning a candle and then sealing the opening. Grains stored this way get a musty odor, a different colour, loose the germination power and suffer heavy damage by moisture which varies between 1 to 20% according to the time of storage.

In the South Deccan rabi jowar is mainly stored and the insects damaging it are *C, oryza* and *R. dominica.* The cultivators use *kanagies* or bags without any preservative and merchants store the grains in bags. In some places underground *pevas* are also used but they are getting obsolete now. The damage in this tract in 8-10 months storage is observed to be 0·5 to 1·5%.

In the Karnatak area jowar, wheat and paddy are the main crops stored. Out of these jowar and wheat are stored in underground pits and paddy in bags. The pits are simple dugouts in highlying area preferrably in laterite soil. Straw is used on all sides before putting in the grains and the grain is stored in bulk. The capacity of the pits varies from 1000 to 50000 lbs. Pitted grains are taken out as and when required, the maximum storage usually not exceeding two years. Grains stored in pits are not fit for seed purposes and give characteristic pitty smell. Moreover, if not dried properly after removal from the pits they deteriorate quickly on account of the high moisture content.

**Suggested additions :** Where grains are stored in airtight containers like earthen, bamboo or metal bins, do not mix anything with the grain but pour grain in the container and on top add ED/CT, a liquid fumigant, at the rate of one ounce per maund of grain. The container is then kept closed till required. The grains kept this way remain fit for seed or consumption purposes and free from rats or insect damage. The cost of the treatment ammounts to one anna per maund of grain.

For bag storage the grains should be thoroughly dried in the sun and the grain bags kept on suitable dunnage in a well ventilated place. Besides, either mix Magnesium oxide with the grain at the rate of 1 lb per 500 lbs of grain or subject the bags to surface dusting with 4·5% BHC dust. The latter method is cheaper and in this case every bag is to be dusted from outside initially and only the exposed surfaces subsequently every month. The rate for each dusting should not exceed 8 ounces per 100 sq. ft. area dusted.

If the grains are meant only for seed purposes 4·5% BHC dust mixed with the grain at the rate of one pound per thousand pounds, keeps the grains free from insect damage. Such grains, however, are not then fit for human consumption.

For underground storage moisture is the only damaging factor and this could be avoided by keeping a layer of bagged husk (any locally available paddy or groundnut husk) at the bottom and sides before putting in the grain. Besides, grains taken out of the pits or *pevas* should be thoroughly dried in the sun before subsequent storage.

# The Role of Birds in Agriculture

By

NARAYAN G. DASTANE *

Who is not attracted and allured by the charming beauty of birds? Even a lay-man finds a unique joy in their lovely forms and pretty plumes, graceful flights and sweet songs. The ornithologists regard them as benefactors of the universe.

Of course, it is true that there are few baneful activities of birds. They destroy the field and orchard crops. Some of them devour the beneficial insects. Some birds fertilise the flowers and disseminate the seeds of noxious plants and weeds. Some like hawks and vultures rob the poultrymen of their chicken. There are certain birds who shout out at night, in harsh discordant screams and with hissing notes, awakening us from sound sleep after the day's hard work.

But all this does not mean that the bird kingdom is nothing but a nuisance to mankind. The damage and the destruction caused by the birds is usually exaggerated. On the contrary, the birds repay the meagre loss by performing the manifold and indispensable services for human welfare.

Most of the birds maintain themselves on the insects and pests which would have damaged the crops by billions of rupees. It is said that "But for the insects, the birds would perish". From this, we can imagine the relation of insects and birds. The crows and the cranes devour greedily an immense number of cutworms and caterpillars, crabs and crickets. The paddy birds and partridges prey voraciously on frogs and fishes, moths and maggots. Storks are well reputed locust destroyers. Ants and grubs form the dainty diet of robins and woodpeckers. Owls, hawks and vultures are among the most important of the natural checks on mice and lizards, rats and rodents which are swallowed entirely.

Thus the birds are of great economic use to the agricultural industry. Most of the birds take a heavy toll from the insect kingdom. If there would have been no birds, the insects would have multiplied in geometric progression and human life would have been impossible. The ornithologists have estimated that a single pair of birds with their progeny destroys 150 million insects per annum. A single pair of potato bugs, without any check will multiply in one season to about 50 million while a couple of rats increases to 800 in a year. If there would

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have been no check on this tremendously increasing population of insects and pests by birds, one can imagine what would happen to the weary human life!

Besides this, the birds also play several other roles which are not of less importance to the agriculturists. They act as scavengers. Kites and crows clear off the carcasses of cattle. They dispose off the dead and decaying matter which putrifies and befouls the atmosphere. Their services are highly valuable during the outbreaks of cattle epidemic.

Bees and butterflies are not the only creatures who can boast of being the pollinating agents. Birds also render appreciable services in this aspect. Many a bird possesses special adaptations in the structure and mechanism of their bill and tongue. Silk cotton tree, which is specially used for match industry, is pollinated mostly by birds. The flowers of coral tree which is grown for shades in tea and coffee plantations are chiefly fertilised by birds.

In dissemination and distribution of seeds, birds play a prominent and a predominant part. Mulberry and loranthus are mostly propagated by birds. Bulbuls and barbets are largely responsible for dissemination of Sandal Wood in southern India; and at present the experiments have shown that the seeds of plants, after passing uninjured through a bird's intestine, produce stronger plants than those without such a passage.

Birds themselves serve as a food and supplement the menu in many an Indian home. This is an important source of food in these days of food shortage. Innumerable species of birds are shot and sold in the markets which yield substantially for the sustenance of those engaged in these trades.

There are other industries too, depending on the birds. Ergret farming was a profitable cottage industry for precious plumes and was largely practised in Sind. The pretty plumes of these birds were largely exported to the West for ladies' head-dresses, tippets, boas, muffs and other ornamental purposes. At present, the demand has dwindled due to the change in fashions. Guano—the excreta of seabirds on the coasts of Peru—is used as a manure and is a commercial product today.

Thus the birds protect our crops from insects and pests. They act as scavengers. They serve as pollinating agents. They also help the dissemination of seeds. They serve as food. They yield precious plumes and valuable guano. Considering all these, we can definitely state that the birds are rendering multi-fold agricultural services which outweigh the little damage they cause. They are not foes but faithful friends of the farmers. The bird kingdom is a blessing to them by the Almighty.

In addition to all these agricultural and the materialistic aspects, the birds give us mental pleasures. Watching the birds is a pleasant hobby. The grandeur and the splendour of their features and colour, the sweetness of their songs uttered in courtship display, allure and entice us leading us away from the worry of our world.

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*Reference* :—"Indian Birds"—By Salim Ali.

# Cacao Bean Husk as a Cattle Feed.

By

N. G. PERUR ‡

Fairly large quantities of cacao bean are being imported into India during the last few years for the manufacture of cocoa and chocolate. The cacao bean possesses a shell and a ton of bean yeilds about 300 lbs. of this shell on dehusking. In foreign countries, this husk is valued for its oil, colouring matter, theobromine and essential oil. But in India, for want of equipment, the shell is finding no use and is treated as a waste to be burnt in the boilers. It was thought that the cacao husk could very well be used as a scarcity cattle feed and the present investigation was undertaken.

**Food value of cacao bean husk** :—The proximate analysis of the cacao bean husk is given in table 1 below. The analysis of some of the common cattle concentrates like cotton seed cake, wheat bran and *tur chuni* are also given for comparison.

**Table 1**

Analysis of roasted cacao bean husk*

| | Cacao bean husk | Cotton seed cake | Wheat bran | *Tur chuni* |
|---|---|---|---|---|
| | ( Percent on air dry sample ) | | | |
| Moisture | 6·50 | 5·30 | 7·90 | 7·20 |
| Ash | 7·35 | 5·70 | 4·80 | 7·50 |
| Oil | 5·89 | 4·60 | 4·00 | 3·60 |
| Fibre | 17·05 | 24·30 | 11·85 | 12·15 |
| Proteins | 14·00 | 20·50 | 14·43 | 18·37 |
| Carbohydrates | 49·21 | 39·60 | 57·02 | 51·18 |

( *Sample collected from Sathe Biscuit Factory, Poona )

The composition of the husk varies with the variety, method of fermenting the beans and degree of roasting the beans. The analysis shows that the husk is similar to wheat bran in its nutritional value.

‡ Lecturer in Agricultural Chemistry, College of Agriculture, Poona 5.

**Feeding trials :**—There is no record of cacao bean husk having been tried as a cattle feed in India. Preliminary trials showed that cattle do not relish the husk in the beginning for a few days due to its strong odour. But they get used to it within a week or so. The husk moistened with salt water was relished by the cattle. It may also be mixed with molasses of the sugar factories. Good results have been obtained on experimental farms abroad by feeding cattle with cacao husk; the animals thrive on the diet and put on weight, a definite increase in amount of cream in milk and quantity of milk was also found with miltch cattle. *

The shelling percentage of the cacao bean husk is about 15. One ton of cacao beans, yield about 300 pounds of husk as a waste product. As the husk occupies a large space in the factories, the proprietors will be glad to dispose off this bulky waste product free or at a nominal price. The husk being bulky it may not be convenient for handling and transportation. This difficulty can however be overcome by pressing the husk into cake with some edible adhesives like molasses.

**Summary :**—Cacao bean husk which is an industrial waste product has been shown to possess a good potential food value as a cattle feed. Though it cannot replace any of the present feeds, it serves as a scarcity feed during famines and to supplement the present cattle ration in the urban areas.

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* Cocoa and chocolate, their chemistry and manufacture; by R. Whymper–1912 : 193

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— The Western Australian Government has decided to sponsor a scheme for producing synthetic rice from wheat. The process consists of washing and cleaning the grain with repeated steamings at a pressuse of 20 lbs per square inch to distill off fatty acids and to remove the wheat flavour and aroma. The wheat is then vacuum-dried so as to case harden the individual grains. The husk is then removed in an ordinary rice mill and the product is ready for packing.

The synthetic rice has certain advantages over genuine rice. Being hard it is resistant to weevils. It does not go rancid quickly; and it has almost the same vitamine content as wheat. It is estimated that when the scheme begins to operate fully 51, 600 tons of synthetic rice will be prepared from 79,000 tons of wheat. This will also yield 2, 400 tons of ordinary bran and 15,000 tons of high quality cooked bran. It is stated that the rice thus produced will have a ready market in India, Pakistan and other far eastern countries.

— Agricultural News letter
(Release No. AGN/267)

# Insects in Relation to "Grow More Food Campaign"

By

A. K. B. Cazi *

From economic point of view insects may be classed into three categories viz.: (1) useful insects (2) beneficial insects and (3) harmful or injurious insects.

Useful insects are those that carry on useful activities so far as humans are concerned either by producing useful products such as honey or doing useful service such as acting as pollinating agents or scavengers or aiding the formation of humus in the soil. Beneficial insects are those that suppress the multiplication of injurious insects acting either as parasites or predators. Harmful insects are those that do damage to the crops or stored products or affect the life and health of human beings and their live stock and by acting as carriers of diseases.

It is generally recognized that one of the best pollinating agents is honey bee and the orchard owners in the Western Hemisphere purposely stock their orchards with domesticated honey bees which, besides being a fruitful cause to increase the yield of fruits to an appreciable extent, also yield an economic food product which goes under the name of honey.

The following extract gleaned from the bulletin " Dominion Experimental Farms in 1947—Annual Report of the Director Canada Department of Agriculture "—shows to what extent there are potentialities to increase the yield of seed through increasing the number of honey bees by the establishment of apiaries.

" In the fall, the clover from all areas was harvested and seed yields determined. These were as follows:—

*District in which honey bees were abundant.*

| | | |
|---|---|---|
| Honeybees only in cages | Average seed in lb. per acre | 230·9 |
| No bees in cages | Seed in lbs. per acre | 5·3 |
| Open pollination | Seed in lbs. per acre | 371·2 |

* Deputy Director of Agriculture (Manures & Firtilisers), B. S., Poona 1.

*In a district where there are no honey bees.*

| | | |
|---|---|---|
| Honeybees only in cages | Seed in lb. per acre | 122·7 |
| No bees in cages | Seed in lb. per acre | 8·1 |
| Open pollination | Seed in lb. per acre | 74·6 |

The above figures show that where pollinating insects were excluded the seed set was practically nil; also that heneybees alone performed more efficient work than where only wild bees had access to the clover. The greatest yield of seed, however, was obtained where both wild and honeybees worked the clover together."

On an average it is estimated that harmful insects normally damage the crops and trees to the extent of not less than 10%. But in several cases entire crops are ruined. Most of the diseases known are transmitted by insects thus causing enormous economic loss to the human beings. Fortunately, of late, we see a number of reliable and efficient insecticides which have given promise to deal effectively with the scourge that injurious insects bring. D. D. T. is one of such insecticides which is a marvel of the recent days being the miraculous cure of the insect pests. However, if it kills insect pests, what guarantee is there that it may not kill also the useful or beneficial insects? If it kills the insects of the latter category also then there is every chance of its being an additional scourge of the worst type rather than a boon.

But fortunately for us foreign workers in the field of scientific research were alive to the needs of carrying on conclusive tests. In fact the very phenomenon of the insect killing activities by sweeps of D. D. T. made the bee keepers of the fruit growing areas in the West alarmed as to the effect this particular poison might have on their bees.

The scientific workers after carrying on elaborate experiments in succession have now come to the conclusion that beyond doubt under normal field conditions D. D. T. is not harmful to honey bees (Canada Department Agriculture–Dominion Experimental Farm in 1947—Annual Report of the Director).

Honey bees belong to the insect order Hymenoptera. In this order there are many genera of insects which carry on useful work of pollination. A vast number of parasitic or benificial insects also belong to this order.

If the nature of the insects that may be peculiar to the order be responsible for giving protection against the poison then it seems we are definitely to be thankful to DDT which is one of best weapons in the cause of "Grow More Food" Campaign.

# "Lazy Acres" Can Yield far More Food *

By

JAY RICHTER

There is new hope among men who know the land that within the lifetime of most of us we can dispel the ghost of the English economist, Thomas Robert Malthus, who 150 years ago envisaged a world in constant misery and want because it could not produce enough food to match the rate of population growth. Although this dim Malthusian outlook still might be valid if we fail to solve formidable problems of distribution. the production of enough food for all peoples is now possible through widespread application of modern technology. America's recent production record provides a measure of what can be accomplished elsewhere, since the vast land area of the United States includes a wide range of soils exposed to a variety of weather and other growing conditions.

In the 70 years prior to 1940, America's acre-yield of major crops increased little, if any. Since 1940, crop productien per acre has increased by approximately 30 percent. Reduction in the rate of soil loss, and reinvigoration of deteriorated soils, are two of three major reasons why the production stalemate has been broken. The third is the fact that more producers have adopted improved technology, a trend hastened by wartime and post-war production imperatives and good farm prices.

These gains may look small 10 years from now. Food production in the next decade can be increased by 50 percent, or five times our expected population growth of about 10 percent, in the view of many conservative agricultural scientists. Their rosy outlook is prompted in large measure by a revolutionary new approach to crop production research which is resulting in truly amazing increases in yields. The scientists sum it up in the phrase "the proper integration of all production factors." That means, as one of them explained, "working cooperatively with individual farmers under ordinary farm conditions," and trying several new techniques at varying rates and in different combinations.

Adoption of the integrated production technique for specific crops rules out the traditional approach to agricultural research known as the "single factor"

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* Reprinted from "The New York Times" taken from "American Newsfile —Agriculture Supplement", 50-A-7 of 5th April 1950.

concept. This theory holds that only one new production practice should be tried at a time, preferably in a hothouse atmosphere where other factors can be held rigidly constant. That notion now belongs with the manpowered plow, and inevitably will be abandoned even by the agricultural experts still in the thrall of their own speciliaties.

A direct comparison brought this lesson home to researchers at the State Experiment Station in Raleigh, in the state of North Carolina. Single-factor experiments were carried out in plots adjoining one where the combined approach was used. In the first plot, a hybrid corn variety increased yields 14 bushels an acre above the 27—bushel average; in the second, extra heavy doses of nitrogen brought a similar increase; in the third, where the number of plants per acre was increased, yields fell almost 12 bushels below the average. Totaling the two increases and subtracting the decrease gave the scientists a theoretical gain of about 16 bushels. That is the result they expected in the fourth plot, where all three practices were tried in combination. Actually, the increase was 50 bushels above the 27–bushel average. In a similar trial, yields bounded from a 20–bushel average to an incredible 120 bushels In the state of Mississippi improved corn production techniques, when tried separately, added up to a theoretical gain of 40 bushels per acre. When the practices were combined the increase was 61 bushels. Two conclusions were abundantly clear: (1) A single crop practice may increase yields, but production can be pyramided when several practices are used together in the right combination; and (2) A single practice, although it reduces yields in a sole trial, may actually bring substantial increases when combined with others.

Conrad H. Parker, a farmer in the American South who cultivates about 70 acres in the state of North Carolina, is a typical example of the new approach. Four years ago, he brought in a corn crop which was the biggest surprise of his hard-working life. One of his 25 acres planted to corn had outyielded the others by at least three to one.

Parker's surprise was freighted with considerable chagrin because of the indifferent reception he had given Dr. Bert Krantz, soil research scientist at the State Experiment Station, Raleigh, North Carolina, before planting time the previous spring. Dr. Krantz had persuaded Parker, against his judgment, to apply to his 75-bushel-acre production practices which did violence to techniques evolved over 150 years by the best farmers in the area.

"I thought Dr. Krantz was out of his mind," Parker admits today, "but in 1946 and 1947 we got 90 to 100 bushels to the acre over the whole farm."

Parker was not the only farmer in North Carolina who gave up the traditions of his forefathers. Some 350 other farmers in the state discovered they

were in possession of a gold mine whose resources are renewable. Ten thousand of the state's farmers, since converted, are now producing corn at more than triple the pre-1945 rate. By 1948, more than 50,000 farmers throughout the southern states of Alabama, Georgia, Mississippi, North Carolina, South Carolina, Tennessee and Virginia had applied the new techniques. Their yield has been quadruple that of average yields throughout the area for the 10 years, 1935-44.

When he visited Parker, Dr. Krantz was bringing with him considerably more than his own specialized knowledge of soil types fertilizer and plant spacing. He was also offering the plant breeder's knowledge of new varieties; the agricultural engineer's knowledge of new equipment and fertilizer placement, and the agronomist's knowledge of weed control and other cultural practices.

Further trials in the state of North Carolina have produced results with oats, wheat, and soybeans similar to those achieved with corn. The techniques and combinations vary, the principle remains the same. Larger crops foreshadow an expanded livestock production, currently the major objective of American agricultural policy makers.

Improvement and increase of forage production in the southern tests indicate that production of dairy products could be doubled throughout the region. By use of the new approach in management of pastures, beef production has been increased as much as 150 percent.

The new approach also is catching on outside the American South. In nine tests with soybeans in various states, yields were increased threefold. In the midwestern state of Iowa, one farmer produced an astronomical 224 bushels to the acre. In the Pacific Coast state of Washington, researchers found that heavier irrigation alone reduced potato yields by 24 bushels per acre,but that more water, in combination with nitrogen, brought yields up to 522 bushels per acre compared with a normal 392. In the western state of Utah, 13 tons were added to normal 16-ton yields of sugar beets.

In a corn experiment on irrigated land in the Pacific Coast state of Oregon, extra water brought a four-bushel gain; a normal water supply, with nitrogen side dressing, added 41 bushels. When the two practices were combined, however, the normal yield of 52 bushels was increased by 80 bushels per acre.

In most other countries, American agricultural scientists believe, a wide spread application of the modern technology on land already being cultivated could increase world food production by 25 percent within five years at a conservative estimate. Total world food supplies are still tragically short of needs, but we are making some progress toward closing the gap. American hybrid corn

*varieties, planted in Italy's Po Valley, are increasing yields by approximately 40 percent. Eventually, this project may become an important factor in expanding livestock production throughout the whole of Europe.*

There is an unprecedented rate of exchange among the nations of technical agricultural experts. American officials report that other nations are drawing heavily upon the ability of U. S. farm experts to put their knowledge to work on the land. Materials for insect and disease control, seeds, and planting stocks of proved superiority are important items in world commerce.

Increasing food production in underdeveloped areas is a formidable task depending upon solution of complex social, economic, and political problems, but we can start at once to do some things: expand fertilizer manufacture; start a few more irrigation projects in the most promising areas; and prepare the way for hydroelectric projects, especially in the tropics where potentialities for power are promising.

North of the temperate region in northern Eurasia and northern North America, there are at least 300,000,000 acres which could be developed for successful dairying and vegetable production. Of far greater importance are great areas in East Africa, South America, Central America, Southeastern Asia, and the Pacific islands. Altogether, it would be possible to increase by approximately 40 percent the 3,000,000,000-acre land area now under cultivation throughout the world, according to estimates of the United Nation Food and Agriculture Organization.

Application of modern technology on new lands, plus production increases in sight on land now under cultivation, would provide more than enough food for the estimated world population in 1960. It comes to this: man himself now may choose whether he is to have an adequate diet.

# NIRA

By

L. M. CHAVAN, B. Sc. (Agri.) class

Now that total prohibition is in enforcement in Bombay State and the Government is sponsoring the use of Nira as a health giving drink and as a cheap source of some valuable by-products, it is worth-while to know what exactly is meant by Nira. This word Nira has been derived, it is said, from the *sanskrit* word " नीर " ( Neer ) which means water It is a sweet sap given out by some sugar palms viz. cocoanut, wild date, palmyra, Indian Sago etc., when fresh. It is a colourless, pleasantly smelling, sweet liquid totally harmless to the human constitution. It does not produce any intoxicating effect But if it is kept as such for a length of time fermenting process sets in, converting it into a milky white fluid, called toddy, which contains about 5% alcohol.

Cocoanut palms grow best in humid and temperate regions and, therefore, dry inland tracts are not congenial to their growth. The life span of a cocoanut palm is more than 100 years and it can be tapped after 7 or 8 years. In India cocoanut palms grow luxuriantly all along the southern strip of its coast.

Wild date palms are found growing all over India, but they thrive best under humid climatic conditions and also in some other parts of Maharashtra. Its life span is 40 to 50 years and it can be tapped after 4-5 years.

Palmyra palm grows in low lying sandy areas and its life span is more than 100 years. It bears inflorescence at the 10th year of its growth when it becomes fit for tapping.

Sago palm is found in a wild state on mountains though it can also be cultivated. It reaches the tapping stage after 15 to 20 years. It is found in Thana and Kolaba districts and parts of Karnatak.

The process of extraction of the sweet sap from these sugar palms is termed as tapping. The process gets this name due to the peculiar sound made by the palm scathe while the process is going on. There are four different methods of tapping:—1. Wardha process. 2. Bengali process. 3. Surti process. 4. Telgu process.

The basic principle remains the same in all the above processes with only slight variations. Of the above processes the Bangali process is regarded as the best. Tapping, which is a skilful process, consists of cutting the top most tender part of the palm.

**Tapping of cocoanut palm :**—Generally fruit boaring palms are selected for tapping. The tree is usually tapped on either eastern or western side, though this is not a general rule. Some superstitious tappers think that the sliced part dries up if tapping is done on southern or northern side. The portion to be tapped is first cleared off taking care not to remove the leaves on the other side. The slicing is extended upto the inner core after which the tree should be given a sufficient rest to recoupé. When the tree is sliced again, it should be rested further for a period of 8 days. After this slicing is carried on at regular intervals, Nira trickles down from the tip of the slice and a sufficient quantity of Nira is collected in earthware pots attached to the tree. Pots should be kept very clean and should be sterilized by heating. To prevent the Nira from being absorbed by the porus earthenware pots, use of lacquered pots is highly advisable. Tapping can be carried out all the year round. It is observed that the yield of Nira is very low in October and November while it is maximum in May a ndJune and, therefore, it is desirable to commence the tapping in the month of April. Though Nira can be collected at any time of the day or night, it is generally collected early in the morning at about 4 to 5 A.M.

Date palm trees can be tapped for three months only while other palms can be sliced thrice in a day. The date palms are sliced only in the evening. If tapped on alternate days it yields 200 lbs. within 90 days.

Palmyra palm is dicœcious and both male and female palms can be tapped once they put forth the spathes, which enclose the inflorescence of the palm. In female palms Nira is tapped from the spathe and also from the inflorescence, whereas in case of the males it can be tapped only from the spathe. The spathes when fully grown are cut and beaten with a wooden baton when Nira begins to drip out. Flowering stalks are also fit for tapping. The slicing of stalks should be done at regular intervals. It is said that tapping improves the quality of the fruits produced by the palms. Palmyra palm puts forth spathe twice a year and spathes put forth in hot season give more yield. In a season of 3 to 4 months it yields 300-350 lbs. The duration of season varies in different localities. Generally male plants are tapped from October to December and female plants from December to February.

A Sago palm is not easy to tap as it requires more nursing. However, when tapped the process followed is the same as in the case of either a cocoanut or a palmyra palm. The spathes are long and are pendulant like the elephant trunks. The palm puts forth the spathe in summer and yields Nira for as long as 10 months. The maximum yield is obtained from November to April.

**Fermentation :**—The sweetness of Nira is due to its sucrose content. If Nira is kept as such for a length of time, fermentation sets in due to the activity of micro-organisms and sucrose is converted into alcohol. Addition of some tincture makes it more alcoholic.

**Preservation :**—Nira is very susceptible to alcoholic fermentation and is turned quickly into a milky white fluid known as toddy. Therefore, to hinder this process of fermentation and thus to preserve Nira for a longer time some preservative has to be added to it. A common preservative used is lime, which keeps Nira in good condition for a period of about 12 to 18 hours. A stronger preservative is being searched out so that Nira can be preserved even for a much longer time than this.

A solution of slaked lime in water is added to the pots before suspending them on the palm trees. It should be somewhat thick in consistancy and should not go dry. The quantity of lime should be proportional to the quantity of Nira to be collected in the pot. Lime has a double chemical action over Nira which helps to preserve Nira; firstly, lime disolved in water gives calcium hydrate which is highly disinfectant and secondly, lime neutralises the acidity which inhibits the activity of alcohol forming micro-organisms. If the lime goes dry it becomes calcium carbonate which, however, has no disinfective action. If this practice of adding lime is followed Nira may be safely collected at any time of day or night. On very cold nights Nira may be taken without adding lime.

To remove the lime from Nira prior to use, it is strained through a piece of cloth or preferably through a wire guaze. Nira is then allowed to stand for some time so that small lime particles in suspension may settle down at the bottom of the container and then the clear liquid at the top can be decanted. Nira should be strongly alkaline if it is to be used as a beneficial drink. Nira gets an alkaline taste due to liming which, however, can be slightly modified by adding a phosphatic solution when Nira is being heated for sterilization. Some people regard heating of Nira as undesirable as it mars its natural taste.

Formalin (40% solution of fomaldehyde in water) is very effective in preserving Nira, but it requires to be used most judiciously as it is poisonous to the human system. Nira when taken fresh is a colorless, sweet tasting beverage with a high nutritive value as will be seen from its composition.

**Composition of Nira.**

| Obtained from. | Moisture. | Carbo-Hydrates. | Proteins. | Fats. | Ash. |
|---|---|---|---|---|---|
| Cocoanut Palm. | 84·2 | 14·35 | 0·1 | 0·17 | 0·66 |
| Date Palm. | 87·2 | 11·28 | 0·2 | 0·02 | 0·24 |
| Palmyra Palm. | 86·1 | 13·20 | 0·3 | 0·02 | 0· 4 |
| Sago Palm. | ——————————Do—————————— | | | | |

Nira contains vitamins "C" which is useful in preventing tooth-decay and affections of the spinal cord. It is specially useful to women in pregnancy and lactation. Nira is recommended by the doctors for diseases like scabis, jaundice, anaemia and even for tuberculosis. Consuming large quantities of Nira does not bring about any undesirable effect. Nira is not habit forming. With every cup of Nira you take in a small quantity of lime, not more than what you use in pan. This lime is also useful to the body. Nira itself will be a good substitute for milk of which we have not a sufficient quantity to go round.

**A New Cottage Industry :**— As stated above, Nira consists of sucrose and, therefore, when Nira is boiled to a high temperature, and is allowed to cool it solidifies to form palm-*gur* or jaggery. Palm gur is crystaline and is of attractive colour. It contains calcium, magnesium, phosphorous and sulphur. Vitamin C found in Nira is retained in the *gur* too. The process of manufacturing palm-*gur* from Nira is simple and can be picked up easily. It requires small investment, simple and handy tools and simple technique. Palm *gur* manufacture will be a cottage industry in days to come which will surely help to redress the grievance of the unemployed *toddy* tappers. Also if this national wealth were utilised for drawing Nira and producing *gur*, annually 10 lakhs of tons of palm *gur* can be produced and it will help the Government in its 'Grow More Food Campaign' by making more land available to grain crops which at present is under sugarcane. Sugar, ice cream, toffee, biscuits and delicious sweets are also made from palm gur. Thus, it is possible to turn this gift of nature into wealth instead of waste.

It is, therefore, quite in the fitness of things that our new Food Minister, the Hon. Shri K. M. Munshi, should have considered the cultivation of trees as essential for India's self sufficiency in food and, therefore, promulgated the idea of celebration of a Vana Mahotsava on a nation wide scale.

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— T. Stephanides, reporting in The Lancet on some of the native remedies used by the Greek peasants, cites two remarkable cases in which the application of cow dung to deep abdominal wounds with protrusion of the intestines was followed by complete and uneventful recovery. In both cases, one a soldier suffering from a shell wound, the other a farmer who had been gored by a bull, bystanders had placed sacks of fresh cow dung on the abdomen to hold back the intestines and on the physician's arrival, the peritoneal cavity was filled with liquid manure. The cure resulting in these seemingly hopeless cases recalls the fact that in India cow dung is regarded as a potent remedy against many diseases and the author concludes that " this subject might repay further investigation. Antibiotics have been extracted from the soil and from various moulds; it is not impossibe that they could be isolated also from cow dung with its vast and little-known micro-organic fauna and flora. "

— From, American Practitioner,
Volume 1, Number 3, Page 52.

# Agriculture and Public Welfare

By

MOTI K. MOOLANI *

In the context of our present food position there is no doubt that the top priority has to be given to the intensification of campaign for growing more food by improved methods of agricultural practices.

The emphasis must now be more on technical and scientific education without which production cannot be increased in quantity, quality or speed. Now that India is free the freedom which we have won will be meaningless if the main problems of our poverty, ignorance and scarcity are not solved. The future of India depends on agriculture which is now carried on by poor peasants But the peasants are uneducated, under-nourished and illclad and carry on a miserable life to keep body and soul together. Black market, jobbery, favouritism and nepotism will be nipped in the bud when the agriculturists will be educated. Poverty can only be removed when the tiller of the soil is relieved from the continuous chains of pinches, tortures and troubles of cruel money lenders. Ignorance can be removed by opening ideal institutions where they may be instructed and educated to some extent. Scarcity can be wiped off by improving agriculture by methods of technical and scientific education.

The urgent need of today is to produce more of material things so that there will be a better standard of living available. There is enough material but technological progress is very slow in India and technical personnel is inadequate.

The institution of an "Extensive Service" to educate the farmer in improved methods of farming and to secure his whole-hearted co-operation in food production schemes, should receive due emphasis. Land reclamation, development of fisheries and awards of prizes to enterprising cultivators are the means of increasing food production in India. The surplus food grains available in certain parts, should be made available to under-nourished countries at special prices.

The various suggestions for better education should also be brought into practice. The prevailing atmosphere in the state educational institutions is

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unpleasant and unhealthy. It can never be changed merely by expressing pious wishes for a change. The first step for bettering education is that there should be a teaching university. It is necessary next to improve available accomodation in hostels, to reduce tuition fees and to provide for better libraries. Better facilities for practical work for research workers should be made. The college teachers must be given better status, a generous scale of pay and residential quarters so that their mind and soul can be concentrated in technical improvements only. At present the teaching staff are living in conditions of squalor and misery. The university must enjoy a wide measure of autonomy if it is to fulfil its functions as a training ground of character and initiative.

There should be a " moral incentive " for those engaged in the process of production. That is, the confidence that what they produce should be fairly and equitably distributed. This confidence when diffused throughout the social life will bring about an early progress.

Co-operation which forms the basis of a new social order is a movement for economic self-help. The economic structure in a progressive democracy depends solely on co-operative movement. It is through co-operation that every citizen can render some service to his neighbour and to his country. If the national economy is to be stabilised, then we should see that the gulf between the producer and the consumer should be minimised if not eliminated.

In India there is no dearth of land and man-power but the difficulty is that of proper coordination between the two. If there is real coordination, India would solve her food problem much earlier than expected.

It is a standing grievance of the farmer that he never gets all the vital things needed to raise a good crop. Sometimes there is a lack of implements or suitable well decomposed manure. At other times it is the absence of willing workers. Agricultural labour today is restive and becoming more costly.

The cultivators should be induced to increase production of food by awarding prizes to individual cultivators who produce the highest yield per acre. Application of night soil manure should be practised as is done in West-Khandesh District and its importance for food grains should be stressed intensely. Intensive cultivation should be resorted to by supplying in time fertilisers, manures, implements and seeds to royts. The agriculturists both in India and China are illiterate but those in the latter country get from the fields three times as much as those in the former ones and the reason for this is that the Chinese people return to the soil an equivalent of all that they get from it, in the form of manure.

India's real power and strength do not lie in machinery but in her man-power. She will not have to do much more if she could organise her vast natural resources and her huge man-power. The river valleys should be surveyed to find

suitable places for lift-irrigation, and electric pumps should be installed wherever possible. Mechanical equipment such as Diesel pumping sets should be proposed and facilities for clearing the jungles should be given. Provisions for opening health units, and establishments of inter-village communication should be made promptly.

Improved transport system and increasing yield of food are corelated to a great extent. An improvement in the present inadequate transport system of the country is vital to increase production. The roads should be improved and Transport Development Associations should be formed. The land can yield food and industrial raw material wherever means of access to it and facilities for the movement of men and material are in existance. But no economic activity is possible if such facilities are absent. The primary means of transport are everywhere but it is only when every acre of fallow and uncultivated land in the country has a road to serve it that the cultivators could be induced to put it under the plough. Mere paper schemes will be of no avail if the effective machinery to put them into operation is not built up with well qualified technical personnel.

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— The Soil Survey Service of the United States Department of Agriculture has so far published soil maps, and reports on 1,300,000,000 acres of land in all parts of the United States. These maps and reports are of considerable value to the farmers as they help in determining the suitable crops and cultural methods which will be ideally suited for their type of soils. They also include information as regards the response that a particular soil would give to different farming practices. These maps are prepared in multicolors by skilled draftsmen and printers and show the soil pattern of entire country at a stretch. Each house and road is clearly shown thereon to enable a farmer to easily locate his field over it. The report gives precise information as regards the type of soil,its acidity or alkalinity, its tendency to erods and also as regards some other important features of the soil. The technique of plotting of such maps has considerably advanced recently and now surveys for this purpose are made by photographic methods.

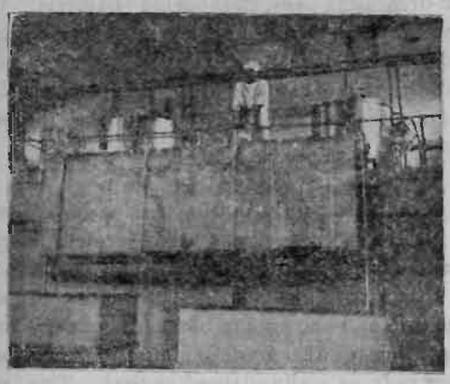
Similar work has been undertaken by some other nations under the guiding stimulus of U. S. A. Also the U. S. Soil Survey Service is now compiling a composite map of the soils of the world, with a view to increase an intercourse of knowledge between the different nations

— A. N. F. Dec. 14, 1949.

# More and Pure Milk

By

SHIRISH G. WASANI B. SC. (Agri.) class



*(1) Pasturising and cooling plant—the milk is heated in the pasturising vessels for half an hour upto 60° C. It is then suddenly cooled by passing through the cooling plant. The capacity of each vessel is 1700 lbs.*

Milk is considered a perfect food for the young ones of the mammals. It is necessary to have some sort of animal products in our diet. This is especially required for the population of India where most of the people are vegetarians. The only animal product that such vegetarians can take is milk.

Milk supplies the required nutrients for the proper building of the body. It contains valuable vitamins and most of the mineral matter. According to the latest statistics the per capita consumption of milk and its products is about 3 oz. per day in India whereas for balanced feeding one pound of milk per day is required in human diet.

Cattle population is not low in India. It is felt that the milk produced by our animals is low. The cattle do not produce sufficient milk even for their young calves. The defect lies in the proper breeding and feeding.

With the growing population of India, there is not enough food for the human beings and it is not possible to set apart any food or land out of the total available for the cattle.

The problem of feeding the cattle efficiently with a view to increase the yield of Milk is very difficult under the present circumstances but the question

can be tackled firmly by discarding the useless stock and breeding only the good animals. The available grazing area if properly managed by trenching and afforestation will supply sufficient grass for the cattle.

The question of housing and management of the animals is also as important as the feeding. This could best be done in the forest areas. The animals should be kept in clean and hygienic byres. The milking of the animals should be done in clean places and by clean labour. The milk produced in this way should then be sent for pasteurisation.

Milk is an easy prey to the micro-organisms and pathogenic bacteria. It is extremely important that the milk should be free from any harmful organisms before it is consumed. Modern methods of pasteurisation effectively destorys all the harmful organisms, and with this, additional advantage, the composition of milk is not materially altered. The characteristic cooked flavour and the formation of scum is also avoided by this process.

The question of supply of pure and harmless milk in the cities of India has become very disturbing and complex. Before the big cities were formed there was sufficient milk available in the rural areas. With the migration of people to cities and industrial centres the milking cattle have also migrated to these centres. This has resulted in the neglect of cultivation and the supply of useful manure to the cultivated areas and the loss to breeding is also great Manure from the animals kept in the cities is all wasted or only partially utilised as fuel. This has made the agricultural lands infertile.

In textile industry, just as cotton the basic raw material is not grown in the cities where most of the mills are built, similarly milk should not be produced and cattle should not be kept in the cities. This will keep up the fertility of the land and the cities will keep cleaner also. The transport of cattle and cattle feed will also be saved. Milk alone should be transported from the rural areas to the cities. The transport of milk is cheaper as it requires comparatively less space for transport.

The English and American cows are well known for their yield of milk. Efforts have been made to introduce foreign cattle in India but it has been found that they do not get acclimatised and they deteriorate in the yield here. Attempts were also made to cross the Indian cows with foreign breeds but the results are not very encouraging in as much as in the first few generations the yield was good but later on the yield deteriorated.

# College Notes and News

The Gymkhana activity started with the election of the offiice bearers held on 9th June 1950. There was a keen contest between a large number of candidates for the different posts. The following people were elected.

(1) Hon. Gen. Secretary for Social Gathering. Shri A. F. Rego.

**Gymkhana Managing Committee**

| | | |
|---|---|---|
| (1) | Hon. Gen. Secretary for Gymkhana | Shri U. R. Pawar |
| (2) | Hon. Secretary for Cricket | ,, V. G. Jhala. |
| (3) | ,, ,, ,, Tennis | ,, M. H. Gursahani. |
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| (5) | ,, ,, ,, Foot-Ball | ,, * D. S. Patil. |
| (6) | ,, ,, ,, Athletics | ,, K. M. Mahajan. |
| (7) | ,, ,, ,, Indian Games & Gymnasium | ,, S. N. Dharu. |
| (8) | ,, ,, ,, Minor Games (Indoor) | ,, M. B. Rana. |
| (9) | ,, ,, ,, Minor Games (Out door) | ,, M. Manohar Rao. |
| (10) | ,, ,, ,, Reading Room | ,, P. V. Salvi. |
| (11) | ,, ,, ,, Agricultural Association and Debating | ,, K. G. Agaram. |

**College Magazine**

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| (2) | Junior Editor | ,, R. S. Savant. |
| (3) | Senior Manager | ,, L. M. Chavan. |
| (4) | Junior Manager | ,, V. D. Vaidya. |

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We offer our hearty congratulations to the electees. All Secretaries of the various departments have started their work with great enthusiasm and are working hard in the interests of the College.

(* Left College in July. Shri. A. I. Faria is appointed in his place.)

**U. R. Pawar**
Hon. Gen. Secretary,
Agri. College Gymkhana, Poona 5.

# Appointments & Transfers

**Class I appointments.**

| | | |
|---|---|---|
| 1. | Dr. H. R. Arkeri, B.Ag., M.Sc., Ph.D. | Professor of Agronomy, College of Agriculture, Poona. |
| 2. | Shri G. B. Patel | Cotton Development Officer, Surat. |

**Class II appointments.**

| | | |
|---|---|---|
| 1. | ,, S. D. Kololgi, M. Sc. (Agri.), M. S. | Assistant Horticulturist to Govt., B. S., Poona. |
| 2. | ,, N. Gopalkrishna, B. Sc. (Agri.), M S. (Ill). | Officer i/c Nucleus Seed Scheme, Poona. |
| 3. | ,, M. B. Patkar, B. Sc. | Plant Breeder and Officer, i/c Rice Breeding Station, Karjat. |
| 4. | Dr. G. B. Deodikar, B.Sc., LL.B., Ph.D. | Plant Breeder and Officer, i/c Cereal Breeding Station, Niphad. |
| 5. | Shri M, S. Pandya. | Superintendent, Agricultural School, Baroda. |
| 6. | ,, S. G. Patil. | Superintendent, Agricultural School, Kolhapur. |
| 7. | ,, K. L. Shiggaon. | Professor of Veterinary Science, College of Agriculture, Dharwar. |
| 8. | ,, V. S. Abhyankar. | Biochemist, Fruit Products Laboratory, Poona. |
| 9. | ,, S. K. Patil. | Soil Survey Officer, Soil Extension Section, Sugarcane Development Scheme, Padegaon. |
| 10. | ,, G. M. Talgeri. | Crop Protection Officer, i/c Organisation of Crop Protection Service, Poona. |
| 11. | ,, N. A Phandnis. | Superintendent, i/c Banana Research Scheme Kopergaon. |

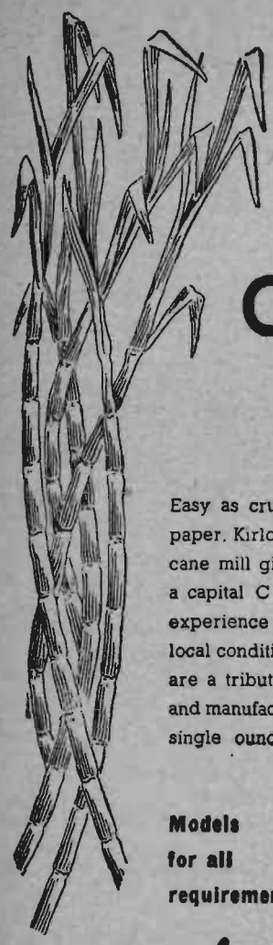
**Soil Conservation Section.**

| | | |
|---|---|---|
| 12. | ,, G. V. Patel, B. E. (Bom.) | Divisional Soil Conservation Officer, Baroda. |
| 13. | ,, H. V. Rajmane, B. Sc. (Agri.) | Sub-Divisional Soil Conservation Officer, Satara. |
| 14. | ,, S. P. Patel, B. Sc. (Agri.) | Assistant Land Utilization Survey Officer Baroda. |
| 15. | ,, E. L. Zopay, B. Sc., (Agri.) | Assistant Land Utilization Survey Officer, Poona. |
| 16. | ,, G. B. Bagul, B. E. | Executive Engineer, Lift Irrigation Division, Bijapur. |
| 17. | ,, S. M. Bhide, B. E. | Deputy Engineer, Lift Irrigation Sub-Division. Bagalkot. |
| 18. | ,, V. M. Desai, B. E. | Do Broach. |
| 19. | ,, M. R. Ghodhe, B. E. | Do Nasik. |
| 29. | ,, R. B. Bhosekar, B. E. | Do Pandharpur. |
| 21. | ,, S. T. Dange, B. E. | Technical Assistant to the Joint Director of Agriculture (Engineering), Bombay State, Poona. |
| 22. | **Vacant.** | Deputy Director of Agriculture (Eng.). |

---

The readers are requested to please read line No. 32 on page No. 63 in the Poona Agricultural College Magazine, Vol. 41 No. 1 of June 1950 as follows :—

(114) P. R. Joshipura, Esqr., B. Sc. (Engr.), A. M. I. E (Ind )



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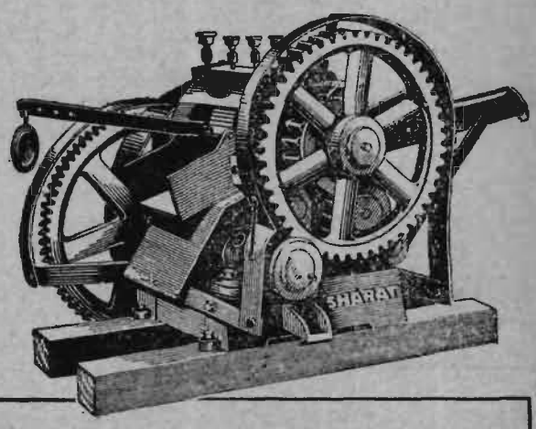


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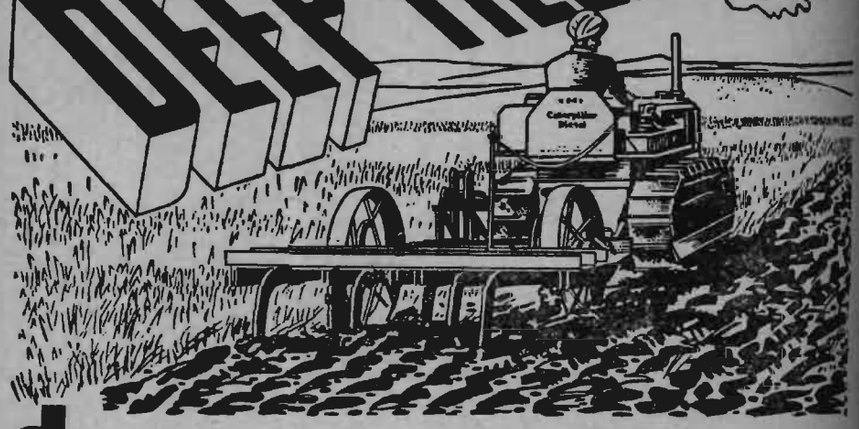

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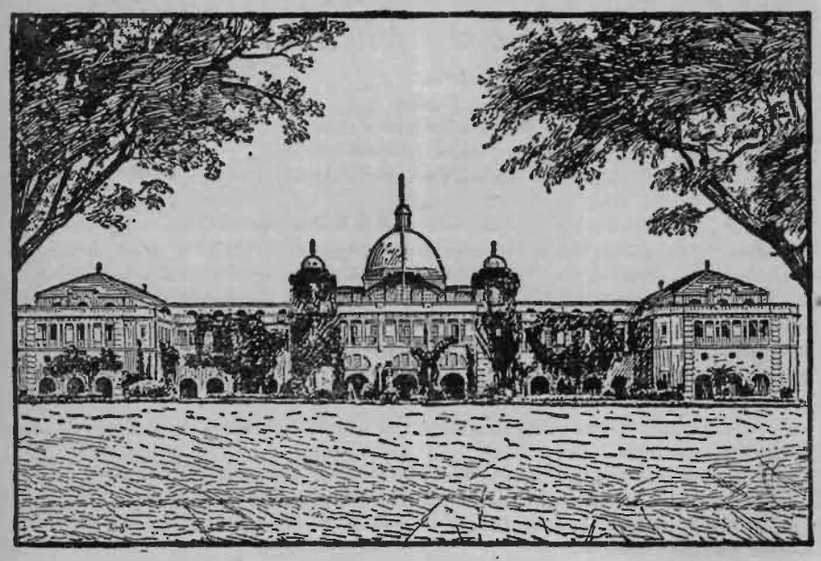
VOL. 41 NO. 3 ] THE [NOVEMBER, 1950

# Poona Agricultural College Magazine



"Everything possible should be done to draw water from the bowels of the earth. There is talent enough in this country for the purpose. Provincial selfishness should give place to the national want."

..... **Mahatma Gandhi.**

"..... I would not use the plough to begin with. I would arm our children with the hoe and teach them to use it effectively. It is an art. Bullock power can come later."

..... **Mahatma Gandhi.**

# THE POONA
# AGRICULTURAL COLLEGE MAGAZINE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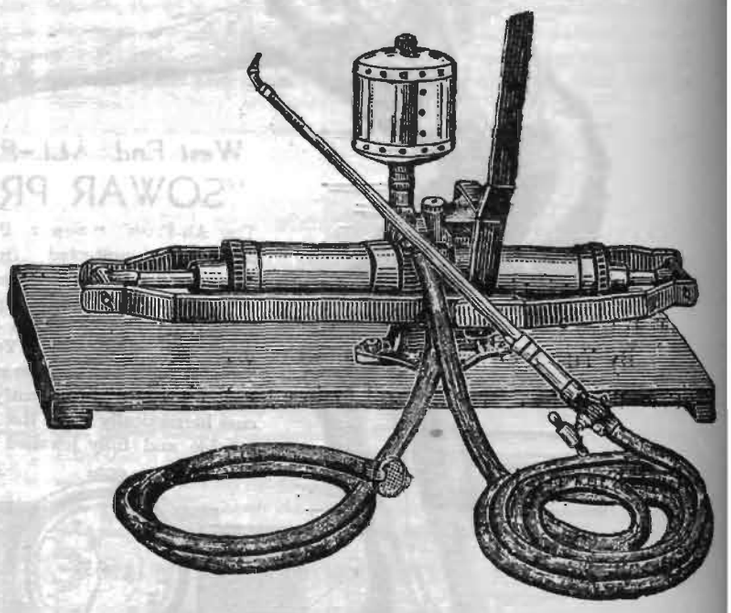

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THE POONA

# AGRICULTURAL COLLEGE MAGAZINE

VOL. 41 ] NOVEMBER 1950 [ No. 3

## Editorial

In a recent note the Government of India have published details about the activities of Shri Jivram Vyas well known all over the country as " Paniwala Maharaj- पाणीवाला महाराज" ( Water Divine ). This 50 years old Yogi is able to locate water upto a depth of one mile below the earth's surface purely with his ( one may call them ) X-ray eyes. It appears that he has obtained this power of waterfinding by a number of years ascetism and penance during his lone residence in the Girnar jungles.

He requires no helper. His method of location of underground water is not the same everytime. Sometimes he moves his fingers over the map of a region and fixes a pin at the place where water will be found. At times he is able to locate underground water from his seat wherever he may be or sometimes from the railway train while travelling. At such times he sees a cloud at a depth underground where water is situated. He is able to foretell how deep the water is situated, how much water can be tapped, and also whether the water is sweet or saltish.

His powers first came to the note of the Saurashtra Government. Subsequently the Food Ministry of the Government of India has taken over his services. Some of his achievements consist of water location at Tehra near Delhi, at many sites near Jaipur, and Dundara in Rajasthan and at a village in the dry waterless region near Wadhwan in Saurashtra. Two successful tube wells have been operating at the sites shown to Rajpura Sudharna Mandal. Eight successful tube wells yield 35000 gallons of water per hour at sites shown to Faridabad Sudharna Mandal, where scientists had declared non-availability of underground water. At Samadri in Rajasthan a well dug at the indicated site yields 120000 gallons of water and three tube wells yield 10000 gallons per hour.

In the present day scientific age, it is impossible to believe or scientifically explain such powers. However scientists and other criticizers are unable to explain either scientifically or otherwise his Yogic powers and capability of underground water placement without any aid and are surprised at his successes.

* * * *

The monsoon has been most erratic this year. It started late in the State, but the lateness is over compensated by extraordinary heavy rainfall in parts of the State, especially the northern areas. Unprecedented excess resulting in floods and consequent damage has been experienced in Gujarat. It was felt that the monsoon was steadily setting in late year after year and hence the agricultural meteorologist, Dr. L. A. Ramdas, was consulted about the matter. He carried out an objective study of the actual data for the last 50 years. His investigations have shown that while the mean data fluctuates from year to year there is no persistant change as such nor is there a persistant change in the rainfall of June during recent years. Other observations show that spells of floods and drought are short in Konkan. The spells of drought are more frequent in the Deccan but lass persistant than those in Gujarat. Long spells of drought may occur in Gujarat. While this information is no doubt useful, it shows that nature has its own way and cannot be controlled. Such adverse experiences, however, stress the needs of crop insurance and provisioning for emergencies.

The country has had to face a series of disasters this season. Assam has been seriously affected by earth quakes with their long lasting and persistant tremors. Its effect is so serious that physical features of parts of Assam are considerably altered. Flood damage has caused devastation in a large number of States notably East Punjab, Uttar Pradesh, Bihar, Assam, Bengal, Saurashtra and Gujarat in the Bombay State. There has been a great loss of human life and cattle wealth accompanied by enundation and erosion. The monetary loss is counted in terms of crores of rupees. The flood damage and erosion has once again stressed the necessity of forests to control the floods and also soil and water conservation measures. We deeply sympathise with all those who have been affected.

* * * *

News of acuteness of food shortage is being received from several parts of the country. Although the State of Bombay is a deficit State, all measures are being adopted to increase the food output by increasing minor irrigation works, tanks and bandharas, by way of cooperative lift irrigation, by reclamation, colonisation and bringing under the plough a large area of waste lands, by supplying improved seeds, by increasing compost making activities and by practising intensive rice cultivation in the rice growing districts of the State. The several schemes will no doubt help to relieve the food shortage partially, but it is upto the peasantry of our country to try its level best to raise the crop yields to the maximum possible extent. Any little effort which will increase the yield of an individual and thereby increase total output of the State will help to decrease the food shortage of the country.

* * * *

Museums are a useful asset in education. They enable people to visualise and study the progress and development of the trades and industry of a country. It

is welcome news that the trustees of the Bombay State Agricultural Show Fund have decided to equip the three colleges of Agriculture in the State with up-to-date agricultural museums. The three museums will be situated in the three main regions of the State, viz, at Poona for Maharashtra, at Anand for Gujarat and at Dharwar for Karnatak. The material from the museum will be utilised for the district and rural agricultural exhibitions and shows.

* * * *

*Vanamahotsava* was very successfully observed in the State. Seeds and seedlings to the extent of 44 lacs have been planted altogether. This is extremely commendable as the figure considerably exceeds the year's target of 25 lacs. It is suggested that an attempt be made to cover the barren hills of the Deccan with Babul (*Acacia arabica*).

* * ā *

Second of September marked further progress in the sporting side of the college, when Shri Vijay Merchant, Bombay's A–1 cricketer sportsman performed the opening ceremony of the महात्मा गांधी क्रीडा मंदीर **Mahatma Gandhi Krida-mandir**, the Gymkhana's Pavilion. The students and staff contributions amounted to Rs. 9000 while the Government made up the rest of the cost of Rs. 40,000. The need for the pavilion has been felt for a long time and the dream has at last been fulfilled. It was but befitting the occasion that a distinguished sportsman should perform the opening ceremony. Our thanks are due to him for accepting our invitation. We are thankful to the Hon. Minister for Agriculture and Forests, **Shri M. P. Patil** and our Director of Agriculture, **Dr. B. N. Uppal** for their active interest in fulfilling the long felt sports needs of our students. Dr. Kirloskar gave an excellent exhibition of table tennis in our college Main Hall after the ceremony.

* * * *

**H. E. Sir Maharaj Singh,** Governor of Bombay, visited the college on Saturday the 9th September 1950 at 10-30 A. M. He was taken round the various sections of the college where the work and progress in the research and teaching activities at the college was demonstrated. His Excellency freely mixed with the students as he went round. He has been pleased to donate Rs. 300 to the college towards a cup or a shield for sports.

# Third Anniversary of Indian Independence.

## August 15th, 1950

The third anniversary of the Independence of India was celebrated on 15th August 1950. The staff, students, college and farm servants and farm school staff and children paraded before the specially erected flag post on the college gymkhana ground. After the flag salutation the Principal gave the following message.

" In celebrating the third anniversary of our country's independence it is natural to look back and to take stock of our commissions and ommissions and from the experience gained in the past to plan for the future. The first year was one of turmoil and tragedy. The second, one of attempting to settle down to work and the third, the year of enactment of the charter of the country's freedom. Amidst all these happenings the country has remained unsettled, major problems have remained to be solved, the fear of famine and food shortage stalks the land and crisis is in the offing. If the country's problems have not been solved, the fault lies more with the citizen rather than with the statesman. The citizens have not given the unstinted co-operation our leaders and statesmen require in setting the country in order.

There is a desire on the part of many to watch the other man commit faults and to view with suspicion whatever the government may do. Such an attitude is unhelpful. The persistance of black marketing, the tendency to food hoarding and wastage of food are maladies no statesman can cure without the willing co-operation of the majority of the citizens. These ills persist because the average man encourages them for one reason or another. It is the duty of all citizens to help the government to eradicate these cankers. No campaign for betterment will ever succeed unless there is fullest and sincere co-operation of the people. This day is therefore a fit occasion to pledge ourselves to do that which is morally right and to fight evil of every sort.

Inspite of what may appear to be a gloomy retrospect there is a bright side to our country's doings. Against great odds the country is still forging ahead with programme of development in all directions. Temporary setbacks will not deter this progress.

India stands high in international affairs because of the high ideals which are the key notes of her foreign policy. Her earnest desire to avoid conflict at home and abroad, her fair sense of justice and her ardent desire to bring about peace among warring elements has gained her an unenviable position among the nations of the world. This is solely and wholely because of the high ideals which her great teachers like Buddha, great statesman like Asoka and Akbar and a great leader like Gandhiji had set and which she has sought to follow. If the country follows these ideals steadfastly and unwarringly there is no cause for fear of conflict. If we do our duties as citizens there can be no fear of failure.

" JAI HIND. "

# Our 42nd Annual Social Gathering.

The 42nd Annual Social Gathering was held on 23rd August with Hon. Shri **M. P. Patil,** Minister for Agriculture and Forests as the chief guest of the occasion. The gathering was held in one of the large farmsheds specially decorated for the purpose. A number of old boys and distinguished guests were present on the occasion.

The Principal in his opening remarks said that it was proposed to extend the course for the degree in agriculture from three to four years, with the beginning of the academic session in May next. The matter was now being considered by the Poona University and the Academic Council has already agreed to the extension of the course.

After the reading of the welcome speech by the General Secretary, the chief guest gave away the prizes to the several winners in the athletics contests. Thereafter the chief guest in his address to the gathering and specially to the students of this college stressed the following points.

Regarding agricultural education imparted at the college he remarked that both the teacher and the taught should think over and ascertain how far the education is useful in actual practice and also what the outsiders think of this kind of education. If there are any defects therein, suggestions and proposals on the improvement in the syllabus and methods of teaching should be put up before Government. He promised that Government will help in all possible ways to bring about changes along useful lines.

The Hon. Minister stressed the fact that though Bombay State would need all available talent to develop agriculture, it was not possible to absorb all the agricultural graduates in Government service and pointed out that the students should never think of Government service as their only goal. A vast field of private enterprise was open for those who wanted to make use of their knowledge in private life. He stressed the fact that a graduate going in for farming on his own will be a greater asset to the country and would be happier than a Government servant. He promissed that Government would be prepared to help a graduate going in for independent farming in all possible ways. He felt that any amount of such Government help would not lead to success unless the graduate cultivated self confidence and a will to make farming successful.

He referred to the food position in the country, which needed begging for food grains from other countries. Independence is a means to achieve the welfare of the farmers. Although plenty of research work has been done in agriculture, people either do not like the results or do not take kindly to them. It was, therefore, upto the agricultural graduates to make the improved methods of cultivation and beneficial results of other researches popular amongst the farmers. It was only by the scientific development of agriculture, that deficit food production could be eliminated and agricultural graduates must tighten up their belts to work in this direction.

The Hon. Minister promised to look into the complaints made on behalf of the student body as regards opening of doors of other Government department services, elimination of discrimination for selection to the Forest course at Dehra Dun* if any as stated by the General Secretary.

Garlanding, vote of thanks and national anthem brought the function to a close.

Various sections at the college had arranged an interesting exhibition of the research activities of their respective sections. This was much appreciated by the visitors.

The usual performance of dramas and variety entertainments took place on two nights, when the students showed off their histrionic talents. **Shri Mahajan** and **Dalaya** who obtained equal number of marks for sports championship deserve our heartiest congratulations. **Shri D' Silva's** magic tricks were very highly appreciated.

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# The Scope and Manner of Utilization of Chemical Fertilizers and Composts. ‡

By

N. Narayana §

In any system of permanent agriculture the maintenance of soil fertility is of primary importance. This is the duty not only of the citizen but also of the modern State. Soil fertility involves a number of intrinsic and extrinsic factors, some of which can be modified at will, while others are beyond our control. Among the former is the plant nutrient status of the soil with which the present note is mainly concerned.

The soils on the face of the earth are not uniform in composition because of the large variety of rocks and minerals of the earth's crust from which the

* From enquiries by the Hon. Minister for Agriculture and Forests with the Forest Department of this State, it is reliablly understood that no discrimination is made between honours graduates of Agriculture and of Science in matters of admission to the Forest College, Dehra Dun.

‡ Prepared for the Crops and Soil wing Meeting held at Patiala in March 1950.

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soils are derived. Again, different types of vegetation remove different quantities of nutrient elements leaving the soils poorer in one or more of the elements. Hence the fertility of soils varies and must needs to be supplemented if they have to yield adequate crops. In the earlier days when there was not any heavy pressure of population it was found that it was enough to give the land a little rest and nature would do the trick. This was the natural method of recuperation. The nitrogen removed by the crop or lost through the soil was replaced partly by the rain water and partly by fixation from air by the large microscopic flora of the soil. The other nutrient elements were slowly made good by the natural processes of weathering. But the rate of recuperation was too slow and could not keep pace with the resources when the land began to be continuously cropped.

But more food had to be produced and some other methods of maintaining soil fertility had to be evolved. In countries like Africa which abounded in virgin forests, people resorted to a system of shifting cultivation. This, as is known, is a wasteful system and leaves behind, eroded, infertile and barren land for posterity. Somewhat analogous may be said to be the exploitation of virgin prairie lands of North America. The reserves of fertility were cashed in without putting back anything. The result was the man-made deserts, the so-called dust bowls.

In countries like Egypt, China and India, use was made of the plant foods in the rich silts of the innundation waters of rivers. By a system of terracing technique the silt is collected and the soil fertility is being maintained since thousands of years. However this method is limited to only those areas innundated by rivers.

Another method is to scrupulously return to the soil the plant nutrients removed by the crop, in the form of dung or nightsoil. This was most successfully practiced in China during the last 4000 years and the fertility of Chinese soils is certainly at a higher level than that of the Indian soils. But, the system is not capable of any further improvement. In these modern days of big cities and efficient transport, the plant foods in crops sent over long distances and to crowded cities are completely lost to the soil.

This brings us to the modern methods of intensive agriculture, wherein the fertility of the soils is maintained at a high level by the addition to the soils of plant nutrients in the form of fertilisers in addition to dung, night-soil and other bulky manures. The levels of fertility that have been achieved by all these methods is brought out by Richardson ( Emp. Jour. Agri. 1946 IV- 3 ) who gives the average yields of wheat in bushels per acre obtained in different countries.

**Natural recuperation**. India-10; Russia-12; Old England-10; U. S. A.-13 ( average-12 ).

Natural recuperation
plus Farm Yard Manures. China – 16; France – 16; Italy – 21; Japan – 25. ( average 20 ).

**Intensive agriculture.** England–33; Belgium–38; Germany–32; ( average–35 )

From the above brief review of the methods of maintaining fertility of soils, it will be seen that we in India should resort to the intensive methods of agriculture if we have to feed the over-increasing population of the future or even feed ourselves of this generation adequately. The average yields of crop in various countries run parallel almost with their consumption of fertilisers. The most recent example, Russia, is today a surplus country with food for export. Its fertiliser consumption has increased from nil to four million tons between the two wars. It is time that India took this lesson and followed the other advanced countries.

The question then arises if similar results can be achieved with Indian soils. The answer to this is apparent in the large volume of experimental work of the agricultural departments of the Provinces. Although these experiments suffer from many drawbacks they definitely point to the conclusion that crop yields could be very much increased by the judicious use of chemical fertilisers in combination with bulky manures. Rice, wheat, cane and root crops respond marvellously to dressing of nitrogen. More recently the possibilities were spectacularly demonstrated in a competition held by the Maharashtra Chamber of Commerce in the Deccan Canal area. A crop of 120 tons of cane was raised as against the average 40 tons. One cwt. of sulphate of ammonia gave an increase of 50 cwts., of cane equivalent to 5 cwt. of sugar. Thus there can be no doubt of the possibilities of the use of chemical fertilisers in our country.

But the quantities of fertilisers being used at present in India are infinitesimal, compared to the large area involved. Mostly, no manure is given. Even the available farm-yard manure is restricted to irrigated areas and cash crops. The rest of the land depends mainly on natural recuperation. No wonder our average yields are so small.

## Nutrient Requirement of Indian Soils.

Nitrogen seems to be the chief need of our soils. Almost all field experiments have demonstrated that when this element is supplied in appropriate amount astonishing increases in yield are obtained. There are also a few areas which are deficient in phosphate also, as parts of Bihar and Travancore. Rice, in the heavy rainfall and coastal tracts of Bombay, is shown to need phosphate. Nitrogen fixation by legumes is also helped by phosphate. In land where nitrogen has been continuously used, a need for phosphate has been felt. However the visual effects due to phosphate addition are not so apparent as with

nitrogen. But phosphate, as is well known, plays an important part in promoting development of grain and hastening ripening. The third important plant food -potash- is needed in much less quantities than phosphate. Our soils are supposed to be fairly well supplied with this element. Except with tobacco, root crops like potatoes and fruit trees, the response with other crops for potash has not been very encouraging. The same is the case with lime. Except the laterite and acid soils in heavy rainfall tracts, periodical liming is not necessary.

In addition to the above, plants need magnesium, sulphur and iron and the so-called trace elements–manganese, boron, zinc, copper and molybdenum. We have, however, practically no definite knowledge of the minor element status of our soils.

## Types of Fertilizers.

**Nitrogenous**:—By far the most important nitrogenous fertilizer is ammonium sulphate which has established itself for more than a century. Formerly a bye-product of coal gas, it is now manufactured synthetically. It is only during the last 10 to 15 years that any of this fertilizer is being manufactured in quantity in India. Including the proposed plant in Bihar the total production does not go beyond half a million tons while our needs are near about 3 to 4 million tons at a conservative estimate. Soils on which ammonium sulphate is used tend to lose their calcium to an extent of about a third of the weight of the fertilizer added. But this can be easily made up by regular liming. As the ammonium ion is held back by the colloidal complex of the soil, this fertilizer is good for shallow rooted crops and for wet and irrigated areas.

Ammonium nitrate is also a synthetic nitrogenous fertilizer produced for explosives. Owing to its tendency to explode or to absorb moisture and to cake up, it is not popular. Water-proofing of granules or mixing with calcium carbonate into nitrolime, have been tried. But in India very little of this form of nitrogenous fertilizer is used.

Liquid ammonia is just being introduced and has many possibilities as the loss of lime is eliminated. But great skill is needed in its use.

Nitrate of soda imported from Chile is rapid acting and hence valuable as a top dressing. It is easily washed into the sub-soil and is useful for deep rooted crops. But owing to the presence of sodium ion and as many of our soils are of a high pH the use of this fertilizer is not recommended. Owing to the readiness with which it gets leached out, it cannot be used for light soils or in wet areas. It is preferable to restrict its use to vegetable gardening mainly.

Other nitrogen fertilizers in great use in India and available in quantity are the oil cakes. They have the merit of being slow acting and requiring no

skill in their use. They are easily acted upon by micro-organisms and the nitrogen is almost as easily available as that of the fertilizers. The other organic wastes like bones, leather etc., are not as easily broken down, the rate depending on the size and shape of the ground material. But all these organic materials are more costly than the fertilizers on a nitrogen basis. Many of the cakes can better be used as cattle food. As sources of organic matter, they are not of such great value. According to Crowther the first 3 percent of nitrogen of most plant and animal wastes is almost useless and this rules out many of the low grade organic waste materials

**Phosphatic** :—Bonemeal and bone-super are the two important sources of phosphate in India at present. But this source soon may not be available as it is more economic to use bones for the manufacture of more valuable products like gelatine, glue etc. The other source of phosphate is the rock phosphate deposits of South India. But this is tricalcium phosphate and is not available as such to the plants. It must be converted to superphosphate by treatment with sulphuric or phosphoric acids. Another source of phosphate is the basic slag of the found ries But this source is not yet properly exploited.

Phosphates added to soil are soon changed to unavailable form. Less than half the added phosphate is not available for subsequent crops. In acid and laterite soils it is fixed as iron and aluminium phosphates. Liming delays this wastage to a certain extent. It has been found to be preferable to use bonemeal instead of super for rice in laterite soils. On very calcereous soils also, the phosphate reverts to an inert apatite. So the only way to apply phosphate is to apply the soluble forms frequently and in small doses to get maximum immediate effect. Experiments at Padegaon have shown that where bulky manures are added, the carbon dioxide produced by the micro-organisms slowly liberates the fixed phosphate.

**Potassic**—The chloride and the sulphate of potassium are the main compounds for potash fertilising. The main world sources are the deposits in France Germany and the Dead Sea. India has to depend mainly on imports for these compounds. Plant ashes are good sources of potash. The large quantities of ash from gul factories and the deposits of felspar may be exploited. Luckily Indian soils are supposed to be fairly well supplied with potash. But fruit crops tobacco and potato respond very favourably to potash dressings.

Potash is leached out to a large extent in the lighter and shallower soils In presence of bulky humus and clay, it is held back, but nearly half the added potash is fixed in an inert form.

## Utilisation of Fertilizers.

The problem of utilisation of fertilizer to best advantage necessitates a intimate knowledge of the needs of the individual crops with reference to the so

and the climate. Previous manuring and the availability of bulky manures have also to be taken into consideration. The growth of crops is an extremely complex affair and there is no straight rule which can be applied all over.

**Fertilizer and crops :**—As a rule cereals need nitrogen and the best response is given with ammonium sulphate. About 15 to 21 lbs. of nitrogen is the recommended dose. With rice however the experiments have shown that the response increases linearly up to 90 lbs. nitrogen after which, it falls off. The fertilizer is best given in three doses, at transplanting, at tillering and at flowering. Experiment with potato is still in progress and about 40-60 lbs. each of nitrogen, potash and phosphoric acid is recommended along with heavy doses of bulky manures. For cane in the Deccan Canal area, experiments have shown that it is best to give 300-350 lbs. of nitrogen in the form of equal quantities of cake and ammonium sulphate in four doses. Although cereals respond to heavy doses of nitrogen, it is preferable to use lower rates to avoid lodging. In the case of other crops, there has not been enough experimental work to give definite recommendation.

**Fertilizers and climate :**—In areas where the growing season is short, it is necessary to decrease vegetative growth and secure early ripening, by cutting down the nitrogen and increasing the phosphate. In heavy rainfall tracts, leaching predominates and nitrates will be wasted. In such soils there is a deficiency of lime usually and hence phosphates get fixed up quickly leaving no residual effect. Hence in determining the most profitable method of firtilizing the climatic considerations are important.

**Fertilizers and Soils :**—Light and heavy soils require different types of fertilizers. Individual soils vary widely in their nutrient status and average results are not applicable. It is essential to diagonise the mineral deficiencies of the area by soil analysis and survey and by field experimentation on the cultivators' fields. Otherwise the application of fertilizers will not be economic. The response to a particular nutrient will be disappointing unless it is established by analysis that the soil is dificient in that particular ingredient.

**Placement of fertilizers :**—This aspect of the fertilizer problem is receiving attention nowadays particularly with reference to phosphatic fertilizers. Drilling of $1\frac{1}{2}$ cwt. of super has been found to be as efficient as broadcasting 3 lbs. of super. This is an obvious way of economy in the use of fertilizers. Fertiliser broadcasted would be dispersed in an unnecessary bulk of soil and may not be available to the plant when it needs. In the U. S. A. special fertilizer-seed drills have been designed to place the fertilizers about 1-2 inches below the seeds of maize and cotton. In the case of potatoes broadcasting the fertilizer over the ridges has been found to be more efficient. In India, there

has been very little work on this aspect. Controlled placement of fertilizers evidently has great possibilities in economising and should be adopted after careful experimentation.

**Balance of nutrients and fertilizers :**—It is well known that response to one nutrient by any crop depends on the presence or absence of other nutrients. For example potatoes respond to phosphate increasingly with increasing dose of nitrogen and potash. But the latter two act more independently. With sugar-beet the response to nitrogen is dependent on potash but independent of phosphate. The reaction of the soil and the presence of minor elements profoundly affect the availability and uptake of other nutrients. Experiments of this type are however very few and isolated. For each crop the complicated interactions of nutrients require to be determined if the fertilizers are to be used to the greatest advantage.

**Time and number of application of fertiliser :**—Not only the placement but also the time of application of the fertilizer is of importance in economising. It is best to give the nutrient when its uptake by the crop is most rapid. In the case of rice, the best results are obtained by giving the nitrogen in three doses at the times of transplanting, tillering and flowering. Similarly with cane, four doses are recommended.

The soil is a poor storehouse for plant nutrients and the most economical way is to use the fertilizers to ensure immediate returns. Heavy dressings in many cases are wasteful. As Crowther has stated " The modern tendency in manuring is towards ' little and often ".

**Bulky manures and fertilizers :**—How far farmyard manure can be considered a source of plant nutrients is difficult to say. There have been too few experiments to arrive at definite conclusion. On an average, farmyard manure or compost contains N-0·5 to 1; $P_2O_5$- 0·2 to 0·5 and $K_2O$ 0·5 to 1 per cent Five tons per acre of farmyard manures is usually applied in India to irrigated fields. Experiments in Denmark have shown that the N. P. K. of F. Y. M is about half as good as when given as pure fertilizers. According to Crowther, most of the nitrogen is unavailable and only half the phosphate and potash can be taken into account. Hence in practice the F. Y. M. treated plots should get the same quantity of nitrogen but lesser quantities of potash and phosphate. How far these results are applicable to our country needs to be determined.

**Quality of crops and fertilizers :**—The quality of any crop depends on the purpose for which it is used. Except in a few isolated instances, there has been no report of any deterioration in quality due to fertilizer additions. Even with food crops, there is no direct experimental evidence of lowering of vitamin content or protein quality.

**Fertilizers and profit :**—Unless the extra crop returns at least make up the outlay on the fertilizers added, no farmer can be induced to waste this money. If to a field, the fertilizer additions are increased step by step, it is well known that the crop returns will fall off regularly each additional step according to the Law of Diminishing Returns. By means of well laid-out experiments on a large number of farmer's fields, it is possible to arrive at average response for different amounts of each of the three principal plant foods. The point at which the cost of the extra fertilizer is just repaid by the extra crop, would be the most profitable dosage. These rates cannot be permanent but vary with the market prices of crops and fertilizers etc. As already pointed out, the amount and nature of fertilizers needed will depend on a number of factors—nutrient status of soil, climate, bulky manure available, method of use of fertilizer etc. Unless all these factors are determined by experiment for each area, it is risky to advise the use of fertilizers.

## Limitations in Fertilizers use.

Having briefly discussed the scope of fertilizers, some of the main limitations in their use in our country may be briefly referred to.

**Water :**—This is by far the greatest limiting factor. It is well known that crops wither if fertilizers are applied in the absence of abundant water supply. Use of fertilizers will therefore be restricted to irrigated areas and tracts with an assured rainfall. About 60-70 million acres of arable land in India can be said to have some kind of assured water supply. And only here will there be assured return over the outlay.

**Availability :**—India is mostly dependent on imports from foreign countries. The State and the citizen are only just becoming fertilizer conscious. Plans are afoot for the manufacture of ammonium sulphate on a large scale. But as already pointed out need is so great and at maximum production the ammonium sulphate will suffice for only a fifth or sixth of our needs. With regard to phosphates, bone is the main source and it is not a dependable source. The rock phosphate deposits should be exploited. In the case of potassic fertilizers, we have been very complascent as we take it for granted that our soils are not in serious need of this element. This however requires careful scrutiny. From these, it will be evident that we should try to make the use of the available material to the best advantage with exercise of strictest economy. The scientist should be pressed into constant service so that he can tell us the best mode of application of fertilizers to yield the maximum benefit. For the present we have to fall back upon the oil cakes, bones and composts and use them to the best advantage.

**Cost of outlay :**—Except in the case of big landlords and factory managed estates, the cost of outlay for fertilizers is a serious handicap with the majority of our farmers. Even though good returns may be assured, the farmer has not the

wherewithal to make a beginning. Unless Government help with a suitable organisation is forthcoming, the use of fertilizers cannot make much headway in our country.

**Experiment and Research :**—Experimental work on the various aspects of fertilizer practice is very little or almost nil in our country. The older work is of no value as the experiments were not laid out on a statistical basis. Owing to paucity of funds, no new experiments on a sufficiently big scale have been possible. Without definite knowledge, it is not possible to advice. There should be experiments not only at research centres but also on cultivators' fields. Specific needs of individual crops in local climates and soils, the nature, rate, time, placement etc.,of fertilizers and methods of economising their use–all have to be investigated for each crop and each tract. It is only then that one can recommend the most profitable method of fertilizing the crop and soil and convince the farmer of the economic advantage of the treatments. Finally, there must be set up suitable organisations who can correctly and quickly diagonise mineral deficiencies and confidently advise the public.

## Scope of Compost.

The soil is not an aggregation of decomposed rock. It is a mixture of these and organic matter which is being constantly acted upon by a host of micro-organisms. Soil depleted of organic matter is dead and its ability to produce crops declines. The value of organic matter for maintaining and improving the productivity of soils has been recognised from ancient times.

**Role of organic matter** :—The average F. Y. M. or compost do not rate very high as a source of plant nutrients. Its N. P. K. value is near about 0.5 -0·25 -0·5 only. Most of the nitrogen and nearly half the phosphate and potash are in an unavailable form. Fertilizer equivalent of a ton of F. Y. M. would not be more than a 100 lbs. in weight. It costs next to nothing and is also without the extra expense of transporting and spreading the bulky manure. Hence it is not as a fertilizer that organic manure should be valued. The benefit from bulky organic matter is indirect. By supplying humus, it improves the tilth or physical characters of the soil, its water holding capacity, aeration and temperature relations. Both heavy and light soils are benefitted. Organic matter affords the food necessary for the biological activities of the soil micro-organisms which bring about the decay and mineralisation of the plant nutrients and make them available. Experiments have shown that added phosphates have a better residual value in presence of bulky manures. The reducing action of these manures aids in making iron and manganese available. Finally the manures are also sources of harmones and growth promoting substances.

**Organic matter of our soils:**— The average C and N contents of our soils are 0·60 and 0·05 percents respectively as compared to 3·0 and 0·15 percent of the European and American soils. The low values for our soils

need not alarm us. The level of organic matter of soils is a factor of climate, temperature, precipitation and evaporation. In a dry and hot country like ours, the natural level of organic matter is bound to be low. Hence attempts at increasing this level to any great degree by hoarding organic matter will not be successful. As already pointed out, the value of organic matter is during its continuous decay. Hence the objective should be to maintain the status quo of a steady supply of organic matter continuously undergoing the decomposition.

**Sources of organic matter:**— In addition to the crop residues the main source of organic matter in our country is the farmyard manure. Our potential capacity of the F. Y. M. is said to be about 6 to 8 hundred million tons. But not all of it goes to soil. Nearly 20 per cent is wasted and about 40 percent is used as fuel. The cultivator cannot be blamed for this as he has no alternative source of fuel. This leaves only 2 to 3 hundred million tons which is all that is put to soil. Experience has shown that most of it goes to the irrigated areas. Howard at Indore and Acharya at Bangalore have worked out improved methods of production of compost and plans are afoot in many of the Provinces, of implementing these improved methods. This will increase the production by another 100 million tons. From towns and cities with population above 2000, the wastes are being composted yielding another 20 million tons of good quality manure. Thus with all the improvements the total production cannot be more than 400 million tons as against a requirement of 1500 million tons for the 300 million acres of arable land. Thus there is a limitation to this source. All the same, all possible methods of conserving bulky manures should be pursued and the most economical use should be made of the available material.

In addition to composts, there are other good methods of restoring organic matter to soils. The most important of these is green manuring for which a fair trial has not been given. Ley farming which has been very successful in England and Europe may also be tried.

**Bulky Manures and Fertilizers :—** There is no conflict between these two. Each serves a different purpose and the best results are obtained by a judicious combination. One maintains the tilth of the soil and the other provides the specific plant nutrient in a readily available form. There is a school of thought which advocates adding compost to the exclusion of anything else, on the plea of loss of quality, proneness to disease etc. There is no experimental evidence in proof of these statements which therefore need not be taken seriously. On the other hand, by the use of fertilizers, the increased crop production leaves behind increased crop residues with consequent increase in the organic matter of the soil. The two-bulky manures and fertilizers are thus complementary to one another.

## Conclusion.

Finally, a brief reference may be made as to how the available fertilizers can best be employed in the immediate present in the context of our dire necessity of

attaining self-sufficiency in food before 1952. The first thing to do is to restrict all the available chemical fertilizers and cakes to areas which are either irrigated or have other guaranteed sources of water. Even in such areas, the first preference should be given to the rice crop, so far as the ammonium sulphate fertilizer is concerned. Rice being a semi-aquatic crop is usually grown in tracts with a fairly sure supply of water. Rice responds best with ammonium sulphate and among the cereals it gives the highest return of grain per pound of nitrogen supplied. Rice occupies nearly 60 million acres which is the largest acreage for any single crop in India. Of this area about a third is irrigated and another third can be said to have a certainty of sufficient rainfall. Thus about 40 million acres under rice can be safely fertilized with ammonium sulphate. Given at the rate of 10 lbs. of nitrogen per acre this would yield a sure and quick return of nearly 2 million tons more of rice. The quantity of manure needed would be about a million tons of ammonium sulphate or one and a half million tons of groundnut cake. Along with the fertilizer sufficient bulky manure should always be added and wherever possible it is preferable to supplement with bonemeal or other phosphatic fertilizer. After the needs of the rice crop have been satisfied the remaining fertilizers, and bulky manure may be given to other irrigated crops, like wheat and cane. Under the existing conditions it would be wasteful to manure our dry crops with inorganic fertilizers. Our scarcity areas should, for the present, resort only to dry farming methods and bulky manures for maintaining their soil fertility.

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# Effect of Sulphate of Ammonia on the Depletion of List from the Rice Soils of Karjat-Kolaba District, Bombay State.

By

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Sulphate of ammonia is known to be a physiologically acid fertilizer, which, when applied to soils, has a tendency to render them acidic by depleting their lime. According to Russel (1942), the ammonium ion displaces some of the reactive calcium of the clay complex with the formation of ammonium clay and an equivalent quantity of calcium sulphate, which being soluble, is readily washed out in the drainage water. The ammonium ion is then nitrified with the production of calcium nitrate which being soluble is again washed away. Thus two equivalents of lime are lost from the soil which works out at 84·8 lb. of lime per 100 lb. of sulphate of ammonia added. However, when there is a crop, it takes most of the nitrate ion, and the second equivalent of lime is retained in the soil in which case the loss of lime would be only 42·4 lb. per 100 lb. of sulphate of ammonia. The recorded results show that in practice the loss of lime lies between these two figures. As long as there is a reserve of lime, this loss of lime falls on this substance and not on the exchangeable calcium as was demonstrated on the Broadbalkplots after 80 years of addition of 200 lb. of sulphate of ammonia per acre per year. But at Woburn, there was a serious depletion of exchangeable calcium and the soil became acidic. Crowther and Basu (1931) working on the Stackyard field plots found that the yield of barley and wheat decreased considerably by the continuous application of sulphate of ammonia for over 50 years. This is attributed to the loss of exchangeable calcium and consequent increase in acidity of the soil. High acidity of the soil renders the iron and aluminium salts soluble which causes harm to the plants.

In the Bombay State, fortunately most of the soils are rich in their lime reserve, the calcium carbonate content being as high as 10 per cent in many cases. In such soils, there should be no danger from the application of sulphate of ammonia. But there is a fairly good area of soils in the high rainfall tract, wherein, owing to the high precipitation, the soils have been depleted of most of their bases and have become acidic. The problem is to determine how far it is advisable to apply sulphate of ammonia to such soils. In order to know if there is any relation between the amount of sulphate of ammonia added and the

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consequent removal of lime, a preliminary experiment was carried out using the light acid soil of the Rice Breeding Station at Karjat. These soils are typical of this rice growing tract.

**Experimental:**—Field soil representing the first 12 inches was passed through a 2 mm. sieve and placed to a depth of 10 inches in tall cylindrical percolators of 3 inches diameter, made of galvanised iron sheets and painted with asphalt on both sides. Before putting the soil, gravel and stone were placed at the bottom of the percolators to a depth of 3 to 4 inches. Enough sulphate of ammonia at the rate of 0, 100 lb., 200 lb., 300 lb. and 600 lb. of nitrogen per acre and sufficient distilled water to the maximum water holding capacity, was added to the soils which were kept covered with lids. Preliminary trials had shown that addition of 550 ml. of water to such a soil would yield nearly 500 ml. of percolate. Therefore, every week, 550 ml. of distilled water was added to the soils and the percolates collected were analysed for their lime content. The soils were tested every week for their pH.

**Results:**—The analysis of the soil used and of the percolates collected every week are given in Tables 1 and 2 respectively.

**Table I**

| | Per cent on fine matter. |
|---|---|
| *Moisture* | 6·25 |
| Carbonates (as $CaCO_3$) | 0·01 |
| Organic matter | 2·01 |
| Clay | 20·45 |
| Silt | 32·95 |
| Fine sand | 29·65 |
| Coarse sand | 8·68 |
| Moisture equivalent | 36·70 |
| Maximum water holding capacity | 63·43 |
| | Miliequivalents per cent. |
| Exchangeable Ca | 26·42 |
| Exchangeable Mg | 14·64 |
| Exchangeable K | 0·26 |
| Exchangeable Na | 2·67 |

**Table II**

| | No manure (water alone) | 100 lb. N | 200 lb. N | 300 lb. N | 600 lb. N |
|---|---|---|---|---|---|
| Quantity of leachate collected every week | | 500 ml. | | | |
| | | 1 Week | | | |
| 1 pH of soil | 6·5 | 6·3 | 6·3 | 6.1 | 6·2 |
| 2 CaO in mgm in the leachate | 78·83 | 86·57 | 123·90 | 140·80 | 240·70 |
| | | II Week | | | |
| 3 pH of soil | 6·5 | 6·5 | 6·1 | 6·3 | 6·1 |
| 4 CaO in mgm in the leachate | 39·42 | 65·68 | 91·49 | 91·49 | 67·56 |
| | | III Week | | | |
| 5 pH of soil | 6·5 | 6·4 | 6·0 | 6·0 | 6·2 |
| 6 CaO in mgm in the leachate | 60·56 | 45·17 | 54·93 | 56·33 | 81·68 |
| | | IV Week | | | |
| 7 pH of soil | 6·0 | 5·8 | 6·0 | 5·8 | 5·6 |
| 8 CaO in mgm in the leachate | 43·64 | 35·89 | 38·01 | 39·42 | 43·64 |
| | | V Week | | | |
| 9 pH of soil | 6·4 | 6·1 | 6·1 | 5·9 | 5·6 |
| 10 CaO in mgm in the leachate | 43·64 | 29·56 | 32·38 | 22·52 | 42·23 |
| | | VI Week | | | |
| 11 pH of soil | 6·5 | 6·5 | 6·5 | 6·2 | 5·7 |
| 12 CaO in mgm in the leachate | 30·97 | 24·64 | 28·16 | 21·12 | 33·79 |

**Table II (Contd)**

| | | | | | |
|---|---|---|---|---|---|
| | | VII Week | | | |
| 13 pH of soil | 6·4 | 6·3 | 6·2 | 5·8 | 5·7 |
| 14 CaO in mgm in the leachate | 29·56 | 24·69 | 28·16 | 18·31 | 30·91 |
| | | VIII Week | | | |
| 15 pH of soil | 6·0 | 6·0 | 5·9 | 5·9 | 5·7 |
| 16 CaO in mgm in the leachate | 23·94 | 22·53 | 22·53 | 22·12 | 29·56 |
| | | Average of 8 Weeks | | | |
| 17 pH of soil | 6·35 | 6·24 | 6·14 | 6·00 | 5·85 |
| 18 CaO in mgm in the leachate | 43·82 | 41·84 | 52·44 | 51·51 | 71·26 |
| 19 Total lime leached out in lb. per acre foot | 579·20 | 552·90 | 693·10 | 680·80 | 941·90 |
| 20 Net amount of loss in lb. per acre foot after accounting for the Control | ... | ... | 113·90 | 111·60 | 362·70 |
| 21 Theoretical loss of lime in lb. per acre foot | ... | 400 | 800 | 1200 | 400 |
| 22 Exchangeable lime in m. e. p. c. at the end of the Experiment | 22·65 | 22·70 | 23·42 | 21·70 | 22·40 |

**Discussions**:—The soil is a clay loam with practically no reserve of calcium carbonate. The pH is slightly on the acid side of neutrality. Among the exchangeable bases, calcium is preponderant (55 per cent of total bases) and magnesium is also high (33·3 per cent).

There is a definite lowering of pH in all soils including that where no sulphate of ammonia was added. The lowering of pH increases with increasing doses of the fertilizer.

Similarly, all the soils show losses of calcium including the one with no treatment. The loss in lime in each case is the highest at the end of the first week suggesting that the reaction between the soil and the fertilizer is very quick being of the nature of base exchange as suggested by Russel (loc cit). In the succeeding weeks, the loss of lime decreases and by the 8th week reaches an equilibrium value, being more or less the same in the treated and untreated soils.

The figures for the total loss of lime (Row No. 19 of Table II) show that even when fertilizer is not added, water alone removes fairly large quantities of lime. Addition of 100 lb. of nitrogen as sulphate of ammonia does not aggravate the loss. But with further increasing doses of the fertilizer the loss of lime also increases. The increased losses of lime due to application of sulphate of ammonia and the calculated losses of lime on theoretical basis are given in row 20 and 21 of Table II. It will be seen that the actuals are far below the calculated values and there is no proportionality between the two. The exchangeable lime contents (last row of Table II) show a lowering almost to the same extent in all the soils. The exchangeable lime of the original soil (vide Table I) is 26 42 m. e. p. c. This is reduced almost to the same extent by treatment with sulphate of ammonia in increasing doses or by leaching the soil with water alone. It is therefore suggested that whatever loss of lime that takes place is in the form of exchangeable calcium. It is interesting to note that there is no proportionality in the losses of exchangeable lime on the one hand and the amount of sulphate of ammonia applied on the other. Similarly water alone causes considerable loss in the exchangeable lime contents of the soil.

Recently a number of people have expressed their fear at the extended use of sulphate of ammonia as fertilizer for paddy particularly in the acid soils of Ratnagiri, and Kolaba Districts. There is a natural loss of lime from all soils due to drainage. This is more so in the rice tracts with heavy annual precipitation. From the results given in this paper it will be seen that the addition of sulphate of ammonia does not aggravate the loss of lime. Hence there is no sufficient cause for raising an alarm against the use of sulphate of ammonia. Whether this fertilizer is used or not it is advisable to lime the rice soils periodically to make up the losses of lime due to natural drainage.

## Summary

(1) There is no proportionality between the amounts of sulphate of ammonia applied to the soil and the losses of lime through drainage as a result of these applications.

(2) Water alone removes considerable amounts of lime from the soils through drainage.

(3) The actual losses of lime caused by increasing applications of sulphate of ammonia are considerably lower than those calculated theoretically.

(4) The acidity of the soil increases with the increase in the amount of fertilizer applied.

——0——

*The authors are thankful to* **Dr. J. A. Daji** *for his guidance during the progress of the work and at whose instance the experiment was undertaken.*

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# BERMUDA GRASS ( Hariali )

## ( Cynodon dactylon )

By

DR. B. A. CHAUGULE *

**Introduction:**—One of the most valuable and at the same time most troublesome of the perennial grasses is Bermuda grass which has spread in all of the warmer parts of the world. One would find many people praising this grass for its value as one of the most useful of the decorating grasses in lawns; for its value as one of the most palatable of the pasture plants, and also one would find it being highly esteemed as one of the most enviably efficient of the grasses combating soil erosion. Regarding its value as a lawn grass and pasture plant especially, it stands second to none in Tropics and so it does in all of the warmer parts of the United States. Besides being valuable for all of its multiple uses as

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mentioned above, it is especially favoured in some parts of India on some particular sacred occasion at least, on account of its value as a sacred grass to be offered to the God "Ganapati". For about five days of that occasion it sometimes becomes hard for one to find but a few blades of this grass for offering to the God.

The apparently contradictory statement made in the beginning of this paper is readily understood by the tenacity, vigor and ease with which the grass gets established and becomes, in a short time, valuable as a forage and lawn grass, and becomes pestiferous because of these same habits when it invades places where it is not desired, i. e. in crops like lucerne, tobacco, maize, vegetables, etc. With this peculiarity of the grass in mind, then, certainly one would like to know much more about this grass than is available by way of a mere introduction heretofore given.

**History :**—Undoubtedly Bermuda grass is a native of the old world, probably of India, but now it is common in all of the tropics and sub-tropics, wherever warm climate is available for its maximum growth. It is a peculiarly sun-loving grass and does not make good growth in the shade of trees. Its entry in the United States took place before 1807, since it has a reference in Mease's Geological account of the United States. It is known as Bermuda grass in the U. S. A. because it might have gone there via Islands of Bermuda, but no definite published record of such a source has been known. It is known by various names in different countries and various localities. In the United States it is also called wire grass, scutch grass, dog's tooth, or Bahama grass, and in California and Arizona especially it is often called 'Devil grass' due to its surprisingly quick infestation and gigantic growth in all cultivated fields. In Hawaii it is called 'Manienie', in North India it is called 'Deub' and in South India it is called 'Hariali', 'Durva' etc. It is often mistaken for ditch grass or knot grass but can be distinguished from the latter by the fact that it has 3-6 seed spikes while the ditch grass has but two.

**Description and Methods of Propagation :**—Bermuda grass is a creeping perennial spreading by runners and rootstocks or by both and also by seeds. Runners may be 3'–4' in length though a figure like 20' is not uncommon. Erect flower bearing branches about 6"–12" in height arise at each joint of the runner. Leaf blades are narrow and flat, 1"–4" long, each bearing a ring of minute white hairs at the base. Flowers are slender spikes 3-6 in a cluster. The individual spikelets of each group are arranged in two alternate rows on spikes that are characteristically one sided. Each spikelet is flattened, closely attached to the axis of the spike and slightly overlapping its neighbouring spikelet. There is one flower in each spikelet. The seeds are very small, light in weight and easily carried by wind and water. Stems are peculiar in that they often appear to have from 2–4 leaves at each joint, only that the joints may be telescoped together.

In most warmer countries it freely produces seeds of about 95% viability but does not seed in heavy rainfall regions such as the Gulf Coast of United States and West Coast of Southern India, and in places subjected to occasional frost in Western Countries. It produces lots of rootstocks underground, often times to the extent of stopping the wooden plough at work in India; but there is little relation between growth of rootstocks underground and growth of vegetative organs above ground. The nature of growth habit is, however, associated with different varieties–varieties with longer surface runners being naturally easy to eradicate. It succeeds in establishing itself very well by striking roots at each aerial node while creeping. Once it thus strikes roots, it does not depend for nutrition on the parent stock. All vegetative organs—aerial and underground as well—are strongly solid in build, indicating the large food reserves and hardiness which keep any bit of the grass thus well equipped to carry on its life cycle independently in cases of mechanical separation from the parent stock. So the famous ' Bermuda Grass' can propagate itself by seeds (in its most favoured habitat) or better by runners but does so most efficiently by the underground root stocks.

**Soil and Climatic Adaptation:**—Bermuda* does well on any fertile but not too wet a soil. However, it will do better on heavier types of soils than on lighter ones. In many parts of India it makes such an enormous growth on alluvial soils on the banks of rivers after the floods subside that the cattle are maintained only on this grass for about a month or two before putting the land under any crop. Even after the lands on the banks of rivers are sown it goes on yielding excellent palatable food until the cessation of crop growth. It grows well even on highly alkaline soils that are totally barred from use for most of the field crops as well as fruit trees because of alkali doposition. Due to its enviably excellent tolerance to high alkali content of soils Bermuda grass has claimed a prominent place in the reclamation of alkali lands in the San Joaquin and Imperial Valleys of California, and outside in the arid and semi-arid parts of United States. It is on record that "patches of Bermuda grass near Mecca, California, although submerged in Salton Sea for over two years, were still alive and making new growth from the stems when that body of water finally evaporated to a lower level". It grows equally well on heavy deep black soils derived from the trap rock in Southern India, where thousands of acres of cultivated land have been thrown out of cultivation because of the heavy undergroud matting of Bermuda rootstocks which make a successful cultivation of the land by animal power impossible. In the United States it grows on sandy loam and also on sandy soils of the coast region where it forms a valuable pasture grass.

Bermuda grass in one of the more exacting grasses in its climatic requirements. It being a native of the warmer regions, grows at its best only in warmer parts of the world and only in warmer seasons, in a particular locality It is

* In the text which follows the word 'Bermuda' when used alone is intended to mean "Bermuda grass".

amazingly tolerant towards intense summer heat without any injury. In fact such type of climate makes its seed propagation also equally successful. It can stand moderate degree of cold but does in no case survive below 0°F. The rootstocks, however, stand still lower temperatures. A mean daily temperature ranging between 20°C–25°C prohibits the germination of seeds but with alternating temperatures between 15°C–35°C germination is good. Lack of sufficient moisture and prevalence of low temperatures retard the seedling emergence and stolon development. So also, heavy rains as those occurring in tropics retard the seedling emergence regardless of prevailing favourable temperatures. Experiments conducted elsewhere indicate that seeds buried deeper than 1/2" into the soil do not germinate. Bermuda is also a poor competitor with other weeds and crop plants in early seedling stage.

Rootstocks of Bermuda grass, however, can stand as low a temperature as 0°F or even lower. Instances are not uncommon of the rootstocks having survived through a temperature of -10°F to -18°F. It grows well in many parts of India and it is a constant source of nuisance in alfalfa and vegetable fields and irrigation ditches of many counties of the San Joaquin and Imperial valleys in California. About 10 of the South Eastern states in the U. S. A. with warm climate have favoured the growth of this grass and in them it has gained popularity as a valuable pasture and lawn grass. This discussion of temperature relationship of ' Bermuda grass ' should not lead one to suppose that it is exacting only in its temperature requirements and not in others like moisture. It does require abundance of moisture and good drainage for its successful growth. Bermuda grass stands flooding for some weeks but will not grow in stagnant places. It is favoured by sunny clear weather and does not bear shading well. Advantage of this weakness, therefore, is taken to secure eradication by growing smother crops.

**Bermuda as a Valuable Grass :**—In any consideration of a plant which is more useful than harmful the value should receive the first consideration. Bermuda grass commands its usefulness as—(1) An excellent sod plant. (2) An excellent pasture plant, when pastures are seeded with Bermuda seed in mixture with some legumes like black medic or Bur Clover. In India, when the river beds are seeded with some perennial legume (Sesbania Spy.) after the flood water subsides, the naturally growing Bermuda grass forms a very palatable forage mixture with legume. (3) A very good hay crop. (4) An excellent soil binding and soil saving grass. The grass forms a thick network of rootstocks underground so that the whole soil mass is held together as if reinforced by metallic bars. Again Bermuda is not at all suppressed or killed by piling masses of soil or mud on it and thus has become most popular in the wind eroded areas of the ' Dustbowl ' in Kansas and other western and south western semi-arid states in the U. S. A. By virtue of this same property it has been highly esteemed in water erroded areas of the south eastern states in the U. S. and the river beds in India. (5) A source of business in seed production.

Being best favoured only by some few warmer states like New Mexico, Arizona and Southern California in the U. S. A. it produces prolific amounts of seed of high viability, making it a profitable plant for seed production and seed distribution.

**Bermuda as a Weed :**—Not withstanding the fact that Bermuda grass has gained so much of a fame and popularity for its forementioned significant uses in certain localities, it often becomes a constant source of nuisance to farmers by becoming pastiferous when it invades places where it is not desired, especially in such cultivated crops as alfalfa, cotton, tobacco, etc. This is especially prominent and therefore of paramount importance to tropical agriculture and in the agriculture in warmer regions of sub-tropics. In these regions it propagates by all possible means–seeds, creeping stems upon the surface of the ground, creeping rootstocks below the surface of the ground, and detached pieces of either of these stolons or rootstocks. Once thus propagated and properly established it begins to slowly capture the whole field from above and below the cultivated zone of soil. This characteristic greatly increases the difficulty of control and eradication of the grass, making it costly, many times of doubtful success. However, a detailed study of its growth habits and requirements has made the problem of its control a bit easier, though slight control would cost quite a bit of enternal vigilance and patience and require the application of wise methods of cultivating the crops.

**Methods of Control and Eradication :**—In any programme of control or eradication advantage is to be taken of the weaknesses of the pest and accordingly the following mechanical methods have been suggested for the control and eradication of ' Bermuda grass '.

### (1) Mechanical Methods :

(a) **Eradication by combining shading and using intertilled crops.** It is a well known fact that rootstocks of Bermuda grass are unable to withstand exposure either to intense cold or severe drying and that the plant cannot stand prolonged shading. Bermuda thrives best only in open places and therefore this makes it relatively easier to control by smothering the grass with heavy thick growing crops alternating with intertilled crops. In the United States they advocate a practice of growing summer, shade crops like velvet beans, cowpeas, Soybeans, Sorghum, millets etc., which is advantageous in its control. The following crop might be winter oats or rye either with or without vetch. After removal of oats or rye, a row crop like cotton or corn allowing cultivation for a longer time is grown.

In parts of India, wherever possible **Sann** hemp (*Crotolaria juncea*) should be grown for green manuring immediately after the early showers of monsoons in June. The rains during the monsoon period especially from June to August do

not allow very frequent or timely cultivation of land and in such cases if a sparse growing crop is planted Bermuda grass would get a very good chance for its luxuriant growth. Therefore, in locations where green manuring is feasible, this thick growing crop of legume should be grown and towards the latter half of monsoon period it should be buried into the soil. After green manuring, either wheat or a winter variety of sorghum or a row crop like tobacco should be taken. The crop of tobacco requires very frequent cultivation and therefore Bermuda grass does not get any chance to head. In such a system of cropping, the grass is already weakened by the shading of the green manuring crop and this facilitates an easy killing of the grass by growing the subsequent cultivated crop like tobacco. After the winter crop is harvested the land should be ploughed deep and the root stocks exposed to the scorching heat of the sun, and if time permits all the thus loosened rootstocks should be pulled out for burning them.

Growing of a spreading crop like sweet potato also could be effective in controlling Bermuda grass in the field. This crop quickly covers the ground completely within a few weeks and thus inhibits the growth of Bermuda grass. This crop, further necessitates the digging of the land for harvesting the underground tubers and thus facilitates at the same time the digging out of Bermuda rootstocks.

The main point to be remembered therefore, is that there should be no interval during which the grass will have a chance to develop and spread.

(b) **Eradication by winter killing :**—This is possible only in cold countries. The fact that Bermuda grass cannot stand severe cold has thrown much light upon its weakness from the eradication point of view in the Northern States of the United States of America. Under the conditions of these states they advise the farmers to plough up the land shallowly to expose the thick matted rootstocks in the fall season to winter freezing. This often completely destroys the growth of the grass in the field. Rootstocks in the grazed fields are near to the surface, and therefore only shallow ploughing is necessary. In dry summer regions they expect the best results from :—(1) Utilizing the grass for hay or pasturing it up for an entire season, (2) continuing grazing the following season till midsummer, (3) shallow ploughing rather than deep ploughing which is more beneficial to the grass for getting a good foot-hold, (4) raking the plowed land to remove deep seated rootstocks, (5) disking the land during the remainder of the season at intervals frequent enough to keep in check any top growths of the grass, and (6) growing an intertilled crop in the following season.

Thus they claim that the drying influence of the sun and prevention of the green growth of the grass would exterminate Bermuda grass in but one season or two. In a season with rainfall at intervals this attempt is expected to meet with grand success.

(c) **Mechanical Control Measures for Small Areas** :—(i) The land should be plowed shallow to a depth of about 3" during a midsummer period of dry weather and the matted rootstocks should be exposed to the surface as much as practicable. (ii) When the mass is thoroughly dry it should be piled into heaps and burned. (iii) For still smaller patches, the infested area should be covered in summer with tarred or other heavy paper in such a manner that the light is entirely cut off from the grass. The edges of the paper should be well overlapped or covered with soil and the entire area of the paper well weighted down with soil or stones. In about two months time this would have a good killing effect on Bermuda.

(d) **Control and Eradication of Bermuda as a weed in Lawns :—** Bermuda grass as a weed in lawns is still more difficult to control or eradicate. The most practical method of eradication as suggested by Ball and Robbins (1932) is to reestablish the lawn. To accomplish this it may be necessary to remove completely the first four to six inches of soil, taking care that all roots are removed along with the dirt and also from the soil which is below that removed, while replacing the soil removed by new fresh soil care should be taken to see that the soil is free from weed seds of undesirable type. The lawn should be seeded to a high test grass mixture and a regular system of inspection of the newly established lawn in order to detect and remove any growth of Bermuda grass should be inaugurated.

(e) **Method of Control of Bermuda Grass in Alfalfa as followed in the U. S. A. :**—Bermuda grass is supposed to be the weed pest most troublesome to alfalfa in many sections of far western states. Broadcast summer growing crops which cannot thoroughly be cultivated are the hardest to handle with reference to Bermuda. Alfalfa is the chief of such crops and Bermuda grass does the greastest damage to this crop. Notwithstanding its dense vigorous growth, alfalfa unassisted will gradually yield to Bermuda grass wherever the latter withstands the cold of the winter season. When alfalfa is cut for feeding, land remains bare and especially in August or September Bermuda makes the maximum growth. They consider that the most practical method of control as far as this situation is considered is to go over the field of alfalfa after each cutting in the month of August and September, to cut all stolons and rootstocks of the grass with a sharp shovel and to turn them up to the sun for drying. If this method is consistantly followed up it would well repay its cost. But if neglected, the grass will finally gain such a headway that the land can be reclaimed only by putting it under a cultivated crop. When the land is to be under a different crop, it is recommended that it should be deeply plowed late in fall or early winter. Two or three years should elapse before again seeding to alfalfa and the summer crop should be one that permits cultivation and destruction of such Bermuda grass as reappears.

(2) **Chemical Methods :**—Bermuda grass, like all other grasses in general, is hard to control by chemicals, and especially so because of its perennial habits.

Its tough slender small leaves, its hard impregnable aerial stolons and equally tough underground rootstocks, all contribute towards the protection of the plant from injury by chemicals. Thus far, a number of mechanical methods of control have been tried. However, the uncontrollable nature of seasons and their diversity have made a standardized single method of mechanical control impossible. Sometimes fixing a crop rotation that helps to smother the grass becomes impracticable. Sometimes the type of rainfall and its distribution as in certain parts of our country is such that during the cultivation period there remains sufficient moisture for the loosened grass carried by cultivating implements to take hold and grow, and thus the cultivation part of its control, besides becoming ineffective, helps its further spread, at least under the said conditions.

In some parts of India and also in the United States long exposure of the rootstocks sufficient to kill them is not possible because of the unwanted but unavoidable outbreak of rains. For all these reasons the need for some sort of method which will kill outright the rootstocks and the aerial vegetative parts of the plant, becomes highly imperative and this may be achieved by following chemical methods of weed control. Unfortunately much success in the chemical control of Bermuda grass has not so far been achieved, although it should not be impossible.

Ball and Robbins (1932) report on an effective eradication of the grass in some parts of California by frequently spraying it with oil and burning throughout the growing season. They also report on the success of sodium chlorate at the rate of four pounds to the square rod on experimental plots when applied in winter. In this case, however, enough irrigation water must be applied on areas treated after the rainy season to carry down the salt to the absorbing region of the roots of the grass. On road sides and ditch banks where permanent sterilization is desired, sodium arsenite at the rate of 5 pounds per square rod has given a complete control of Bermuda grass and all of the annual weeds.

Murphy (1933) reports that Bermuda grass can be controlled through the use of chemicals. However, the rate of application and cost, he reports, is such that sodium chlorate or calcium chlorate can only be recommended for patch work control or control along garden and shrubbery borders. The use of either chemical however, at the rate of 100 pounds per acre either as a single application or when applied in two, at the interval of 1½ months did not give a desirable control. Very good control was secured on both mowed and unmowed grass from the use of either chemical when applied in two applications 1½ months apart from July 15 to September 3, each application being made at 200 pounds per acre.

Fromm (1944) makes mention of a series of experiments conducted at Pureto Rico in months October, January, February, July, August and September, so as to note the killing effect of the two chemicals—ammonium sulphamate and calcium thiocyanate—with reference to different seasons. In these experiments 0·5 to 3·0

liters of each of the two solutions was sprinkled per separate square meter containing from 200–1000 plants. Calcium thiocyanate was always used as a solution 1·25 M in CNS, while the concentration of ammonium sulphamate varied from 0·5 to 2 OM.

The control of Bermuda grass as reported by him, was complete within a week with as small an amount as 0·6 liter of 1·25 M in CNS per square meter when there was no rain in the first four days after treatment. The plots remained free of weeds for three to six months after the treatment. However, the success of this treatment largely depends on season. Control was absolutely complete in dry weather. Retarding effect on control of small showers of rain up to 1/2" could well be counteracted by increasing the dose to 1 liter of 1·25 M in CNS per square meter. Heavier rains, however, materially limit eradication and cannot then be counteracted by higher doses of the herbicide.

In one of the same series of experiments he got a successful kill of Bermuda grass by ammonium sulphamate applied in doses of 0·6–1 liter of molar solution in dry seasons. He reports, that control due to this chemical lasted from 3-5 months. Rain affected its action more than that of calcium thiocyanate.

Robbins, Crafts and Raynor (1942) and Hannesson, Raynor and Crafts (1945) while reporting on the response of different perennial weeds to the application of carbon disulphide mention that shallow rooted perennials like Bermuda grass and nut grass have been hard to control with this chemical in lawns in sandy soils or wherever the root distribution requires shallow treatment. They recommend that this chemical may be applied by merely sprinkling the infested area with an ordinary sprinkling can and immediately covering it with wet canvas. At least 2 gallons of carbon disulphide are required per square rod. It kills all the vegetative covering although the weed seeds are not harmed. This is a chemical excellent for patch work control of Bermuda grass.

## Future of the Chemical Aspect of Hariali Control

From the foregoing discussion on the control and eradication, it will be seen that unlike annual weeds, the control of Bermuda grass, though not the hardest, is a hard nut to crack, indeed ! Many farmers with all their knowledge of the best cultural methods, have met with an utter disappointment because of their inability to successfully combat the grass and exterminate it. Instances, however, are not uncommon where wise crop husbandry and eternal vigilance as to the methods of propagation and introduction of the grass have achieved a great deal by way of success in putting a permanent end to this nasty weed. Chemical methods have often been sought for eradicating Bermuda grass. But although this alternative is showing a great hope of success, one should not be too optimistic in expecting wonders from this aspect of weed control. After all, chemical control methods are far from being magical in their action. They are wonders no doubt, but are man-made and require time and patience. They would have been

more surprising if weeds had been something far different from our common economic plants. It would be quite out of the scope of this paper, and also out of place to discuss the complexity of the problem of chemical weed control. It can only be said in conclusion that the marching ahead with astounding rapidity of scientific methods of agriculture including chemical methods of weed control, and the presence today of selective herbicides—things not even dreamed of in the past—have extended a very bright ray of hope on the scientific horizon of today. And with the present rate of progress, therefore, it would certainly not be too early to hope for a day to come when extermination of Bermuda grass by some such selective herbicide would make it a rare weed of no more importance than a laboratory specimen.

## Summary

(1) An attempt has been made to give a short description of Bermuda grass with its history, growth habits and prominent uses.

(2) Bermuda grass as a weed is described and some mechanical methods are suggested for its control and eradication in different situations.

(3) Use of chemicals like oil, carbon bisulphide, sodium and calcium chlorates, ammonium sulphamate, etc. has given varying success in the control of Bermuda grass under different conditions. It is hoped that a complete control and eradication of the grass would be possible in the near future.

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# Refrigerated Fruit Storage Plant: a Profitable Investment for Small Fruit Farm.

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Although most fruit growers know that refrigeration is the answer to their storage problem, the initial cost of space and equipment is sometimes an obstacle. This is especially true for a small farm operator. However, if the additional profits pocketed each season are balanced against the cost of proper refrigeration facilities, over a short period of years the investment for equimpment is within the reach of most growers.

**Sound, Simplified Construction Desirable.**

A typical building for fruit storage is made of concrete blocks, 20 by 30 feet with an actual storage floor area 20 by 20 feet. The roof is flat, with two feet of ventilated air space provided over the ceiling of the storage room, reducing the sun effect and refrigeration load. Outside vents provide air circulation in this space.

Walls, floor and ceiling can be painted with a heavy asphalt sealer to provide an effective moisture-vapour barrier before studs and insulation were installed. Four inches of fiber glass comprise the insulation. The inside finish of the insulation in the refrigerated room is black asphalted Cellotex, with edges sealed with hydrolene to protect against moisture loss from the inside of the cold room to the outside during cold weather.

The refrigeration equipment consists of a two-horsepower reciprocating compressor and two forced-air cooling units suspended from the ceiling. The refrigerated storage room is held to about 35°F. Relative humidity ranges from 81 to 92%.

# Use of a Tractor.

By

B. Y. KULKARNY *

India was once a country flowing with honey and milk, now the conditions have changed considerably; and the main effect is that her food requirement is not self sufficient. There are many reasons for it, but the chief one pertaining to our subject is that, Indian methods of food production are not up-to-date. Our farmer is keen about following old methods of farming, because they were followed by his ancestors. In order to attain self sufficiency in food requirement, we will have to change our condition by following modern methods of farming. The same situation arose in the 19th century in European Countries, but people tackled the problem by practising modern methods of agriculture. In order to fill up the gap, we will have to introduce modern methods of agriculture in our country.

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The first step is to till the soil. The major and important problem is whether we should use a tractor for it. We will have to use it principally because we want progressive features of farming. The tractor farming aims at producing more with less human and animal effort; and consequently at lower cost. By reducing drudgery and hard manual labour. the farmer is given more time and opportunity to produce more and to develop lucrative additional activities, such as poultry and dairy farming, bee keeping etc. Such activities are quite essential to our farmers in their spare time, as they will aid in improving the economic status of the agriculturists. The speed of a tractor plough is nearly four times faster than a bullock plough. Hence operations can be carried out when optimum soil conditions prevail and these will result in increased yields of crops. Generally the mechanical power helps the farmers in large scale soil improvements like contour bunding, terracing etc.; such works are often beyond the means of an average farmer with his present indigenous implements. From the above benefits everyone will realise the importance of tractors for cultivation purposes. In our country the Central and State Governments have launched many schemes of tractor farming and mechanical cultivation. In the Bombay State our Government has introduced 110 tractors since October 1944; and they have ploughed 24,854 acres of deep ploughing and 47,547 acres of light ploughing in different parts of the State within a period of one year. We should, therefore, know something about the tractor, their implements and their usage in general.

A Tractor is a mobile power unit i. e., it is a petrol, kerosene or disel engine on wheels or on crawler tracks. The power of a tractor can be used mainly in two ways. Firstly the tractor can be used to trail implements or machines, its pulling power is developed at the draw bar at the rear end of the tractor; secondly the tractor can be used as a stationery engine to operate pumps, threshers etc., in this case the power is developed on the belt pulley with which all tractors can be fitted. As the tractor is the heart of mechanised farming, careful consideration should be given to the choice of a tractor. The condition of the soil, the type of the crop grown and the size of the farm will determine the type of a tractor suitable to our agriculturists. As regards technical details, work expected from a tractor 'Nebraska Tests' are popular, which are useful in judging tractors for different purposes. Wheeled tractors are popular in America, where mechanised agriculture is practised on a large scale. Operations carried out by wheeled tractors require more speed but less pull. Light types of soils are suitable for wheeled tractors. In heavy types of soils, like the Deccan Black Soil, trac tractors are more suitable. Trac tractors work satisfactorily under more sever soil conditions than wheeled tractors. In our country trac tractors are common in sugar-cane factory area, mainly because they are useful in the eradication of deep rooted weeds like kans and hariali.

**Selection of a tractor and implement :**—A tractor and its implement should be put to its maximum advantage, hence general items of work should be carefully considered while selecting a tractor and its implements; and then only it

is beneficial in recovering capital out-lay in the earliest time. The area with which a tractor and its implement can work during an 8 hour day is taken as a base for calculation and the cost of such work depends on the depth to which the implement should penetrate in the soil and overcome the soil resistance. As light soils offer less soil resistance, greater area can be ploughed in a day at lower cost per acre. Hence due consideration is quite essential for introducing a suitable type of a tractor. It is always much cheaper to use a tractor in large sized fields, than in a number of small irregular plots as in the latter case a lot of time and labour is wasted in negotiating sharp turnings.

**Implements :**—Out of wide range of implements and machines which are available for farming operations, we will have to consider only such general implements which are suitable to our conditions.

**1. Mould board ploughs** :—They are used in medium and deep ploughing in medium and heavy soils respectively. They are particularly useful in operating dry soil. The following are the important types.

(a) **A light plough with 2 or 3 furrows :**—It is used for ploughing in medium soils to a depth of 6"-8". It is worked with a wheeled tractor of 25 to 40 H. P. range.

(b) **A medium plough furnished with either 2, 3, 4 or 5 furrows :**— It is used for ploughing in medium and heavy soils which are under cultivation. It ploughs to a depth of 8"–12". It is used behind a trac tractor of 40 to 80 H. P. range.

(c) **A very heavy plough with 3, 4, or 5 furrows:**— It is suitable for breaking virgin land in heavy soils down to a depth of 14". It is useful mainly in the eradication of deep rooted weeds like *hariali*. It is worked along with a trac tractor of 60 to 80 H. P. range.

(d) **A single furrow plough**: — It is used in clearing virgin land of light and medium soils respectively. It works to a depth of 12"–14". It is worked along with a wheeled tractor of 30 to 40 H. P. range.

**2. Disc-ploughs:—** Disc ploughs are suitable for sandy soils and in cases of medium soils with sufficient moisture to obtain the penetration of disc. These ploughs are lighter in draft than mould board ploughs and hence less subject to wear. The following are the main types.

(a) **A light model with 28" disc with 3, 4 furrows:—** It ploughs to a depth of 6"–10"; it is generally used along with a wheeled tractor of 25 to 35 H. P. range.

(b) **A heavier model with 3, 4, 5 or 6 furrows:—** It is used along with a trac tractor of 60–80 H. P. range. It works to a depth of 8"–12".

(c) **A very heavy disc with 32" disc with 3, 4, 5 or 6 furrows:—** It is suitable for soils used for sugarcane plantation. It goes to a depth of 10"–14". It is worked with a trac tractor of 80–120 H. P. range.

3. **Disc harrows:—** They are used in preparing seed beds and mulching, weeding etc. They are available in a wide range of weights and width suitable for wheeled and trac tractors.

4. **Peg-tooth harrows:—** They are used in ploughed fallow fields as an alternative to disc harrows for mulching and weeding. They work satisfactorily in light soils.

5. **Cultivators:—** A cultivator consists of a strong steel frame, on to which various tools can be mounted, like spring tooth, a ridging plough ( middle burster ) for making 3 to 4 furrows and ridges at a time. The cultivator is trailed by a wheeled tractor of 25 to 40 H. P. range.

6. **Seed drills:—** Seed drills are useful in many ways. They make regular seed furrows, drop the seed into the furrow at regular intervals and cover the furrow again; with special attachments even very small seeds like ragi, linseed etc., can be sown accurately. Corn planters are used for accurate planting of row crops like ground-nut, cotton, cowpeas etc.

7. **Mowers:—** For cutting small grains & grass mechanical mowers are used. A mower with 7 ft. cutter bar cuts thin stemmed crops like wheat, barley etc.

8. **Harvesting machines:—** Such machines are called as combines. They cut standing crop, and thresh it while moving across a field. The threshed grain is collected in large bins mounted on the combine or filled straightway into bags mounted on the combine. If the straw is necessary for fodder a wind rower is used to cut and heap the straw in wind rows.

9. **Stationary machines:—**Every tractor is fitted with a belt pulley. Thus a fitted tractor is useful in many ways; like hay baling, ensilage cutting and operating pumps, sugar-cane crushing. For transporting farm produce to marketing areas trailers can be hitched to any wheeled tractor. Thus a tractor can be used in various ways. In our country we will have to go forward by introducing various measures of mechanical cultivation on a cooperative basis, then only the problem of self-sufficiency in food requirement can be easily dealt with satisfactorily.

**Economics of Tractor-farming:**— Many items of cost will have to be considered some of which might be quite different in different parts of our country. The cost of operations like ploughing, harrowing will thus differ according to the type of soil, shape of land, skill and the condition of a tractor and its implements. A tractor which is well handled and maintained well will have few breakdowns and will require few spare parts to repair. In order to draw a balance sheet of tractor ploughing, items like depreciation, interest, maintainance, repairs, and cost of operation, etc. should be considered.

Lastly, we will have to introduce tractors in place of bullocks gradually, because work turned out by a tractor is superior, faster and economical. For instance a wheeled tractor of 25 H. P. ploughs 4 acres of land in a day of 8 hours, while Khillari pair with Belgaum plough ploughs 2/3 acre of land within a day of 8 hours. The cost of tractor ploughing will be Rs. 21-5-0 per acre approximately, while the latter will cost Rs. 28-7-0 per acre approximately.

Hence use of a tractor is both economical and essential in the present condition of food shortage. The comparative cost of tractor ploughing and bullock ploughing is based upon 200 working days in a year.

*The author is highly indebted to Major R. S. Basrur, Mechanical Cultivation Engineer to Govt. B. P. for the supply of information and his personal guidance.*

# Deep Tillage *

By

E. W. RUSSELL, Rothamsted Experimental Station

Deep tillage has been practised in parts of Britain for nearly 200 years on light sands, and for 100 years on heavier soils, although it was a very laborious operation until the introduction of the steam engine to the farm over 80 years ago. Deep tillage has become even easier during the past 20 years with the introduction of large track laying tractors. In spite of its long history, deep ploughing is still an operation on which different successful farmers, farming on apparently similar soils and following the same general methods of farming, hold

* Extracted from the "Agricultural Engineering Record," Spring, 1948.

diametrically opposed views. It would therefore appear that deep ploughing can be of benefit only under certain conditions, for otherwise it would not be possible for competent farmers to be in disagreement on such an essential part of the technique of cultivation. There is still very little knowledge of just what consequences deep tillage, either sub-soiling or deep ploughing, has on a soil or crop, and it was to learn something about the subject that the Agricultural Improvement Council, with the encouragement of the Agricultural Research Council, initiated a series of deep tillage experiments that are being carried out on farms all over the country. These experiments were started in the autumn of 1944, and only slowly can the consequences of the various effects deep tillage has on the general management of arable land be unravelled.

In this article, deep tillage operations are considered as falling into two groups : those that are primarily subsoiling,or the loosening of the subsoil without bringing it to the surface; and those that are primarily deep ploughing, or the inversion of the soil so that much of the subsoil is brought to the surface. In practice, the division is not always quite so clear cut, as on the one hand the design or equipment of the plough can be changed to allow a greater or lesser proportion of the surface soil to be buried deeply, and on the other hand there are implements such as the gyrotiller that can be regarded mainly as subsoilers but are capable of bringing up varying proportions of subsoil to the surface.

Deep tillage has one obvious consequence. The soil is loosened and the number and size of the large pockets of air in the soil are increased. If the base of the loosened layer is impermeable to water, and rain follows the deep tillage before the next crop is able to use much of the water, the air pockets will become full of water, and the soil will be turned into a marsh. Hence, the first point that should always be borne in mind is that deep tillage must only be practised on drained land. Land with impermeable sub soils or high water-tables must never have the subsoil loosened. However, deep tillage, whether subsoiling or deep ploughing, can improve drainage by increasing the size of the air spaces in the soil, provided that the water percolating through the loosened layer can get away into drains or into deep ground water. It is not yet known if subsoiling and deep ploughing are equally effective for this purpose, but it is possible that deep ploughing is the more reliable method of improving the case of drainage. When the subsoil is dry, subsoiling is probably as efficient as deep ploughing in this respect, but in some years this condition occurs only in summer and under a standing crop. Also, it is possible that on some soils such as silts, where the soil particles run together easily, deep ploughing, by bringing the subsoil to the influence of the sun, mellows it so that the clods when wet do not run together as easily as they did when they were in the subsoil. However, these points of difference between sub-soiling and deep ploughing as they effect drainage have not yet been proved by rigorous experiments. Deep tillage can increase the air content of the subsoil, and hence improve the aeration of the soil around the roots of plants.

It can also increase the amount of water the soil can hold when it becomes water-logged; but it cannot increase the amount of water a well-drained soil can hold, that is usable by crops. If deep tillage improves the drought resistance of crops, it is for reasons other than this.

Deep ploughing differs from subsoiling in that the surface soil is buried under a layer of subsoil. This has three distinct consequences : surface weeds and weed seeds are buried deep; the deep roots of pernicious perennial weeds, such as dock and thistle, are brought to the surface; and manure, lime, fertilizers, or more fertile friable soils, are distributed through a deeper layer.

The power of deep ploughing to control weeds can be remarkable. In all the experiments recently carried out in England, deep ploughing—ploughing, that is, from 4 to 6 inches more than the customary depth—has never brought up weed seeds, although ploughing that has been only 1 or 2 inches deeper than usual has brought up many buried seeds. When some strips of land have been ploughed deep and others shallow in autumn, the shallow ploughed strips have sometimes been green in spring while the other strips have always been practically free from weeds, provided that the ploughing has been done well. In several areas the chief difficulty of making a good job of deep ploughing is that the subsoil sticks to the mouldboard. Also, it is difficult to set some multi-furrow ploughs to bury all surface weed seeds and rubbish very deep, because they cannot be set to cut a sufficiently wide furrow for good inversion when they are working deep, although the depth may well be within the capability of the mould-board. The power of autumn deep ploughing to give cleaner land in the spring can be of very great value if for any reason a farmer is late with his spring work, as was frequently so last year; he is able to prepare the top few inches of surface soil into a seed bed rapidly, without risk of it drying out. An example of the benefit of this extra cleanness of the soil is furnished by deep ploughing experiments at Rothamsted in the spring of 1947. The land to be sown with sugar-beet was worked quickly and apparently well, and was drilled in late April. However, annual weed seeds germinated with the sugar-beet on plots ploughed 6 inches deep, while none germinated on those ploughed 12 inches deep. Although germination was rather slower and not so even on the plots ploughed deep, the beet grew quicker than that of the shallower ploughed plots, even though the latter plots were horse-hoed, singled, and hand-hoed, as early as possible, and at harvest, probably largely in consequence of the freedom from early weeds, the yields of beet on the deep ploughed plots were over 3 tons an acre higher than on the other plots. This greater freedom from weeds often persisted throughout the season, although there always were some fields where they appeared worse on the deeper ploughed plots. These differences from the usual behaviour, however, were noticed only in the summer and not in the spring.

A second possible consequence of deep ploughing is that it enables nutrients to be incorporated more deeply than when shallow ploughing is practised.

This effect is important only when the nutrients cannot move easily in the soil, and therefore applies to lime, potash, phosphate, and farmyard manure, but not to nitrogen. These materials fall into two classes: lime and plant foods. If the subsoil is very acid, the spreading of lime on the soil surface, followed by deep ploughing and a further spreading of lime, will quickly sweeten a much greater depth of soil than if the lime were incorporated in only the top few inches of soil. The advantage of sweetening the soil in this way can be very striking in short periods of drought, for deepening the sweetened layer of soil allows the roots to penetrate more deeply and to take more water from the soil. The depth to which farmyard manure is ploughed—in the soil seems to have no effect on its value to the crop. In the Rothamsted experiments, farmyard manure that was spread on the land in the autumn and then ploughed-in either 6 or 12 inches deep increased the yield of potatoes and sugar-beet equally for both the deep and the shallow ploughed plots. The responsiveness of the crop to potash and phosphate may depend on the depth to which these nutrients are ploughed-in.

It would be thought that deep incorporation of these fertilizers would benefit during dry periods those crops, such as sugar-beet, that grow fast in mid-summer, for plant roots can only extract their food from moist soil, and during a dry period the crop tends to dry the soil from the surface downwards. Hence the deeper the fertilizer is placed in the soil, the longer it will remain moist and the longer it will be available to the growing crop. If this is correct, it would be expected that the poorer the subsoil the more desirable it would be to plough the soil deep, in order to bury the nutrients in the subsoil and make it possible for the poor soil brought up to be enriched. Yet these are the very soils that many farmers, who practise deep ploughing, suggest should not be ploughed deep, or at least, should be increased in depth only slowly year by year.

The experimental results so far obtained are not yet numerous enough to be conclusive, but they suggest that yields of sugar-beet can be increased if potash and phosphate are applied in the autumn instead of the spring, and the land then ploughed between 6 and 9 inches deep. In 1946, autumn ploughing-in of fertilizers on some soils increased the yield of beet by a ton an acre, which is not a poor reward to receive for the extra trouble of having to drill potash and phosphate in the autumn, and nitrogen in the spring. However, on land ploughed to 12 inches or more in depth the results have been much more erratic, possibly because not enough care had been taken to ensure that adequate quantities of fertilizer were added to the seed bed, which was composed mainly of weathered subsoil, to overcome the harmful effects of its poverty. There is some evidence that on land with a poor subsoil, crops will respond more profitably to large amounts of phosphate and potash if the soil has been ploughed deep, provided the fertilizer is given in two dressings, one before and one after the ploughing.

### Conclusions

Deep tillage should only be practised on drained land. If the field has a drainage system already installed, or has a naturally free-draining subsoil, deep tillage will often increase the speed of drainage. There is an indication not yet well established that deep ploughing is rather more efficient than subsoiling for this purpose.

Deep ploughing usually gives a better control of weeds in the early part of the growing season, and in consequence may allow spring-sown crops to be planted earlier with less loss of water from the seed bed than is possible on shallow ploughed land.

Deep ploughing enables the depth of fertile soil to be increased. It has not yet been possible to demonstrate rigorously under what conditions this extra depth results in increased yield.

Provided that adequate fertilizer is added to the seed bed to ensure that it is not too poor, that the field is well drained, and that the subsoil does not consist of broken pieces of limestone or large lumps of solid chalk, there is no indication that deep ploughing will depress crop yields no matter what kind of sand or clay is brought up. It is not therefore a dangerous operation under the conditions specified.

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# Trace Elements in Agriculture*

By

HARLAND MANCHESTER

There is a small valley area in the state of New Hampshire in the north-eastern part of the United States where, until a few years ago, it was hard to raise good cattle. The animals would not put on flesh, their coats got rough, their eyes became sunken, they wobbled around, and eventually fell down and died.

* Reprinted from " Nation's Business "; taken from " American Newsfile—Agriculture upplement ", of June 7, 1850.

A thorough investigation was carried out by W. O. Robinson, a chemist at the U. S. Government agricultural experiment station in the state of Maryland. Robinson is an authority on the effects on plant and animal life of so-called trace elements in the soil, which often play a role in agriculture roughly comparable to that of vitamins in the human organism. He suspected at once that something was the matter with the soil that fed the forage these cattle ate. He procured soil and vegetation samples which were analyzed for their mineral content. The soil was ground to fine powder and burned to destroy organic matter, and the residue was treated chemically to detect the presence or absence of various elementary components. As a result of the investigations it was found that the soil was largely composed of coarse granite residue from glacial deposits, and that the valley was suffering from a lack of cobalt which is essential in minute quantities to the health of ruminant animals like cattle and sheep. This discovery was made in 1940. After nearly two centuries the disease has now been conquered by adding a bit of cobalt to commercial fertilizer, or by feeding it directly to the cattle. Less than one part out of 1,000,000 in the feed is enough.

This is only one of many recent applications in agriculture of the new knowledge of trace elements, which has been taken seriously for less than two decades. Since commercial fertilizers began to supplement or supplant farm manures, most fertilizer manufacturers as well as farmers have placed primary emphasis on the nitrogen, phosphorus, and potassium, of which the chemical fertilizers are mainly composed. The need of certain other substances, like calcium, sulfur, chlorine, and sodium, also had been recognized. Until recently, these seven were considered sufficient.

Before 1900 Gabriel Bertrand of France discovered the need of plants and animals for certain minor elements, and pointed out the way for further research, but his findings largely were ignored until the early 1930's. Then it was found that the heart-rot disease of beets was caused by a lack of boron. This stimulated work in several U S. Department of Agriculture experimental stations, as well as experiments in other countries, and today trace elements are in wide commercial use. Five minor elements—cobalt, manganese, zinc, boron, and copper—are now attracting wide interest as new tools for the improvement of plants and animals.

The New Hampshire soil is not unique. Throughout the world hundreds of similar examples are to be found : in Scotland, in other parts of Europe, in East Africa, in Australia, and in New Zealand. New Zealanders had been clearing large new areas and growing big crops by using chemical fertilizers. Many new dairy farms were established, but the cattle came down with "bush sickness". In the late 1930's the cause was discovered—cobalt deficiency. Farmers found that if they added to the fertilizer two pounds of cobalt sulphate for every acre, it made the difference between prosperous dairying and no dairying at all.

Trace-element scientists have found in recent years that the need for a dash of manganese in the soil or the feed is responsible for disease in both plants and animals. Only about 15 years ago it was established that a legbone deformity in chickens known as perosis is caused by manganese deficiency. The bones of these chickens, ground up and analyzed, are found to contain about one-third as much manganese as normal chicken bones. Manganese seems to have a great deal to do with sexual behavior. Male laboratory rats, deprived of manganese, become sterile; the females lose their maternal instinct and their mammary glands function poorly.

A wide variety of plant diseases have been found to be caused by lack of manganese in the soil. There is no correlation, however, between the amount of manganese in a given soil and the amount found in the plants growing on it. The manganese must be made available for the plant. Sometimes, by applying 25 to 50 pounds of manganous sulphate an acre, farmers got tremendous crop increases but there is no standard recipe which can be used in all soils.

Tracking down the cause of a trace-element shortage often is not easy. On some American farms where tractors have supplanted horses, symptoms of manganese shortage appeared. At first the deficiency was laid to the lack of horse manure; then it was shown that the straw used to bed down horses, but seldom used for other animals, had contained the needed element. In general, however, the mechanization of farms and the use of commercial fertilizers of high purity have played a leading role in depleting the soil of these indispensable substances. In the United States the minor elements are being added more and more to the chemical fertilizers as local needs are being discovered.

Such infinitesimal amounts of certain trace elements are needed that they are often supplied by accident. In the 1930's, California peach trees and grapevines were assailed by the "little leaf" disease, which no one understood. A scientist from the University of California thought the ailment was caused by a deficiency in iron, so he sprayed some test trees with iron sulfate with excellent results. Other scientists tried to duplicate his experiment and failed. Then it was found that he had used galvanized-iron buckets, and that the zinc in the coating had benefited the trees. Since then, it has been shown that zinc shortage is responsible for diseases in many plants, among them citrus, apple, pear, apricot, and walnut trees, as well as wheat, barley, beans, buckwheat garden peas, and tomatoes.

When Dr. Cheng Tsui of the University of Wisconsin grew tomato plants in a culture solution free of zinc, they reached a height of a few inches and then stopped growing. He added a trace of zinc and they resumed their growth.

Supplementary zinc is now in wide use in the United States, especially in fruit orchards. It may be added to the fertilizer, a solution may he sprayed on the foliage, or a small zinc tack may be driven into the trunk.

The elusive nature of these little traces of elements make laboratory work most exacting. When plants are grown in a controlled solution from which a single element is excluded, to determine whether deficiency disease will develop, a few millionths of the element may enter the solution by means of the water, the chemicals, the sand, or one of the containers used, and falsify the results of the experiment. In trace-element field tests at the U. S. Nutrition Laboratory in Ithaca, in the state of New York, plots are weeded by hand to prevent contamination by metal tools. As the working surfaces of plows, harrows, cultivators and hoes wear thin, the metal is obviously added to the soil. The effect on plant and animal health of tool metals of various compositions is, so far, unknown.

For many years boron was out of favour in the United States. During World War I, when American potash first was used extensively for fertilizer, it contained an overdose of borax which was toxic to plants. But in 1931, it was found that a little of the element was essential. A little boron prevents heart rot and dry rot of sugar beets, the apple disease known as "internal cork", top rot of tobacco, cracked stem of celery, and internal browning of cauliflower.

Copper is another of the mysterious tree elements without which plants and animals do not thrive. It helps the body utilize iron in the formation of hemoglobin in the blood, and it also appears to perform a function in the liver. For many years in Denmark and Holland a so-called reclamation disease has affected grains and forage grown on newly reclaimed heath and moorland soils. In the early 1930's plant scientists found that the disease could be cured by adding copper sulfate to the soil. It was also known that cattle which lived on this forage came down with "licking sickness", characterized by debility, loss of appetite, and low hemoglobin content in the blood. When the cattle were dosed with copper sulphate, they recovered as the plants had.

Meanwhile the "die back" disease of cirtue fruits (death of the young growing tips) was found to be caused by copper shortage, and the use of copper sulfate in certain soils increased the yield of tobacco, lettuce, and onions. It must be used carefully, because too much copper will stunt plant growth.

Dispite the new surge of interest in these indispensable dashes of substancess knowledge of where the trace elements go and what they do in plants and animals is still vague. But atomic research brought agricultural scientists a new tool—the radioactive isotope, which is already being used in several American laboratories to trace the progress and behaviur of the minor elements in crops

and livestock. By this method atoms of the various elements are treated with radioactivity at the great nuclear research centers, so that when a Geiger counter is pleced near them, it reveals their position by ticking like a clock.

Scientists at the Floride Agricultural Experiment Station have fed radioactive cobalt to cows and have followed its course through their bodies. They have found that the cobalt plays a part in the functioning of the cow's rumen, and that it cannot store it up but gets rid of most of it within seven days—important facts to dairymen.

Other radioactive atoms are added to culture solutions which nourish laboratory plants. A University of California scientist fed radioactive zinc atoms to tomato plants and later exposd photographic plates to slices of the fruit, thus demonstrating where the atoms have congregated and giving hints as to their function.

Thus there are many studies showing that fertilization with a given mineral increases its content in a specific crop in a specific location. Other studies however, have shown that the results do not hold for the same crop in the same area another year, or for other crops grown in the same location in the same year. In other words, much still remains to be done. But research in this field promises to increase future world food production with less use of fertilizers.

# Breeding of Safflower in the Bombay State

By

G. P. ARGIKAR *

Safflower, *Carthamus tinctorius* Linn, is an important oilseed crop of the semi-arid regions of India. It is grown to some extent in almost all the States, Bombay having the maximum area of about 500,000 acres. It is next in importance only to groundnut in this State. The acrage, by districts in 1948-49 was as below :—

| Deccan | Acres. | Karnatak | Acres. |
|---|---|---|---|
| Nasik | 4,095/- | Belgaum | 10,430/- |
| Nagar | 1,55,069/- | Bijapur | 74,274/- |
| Poona | 85,799/- | Dharwar | 23,088/- |
| Sholapur | 82,761/- | | |
| Satara | 20,520/- | Total | 1,07,792/- |
| Total | 3,51,244/- | | |

* Agricultural Officer I/C Crop Breeding Station, *Bailhongal*, Dist. Belgaum.

It will be seen from the above statistics that Deccan and Karnatak together command about 90% of the total acreage under the crop in the State.

Safflower is grown either as a mixture or as a border crop in the fields of wheat, gram and rabi jowar. Being spiny, it provides fairly good protection from cattle to the main crops, particularly when grown on the borders. Being Xyrophytic, it can endure considerable amount of drought. The large area of 1,55,069 acres under this crop in the dry district of Nagar which has an average annual rainfall of only about 23'' lends support to this fact. In the State of Western Nebraska in the U. S. A., it has been found to give fairly good yields of about 300 to 700 lbs. of seed per acre even with a low rainfall of about 15 inches.

The yields of this crop are very flexible. With good irrigation yields have shot up even to about 2,000 to 3,000 lbs. per acre at the Scottsbluff Field Station, Montana.

It appears that the yield and oilcontent do not usually go together in this crop. The oil contents of the seed produced in Eastern Nebraska, for example, where the yields are fairly high, i. e. about 750 to 1,000 lbs. per acre, are reported to be about 8 to 10 per cent lower than that of the seed produced in the Panhandle area. The American workers have found the Indian varieties to contain a greater proportion of oil than those of other countries and have used them as a source of material for selection of their improved strains.

In spite of the fact that India has about 23 million acres, i. e. about 8 per cent of her net cropped area under oilseeds, an acute shortage of oils has developed in the country since the termination of the second world war. The increasing demand for edible and drying oils and high protein supplements within the country has brought safflower into prominence, both agriculturally and industrially. Besides being very useful in cookery, Safflower oil has almost a similar value as that of linseed oil in preparing paints and varnishes. In fact, it is the only oil that does not give yellowing effect to the white paint. Its similarity with linseed oil can be seen from some of the physical and chemical constants given below :—

| Item | Specific gravity at 15°C | Refractive index | Saponification value | Iodine value | Unsaponificable matter |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Linseed Oil | 0.932 to 0.936 | 1.479 to 1.480 | 189 to 191 | 180 | 1.5% |
| Safflower Oil | 0.925 to 0.928 | 1.468 to 1.469 | 188 to 194 | 140 to 150 | 0.5% to 1.3% |

The oil is also used for waterproofing material and its plastic of thicker consistency is used as an adhesive for glass.

Having realised the importance of the crop, both the Union and the State Governments have seriously undertaken programmes for its improvement by plant breeding methods.

A high yielding strain, No. 630, evolved by the Dy. Director of Agriculture ( Crop Research ) B. S., Poona, at the Cereal Breeding Station, Niphad ( Nasik ) is under multiplication and distribution in the Deccan. It gives about 10 per cent higher yield than the local variety and has an oil content of 31 per cent. The two strains, Bailhongal 1-6 and Sangamner 2-10 evolved at Poona by the Economic Botanist to Govt., B. S., Poona are being tested in Deccan and Karnatak. Some types have also been evolved by the Indian Agricultural Research Institute, Pusa and other plant breeding stations in the country. Most of all the above, are selections made only for high yield. However, there are several other problems in the case of safflower which deserve the attention of the plant breeders. They are :—( i ) Good, large, bright seed with good test weight. ( ii ) High oil content of seed. ( iii ) Clear, bright quality of oil ( iv ) A deeper root system to suit drier regions. ( v ) Early maturing types for low rainfall tracts. ( vi ) A shorter ' rosette ' stage, probably associated with early maturity to facilitate early interculturing. ( vii ) Less spiny or spineless plants for those who prefer the character for ease of harvest. and (viii ) Resistance to Aphis, *Macrosiphum jaceae*.

From the year 1947-48, the genetic improvement of safflower has been taken up by the State of Bombay at the Crop Breeding Stations at Karad ( District Satara ), Bailhongal ( Dist. Belgaum ) and Annigeri ( Dist. Dharwar ) for tackling some of these problems besides yield. At these Stations much promising material is under study.

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# Economic Seed Rate for the 'Chafa' Gram of the Bombay State.

By

SHRI V. M. CHAVAN * B. B. CHAUDHARI § J. A. PATIL ‡

Gram, *Cicer arietinum* L, is an important pulse crop, occupying an area of about 580,000 acres, (exclusive of area in the merged States for which figures are not available) in the Bombay State. Of this area, about 57 per cent is in Deccan, 23 per cent in Karnatak and 19 per cent in Gujarat. Nasik, Nagar, Satara and West Khandesh districts command most of the area under this crop in Deccan.

Gram is a dry, rabi crop usually grown in rotation with either wheat or rabi jowar and sometimes as a second crop in paddy fields. It serves as a nutrious supplement to cereals in the diet of the people, gives richer 'bhusa' for cattle and, being a legume, enriches the soil by fixing atmospheric nitrogen therein.

The improvement of this crop by plant breeding methods was undertaken in 1933 at the Cereal Breeding Station, Niphad, which resulted in evolving a high yielding strain, 'Chafa' by selection from the local variety—Kadam (1945). The strain has been so named on account of the attractive golden yellow colour of the grains resembling that of the 'Champak' flower. It is rich in protein containing about 19·56 per cent of it. Through trials conducted in various parts of the State, it has been found to suit cultivation in Deccan and Karnatak and has very rapidly covered almost all the area under the crop in these two tracts.

As it was important to know the seedrate needed for the most economic cultivation of this strain, an experiment was undertaken at Niphad in the year 1946-47 and has been run for 3 years. The results obtained are set out in the following table.

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**Grain yields obtained in lbs. per acre in the seedrate experiment on ' Chafa ' gram at Niphad, District Nasik.**

| Season Seedrate | 25 lbs. per acre | 30 lbs. per acre | 35 lbs. per acre | 40 lbs. per acre | 45 lbs. per acre | Signi-ficance | Critical differ-ence |
|---|---|---|---|---|---|---|---|
| 1946-47 | 109 | 166 | 152 | 201 | 128 | Not signifi-cant. | ... |
| 1948-49 | 754 | 840 | 704 | 888 | 833 | Significant at 5% level | 135·6 lbs. per acre |
| 1949-50 | 537 | 547 | 519 | 555 | 556 | Not signifi-cant. | ... |
| Averages | 467·3 | 518 | 458·3 | 549·5 | 505·8 | | 52·1 |

It will be seen from the table that the average grain yields are the highest with seedrates of 40 lbs. and 30 lbs. per acre. Significant differences are not observed between the different seedrates in the year 1946-47 and 1949-50. In 1948-49, however, seedrates at 30 and 40 lbs. are significantly superior to seedrate at 35 lbs. per acre. The former two do not differ significantly between themselves and are also statistically on par with the seedrates at 45 lbs. and 25 lbs. per acre. Again the superiority of both 30 lbs. and 40 lbs. seedrate is noticed consistently in all the 3 seasons. Naturally, therefore, the average outturns obtained from both 30 lbs. and 40 lbs. seedrate are higher than the outturn from the seedrate at 35 lbs. per acre. It appears certain, therefore, that the seedrates at 30 lbs. and 40 lbs. are better than the latter.

It is rather disconcerting that the intermediate seedrate of 35 lbs. should be significantly worse than both the higher and lower seedrates in all the three years. The possible meaning of this fallacy is that the sparser sowing resulting from the seedrate at 30 lbs. gives more vigorous plants individually giving higher yield while the seedrate at 40 lbs. yields more due to the larger population of plants. Probably, the intermediate seedrate at 35 lbs. combines the disadvantages of the seedrates on either side. This point is under investigation.

Considering the economics of seedrates, it will be seen from the table that seedrate of 40 lbs. gives on an average 31 lbs. of grain more than the rate of 30 lbs. That is to say, it gives a net extra yield of 21 lbs. of grain per acre. So, it may be concluded that a seedrate of 40 lbs. per acre is the most economic seedrate for ' Chafa ' gram.

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# Breeding Rust Resistant Varieties of Wheat for Bombay State

By

1 V. P. Gokhale, 2 B. B. Chowdhary, 3 M. K. Patel,
4 V. M. Chavan.

**Introduction**:—Wheat occupies the fourth place among Cereals in Bombay Province and is cultivated over an area of about 1.7 million acres. About 88 per cent of this area is under dry (non-irrigated) cultivation. Roughly 90 percent of the area grows *durum* types, about 8 per cent *vulgares* and only about 2 per cent *dicoccums*. Most of the irrigated wheats comprise the latter two types.

The following are the important varieties grown in this state.

A. **Gujrat**— 1) *T. durum*– Dhola Katha, Rata Katha and Gulab.
2) *T. vulgare*– N. P. 4, Niphad 4, Wagia and Chandausi.
3) *T. dicoccum*– Popatia.

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B. **Deccan**— 1 ) *T. durum*– Bansi, Baxi, Shet Parner, Motiya and Vijay.

2 ) *T. vulgare*– N. P. 4, Niphad 4 and Mondhya.

3 ) *T. dicoccum*– Khapli.

C. **Karnatak**— 1 ) *T. durum*– Jaya ( B. P. 808 ) and Karnatak local red.

Rust as a limiting factor in the cultivation of wheat is in no way less serious in Bombay than in other states. The disastrous epidemic of 1946–47 left nobody in doubt as to what the disease can do under conditions of weather most suitable for its spread. In that year the province was deprived of wheat valued at about Rs. five crores. Only two years later i. e. in 1948–49, the wheat crop in the southern districts of the state was almost a complete failure. It is now an established fact that the breeding of rust resistant varieties is the most feasible and economic method of controlling the disease.

**Loss is mainly due to stem rust:**—Stem rust of wheat (*Puccinia graminis tritici*) is mainly responsible for the loss in yield in this state, although heavy infection of leaf rust ( *P. triticina* ) is sometimes observed in the central districts. The main object of the present programme of breeding, therefore, is to evolve varieties resistant to stem rust, though the desirability of combining resistance to both stem and leaf rusts has not been lost sight of. Discussion in this paper will, however, be confined to stem rust only.

**Relative Susceptibility of the Different varieties:**—Although none of the varieties mentioned above is resistant to stem rust, differences do exist between them as regards the degree of susceptibility. Broadly speaking the *durum* varieties are the most susceptible and succumb to rust in a short period. The *vulgare* wheats come next. Those belonging to *dicoccum* species are not, as a rule, severely damaged, although at times they are as badly rusted as the *durum* varieties, especially if the weather conditions are favourable for the development of rust after the heading stage. It may be mentioned here that N. P. 4, although highly susceptible under severe epidemics of rust, generally escapes heavy damage on account of its early maturing habit. Niphad 4, an improved wheat variety bred at Niphad ( District Nasik ) suffers less damage as compared to the other varieties of *vulgare* and *durum* groups, although it ranks much below the *dicoccum* varieties in this respect.

**Earlier attempts to breed rust resistant varieties:**— The work of breeding for resistance to rust was attempted since the year 1923 when *Khapli*, apparently a resistant type, was crossed with Bansi, a quality wheat occupying a large area in the state. An early selection from this cross, viz. Bansipalli 808 ( Jaya ) was observed to be resistant to rust under field conditions. When tested under artificial epidemic in 1942 it was, however, found susceptible. Bansipalli 809, a sister strain of Jaya, was also crossed with N. P. 4 from which cross the

improved hexaploid strain Niphad 4 referred to above was isolated for its suitability for irrigated cultivation and for superior agronomic qualities. Work based on the knowledge of the physiologic races of stem rust occurring in India was started in 1941.

**Occurrence and relative importance of physiologic race of stem rust in Bombay State**:—Although data regarding the occurrence of physiologic races in Bombay State alone are not available, Mehta (1940) reports five physiologic races for Peninsular India for the 6-year period 1931–32 to 1936–37. Races 15, 40 and 42 occurred in two and race 75 in three years. Of the 262 isolates, 145 belonged to race 42, 58 to race 15, 51 to race 40 and four each to races 24 and 75. It will thus be seen that races 15, 40 and 42 were occurring most commonly in Peninsular India during the above period, race 42 predominating. Mehta in an official communication, kindly supplied the data for a further period of ten years. Besides races 15, 40 and 42 which were very common during this period also, four additional races viz. 21, 34, new race A and new race B, occurred during the period 1941–42 to 1946–47. Of these, race 21 was more common than the others. Race 75 has not been noted during this period and races 24, 34, new race A and new race B were never widely distributed. In fact, during a period of ten years preceeding 1947, race 24 was met with in one, race 34 in two, race A in one and race B in two years only. Uppal and Gokhale (1947) isolated two biotypes of race 42 viz. 42 A and 42 B, which differ from race 42 supplied by Mehta in 1941, and also a new race which is similar to race B supplied by Mehta.

From the foregoing discussion it will be seen that only eight races of stem rust prevailed in this state during the past ten years, of which four, viz. 15, 21, 40 and 42 (and possibly its biotypes) were most common.

**Methods of testing wheat varieties and hybrids for reaction to stem rust:**—With the object of providing facilities to the wheat breeders in Peninsular India for testing reactions of wheat varieties and hybrids produced by them, a scheme was sanctioned by the Indian Council of Agricultural Research, the work under which was started at Mahableshwar in 1942. At present the scheme is being jointly financed by the Indian Council of Agricultural Research, the Government of Bombay and the Government of Madhya Pradesh. The 'Wheat Rust Station' at Mahableshwar, caters to the needs of Bombay and Madhya Pradesh. The programme of breeding for rust resistance in this state is a cooperative effort on the part of the Plant Pathologist to Government, Bombay State, and the Deputy Director of Agriculture (Crop Research), Bombay State.

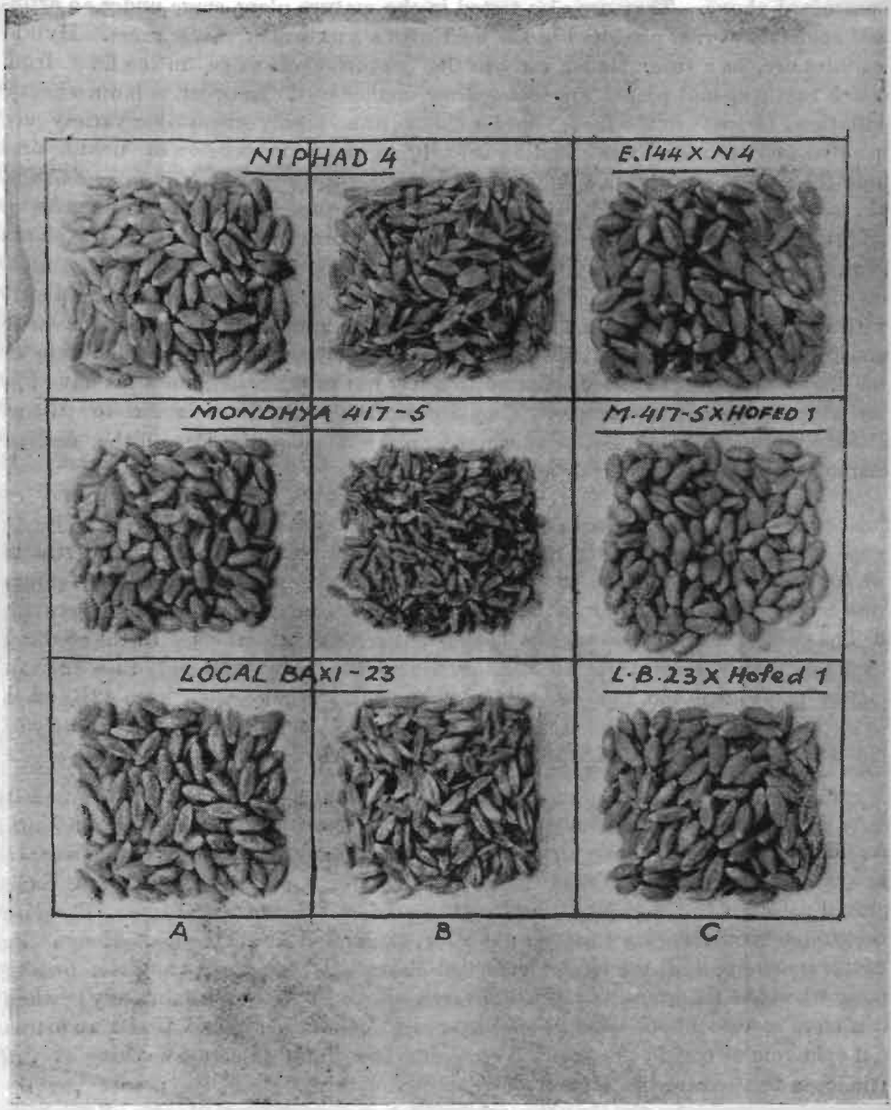
Inoculum of the following races of stem rust was kindly supplied by Dr. K. C. Mehta of Agra : 15, 21, 24, 34, 40, 42, 75, New race A and New race B. These races are maintained in a glass house at Mahableshwar on N. P. 4 which is susceptible to all these races. In addition, biotypes of race 42, viz. 42A and 42B

mentioned above are also maintained: The temperature in the glass house is not allowed to exceed 80°F. as far as possible since a higher temperature is not favourable for the development of rust fungus. Standard wheat varieties are tested in the seedling stage in the glass house separately against each of the races mentained above. Thay are also tested in the mature-plant stage under an artificial epidemic of rust produced in the field with a mixture of these races. Hybrid cultutes are, as a rule, tested only in the mature-plant stage in the field from which rust resistant plants are selected for further test. In order to induce heavy infection of rust in the field, border rows of a highly susceptible variety are planted and are initially infected by injecting a water suspension of uredospores into the plants. Within a few days these border rows get heavily infected and the inoculum is distributed all over the field by means of air currents. As an additional precaution, water suspension of uredospores is sprayed upon the plants of the wheat varieties and hybrids under test. If heavy dews are absent, humidity is maintained round about the plants by (a) irrigation (b) spraying the plants with water and (c) enclosing them with thick cloth at night. The selections made under an epidemic of rust at Mahableshwar are grown in the next generation at the Cereal Breeding Station, Niphad,to select out of them such ones as have the desirable agronomic characters. They are again tested for resistance to rust at Mahableshwar. This process is continued until homozygosity for all the desired characters, including rust resistance, is reached.

**Source of resistance to stem rust** :—Of a large number of indigenous wheat varieties tested, none proved resistant to all the physiologic races of stem rust occurring in Peninsular India. Khapli (*T. dicoccum*) is susceptible to race 42, its biotypes 42A and 42B and new race B but resistant to others. In the seedling stage it is highly susceptible to 42A, and moderately to 42B and race 42. In mature-plant stage too, race 42A seems to paresitize it more than race 42B since in the same naturally infected field, the infection upon *Baxi* consisted mostly of race 42B while that upon Khapli consisted mostly of race 42A.

Amongst the large number of exotic varieties of wheat obtained from U. S A., Canada, Australia, China and other wheat growing countries in the world. Kenya E. 144, Hofed 1, Kenya C. 10854, Charter, Gabo, Dowerin, and Gaza proved resistant to the races of stem rust occurring in Peninsular India. The last one, which is only *durum* variety in this list, ranks first in resistance. Kenya E. 144 is resistant to all the races mentioned above. The resistance however breaks down when the minimum temperature goes above 60°F. (approximately) when it is more susceptible to races 21 and new race A than to others. Under an artificial epidemic of rust in the field, it remains free from infection so long as the minimum temperature is at or below approximately 60°F. The plants usually approach maturity by the time the minimum temperature exceeds this limit with the result that infection appears upon it late in the season. It has been found resistant consistently for a period of seven years to the old as well as new races of stem rust. Charter, Gabo, Dowerin, Hofed1, and Kenya C. 10854 are moderately

resistant since small uredosori are noticed upon them under artificial epidemic of rust. Hofed1 seems to possess mature-plant resistance to race 42B to which it is susceptible in the seedling stage. Detailed reactions of these and a few other varieties are given in table 1 below :—




A— Healthy grains obtained in a rust-free year.
B— Shrivelled grains obtained under heavy infection of rust.
C— Healthy grains obtained under heavy infection of rust. (B & C were harvested from the field area of the Wheat Rust Station, Mahableshwar).

**Table 1**

Seedling and mature plant reactions of selected exotic wheat varieties to the physiologic races of stem rust of wheat (*Pussinia graminis tritici*) occurring in Peninsular India.

| Variety | Seedling reaction | | | | | | | | | | | Mature-plant reaction against a mixture of races. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Race 15 | Race 21 | Race 24 | Race 34 | Race 40 | Race 42 | Race 42 A | Race 42 B | Race 75 | New race A | New race B | |
| Kenya E-144** | I* | I | MR | R | I | I | I | I | I | I | I | I |
| Kenya C.10854 | X- | MR | MR | MR | X- | I | MR | X- | MR | MR | MR | MR |
| Hofedl | R | MR | I | I | R | R | MR | Xtos | I | R | I | MR |
| Charter | R | R | R | I | R | R | R | MR | R | R | MR | MR |
| Gabo | MR | R | MR | I | R | MR | MR | MR | R | R | MR | MR |
| Dowerin | R | R | R | R | MR | R | - | MR | R | R | MR | MR |
| Gaza | I | I | I | I | I | R | R | R | I | R | I | R |
| Kenya Governor | X- | S | R | I | R | I | MR | R | R | S | R | S |
| Kendee | MR | R | MR | R | MR | MR | MR | S | R | R | MR | S |
| Yalta | MR | MR | MR | R | R | MR | MR | S | MR | R | MR | S |

**Breeding rust resistant varieties by hybridization :**—None of the rust resistant varieties mentioned above is suitable for general cultivation in this province on account of one or the other of the serious defects, such as, non-suitability to dry cultivation, late maturity, low yield, poor grain color and grain lustre, hard shelling etc. Kenya E. 144, Hofedl and Kenya C. 10854 were the only rust resistant varieties available when the work was started in 1942. These were crossed with Niphad 4 and or Mondhya 417-5, the improved wheat varieties

* *Explanation of symbols :* I = Immune, R = Highly resistant; MR = Moderately resistant; S = Susceptible; X = Heterogeneous.

* * The resistance of this variety breaks down progressively with a rise in the daily minimum temperature above 60 F.

developed at the Cereal Breeding Station, Niphad. These two local wheats were chosen particularly because they are *vulgare* wheats of commercial qualities and could be crossed with exotic varieties mentiond above which also are *vulgare* ones. Niphad 4 is a synthetic derivative from a cross between *dicoccum* (Khapli) and *vulgare* (N. P. 4) with *durum* (Motia) as the bridging species. As such, it has inherited a certain amount of resistance from *Khapli* and, as mentioned above, it is found to be the most rust tolerant among the locally cultivated wheats of commercial importance. In addition, the strain possesses other desirable qualities such as high yield, high baking and milling attributes, non-shattering habit and awnedness. The combination of all these qualities has made it the best commercial wheat of the province (Kadam 144). Mondhya 417-5 is a selection from Mondhya, a high yielding irrigated wheat with profuse tillering. The hybrid progeny was subjected to the technique of selection for rust resistance and agronomic characters as stated under 'methods' until desirable homozygous selections were obtained. Such selections are now available in the following crosses :— (1) Kenya E. 144 x Niphad 4. (2) Hofed 1 x Niphad 4. (3) Mondhya 417-5 x Hofed 1.

The selections are now being multiplied as rapidly as possible both in *kharif* and *rabi* seasons and it is hoped to distribute seed to a few cultivators in 1950.

Rust resistant selections have also been obtained from two crosses in which both the parents are susceptible. The crosses are : (1) Kenya Governor x Jaya and (2) Thatcher x Niphad 4. Rust resistant segregates were noticed in F 3 and the progeny when tested in F4 and F5 proved resistant or very nearly so. Further selection has yielded true-breeding rust-resistant plants. Similar results were obtained by Stewart ( 1929 ) and Hayes *et al* ( 1927 ).

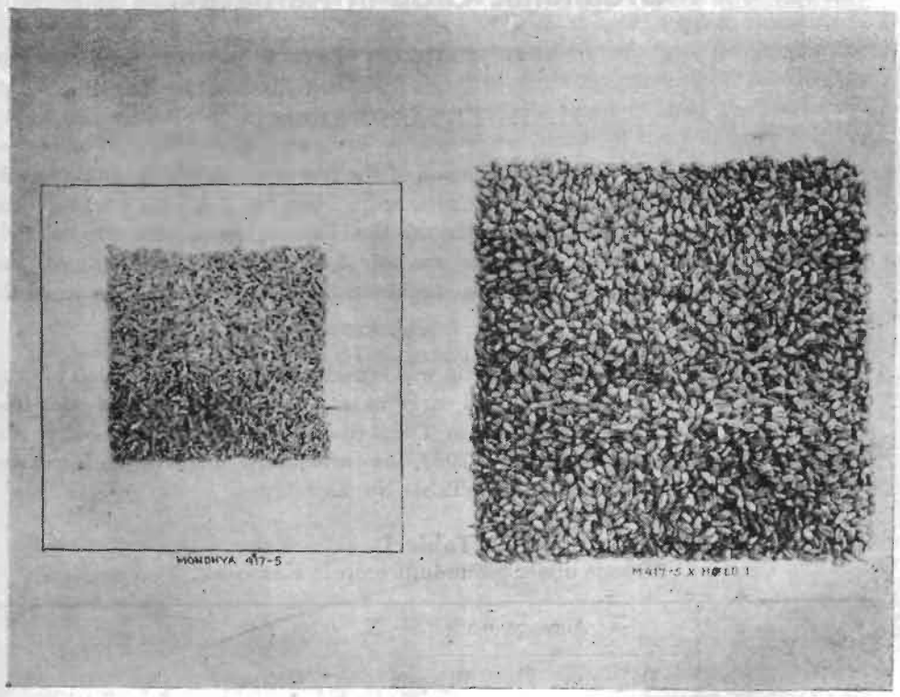
Rust resistant selections from Kenya E 144 x Niphad 4 when grown at four different places in the Deccan and Karnatak tracts of the state in 1948 maintained their resistance whereas the local wheat crop suffered heavily. The results obtained at Mahableshwar under artificial epidemic were thus confirmed under natural epidemic in the wheat growing tracts.

**Future Programme:**—Most of the rust resistant selections obtained so far belong to *T. vulgare*. This is due to the fact that the rust-resistant varieties originally available belong to the same species and crosses between these and the rust-susceptible vulgare wheats were more successful than the *vulgare* x *durum* ones. Considerable sterility was associated with the interspecific crosses and the rust-resistant segregates obtained from them have not yet reached homozygosity for this and other characters. Gaza, a highly rust-resistant *durum* variety was obtained only in 1948 through the courtesy of the Rust Research Laboratory, Winnipeg, Canada. Since a large part of the area under wheat in Bombay state is under varieties belonging to *T. durum*, it should now be possible to develop

rust–resistant *durum* varieties by combining the resistance of Gaza with the agricultural characteristics of the *durum* varieties grown in the state.

The wheat breeding work in this province has how been considerably expanded and selections are being made from the important local varieties on the research farms in all the different wheat growing regions. It is proposed to incorporate resistance to rust into the best selections of each tract.

Photograph showing the comparative yield of a rust-susceptible and a rust-resistant varieties grown under artificial epidemic of rust at Mahableshwar. (Yield of each variety is from 15 rows, each 3 ft. in length).

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**Acknowledgements**:—The programme of breeding rust resistant varieties of wheat in this province was initiated through the zeal and efforts of Dr. B. N. Uppal the then Plant Pathologist to Government, Bombay State, and Dr. B. S. Kadam, the then Deputy Director of Agriculture (Crop Research), Bombay State, to whom the authors are highly indebted.

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# Agronomic Improvements in the Cultivation of Groundnut Crop in Karnatak.

By

M. B. Tippannavar *

**Introduction :**—Groundnut is one of the few crops in which India ranks first in production although it is an exotic crop. One third of the world's total produce comes from India. Even though the cultivation of this crop on field scale started in 1800, the total acreage was only 3,00,000 in the beginning of this century. But since then it has taken rapid strides and now it has reached the figure of 9 million.

In Karnatak, however, the crop was introduced in the beginning of this century and many varieties late and early were tried. The result of this trial showed that the varieties resistant to Tikka disease were suitable. Since the introduction of the suitable types in 1922, the area under this crop is increasing year by year. This can be seen from Table No. 1.

**Table 1**

Acreage under groundnut crop in Karnatak.

| Year | Acreage under G. N. crop | | | Total |
|---|---|---|---|---|
| | Belgaum | Bijapur | Dharwar | |
| 1941-42 | 1,31,832 | 88,333 | 71,568 | 2,91,673 |
| 1942-43 | 1,14,255 | 64,992 | 69,422 | 2,48,669 |
| 1943-44 | 1,41,637 | 1,13,119 | 90,846 | 3,45,622 |
| 1944-45 | 1,42,124 | 1,32,996 | 93,146 | 3,68,266 |
| 1945-46 | 1,26,800 | 2,02,174 | 95,596 | 4,24,540 |
| 1946-47 | 1,28,144 | 2,36,582 | 97,573 | 4,62,299 |
| 1947-48 | 1,37,879 | 3,50,821 | 91,842 | 5,80,542 |

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This increase is probably due to the following reasons:—1. It contains about 45% of oil. 2. It serves as a good rotation crop, being leguminous and of a short duration. 3. It is easy to grow. 4. It is a good money crop. 5 Soil and climatic conditions are favourable.

The object of this paper is to review some of the work done on Dharwar Farm since the introduction of groundnut crop in Karnatak.

**I. Soil and Climate** :—This crop is grown in the dry as well as in the transition tracts of Karnatak and is absent in the heavy rainfall tract. Two varieties of groundnut are commonly grown. The early (erect) variety takes about 100 days and requires 15" to 20" of rainfall well interspread from April to September while the late variety matures in 140 days and requires 20" to 25" of rainfall well spread from April to October. The rains from April to June help the preparatory tillage. The rainfall in first fortnight of July facilitates the sowing and germination of the crop. The rains from 2nd fortnight of July to August are useful for further development of the crop. Then the rains in September and October are essential for the development of the pods and help in harvesting the crop.

This crop is grown in Karnatak on sandy, loamy and medium black soils, provided they are well drained and not alkaline.

**II. Varietal Improvements:** —The groundnut crop was first introduced in 1905-06 on Dharwar Farm situated in the transition tract of Karnatak. Then from 1908-09 to 1922-23 the following early and late varieties were tried. The soil of the Dharwar farm is medium black soil.

| **Early.** | **Late.** |
|---|---|
| 1. Spanish pea nut. | 1. Pandichery. |
| 2. Small Japan. | 2. Big Japan. |
| | 3. Tamboo |
| | 4. Senegal. |
| | 5. Mozabique. |

It was concluded from these trials that the early and tikka disease resistant varieties do well on medium black soil. So again in 1923-24 new seeds of spanish pea nut were imported from America. From this seed two strains, i. e. Spanish pea nut No. 5 and Spanish pea nut improved, were selected and in the meanwhile strain No. 8 from the late variety of Pandichery was also selected. In order to test the superiority of these over local ( introduced ) ones a varietical trial was carried out from 1936-37 to 1940-41. The results are given in table 2.

**Table 2**

Average yielding ability of different varieties and % of oil content.

| Variety | Local or selected strain. | Average yield of dry pods in lbs. | % of increased yield over local. | % of the oil content in Kernels. |
|---|---|---|---|---|
| **Early** | 1. Sp. pea nut. | 1800 | ... | 43 |
| | 2. Sp. pea nut No.5 | 1984 | 10·2 | 45 |
| | 3. Sp. pea nut. | 2026 | 12·5 | 45 |
| **Late** | 1. Pandichery (Introduced) | 1225 | ... | 45 |
| | 2. Pandichery No. 8 | 1591 | 30 | 47 |

From the above table it is obvious that the spanish pea nut improved in case of early varieties and Pandichery No. 8 in case of late varieties are superior to introduced once. Therefore, the improved strains were recommended and further, cultural and manurial experiments discussed later were conducted.

### III Cultural Improvements.

**1 Pod sowing v/s Kernel sowing** :—The groundnut crop is being propagated through both pods and kernels and the cultivation of the crop being new to the tract it was thought desirable to have comparative performances of these two methods. So, an experiment was conducted from 1931–32 to 1937–38 and their results are summerised below :—

**Table 3**

Effect of sowing groundnut in different form on the stand and yield per acre.

| Treatment | Average yield of pods per acre in lbs. | Nature of germination |
|---|---|---|
| 100 lbs. pod sowing per acre. | 1395 | Defective |
| 80 lbs. Kernel sowing per acre. | 1526 | Good |

The foregoing table shows that 80 lbs. Kernel sowing gives 131 lbs. yield more due to the better stand of the crop.

2. **Seed Rate Experiment :**—It is always advisible to have an optimum seed rate to obtain good yield and to economise the seed. With this view a trial from 1928-29 to 1938-39 was in progress. The average results are given below in table 4.

**Table 4**

Effect of seed rate on the final yield of G. N.

| Treatment | Average yield of pods per acre in lbs. |
|---|---|
| 60 lbs. Kernel sowing per acre. | 1735 |
| 80 ,, —do— —do— | 1832 |
| 100 ,, —do— —do— | 1905 |
| 120 ,, —do— —do— | 1961 |

The above data indicates that the yield increases with higher seed rates but the increase is not proportional and appreciable. If the economy of seed and the increase in yield are taken into consideration the 2nd treatment i. e. sowing with 80 lbs. Kernel per acre is better.

3. **Spacing Experiment :**—The spacing is one of the important factors in the cultivation of crops which determines the yield. So, an experiment was conducted from 1939-40 to 1940-41 and the average yields are enumerated below.

**Table 5**

Effect of spacing on yield.

| Treatment | Average yield of pods per acre in lbs. |
|---|---|
| Sowing at 6"x4" | 1662 |
| —do— 6"x9" | 1622 |
| —do— 12"x9" | 1288 |

The above figures show that groundnut crop responds to closer spacing. But it is not possible to use bullock labour in closer spacing and as such the wider spacing i. e. sowing 12" apart is advantageous.

4. **Rotational Experiment :**—In successful cultivation of crops, rotation is the most important factor governing the out-turns of the crops. So, to ascertain the most advantageous system of cropping an experiment with following treatment was carried out from 1928–29 to 1938–39.

**Treatment.**

1. Cotton–Jowar in blocks. (Cotton black)
2. Groundnut and cotton in alternate rows–Jower. (Groundnut and Cotton in alternate rows)
3. Groundnut and Gram–Jower (Groundnut and gram black)

and the results are tabulated below :—

**Table 6**

Averege Yield and net Profit of different rotations with and without groundnut, per acre.

| Item | Cotton Black | | Cotton and Gr. Nut | | | Gr. Nut and gram | | |
|---|---|---|---|---|---|---|---|---|
| | Cotton | Jowar | Gr. Nut. | Cotton | Jowar | Gr.Nut | Gram | Jowar |
| Average yield per acre in lbs. | 369 | 1081 | 1082 | 242 | 1158 | 986 | 393 | 1265 |
| Net profit per rotation | — Rs. 4-0-0 | | | + Rs. 5-5-2 | | | + Rs. 2-13-7 | |

The above table shows clearly the higher advantages claimed in growing cotton and groundnut in alternate rows from the point of groundnut yield and net profit per rotation.

## IV. Improvement in manuring.

**Manurial Experiment :**—There is a common practice of manuring one or the other crop among the cultivators in order to keep up the fertility of soil and thus to get higher out-turns of crops. Therefore, to study the effect of Farm Yard Manure at the rate of 5 cartloads on groundnut crop to increase its yield and on the yield of succeeding crops, an experiment was carried out from 1928-29 to 1938-39. The results are given in table 7.

**Table 7**

Response of groundnut to manuring and its effect on the succeeding crops.

| Gr. nut manured. Average yield per acre in lbs. | | | Gr. nut unmanured. Average yield per acre in lbs. | | |
|---|---|---|---|---|---|
| Gr. Nut | Gram | Jowar | Gr. Nut | Gram | Jowar |
| 1151 | 457 | 1387 | 1011 | 327 | 1165 |

The above figures show that it is adventageous to manure groundnut crop as it increases not only its yield but also of the succeeding crops like gram and jowar.

## Summary

1. Early varieties do better on medium black soil than late varieties and selected strains yield higher than local (introduced).

2. The seed rate of 80 lbs. with 12" spacing is more suited.

3. In the transition tract where the rainfall is secure, growing of cotton and groundnut in alternate rows is more profitable than any other rotation.

4. Manuring of groundnut with Farm Yard Manure at 5 cartloads per acre gives better yield not only of groundnut but also of succeeding crops.

## References

1. Experimental results and rainfall data from the annual reports of Dharwar Farm.
2. Acreage from the final forecast memorandums of Department of Agriculture.

# Double Bean

By

G. A. PATEL. *

**Natural Order :**—Leguminoseae.

**English Name :**— Double Bean.

**Local Name :**— Dafal.

**Botanical Name :**— Phaseolus Lunatus—Macrocarpus.

Bumper bearing of pods. D. Beans.

Double Bean was first grown at the Agricultural College Farm, Poona in the year 1924–25 and still it is continued. This is the most important species of beans grown in Bombay State. Widely grown by a large percentage of home gardeners and as a market crop, it is grown where there is a good demand for it. This is a native of South America and it was grown by American Indians.

**Climate and Soil :**—The climate required is dry cool climate. The average rainfall required is 20"–25". The maximum-minimum range should not increase more than 25" to 30". This crop is 9 month crop and it is not rain fed crop but an irrigated crop.

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It can be grown on all types of soils practically from light sandy lands to heavy clays. Fairly rich soil, medium and well drained soil is better. Very rich soil is not desired as there is a lot of vegetative growth and lesser pod formation. Even very heavy soils are not good as the excess of water is not drained away.

## Cultivation

**Preparatory Tillage :**—Generally this crop is taken after a heavy irrigated crop and heavily manured crop like Sugar Cane. The area is ploughed after the harvest of the previous crop. In Poona on Agricultural College Farm, it is taken after Sugar Cane; after the harvest of the Cane the land is ploughed by K. 9 Plough in the month of February-March. Then the land is kept as such for one month and in April when the soil is sufficiently dried, the big clods are broken by the maind, the Norwegian Harrow and the disc harrow. The stubbles of the Sugar Cane are collected. After that two harrowings are given, and the soil is brought into fine tilth.

**Manure and Manuring :**—Generally no manure is given as the previous crop of Cane is heavily manured but if Farm Yard Manure is available 5 Cart-loads are applied. No top dressing is given. In this case the residual effect of manure is taken.

**Layout :**—When there is sufficient moisture in the soil by good rain i. e. in the month of June in the 3-4th week, the land is harrowed and the marking is done by the marker 6'x4' or 5'x5'. The area is not increased, it is 25 Sq. ft. per plant.

**Seeds and Sowing :**—In the first or second week of July when there is sufficient moisture in the soil the seeds are dibbled at each cross. 2-3 seeds are dibbled 2" deep. The distance in a line is 4' and between lines 6' apart. The seed rate is 8-10 lbs. But sometimes it is 12 lbs. also. The seeds germinate after 5-6 days.

**After Care :**—Weeding may be done as required. Irrigation, if there is a long break in the monsoon rain the watering may be given and from October onwards till the end of the crop every 8-10 days interval watering is to be given. Clean shallow cultivation should be practiced. Deep cultivation is likely to disturb or cause injury to the root system. When the plants reach full size cultivation is stopped, generally 3-4 cultivations are sufficient to keep down weeds and to maintain the mulch which prevents the rapid evaporation of moisture.

**Trailling or Supporting :**—This is the most important operation and costlier item in the cultivation of this crop. When the crop is 2 months old or i. e. when vines are spreading, the vines are to be supported on the bamboo and

they are tied if this operation is not done in time or delayed, there is reduction in the yield. 3600 bamboos are used and the cost at present is Rs. 650 but it may vary according to the locality. The initial cost of bamboo is too high for the 1st year the cost of cultivation is high but for subsequent years the same bamboos are used. The life of bamboo is taken as 3-4 years. At every spot a vertical bamboo is fixed and 3-4 horizontal bamboos are tied to the vertical bamboo for 4 vertical bamboos. The horizontals are tied at the distance of 1½'-2' apart. The vines are trailed on those bamboos. The trailing is not done across the wind direction but along the wind direction.

**Interculturing :**—One bullock hoe can be used for interculturing, hand weeding and stirring is done. The plants are supported by soil, the soil is raised by the head piece of the harrow so that watering may be done thoroughly. Flowering generally starts after 11-12 weeks and from the date of flowering the pod formation takes one month. So the 1st harvest is ready after 4 months.

**Insect Pests and Diseases :**—The double bean is subjected to several very serious diseases including mosaic, dry root rot, anthracnose and rust.

Anthracnose, Dry root rot and rust are not found in Bombay State.

**Mosaic :**—This disease shows on the leaves as alternate light and dark green yellow areas with bronze colour are found. The causal organism is not discovered. This disease is due to virus. No curative remedy.

**Pests :**—The important pests are been beetles, thrips, aphis etc. For Thrips Nicotine Sulphate 40% 1 to 800 parts water to this soft soap is added for sticking. The spray should be applied under the lower surface of the leaves.

**Harvesting :**—The 1st picking is generally got after 4 months. The well developed pods, not tender, the pods which has got full developed seeds are to be harvested. Harvesting is done entirely by hand and that is why this labour question restricts large scale production. The interval between two pickings is 15–16 days. The crop lasts upto the end of March. The harvesting is to be attended regularly. The number of pickings are generally 12–14. There are 4 flushes of flowers. The maximum yield we get in the months of December. The average yield per acre varies from 8–12000 pods and 200–300 lbs. dry seeds. The seeds are got from the left pods on the plants by oversight and which are above reach. Yield per picking in percentages :—

| | | | | | |
|---|---|---|---|---|---|
| 1st | ... | 5%. | 6th | ... | 14%. |
| 2nd | ... | 6%. | 7th | ... | 40%. |
| 3rd | ... | 8%. | 8th | ... | 4%. |
| 4th | ... | 10%. | 9th | ... | 3%. |
| 5th | ... | 8%. | 10th | ... | 2%. |

The proporation of seeds to skin is 1:1 in green pods.

**Rotation :**—On the College Farm the rotation followed is as follows :—

*Sann Green Manuring* :—Sugarcane: D. bean Jowar and Tur. This is 4 year rotation here the advantage of the residual effect of the manure is taken by the D. bean., and it is a paying crop but irrigated crop and after this there is a dry crop of Jowar and Tur where there is a good market it can be taken after Sugar Cane. Some cultivators take D. bean after Suran.

## Cost of Cultivation :—

Labour units for different operations on average per acre.

| Items | Men | Women | Bullocks |
|---|---|---|---|
| I. Preparatory Tillage. | | | |
| Ploughing. | 4 | ... | 8 |
| Discing. | 1/2 | ... | 1 |
| 2 Harrowings. | 1 | ... | 2 |
| II. Manuring. | | | |
| Spreading 5 carts of F. Y. M. | ... | 1/2 | ... |
| III. Planting. | | | |
| Marking. | 1 | ... | ... |
| Dibbling. | ... | 4 | ... |
| IV. Irrigation (9) | 17 | 2 | ... |
| V. After Tillage and Care. | | | |
| Interculturing by Harrow. | 1 | ... | 2 |
| Earthing up | 3 | ... | 3 |
| Supporting | 45 | ... | ... |
| Weeding (1) | ... | 10 | ... |
| VI. Harvesting. | ... | 140 | ... |
| Total Labour. | 72½ | 156½ | 16 |

**Cost**

| Items. | Rs. As.Ps. |
|---|---|
| 1) Labour Cost. | 174-12-0 |
| Re. 1-0-0 per man per day. | |
| Re. 0-8-0 per woman per day. | |
| Rs. 1-8-0 per bullock per day. | |
| 2) 5 Carts of F. Y. M. | 15- 0-0 |
| 3) Irrigation Charges (8 months) | 12- 0-0 |
| 4) Bamboo cost for one year. | 220- 0-0 |
| 5) Implement charges. | 3- 0-0 |
| 6) Interest on Rs. 425 for 9 months @ 9%. | 38- 0-0 |
| Total... | 462-12-0 |

| Items | Rs. | A.P. |
|---|---|---|
| Receipts per acre, 8,000 lbs. green pods and 100 lbs. dry seed. | | |
| 1) Green pods Re. 0-2-0 per lb. | 1,000- | 0-0 |
| 2) Dry seed Re. 0-8-0 per lb. | 50- | 0-0 |
| Total... | 1,050- | 0-0 |
| Deduct cost... | 462- | 12-0 |
| Net Profit... | 587- | 4-0 |

# Vernacular names of Grasses and their Botanical equivalents

By

Rui D'Cruz *

With the advancement of Indian Agriculture, the improvement of the cattle wealth has become imperative. This has laid much stress on the knowledge of forages with special reference to grass species. The identification of grasses is not easy to laymen and even to those with botanical knowledge. This list of vernacular names is published in order to facilitate the work of those interested in knowing the scientific name of a particular species of grass of which the local name is already known.

Numerous grasses are found in this state and almost all of them are well named and described by Blatter & McCann in their book entitled, 'The Bombay Grasses' (1935). The vernacular names listed below have been drawn from this publication. As this list is written in alphabetical order, it would be easy to find out the corresponding scientific name and would also be useful as an index of vernacular names to the above reference.

It may be noted that though this list is an aid to find out the botanical names of grasses, it might not be very useful in cases where precision is necessary and in such cases the systematic identification of the specimen is recommended.

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It will be seen from the list given below that the same species of grass has more than a single local name in the same place and more often so in different parts of the State, as will be seen in the following example. The species of grass botanically known as *Dichanthium annulatum*, Stapf. in Nadiad is known as *Zinjoo*, in Poona as *Marvel* while in Bijapur it has been given the name of *Marwalyan-hullu*. Whereas in some other cases, it will be observed that the same vernacular name is given to various species of grasses i. e. *Kotir*, is the vernacular given to *Dimeria diandra*, Stapf. *Arundinella setosa*, Trin. & *A. Lawii*, Hook f. Whenever such difficulties arise, there would be the need of getting the specimen completely identified and its name determined.

## List of Vernacular names of Bombay Grasses.

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 1 | Achi-grass | Iseilema wightii, Anders. | 113 |
| 2 | Agiva | Chrysopogon montanus, Trin. | 71 |
| 3 | Akki | Oryza sativa, Linn. | 273 |
| 4 | Anchi | Daetyloctenium aegyptium, Richt. | 265 |
| 5 | Anjan | Cenchrus biflorus, Roxb. | 187 |
| 6 | Anjan dhaman | Pennisetum ciliare, Link. | 182 |
| 7 | Arotaro | Digitaria marginata, Link. Var. fimbriata, stapf. | 125 |
| 8 | Asara | Eragrostis gangetica, Steud. | 236 |
| 9 | Badi | Panicum miliare, Lam. | 160 |
| 10 | Baerki | Andropogon pumilus, Roxb. | 999 |
| 11 | Bagad | Panicum miliare, Lam. | 160 |
| 12 | Bagkeri | Saccharum spontanium, Linn. | 45 |
| 13 | Baika | Hemarthria compressa ( Linn. ) R. Br. | 31 |
| 14 | Baghri | Pennisetum spicatum, Roem. & Schult. | 183 |
| 15 | Bajra | P. spicatum. R. & S. | 183 |
| 16 | Bajri | P. spicatum, R. & S. | 183 |
| 17 | Bal | Heteropogon contortus, Roem. & Schult. | 109 |
| 18 | Bala | Vetiveria zizanioides, Stapf. | 65 |
| 19 | Bale | Heteropogon contortus, Roem. & Schult. | 109 |
| 20 | Bamboo grass | Pagonatherum saccharoideum, P. Beauv. | 25 |
| 21 | Bamna | Chloris incompleta, Roth. | 253 |
| 22 | Bandra | Setaria glauca, Beauv. | 173 |
| 23 | Bandri | S. glauca, B. | 173 |
| 24 | Bangadi | Ischaemum aristatum, Linn. | 11 |
| 25 | Bans | Dendrocalamus strictus, Nees. | 285 |
| 26 | Bansi | Panicum miliaceum, Linn. | 159 |
| 27 | Banti | Echinochloa stagnana, Beauv. | 151 |
| 28 | Bar | Ischaemum rugosum, Salisb. | 13 |
| 29 | Bar | Ischaemum ciliare, Retz. | 18 |
| 30 | Bara | I. ciliare, R. | 18 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 31 | Bara-Churbhura | Eragrostis tenella, P. Beauv. | 232 |
| 32 | Baragu | Panicum miliare, Lam. | 160 |
| 33 | Barchente | Nazia racemosa, Kuntze. | 217 |
| 34 | Bardani | Setaria verticillata, Beauv. | 174 |
| 35 | Bardi | Ischaemum rugosum, Salisb. | 13 |
| 36 | Barigali | Panicum antidotale Retz. | 163 |
| 37 | Bari Joar | Zea Mays, Linn. | 2 |
| 38 | Barik bambu | Bambusa nana, Roxb. | 282 |
| 39 | Barki | Themeda tremula, Hack. | 119 |
| 40 | Barley | Hordeum vulgare, Linn. | 280 |
| 41 | Barn | Panicum antidotale, Retz. | 169 |
| 42 | Baru | Sorghum halepense, Pers. | 56 |
| 43 | Barucha | Thysanolaena procera, Mez. | 201 |
| 44 | Barwari | Panicum antidotale, Retz. | 163 |
| 45 | Basa | Dendrocalamus, strictus, Necs. | 285 |
| 46 | Batal | Sorghum halepense, Pers. | 56 |
| 47 | Batani | Themeda triandra, Forsk. | 115 |
| 48 | Bavto | Echinochloa colona, Link. Var. frumentacea, Bl. & McC. | 149 |
| 49 | Badari | Gracilea Royleana, Hook. f | 249 |
| 50 | Ber | Ischaemum semisagittatum, Roxb. | 15 |
| 51 | Bermuda grass | Cynodon dactylon, Pers. | 250 |
| 52 | Bhabar | Polinidium binatum, ( Retz. ) C. E. Hubbard. | 24 |
| 53 | Bhadli | Setaria glauca. Beauv. | 173 |
| 54 | Bhadli | Setaria italica, Beauv. | 175 |
| 55 | Bhale-kusal | Heteropogon insignis, Thw. | 108 |
| 56 | Bharbhuri | Eragrostis tenella, P. Beauv. | 232 |
| 57 | Bharbusi | E. tenella, P. B. | 232 |
| 58 | Bharont | Cenchrus catharticus, Del. | 186 |
| 59 | Bhas | Apluda varia, Var. aristata, Hack. | 29 |
| 60 | Bhat | Oryza sativa, Linn. | 274 |
| 61 | Bhantandi | Themeda tremula, Hack. | 119 |
| 62 | Bhatharu | T. quadrivalvis, O. Kuntze | 118 |
| 63 | Bhathu | T. quadrivalvis, O. K. | 118 |
| 64 | Bhati | ,, ,, ,, | 118 |
| 65 | Bhatur | Panicum trypheron, Schult. | 158 |
| 66 | Bher | Ischaemum rugosum, Salisb. | 13 |
| 67 | Bherda | I. aristatum, Linn. | 11 |
| 68 | Bhichusa | Apluda varia Var. aristate, Hack. | 29 |
| 69 | Bhobra | Dactyloctenium scindicum, Boiss. | 264 |
| 70 | Bhobriya | D. Scindicum, B. | 264 |
| 71 | Bhoru | Themeda triandra, Forsk | 115 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 72 | Bhos | Amphilophis odorata, A. Camus. | 89 |
| 73 | Bhulni | Eragrostis viscosa, Trin. | 233 |
| 74 | Bhurbur | E. viscosa, T. | 233 |
| 75 | Bhurbusi | E. viscosa, T. | 233 |
| 76 | Birdi | Setaria glauca, Beauv. | 173 |
| 77 | Boari | Eremopogon foveolatus, Stapf. | 96 |
| 78 | Bochri | Saccharum spontaneum, Linn. | 45 |
| 79 | Bonda | Zea Mays, Linn. | 2 |
| 80 | Bongrut | Themeda quadrivalvis, O. Kuntze. | 118 |
| 81 | Boota | Zea Mays, Linn. | 2 |
| 82 | Borati | Panicum Paludosum, Roxb. | 162 |
| 83 | Boru | Sorghum halepense, Pers. | 56 |
| 84 | Borur | Echinochloa colona, Link. | 148 |
| 85 | Bovar | E. Crus-Galli, P. Beauv. | 150 |
| 86 | Broom-Corn | Panicum miliaceum, Linn. | 159 |
| 87 | Buffalo grass | Brachiaria mutica, Stapf. | 134 |
| 88 | Bulrush millet | Pennisetum spicatum, Roem. & Schult. | 182 |
| 89 | Bunden | Themeda triandra, Forsk. | 115 |
| 90 | Bungrat | T. Triandra, F. | 115 |
| 91 | Bungrat | Temula, Hack. | 119 |
| 92 | Bura | Rotboellia exaltata, Linn. f. | 38 |
| 93 | Burbudi | Eragrostis ciliares, Link. | 231 |
| 94 | Burbudi | Panicum miliare, Lam. | 160 |
| 95 | Bursali | Rotboellia exaltata, Linn. f. | 38 |
| 96 | Burwai | Eragrostis pilosa, Beauv. | 241 |
| 97 | Bushi-kussal | Aristida funiculata, Trin. | 214 |
| 98 | Cat-tail millet | Pennisetum spicatum, Roem & Schult. | 183 |
| 99 | Chamge | Iseilema laxum, Hack. | 113 |
| 100 | Chaoria | Dichanthium caricosum, A. Camus. | 93 |
| 101 | Chapar | Brachiaria ramosa, Stapf. | 134 |
| 102 | Chapsura | B. ramosa, S. | 134 |
| 103 | Chansarieu | Digitaria marginata, Link. Var. fimbriata, Stapf. | 125 |
| 104 | Chauval | Oryza sativa, Linn. | 274 |
| 105 | Chenhel | Leptochloa chinensis, Nees. | 244 |
| 106 | Cheno | Panicum miliaceum, Linn. | 159 |
| 107 | Chickwar | Apluda varia, Var. aristata, Hack. | 29 |
| 108 | Chiklenta | Setaria verticillata, Beauv. | 174 |
| 109 | Chiksi | Eragrostis interrupta, Beauv. | 234 |
| 110 | Chikta | E. nutans, ( Retz. ) Nees. | 237 |
| 111 | Chikti | E. viscosa, Trin. | 233 |
| 112 | Chilaya | Setaria verticillata, Beauv. | 174 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 113 | Chimachara | Urochloa reptans. Stapf. | 144 |
| 114 | Chimanchara | Andropogon pumilus, Roxb. | 99 |
| 115 | Chimanchara | Eragrostis nutans ( Retz. ) Nees. | 237 |
| 116 | Chimansar | Elytrophorus articulatus, Beauv. | 276 |
| 117 | Chinee | Panicum miliaceum, Linn. | 159 |
| 118 | Chinkhe | Eleusine verticillata, Roxb. | 260 |
| 119 | Chipal | Eragrostis viscosa, Trin. | 233 |
| 120 | Chiraka | E. tremula, Hochst. | 239 |
| 121 | Chiraka | E. bifaria, Wight. | 241 |
| 122 | Chirchira | Setaria verticillata, Beauv. | 174 |
| 123 | Chireya-ka-dana | Sporobolus diander, Beauv. | 222 |
| 124 | Chirika chanvalia | Eragrostis tremula, Hochst. | 239 |
| 125 | Chirika-dana | E. pilosa, Beauv. | 241 |
| 126 | Chirika ket | E. tremula, Hochst. | 239 |
| 127 | Chiriyaka dana | Setaria intermedia, Roem. & Schult. | 174 |
| 128 | Chirwa | Panicum miliaceum, Linn. | 159 |
| 129 | Chitra | Polypogon monspeliensis Desf. | 207 |
| 130 | Chivari | Oxytenanthera Stocksii, Munro. | 284 |
| 131 | Chokha | Oryza sativa, Linn. | 274 |
| 132 | Chota asara | Eragrostis gangetica, Steud. | 236 |
| 133 | Chota blankta | E. bifaria, Wight. | 241 |
| 134 | Chota kussal | Eulalia argentea, Brogn. | 53 |
| 135 | Chota loniya | Eragrostis unioloides, Nees. | 235 |
| 136 | Choti khidi | E. nutans, (Retz) Nees. | 235 |
| 137 | Choua | Oxytenanthera Ritcheyi, B 1. & McC. | 284 |
| 138 | Christ's Tears | Coix Lachryma-Jobi, Linn. | 4 |
| 139 | Common Millet | Panicum miliaceum, Linn. | 159 |
| 140 | Couch grass | Cynodon dactylon, Pers. | 250 |
| 141 | Crab grass | Eleusine indica, Gaertn. | 289 |
| 142 | Crowfoot grass | E. indica, G. | 259 |
| 143 | Dab | Desmostachya bipinnata, Stapf. | 243 |
| 144 | Dabvi | D. bipinnata, S. | 243 |
| 145 | Dacle | Sorghum halepense, Pers. | 56 |
| 146 | Dagussa | Eleusine coracana, Gaertu. | 260 |
| 147 | Dakli-suckal | Heteropogon contortus, Roem & Schhlt | 109 |
| 148 | Dalaga | Ischaemum semisagittatum, Roxb. | 15 |
| 149 | Dand | Chrysopogon montanus, Trin. | 71 |
| 150 | Dangar Bhatta | Oryza sativa, Linn. | 274 |
| 151 | Dangers | Iseilema laxum, Hack. | 113 |
| 152 | Darbha | Desmostachya bipinnata, Stapf. | 245 |
| 153 | Dareya | Dichanthium annulatum, Stapf. | 94 |
| 154 | Datura ghas | Manisuris granularis, Linn. f. | 32 |
| 155 | Dauria | Isachne australis, R. Br. | 188 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 156 | Deobhat | Hygroryza aristata, Nees. | 271 |
| 157 | Dhab | Desmostachya bipinnata, Stapf. | 245 |
| 158 | Dhaman | Cenchrus, biflorus, Roxb. | 185 |
| 159 | Dhane | Eragrostis tenella, P. Beauv. | 232 |
| 160 | Dharbi | Saccharum spontaneum. Linn. | 45 |
| 161 | Dhone | Paspalum scrobiculatum, Linn. | 137 |
| 162 | Dhoob | Cynodon dactylon, Pers. | 250 |
| 163 | Dhrow | Dichanthium annulatum, Stapf. | 94 |
| 164 | Dhub | Imperata cylindrica, (Linn) P. Beauv. | 42 |
| 165 | Dhub | Saccharum spontaneum, Linn. | 45 |
| 166 | Dhuria | Eragrostis interrupta, Beauv. | 234 |
| 167 | Dib | Desmostachya bipinnata, Stapf. | 245 |
| 168 | Didhina | Sacciolepis myosuroides, Haines. | 166 |
| 169 | Dinohi | Digitaria marginata, Link. Var. fimbriata. | 125 |
| 170 | Dearia | Isachne australis, R. Br. | 188 |
| 171 | Dongri | Gracilea Royleana, Hook. f. | 249 |
| 172 | Doonda | Isachne elegans, Dalz. | 187 |
| 173 | Dossa | Paspalidium punctatum, A. Camus. | 142 |
| 174 | Doub grass | Cynodon dactylon, Pers. | 250 |
| 175 | Drab | Desmostachya bipinnata, Stapf. | 245 |
| 176 | Dubra dub | Cynodon dactylon, Pers. | 250 |
| 177 | Dundi | Arundinella Lawii, Hook. f. | 195 |
| 178 | Dungri-kunda | Ischaemum pilosum, Hack. | 14 |
| 179 | Durba | Cynodon dactylon, Pers. | 250 |
| 180 | Durper | Desmostachya bipinnata, stapf. | 245 |
| 181 | Durva | Cynodon dactylon, Pers. | 250 |
| 182 | Dwarf Bamboo | Bambusa nana, Roxb. | 282 |
| 183 | Elephant Grass | Pennisetum purpureum, Schum. & Thenn. | 184 |
| 184 | Eunthi hullu | Cymbopogon Martini, Stapf. | 104 |
| 185 | Farkria | Digitaria marginata, Var. fimbriata, Stapf. | 125 |
| 186 | Faliu | Chloris virgata, Sw. | 255 |
| 187 | Faradyachne gavat | Arthraxon lancifolius, Hochst. | 77 |
| 188 | Foxtail Millet | Setaria italica, Beauv. | 175 |
| 189 | Ful-gavat | Themeda cymbaria, Hack. | 118 |
| 190 | Fulia | Eragrostis nutans, ( Retz. ) Nees. | 237 |
| 191 | Fulkalu | Chloris virgata, Sw. | 255 |
| 192 | Gadhiu | C. virgata, S. | 255 |
| 198 | Gadre | Panicum miliare, Lam. | 160 |
| 194 | Gahu | Triticum aestivum, Linn. | 279 |
| 195 | Gejre | Panicum miliaceum, Linn. | 280 |
| 196 | Gandeli | Iseilema Wightii, Andets. | 113 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 197 | Ganderi | Saccharum officinarum, Linn. | 46 |
| 198 | Gandh-bel | Cymbopogon Martini, Stapf. | 104 |
| 199 | Gandhi | Iseilema laxum, Hack. | 113 |
| 200 | Gandhi | I. wightii, Anders. | 113 |
| 201 | Gandhi | Dactyloctenium aegyptium, Richt. | 263 |
| 202 | Gandil | Iseilema laxum, Hack. | 113 |
| 203 | Gandwel | I. laxum, H. | 113 |
| 204 | Ganjali hullu | Chloris virgata, Sw. | 255 |
| 205 | Ganni | Iseilema Wightii, Anders, | 113 |
| 206 | Garyali | Heteropogon contortus, Roem & Schult | 109 |
| 207 | Gavatvedi | Amphilophis odorata, A, Camus. | 89 |
| 208 | *Geranium* grass | Cymbopogon Martini, Stapf. | 104 |
| 209 | Ghamar | Panicum antidotale, Retz. | 163 |
| 210 | Ghandel | Eremopogon foveolatus, Stapf,. | 96 |
| 211 | Ghanga | Amphilophis pertusa, Stapf. | 84 |
| 212 | Gharam | Panicum antidotale, Retz. | 163 |
| 213 | Ghatyari | Cymbopogon Schoenanthus, Spreng. | 101 |
| 214 | Ghodila | Eragrostis interrupta, Beauv. | 234 |
| 215 | Ghora | Chrysopogon montanus, Trin. | 71 |
| 216 | Ghorla | Sporobolus indicus, R. Br. | 223 |
| 217 | Ghorila | Eragrostis interrupta, Beauv. | 234 |
| 218 | Giant bamboo | Dendrocalamus giganteus, Munre. | 286 |
| 219 | Giant Reed | Arundo Donax, Linn. | 204 |
| 220 | Girni | Panicum antidotale, Retz. | 163 |
| 221 | Git | P. antidotale, R. | 163 |
| 222 | Godhi | Triticum aestivum, Linn. | 279 |
| 223 | Gogar | Chrysopogon montanus, Trin. | 70 |
| 224 | Goinjol | Zea Mays, Linn. | 2 |
| 225 | Golden Crown Grass | Paspalum dilatatum, Poir. | 138 |
| 226 | Gondal | Andropogon pumilus, Roxb. | 99 |
| 227 | Gondo gavat | Chloris virgata, Sw. | 255 |
| 228 | Gondwal | Andropogon pumilus. Roxb. | 99 |
| 229 | Gondwal | Iseilema Wightii, Anders. | 113 |
| 230 | Govinder | Arthraxon serulatus, Hochst. | 75 |
| 231 | Great Millet (the) | Sorghum vulgare, Pers. | 58 |
| 232 | Green stripped bamboo | Bambusa vulgaris, Schrad. Var. Striata. Auct. | 283 |
| 233 | Gub | Setaria glauca, Beauv. | 173 |
| 234 | Guder | Eleusine indica, Gaertn. | 259 |
| 235 | Guinea Grass | Panicum maximum, Jacq. | 162 |
| 236 | Guj | Ischaemum aristatum, Linn. | 11 |
| 237 | Guli | Gracilea Royleana, Hook. f. | 249 |
| 238 | Gundi | Themeda tremula, Hack. | 119 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 239 | Gurgur | Coix Lachryma-Jobi, Linn. | 4 |
| 240 | Gurgur | Polytoca barbata, Stapf. | 6 |
| 241 | Hairy-flowered Paspalum | Paspalum dilatatum, Poir. | 138 |
| 242 | Hakki kalin hullu | Dactyloctenium aegyptium, Richt. | 263 |
| 243 | Halgyan hullu | Dinebra retroflexa, Panzer. | 265 |
| 244 | Halligyan hullu | D. retroflexa, P. | 265 |
| 245 | Halvivari | Panicum miliare, Lam. | 160 |
| 246 | Handi daroya | Dichanthium annulatum, Stapf. | 94 |
| 247 | Harala | Cynodon dactylon, Pers. | 250 |
| 248 | Harjala | Arthraxon serrulatus, Hochst. | 75 |
| 249 | Harrick | Paspalum scrobiculatum, Linn. | 137 |
| 250 | Haryeli | Cynodon dactylon, Pers. | 250 |
| 251 | Hirvacha | Cymbopogon citratus, Stapf. | 103 |
| 252 | Hog-Millet | Panicum miliaceum, Linn. | 159 |
| 253 | Huda | Ochlandra Talboti, Brandis. | 287 |
| 254 | Hutia | Ophiurus corymbosus, Gaertn. f. | 40 |
| 255 | Ichooi | Eragrostis tenella, P. Beauv. | 232 |
| 256 | Indian Corn | Zea Mays, Linn. | 2 |
| 257 | Iskir | Cymbopogon Schoenanthus, Spreng. | 101 |
| 258 | Italian Millet | Setaria italica, Beauv. | 175 |
| 259 | Itali-suckal | Heteropogon contortus, Roem. and Schult. | 109 |
| 260 | Jai | Avena sativa, Linn. | 199 |
| 261 | Jaura | Eleusine verticillata, Roxb. | 260 |
| 262 | Jave godhi | Hordeum vulgare, Linn. | 280 |
| 263 | Java satu | H. vulgare, Linn. | 280 |
| 264 | Jawa | H. vulgare, Linn. | 280 |
| 265 | Jenkua | Eragrostis nutans, (Retz) Nees | 237 |
| 266 | Jetara | Dichanthium caricosum, A. Camus. | 93 |
| 267 | Jhira | Leptochloa chinensis, Nees. | 244 |
| 268 | Jinjva | Dichanthium annulatum, Stapf. | 94 |
| 269 | Jiria | Echinochloa colona, Link. | 148 |
| 270 | Job's Tears | Coix Lachryma-Jobi, Linn. | 4 |
| 271 | Jondla | Sorghum vulgare, Pers. | 58 |
| 272 | Jowar | S. vulgare, P. | 58 |
| 273 | Juari | S. vulgare, P. | 58 |
| 274 | Jungli rala | Elytrophorus articulatus, Beauv. | 276 |
| 275 | Jwarankusa | Cymbopogon Jwarancusa, Schult. | 102 |
| 276 | Kabbu | Saccharum officinarum, Linn. | 46 |
| 277 | Kadi | Thelepogon elegans, Roth. | 27 |
| 278 | Kagya | Chloris tenella, Koan. | 254 |
| 279 | Kal | Sporobolus orientalis, Kunth. | 226 |
| 280 | Kalak | Bambusa arundinacea, Retz. | 283 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 281 | Kalam hullu | Digitaria marginata, Linn. Var. fimbriata, Stapf. | 125 |
| 282 | Kale kussal | Aristida Hystrix, Linn. f. | 211 |
| 283 | Kali kauli | Dinebra retroflexa, Panzer. | 265 |
| 284 | Kali Kusal | Heteropogon insignis, Thw. | 108 |
| 285 | Kaluargi | Eragrostis gangetica, Steud. | 236 |
| 286 | Kamand | Saccharum officinarum, Linn. | 46 |
| 287 | Kamis | S. spontaneum, Linn. | 45 |
| 288 | Kan | S. spontaneum, Linn. | 45 |
| 289 | Kanden | Ischaemum aristatum, Linn. | 11 |
| 290 | Kang | Setaria italica, Beauv. | 175 |
| 291 | Kangni | S. glauca, Beauv. | 173 |
| 292 | Kangri | Manisuris granularis, Linn. f. | 32 |
| 293 | Kania bans | Dendrocalemus strictus, Nees. | 285 |
| 294 | Kanigyanhulla | Ishaemum pilosum, Hack. | 14 |
| 295 | Kanik | Triticum aestivum, Linn. | 279 |
| 296 | Kansi | Eleusine verticillata, Roxb. | 260 |
| 297 | Kanta-karvel | Polytoca barbata, Stapf. | 6 |
| 298 | Kaodia | Eragrostis cilianensis, (All) Link. | 238 |
| 299 | Kap. kurdi | Dimeria ornithopoda, Trin. | 8 |
| 300 | Karad | Themeda triandra, Forsk. | 115 |
| 301 | Karar | Themeda cymbaria, Hack. | 118 |
| 302 | Karang | Polytoca barbata, Stapf. | 6 |
| 303 | Kard | Eremopogon foveolatus, Stapf. | 96 |
| 304 | Kardia | Coix Lachryma-Jobi, Linn. | 4 |
| 305 | Kare hullu | Chrysopogon montanus, Trin. | 71 |
| 306 | Kari | Ischaemum semisagittatum, Roxb. | 15 |
| 307 | Karkel | I. rugosum, Salisb. | 13 |
| 308 | Kartal | Sorghum halpense, Pers. | 56 |
| 309 | Karvel | Ophiurus megaphyllus, Stapf. | 39 |
| 310 | Kassaibij | Coix Lachryma-Jobi, Linn. | 4 |
| 311 | Kassar | C. Lachryma-Jobi, Linn. | 4 |
| 312 | Katia | Ophiurus megaphyllus, Stapf. | 39 |
| 313 | Kavance hullu | Cymbopogon citratus, Stapf. | 103 |
| 314 | Kawdia | Polytoca barbata, Stapf. | 6 |
| 315 | Kemshi | Elytcophorus articulatus, Beauv. | 276 |
| 316 | Kerpa | Saccharum arundinaceum, Retz. | 47 |
| 317 | Keruch | Coix Lachryma-Jobi, Linn. | 4 |
| 318 | Ket kapuri | Elytrophorus articulatus, Beauv. | 276 |
| 319 | Khair | Saccharum spontaneum, Linn. | 45 |
| 320 | Khari | Eragrostis nutans ( Retz ) Nees. | 237 |
| 321 | Kharia | Dinebra retroflexa, Panzer. | 265 |
| 322 | Khariu | Chloris virgata, Sw. | 255 |
| 323 | Kharrut | C. virgata, S. | 255 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 324 | Kharwel | Apluda varia, Hack. Var. aristata, Hack. | 29 |
| 325 | Khasi hullu | Cymbopogon Martini, Stapf. | 104 |
| 326 | Khas-khas | Vetiveria zizanioides, Stapf. | 65 |
| 327 | Khavas | Apluda varia, Var. aristata, Hack. | 29 |
| 328 | Khavi | Cymbopogon Schaenanthus, Spreng. | 101 |
| 329 | Khavi | C. Jwarancusa, Schult. | 102 |
| 330 | Khave | Ischaemum pilosum, Hack. | 14 |
| 331 | Khurd | Eleusine indica, Gaertn. | 259 |
| 332 | Khurdmendi | E. indica G. | 259 |
| 333 | Kodra | Paspalum scrobiculatum, Linn. | 137 |
| 334 | Kolara | Setaria glauca, Beauv. | 173 |
| 335 | Konda | Oxytenanthera Stocksii, Munre. | 284 |
| 336 | Konda canookoo | Rotboellia exaltata, Linn. f. | 38 |
| 337 | Koosha | Desmostachya bipinnata, Stapf. | 245 |
| 338 | Korakan | Eleusine coracana, Gaertn. | 260 |
| 339 | Koralom | Sacciolepis myosuroides, Haines. | 166 |
| 340 | Kotir | Dimeria diandra, Stapf. | 10 |
| 341 | Kotir | Arundinella Setosa, Trin. | 192 |
| 342 | Kotir | A. Lawii, Hook. f. | 195 |
| 343 | Krer | Eulalia argentea, Brogn. | 53 |
| 344 | Kudak | Oplismenus Burmannii, P. Beauv. | 154 |
| 345 | Kukar | Cenchrus catharticus, Del. | 186 |
| 346 | Kulluk | Bambusa vulgaris, Schrad. | 282 |
| 347 | Kulti | Panicum miliare, Lam. | 166 |
| 348 | Kulus-nan | Panicum paludosum, Roxb. | 162 |
| 349 | Kuncha | Chloris incompleta, Roth. | 253 |
| 350 | Kunda | Ischaemum pilosum, Hack. | 14 |
| 351 | Kurad | Digitaria marginata Link. Var. fimbriata, (Hack). | 125 |
| 352 | Kuras | Perotis indica, (Linn) O. Kuntze. | 220 |
| 353 | Kurdia | Apluda varia, Var. aristata, Hack. | 29 |
| 354 | Kuri | Urochloa Helopus, Stapf. | 147 |
| 355 | Kuri | Panicum miliare, Lam. | 160 |
| 356 | Kuri-chinke | Eleusine verticillata, Roxb. | 260 |
| 357 | Kurisal | Polytoca Cookei, Stapf. | 5 |
| 358 | Kuriya | Urochloa Helopus, Stapf. | 147 |
| 359 | Kusal | Heteropogon contortus, Roem. & Schult. | 109 |
| 360 | Kusali | H. contortus, R. & S. | 109 |
| 361 | Kushuli satu | Hordeum vulgare, Linn. | 280 |
| 362 | Kussa | Desmostachya bipinnata, Stapf. | 245 |
| 363 | Kutaki | Eragrostis pilosa, Beauv. | 241 |
| 364 | Lag | Ischaemum rugosum, Salisb. | 13 |
| 365 | Lalgavat | Andropogon pumilus, Roxb. | 99 |
| 366 | Landga-kussal | Gracilea Royleana, Hook. f. | 249 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 367 | Landgar | Setaria intermedia, Roem. & Schult. | 174 |
| 368 | Landgeya-kussal | Gracilea Royleana, Hook. f. | 249 |
| 369 | Lani | Aristida Adscensionis, Linn. | 210 |
| 370 | Lapti | Setaria verticillata, Beauv. | 174 |
| 371 | Large water-grass | Paspalum dilatatum, Poir. | 138 |
| 372 | Leichardt Grass | P. dilatatum, Poir. | 138 |
| 373 | Lemon Grass | Cymbopogon citratus, Stapf. | 103 |
| 374 | Lili cha | C. citratus, Stapf. | 103 |
| 375 | Little Millet | Panicum miliare, Lam. | 160 |
| 376 | Lona | Dinebra retreflexa, Panzer. | 265 |
| 377 | Longi-kussal | Aristida Adscensionis, Linn. | 210 |
| 378 | Loniya | Eragrostis unioloides, Nees. | 235 |
| 379 | Lundi | Setaria intermedia, Roem. & Schult. | 174 |
| 380 | Luni | Aleuropus repens, (Desf) Parl. | 277 |
| 381 | Mabil | Iseilema Wightii, Anders. | 113 |
| 382 | Mace | Dendrocalamus strictus, Nees. | 285 |
| 383 | Macka | Zea Mays, Linn. | 2 |
| 384 | Madra | Eragrostis interrupta, Beauv. | 234 |
| 385 | Maize | Zea Mays, Linn. | 2 |
| 386 | Majjige hullu | Cymbopogon citratus, Stapf. | 103 |
| 387 | Majore | Paspalum scrobiculatum, Linn. | 137 |
| 388 | Makai | Zea Mays, Linn. | 2 |
| 389 | Makka | Apluda varia, Var. aristata, Hack. | 29 |
| 390 | Makra | Eleusine coracona, Gaertn. | 260 |
| 391 | Malakava | Andropogon pumilus, Roxb. | 99 |
| 392 | Male | Panicum antidotale, Retz. | 163 |
| 393 | Male bamboo | Dendrocalamus, strictus, Nees. | 285 |
| 394 | Malhar | Polypogon monspeliensis, Desf. | 208 |
| 395 | Mana Kodra | Paspyalum scrobiculatum, Linn. | 137 |
| 396 | Manchi | Dactyloctenium aegyptium, Richt. | 263 |
| 397 | Mandjiro | D. Scindicum, Boiss. | 264 |
| 398 | Mandua | Eleusine coracana, Gaertn. | 260 |
| 399 | Mangrur | Panicum antidotale. Retz. | 163 |
| 400 | Manila Grass | Osterdamia Matrella, O. Kuntze. | 219 |
| 401 | Marar | Themeda triandra, Forsk. | 115 |
| 402 | Marel | Peltophorus divergens, (Hack) Camus. | 34 |
| 403 | Marua | Eleusine coracana, Gaertn. | 260 |
| 404 | Marvel | Peltophorus divergens, (Hack) Camus. | 34 |
| 405 | Marvel | Amphilophis pertusa, Stapf. | 84 |
| 406 | Marvel | Dicanthium caricosum, A. Camus. | 93 |
| 407 | Marvel | D. annulatum, Stapf. | 94 |
| 408 | Marvel | Eremopogon feveolatus, Stapf. | 96 |
| 409 | Marwalyan-hullu | Dichanthium annulatum, Stapf. | 94 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 410 | Masel | Iseilema laxum, Hack. | 113 |
| 411 | Matari-kussal | Aristida Hystrix, Linn. f. | 211 |
| 412 | Mathanya | Chloris incompleta. Roth | 253 |
| 413 | Mauritius Grass | Brachiaria mutica, Stapf. | 134 |
| 414 | Medar | Dendrocalamus strictus, Nees. | 285 |
| 415 | Medha | Eleusine indica Gaertn. | 259 |
| 416 | Meckejol | Zea Mays, Linn. | 2 |
| 417 | Mendla | Eleusine indica, Gaertn. | 259 |
| 418 | Mes | Oxytenanthera Stocksii Munro. | 284 |
| 419 | Mes | Dendrocalamus strictus, Nees. | 285 |
| 420 | Mirchia gandh | Cymbopogon martini, Stapf. | 104 |
| 421 | Modhan | Digitaria marginata, Link. Var. fimbriata, Stapf. | 125 |
| 422 | Moi | Eragrostis bifaria, Wight. | 241 |
| 423 | Mordanura | Panicum psilopodium, Trin. | 158 |
| 424 | Moshi | Iseilema Wightii, Anders. | 113 |
| 425 | Mothi bathi | Themeda quadrivalvis, O. Kuntze. | 118 |
| 426 | Mothi Kusal | Heteropogon insignis, Thw. | 108 |
| 427 | Mothi Kussal | Aristida setacia, Retz. | 211 |
| 428 | Motia | Brachiaria distachya, Haines. | 135 |
| 429 | Moti chava | Eragrostis unioloides, Nees. | 235 |
| 430 | Motti-burri | Aristida Adscensionis, Linn. | 210 |
| 431 | Mundgay | Bambusa arundinacea, Retz. | 283 |
| 432 | Munj | Saccharum Munja, Roxb. | 48 |
| 433 | Munja | S. Munja, Roxb. | 48 |
| 434 | Musani | Themeda triandra, Forsk. | 115 |
| 435 | Musa-panchi | Sacciolepis myosuroides, Haines. | 166 |
| 436 | Mussan | Iseilema Wightii, Anders. | 113 |
| 437 | Nachani | Eleusine coracana, Gaertn. | 260 |
| 438 | Nachni | E. coracana, G. | 260 |
| 439 | Nagli | E. coracana G. | 260 |
| 440 | Naka-kera | Setaria glauca, Beauv. | 173 |
| 441 | Nanguli | Eleusine coracana, Gaertn. | 260 |
| 442 | Nani sunkhali | Heteropogon contortus, Roem. & Schult. | 109 |
| 443 | Napier's Fodder | Pennisetum purpureum, Schum & Thenn. | 184 |
| 444 | Nari baluda hullu | Dinebra retroflexa, Panzer. | 265 |
| 445 | Narkul | Phragmites maxima, Blatter &McCann. | 203 |
| 446 | Nellu | Oryza sativa, Linn. | 274 |
| 447 | Nika gadi | Chloris incompleta, Roth. | 253 |
| 448 | Nilidub | Cynodon dactylon, Pers. | 250 |
| 449 | Nuth | Ischaemum pilosum, Hack. | 14 |
| 450 | Oats | Avena sativa, Linn. | 199 |
| 451 | Oleu cha | Cymbopogon citratus, Stapf. | 103 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 452 | Oor-sheme | Oxytenanthera Stocksii, Munro. | 284 |
| 453 | Pacad | Echinochlea Crus-Galli, P. Beauv. | 150 |
| 454 | Pacushama | E. colona, Link. | 148 |
| 455 | Pakedi | Paspalum, scrobiculatum, Linn. | 137 |
| 456 | Pakud | Echinoclea colona, Link. | 148 |
| 457 | Pal | Sehima nervosum, Stapf. | 21 |
| 458 | Palva | Amphilophis pertusa, Stapf. | 84 |
| 459 | Palvan | A. pertusa, Stapf. | 84 |
| 460 | Palvan-hullu | Dichanthium annulatum, Stapf. | 94 |
| 461 | Pandri kussal | Aristida funiculata, Trin. & Rupr. | 214 |
| 462 | Pandri-suckali | Heteropogon contortus, Roem. & Schult. | 109 |
| 463 | Pandhari kusal | Chrysopogon montanus, Trin. | 70 |
| 464 | Pandhri kussal | Aristida funiculata, Trin. & Rupr. | 214 |
| 465 | Paodi | Apluda varia, Var. aristata, Hack. | 29 |
| 466 | Para Grass | Brachiaria mutica, Stapf. | 134 |
| 467 | Patang | Dichanthium caricosum, A. Camus. | 93 |
| 468 | Patang | Heteropogon insignis, Thw. | 108 |
| 469 | Paunat | Sehima nervosum, Stapf. | 21 |
| 470 | Pavna | S. nervosum, Stapf. | 21 |
| 471 | Pavna | S. Sulcatum, Camus. | 23 |
| 472 | Pawn-burri | Aristida Hystrix, Linn. f. | 211 |
| 473 | Payen | Amphilophis pertusa, Stapf. | 84 |
| 474 | Perarl Millet | Pennisetum spicatum, Roem. & Schult. | 183 |
| 475 | Pet-nar | Paspalidum punctatum. A. Comus. | 142 |
| 476 | Pharari | Ischaemum pilosum, Hack. | 14 |
| 477 | Phikar | Panicum miliaceum, Linn. | 159 |
| 478 | Phulaer | Apluda varia, Var. aristata, Hack. | 29 |
| 479 | Phulkaia | Leptochloa chinensis, Nees. | 244 |
| 480 | Phulse | Apluda varia, var. aristate, Hack. | 29 |
| 481 | Pingi-natchi | Setaria glauca, Beauv. | 173 |
| 482 | Poche | Eragrostis interrupta, Beauv. | 234 |
| 483 | Peckli | Apluda varia, Var. aristata, Hack. | 29 |
| 484 | Pocklia | Apluda varia, Var. aristata, H. | 29 |
| 485 | Pohe | Eragrostis interrupta, Beauv. | 234 |
| 486 | Pohe | E. cilianensis, (All) Link. | 238 |
| 487 | Poi | Panicum miliare, Lam. | 160 |
| 488 | Poi | Eragrostis unioloides, Nees. | 235 |
| 489 | Pokalia | Hymenachne myuros. Beauv. | 155 |
| 490 | Pokalia | Sacciolepis myosuroides, Hanies. | 166 |
| 491 | Pokalia | S. interrupta, Stapf. | 167 |
| 492 | Pokalya | Pseudanthistiria hispida, Hook. f. | 120 |
| 493 | Pike | Eragrostis unioloides, Nees. | 235 |
| 494 | Poshe | Elytrophorus articulatus, Beaav. | 276 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 495 | Prose Millet | Panicum miliaceum, Linn. | 159 |
| 496 | Punya-sufed | Eragrostis bifaria, Wight. | 241 |
| 497 | Putena | Ischaemum ciliare, Retz. | 18 |
| 498 | Ragi | Eleusine Coracana, Gaertn. | 260 |
| 499 | Rala | Setaria italica, Beauv. | 175 |
| 500 | Rali | Panicum miliaceum, Linn. | 159 |
| 501 | Ran-jondhla | Coix Lachryma-Jobi, Linn. | 4 |
| 502 | Ranmaka | C. Lachryma-Jobi, Linn. | 4 |
| 503 | Ran pohe | Eragrostis cilianensis, (All) Link. | 238 |
| 504 | Rauns | Cymbopogon Martini, Stapf. | 104 |
| 505 | Revga | Digitaria marginata, Link. Var. fimbriata, Stapf. | 125 |
| 506 | Rhodes Grass | Chloris gayana, Kunth. | 258 |
| 507 | Rhonse | Cymbopogon Martini, Stapf. | 104 |
| 508 | Rohish | C Martini, Stapf. | 104 |
| 509 | Rohisha | C. Martini, Stapf. | 104 |
| 510 | Roira | Eulalia argentea, Brogn, | 53 |
| 511 | Rosem | Cymbopogon Martini, Stapf. | 104 |
| 512 | Roshegavat | C. Martini, Stapf. | 104 |
| 513 | Rusa | C. Martini, Stapf. | 104 |
| 514 | Rusa grass | C. Martini, Stapf. | 104 |
| 515 | Sabai | Pollinidium binatum, (Retz) C. E. Hubbard. | 24 |
| 516 | Sabie | P. binatum, (Retz) C. E. Hubbard. | 24 |
| 517 | Sadhe satu | Hordeum vulgare, Linn. | 280 |
| 518 | Sajgure | Pennisetum spicatum, Roem and Schult. | 183 |
| 519 | Saj-kadi | Ischaemum semisagittatum, Roxb. | 15 |
| 520 | Salkot | Panicum montanum, Roxb. | 164 |
| 521 | Sama | Echinocloa colona, Link. Var. frumentacea, Blatter and McCann. | 149 |
| 522 | Same | E. colona, Link. Var. frumentacea, Blatter and McCann. | 149 |
| 523 | Sam-payen | Dichanthium annulatum, Stapf. | 94 |
| 524 | Samuka | Echinochloa colona, Link. Var. frumentacea, Blatter and McCann. | 149 |
| 525 | Sanwak | Echinochloa colona, Link. Var. frumentacea, Blatter and McCann. | 149 |
| 526 | Saon saron | E. colona Var. frumentacea, B. and M. | 149 |
| 527 | Sar | Saccharom Munja, Roxb. | 48 |
| 528 | Sari | Oryza sativa, Linn. | 274 |
| 529 | Sarvank | Echinochloa Crus-Galli, P. Beauv. | 150 |
| 530 | Satu | Hordeum vulgare, Linn. | 280 |
| 531 | Sava | Panicum miliaceum, Linn. | 159 |
| 532 | Sava | P. miliare, Lam. | 160 |
| 533 | Save | P. miliare, Lam. | 160 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 534 | Sawa | Setaria intermedia, Roem. and Schult. | 174 |
| 535 | Sawan | Echinochloa colona, Link. Var. frumentacea, Blatter and McCann. | 149 |
| 536 | Sawank | Echinochloa colona, Link. | 148 |
| 537 | Sawe | E. Colona, Var. frumentacea, B. and Mc. | 149 |
| 538 | Scotch Grass | Brachiaria mutica, Stapf. | 134 |
| 539 | Sejji | Pennisetum soicatum, Roem. & Schult. | 183 |
| 540 | Sera | Panicum antidotale, Retz. | 163 |
| 541 | Serdi | Saccharum efficinarum, Linn. | 46 |
| 542 | Shama | Echinochloa colona, Link. Var. frumentacea, Blatter and McCann. | 149 |
| 543 | Shamula | E. colona, Link. Var. frumentacea B. and M. | 149 |
| 544 | Shamsukha | Panicum antidotale, Retz. | 163 |
| 545 | Shapia | Sporobolus orientalis, Kunth. | 226 |
| 546 | Shata | Iscilema laxum, Hack. | 113 |
| 547 | Sheda | Sehima nervosum, Stapf. | 21 |
| 548 | Sheda | S. sulcatum, Camus. | 23 |
| 549 | Sheda | Dichanthium annulatum, Stapf. | 94 |
| 550 | Sherudi | Saccharum officinarum, Linn. | 96 |
| 551 | Shetpatra | Eragrostis interrupta, Beauv. | 234 |
| 552 | Shib | Dendrocalamus strictus, Nees. | 285 |
| 553 | Shikaol | Digitaria marginata, Link. Var. fimbriata, Stapf. | 125 |
| 554 | Shikar keli | D. marginata, Link. Var. fimbriata, Stapf. | 125 |
| 555 | Shimpi | Brachiaria Isachne, Stapf. | 135 |
| 556 | Shimpigyan hullu | Digitaria marginata, Link. Var. fimbriata, Stapf. | 125 |
| 557 | Shora | Oplismenus compositus, P. Beauv. | 153 |
| 558 | Shoti gandar | Diplachne fusca, Beauv. | 246 |
| 559 | Sikaliu | Chloris virgata, Sw. | 255 |
| 560 | Sinri | Alloteropis cimicina, Stapf. | 129 |
| 561 | Sivati | Pennisetum setesum, Rich. | 181 |
| 562 | Skerdi | Saccharum officinarum, Linn. | 46 |
| 563 | Sona | Iscilema Wightii, Anders. | 113 |
| 564 | Sonthi | Ophiurus megaphyllus, Stapf. | 39 |
| 565 | Sooate | Rotboellia exaltata, Linn. f. | 38 |
| 566 | Spear grass | Heteropogon contortus, Roem. & Schult. | 109 |
| 567 | Sputter | Ophiurus megaphyllus, Stapf. | 39 |
| 568 | Striped bamboo | Bambusa vulgaris Schrad. Var. striata, Auct. | 283 |
| 569 | Suckal | Sehima nervosum, Stapf. | 21 |
| 570 | Suckal | Heteropogon contortus, Roem. & Schult | 109 |
| 571 | Sukeri musanch | H. contortus, R. &. S. | 109 |
| 572 | Sugarcane | Saccharum officinarum, Linn. | 46 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 573 | Suka | Digitaria marginata, Link. Var. fimbriata, Stapf. | 125 |
| 574 | Sukhli Kursali | Heteropogon contortus, R. & Schult. | 109 |
| 575 | Sul | Eragrostis minor, Host. | 238 |
| 576 | Sunkhali | Heteropogon contortus, Roam. & Schult. | 109 |
| 577 | Sunthia Khad | Chrysopogon montanus, Trin. | 70 |
| 578 | Suphetkar | Sacciolepis myosuroides, Haines. | 166 |
| 579 | Suria | Elytrophorus articulatus, Beauv. | 276 |
| 580 | Surpur Chaurela | Urochloa reptans, Stapf. | 144 |
| 581 | Survalu | Heteropogon contortus, Roem. & Schult. | 109 |
| 582 | Sut | Ophiurus megaphyllus, Stapf. | 39 |
| 583 | Swamp Millet | Isachne miliacea, Roth. | 189 |
| 584 | Tagar Sammi | Dactyloctenium aegyptium, Richt. | 263 |
| 585 | Tandula | Oryza sativa, Linn. | 274 |
| 586 | Tan-sawa | Panicum obscurans, Woodrow. | 157 |
| 587 | Tambat | Apluda variax, Var. aristata, Hack. | 29 |
| 588 | Tambit | Iscilema laxum, Hack. | 113 |
| 589 | Tambit | I. Wightii, Anders. | 113 |
| 590 | Tambiti | Apluda varia, Var. aristata, Hack. | 29 |
| 591 | Tambrut | Amphilophis odorata, A. Camus. | 89 |
| 592 | Tambrut | Andropogon pumilus, Roxb. | 99 |
| 593 | Tambrut | Iscilema Laxum, Hack. | 113 |
| 594 | Tambrut | I. Wightii, Anders. | 113 |
| 595 | Tara | Digitaria marginata, Link. Var. fimbriata, Stapf. | 125 |
| 596 | Tare | D. marginata, L. Var. fimbriata, Stapf. | 125 |
| 597 | Telia | Dichanthium caricosum, A. Camus. | 93 |
| 598 | Teosinte | Euchlaena mexicana, Schrad. | 1 |
| 599 | Tikhari | Cymbopogon Martini, Stapf. | 104 |
| 600 | Tiki grass | Ischaemum rugosum, Salisb. | 13 |
| 601 | Tripha | Thelepogon elegans, Roth. | 27 |
| 602 | Todha | Eragrostis gangetica. Steud. | 236 |
| 603 | Todia | Echinochloa colona, Link. | 148 |
| 604 | Tokarband | Panicum montanum, Roxb. | 164 |
| 605 | Tor | Echinochloa colona, Link. | 148 |
| 606 | Tor chandbol | Eragrostis ciliares, Link. | 231 |
| 607 | Tulsi | Apluda varia, Var. aristata, Hack. | 29 |
| 608 | Turdia | Oplismenus compositus, P. Beauv. | 153 |
| 609 | Turdia | Arundinella setosa, Trin. | 192 |
| 610 | Udha | Dendrocalamus strictus, Nees. | 185 |
| 611 | Udhu-bans | Bambusa vulgaris, Schrad. | 282 |
| 612 | Ululgyan hullu | Dinebra retroflexa, Panzer. | 265 |
| 613 | Under-puncho | Eragrostis ciliares, Link. | 231 |
| 614 | Urodhan | Hygroryza aristata, Nees. | 271 |

| S. No. | Vernacular Name | Botanical Name | Page Number |
|---|---|---|---|
| 615 | Us | Saccharum officinarum, Linn. | 46 |
| 616 | Usa | S. officinarum, Linn. | 46 |
| 617 | Usadhana | Amphilophis odorata, A. Camus. | 89 |
| 618 | Usar-ki-ghas | Sporobolus orientalis, Kunth. | 226 |
| 619 | Ushir | Vetiveria zizaniodes, Stapf. | 65 |
| 620 | Vaidia-gavat | Amphilophis odorata, A. Camus. | 89 |
| 621 | Vala | Vetiveria zizaniodes, Stapf. | 65 |
| 622 | Vale | V. zizaniodes, Stapf. | 65 |
| 623 | Vanguaria | Arthraxon inermis, Hook. f. | 74 |
| 624 | Varagu | Panicum miliaceum, Linn. | 159 |
| 625 | Vari | P. miliaceum, Linn. | 159 |
| 626 | Vari | P. miliare, Lam. | 160 |
| 627 | Varighudi | P. miliare, Lam. | 160 |
| 628 | Varival | Polytoca barbata, Stapf. | 6 |
| 629 | Vasane-hullu | Cymbopogon citratus, Stapf. | 103 |
| 630 | Wag-hakt | Brachiaria Isachne, Stapf. | 133 |
| 631 | Water Grass | B. mutica, Stapf. | 134 |
| 632 | Wheat | Triticum aestivum, Linn. | 279 |
| 633 | Wire grass | Cynodon dactylon, Pers. | 250 |
| 634 | Wontenulyi | Ochlandra Talboti, Brandis. | 287 |
| 635 | Yellow bamboo | Bambusa vulgaris, Schrad. | 282 |
| 636 | Yerwa | Oplismenus Burmannii, P. Beauv. | 154 |
| 637 | Zini bathi | Themeda quadrivalvis, O. Kuntze. | 118 |
| 638 | Zinjee | Dichanthium annulatum, Stapf. | 94 |
| 639 | Zinzma | D. annulatum, Stapf. | 94 |
| 640 | Zinzvo | D. carricosum, A. Camus. | 93 |
| 641 | Zinzvo | Andropogon pumilus, Roxb. | 99 |

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Blatter E. & McCann C. (1935) The Bombay Grasses Sci. Mon. No. 5, Indian Council of Agricultural Research, New Delhi.

# College Notes and News

**Gymkhana Report :**—The activities of the College Gymkhana started in right earnest immediately after the Gymkhana Elections in June 1950, with keen interest and enthusiasm on the part of the various secretaries. All the College annual sports except tennis were held during the 3rd week of August as the Annual Social Gathering of the College was on 23rd of August. A large number of students had taken part in athletic sports this year, and to our credit Shri Felix Pinto has broken the University record in Javeline throw and Shri Mahajan has broken the record of the Poona University in long distance running. Messrs. Dalaya and Mahajan have tied for the individual championship.

Our foot-ball team is second to none but so far there was no chance for us to display our full team due to injury to some of our players. We took part in the Poona College League. Though we are not topping the list we are better off than many other Colleges which have got a wide choice of students. Messrs. Pinto brothers, Rana, Fana, D'silva and Pawar may be mentioned as some of the strong holds of our team.

This year our standard of cricket has improved greatly. Messrs. Jhala and Joshi are outstanding as batsmen and bowlers.

After many years of clamouring for a table tennis table we have at last succeeded in getting one. The College tournaments were conducted in the 3rd week of August and Shri. M. V. Kshirsagar won the championship. Our Badmington tournaments were held on P.Y.C. Gymkhana due to want of a Badmington court of our own. Shri M. B. Rana was the college champion in this item.

Another interesting item was the Body Beautiful competition. This was started last year and has attracted the attention of both the staff members and the students. The title " Mr. Agricultural College " was keenly contested this year both by the staff members and the students. Shri S. N. Dharu obtained this title and our staff member Shri N. R. Paranjape got the first prize for the most muscular body.

Our standard of Indian games and gymnastics is the same as last year. Messrs Mane, Deshmukh and Bhomaj obtained the first places in wrestling in their respective class weights. And Messrs Dharu, Pendse and Dalaya obtained the first places in weight lifting in their respective class weights.

The reading room caters to the taste of every student,as many of the foreign magazines are appearing regularly; moreover we have a new decent radio and excellent lighting in the reading room.

The debating society and Agricultural Association were inaugurated by Dr. M. R. Jaykar, Vice Chancellor of the University of Poona. The progammes organised by the debating society seem to be very poorly patronised by the students. Our enthusiastic Hon.Secy.has joined hands with other colleges to form the Poona Colleges Debating Association.

There is no doubt that much more can be achieved than what has been possible for us under the peculiar and difficult circumstances in which we are placed in this college.

After years of hopes and waiting the dream of having a gymkhana pavilion of our own viz. "The Mahatma Gandhi Kridamandir" has been realised. We are very thankful to our present Government for its substancial help to make up the deficit in our pavilion funds. The opening ceremony of this " Mahatma Gandhi Kridamandir" was performed by the world famous cricketer Shri Vijay Merchant on 2nd September 1950.

*N. B.* :—The Reading Room Secretary Shri P. V. Salvi has left the college in Oct. So Shri. R. J. Nikam is appointed in his place.

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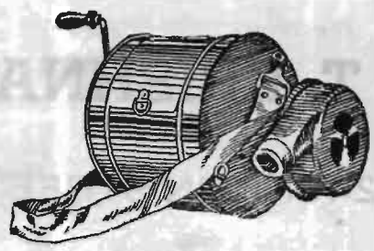

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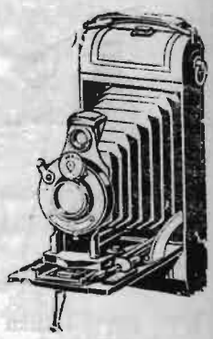

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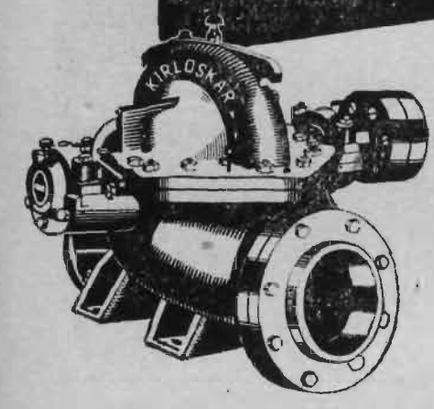


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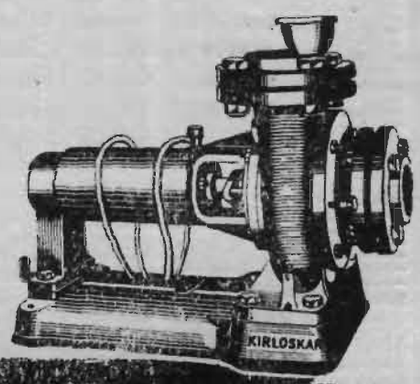


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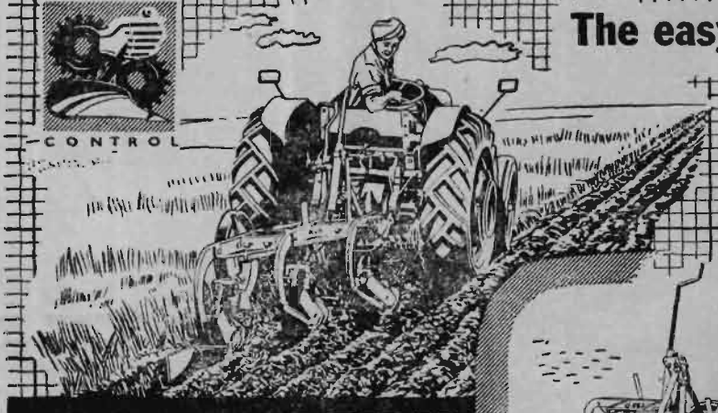

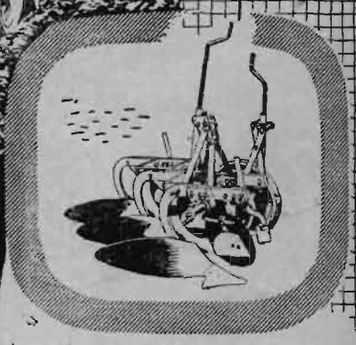

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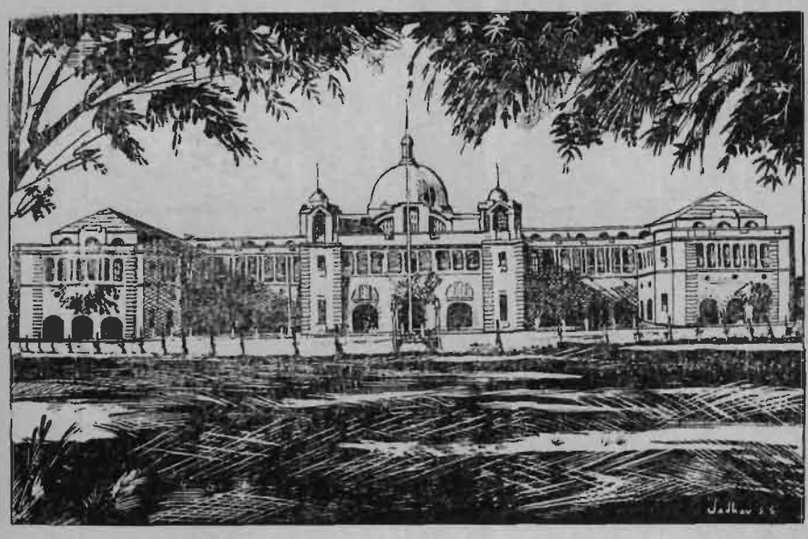

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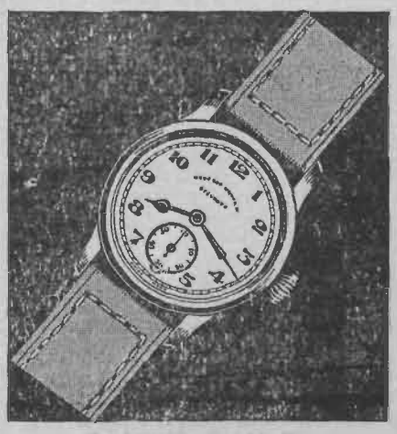

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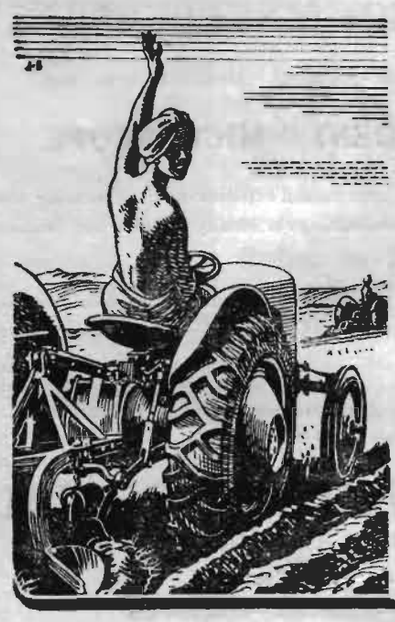

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# COLLEGE OF AGRICULTURE, POONA 5.

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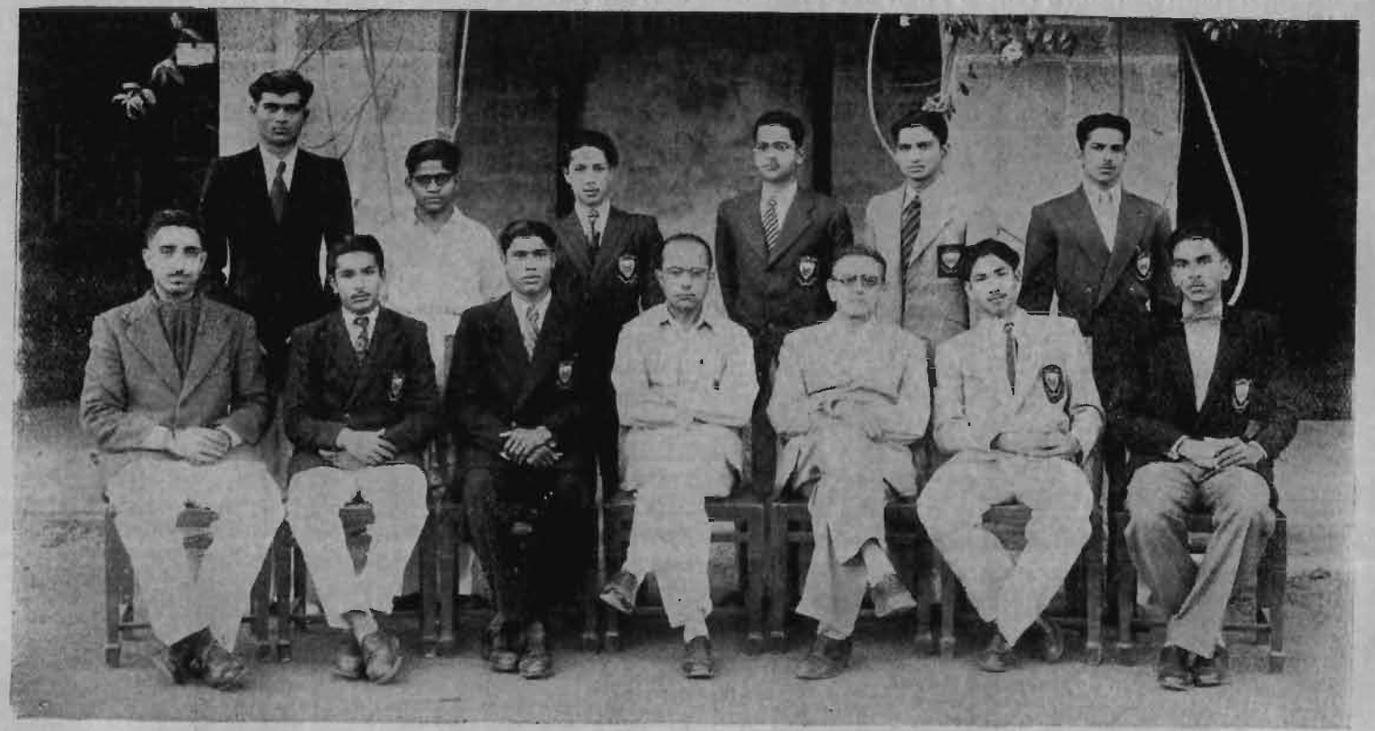

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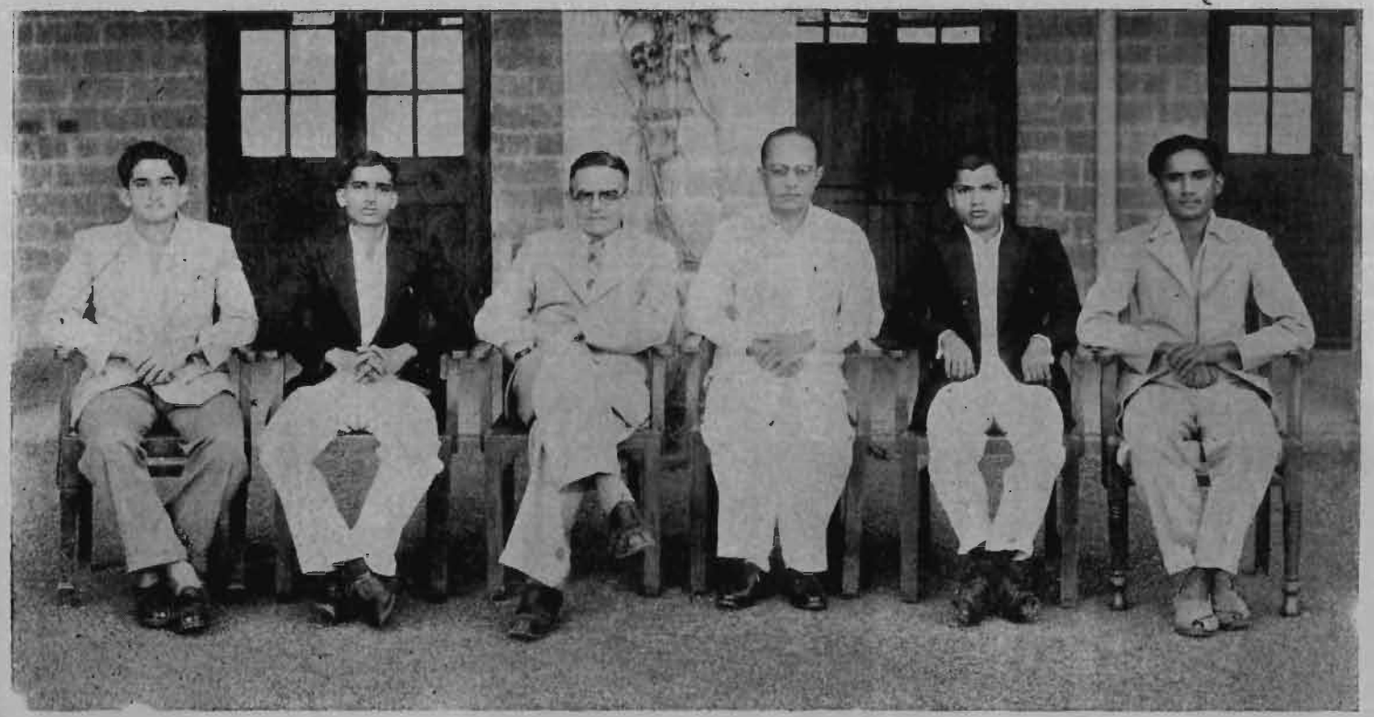

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# The Late Sardar Vallabhbhai Patel

We received the extremely sad news of the passing away of Sardar Vallabhbhai Patel, Deputy Prime Minister of our country on the 15th December. Hardly had the country recovered from the staggering blow of the demise of the Father of the Nation, Gandhiji, it has been dealt another stunning blow. Sardar Patel was a devoted follower of Gandhiji, he was a great patriot, a warrior who fought the battle of the country's liberation. Since its liberation he has been one of the architects who had done much to build the edifice of the newly born democratic state. But for his personal influence, courage, and power, the India of the Princes would have continued to remain as a separate entity and to that extent the country would have been weakened and fallen a prey to disintegrating forces. We owe a unified India to his courageous and farsighted action. It is said of Sardar Patel that he has achieved something which the greatest of the Statesmen of Europe had failed to achieve. A gallant soldier, whose love of his motherland was so great that nothing daunted him in his pursuit to win the freedom of the country and achieve its unification. Unified India will ever remain as a monument to that great and beloved son of India whose death we have met to mourn.

Sardar Patel will be well remembered as the leader of the Bardoli Satyagraha movement which was one of the decisive events which helped the liberation of the country years later. He was the right hand man of Gandhiji and through thick and thin he stood by his leader and followed him.

The country has lost a noble son, a great patriot, and a great Statesman that kept the divergent forces together. The ranks of our elder statesman is slowly thinning. Many of them are over strained with tremendous responsibilities. Sardar would probably have remained with us longer if he had disengaged himself from the ardous duties of the Minister of the State. But his sense of duty was so great that even at the cost of Sacrifice of his health he stuck to his post and carried out his duties entrusted to his care. It will indeed be a difficult task to find another statesman who can take up the work and discharge his responsibilities as ably as the Sardar had done.

A great soul has passed away from our midst and may peace be with it.

# January 26th 1951.

## Principal's Message on Republic Day

To-day marks the beginning of the second year of our Republic. Three years ago when the country declared its independence there were rejoicings everywhere and every one had fervently hoped that great developments would take place with the ushering in of freedom symbolic of peace and prosperity. But at the end of three years of freedom the country finds itself in an unsettled state, the cost of living is very high, essential commodities are scarce, food, clothing and shelter are inadequate. The very best efforts of our leaders to remedy these defects have failed and there appears to be forces working against betterment. The reasons for such a state of affairs are not far to seek. There is an absence of the spirit of cooperation, of willingness to sacrifice and of a sense of tolerance among the people of the country. Apparently democracy is on trial so soon after gaining our independence. Although it is too early to pass judgment on ourselves yet there are unmistakable signs of development of unhealthy tendencies of which our leaders have warned us and which should be stemmed at once. The aim of our leaders is to build an enduring state on secular and democratic lines. This cannot be done unless the people of the country become disciplined, self-reliant, and energetic, so that out of these, selfless and patriotic leaders may arise. Such citizens and leaders are being trained in the colleges and schools of our country. These institutions provide the best training ground and offer facilities and the required atmosphere for the training of the mind and body to develop a sense of mutual help and cooperation, commradeship and understanding, tolerance and fellowship among the young. If right advantage is taken of these opportunities, there can be little doubt that disciplined citizens would become available to help the leaders to achieve the nation's goal of tranquility and contentment.

There can be no greater ideal than to become a good and useful citizen by doing one's duty aright. The country needs the zeal with disciplined enthusiasm of the young for its development. Every college and school can help by developing men with ardent desire to serve their motherland. A great opportunity awaits every student to become a worthy citizen and a great patriot. Towards a consummation of this ideal let our institution play its part.

**- Jay Hind -**

THE POONA

# AGRICULTURAL COLLEGE MAGAZINE

VOL. 41 ] FEBRUARY 1951 [ No. 4

## Editorial

The State of Bombay is deficient in regards to food production. At present it does not produce enough food to supply the needs of its population. A large area of the State is subject to deficient rainfall or famine. It is, therefore, imperative to provide irrigation facilities wherever possible, so as to ensure the production of more food. Government has, therefore, thought it necessary to introduce two new levies on irrigated lands viz., the betterment levy and the irrigation cess in addition to water rates. It is felt that the beneficiaries under an irrigation scheme should contribute sufficient revenue to meet the capital, interest and maintenance cost of each work. The betterment levy is to be imposed on the lands under command of all the new major irrigation works. This levy is to be utilised towards the provincial irrigation fund from which new schemes will be financed. The irrigation cess, which is meant to meet the working expenses of the system would be three rupees per acre in the perennial section and one rupee eight annas per acre in the non-perennial one. The water rates on the existing irrigation works in the Deccan are to be increased from February 15th by one third the existing rates. The rate is to be raised by one half the present rate on perennial and seasonal crops (except food grains and pulses) from 15th February 1952 onwards for a period of six years.

No doubt the agriculturists in the State will have to bear the additional burden of the levies. But consideration of the present high rates of maintenance and management and the benefit to be derived in future by way of increased irrigation facilities over a large area have necessitated these being imposed. One may take comfort in the fact that the future irrigation facilities would enable the State to make a greater headway towards self sufficiency in food. Is it an ill wind that does nobody any good ?

* * * *

Hardly had the agriculturists in the north of the Bombay State taken a breath of relief from flood and heavy rainfall, when they have had to face the menace of swarms of desert locusts ! The locusts settled and started new broods causing considerable damage to crops. All possible measures were taken to fight

the pest. In certain parts of the State people cooperated with Government and a ceaseless vigil was maintained. While at places the locust eradicating squad was attacked on humanatarian and sentimental grounds. This sentiment is undesirable especially when human beings are faced with food shortage. It is extremely important to thoroughly scour their breeding places and eradicate them at the source. The international anti-locust conference, which met at New Delhi, has decided to reinforce the anti-locust organisation in the desert regions of Asia and Africa. Close cooperation in Persia, Pakistan and India would go a long way in the extermination of this pest.

* * * *

The Orissa Government have established a land utilisation board. The function of this board wonld be to restore the ecological balance and to put land to the best economic use. It will apportion land according to suitability and need so as to prevent soil erosion and reclaim eroded land, to work out a coordinated crops plan, to undertake research and control the development of cattle welfare according to available fodder resources. It will have to work out a proper equation between forests, pastures fields and the men and cattle, who work them. The problem is a difficult one to solve and yet if the board envisages the problem properly and works it out in the right direction, much may be achieved with full Government backing and execution of the boards recommendation. A similar board is needed in our State. Our District and Taluka Rural Development boards may well consider these problems as matters of priority and evolve and suggest suitable measures.

* * * *

Colombo plan for the development of the Asian countries concerns the development of nearly four fifths of the population of a region on whose economic welfare and stability depends the future or world's prosperity. The plan envisages different stages of development of different countries, however, it mainly lays stress on the development of agriculture. India has a vital and important place in this plan because of its geography and economic position.

The plan is a six year project to develop Agriculture and Industry in the South and South East Asia and will benefit one quarter of the world's population. It proposes (1) to increase the cultivated land by 18 million acres—an increase of 3½ per cent, (2) to increas irrigated land by 18 million acres—an increase of 17 per cent, (3) to increase the production of food by 6 million tons—an increase of 10 per cent and (4) to increase electrical energy by 67 per cent. Out of a sum of £ 1868 million 34 per cent will be spent on transportation and communication-32 per cent on Agriculture including irrigation and river valley development-18 per cent on housing, health and education-10 per cent on industry and mining and 8 per cent on fuel and power.

The largest expenditure £ 13·79 million is to be incurred in India. 33 per cent of the allocation amounting to Rs. 18396 million to be spent on agricultural development is expected to increase the Indian production of food in 1956–57 by three million tons, cotton by 195,000 tons, Jute by 375,000 tons and oil–seeds by 1,500,000 tons. The increase will bring about an increase of four ounces of ration and 5 yards of cloth per capita.

If India is able to raise sufficient funds Rs. 1030 crores internally and Rs. 800 crores otherwise it will be possible to carry the scheme through. Favourable economic conditions within the country are necessary to fulfill the programme. Mutual confidence between the Eastern and Western countries and cooperation will go far to achieve this end. Let us hope and pray that the dream may come true.

* * * *

During the last few years, there has been a great incentive in utilising underground water resources in our State. Well construction has progressed considerably. In the August issue of this magazine a reference was made to the increasing of tube wells in Gujarat. At the end of November last, Shri B. G. Deshpande addressed the Institution of Engineers (India) Bombay centre, on the subject of "Underground Water Resources of Gujarat". He explained how the alluvial substratum in the region comprising Ahmedabad and Kaira districts and parts of Saurashtra, Panchmahals, Baroda and Broach districts was responsible for the availability or otherwise of water and the quantity available. He suggested that there were three distinct sources of ground water supply viz. the sub-soil zones, the sub-artesian zone and artesion zone, and stated their tentative depths. He observed that water in the sub-soil zone was brackish in many places that from the sub-artesian zone fresh and potable and the water from the artesian zone not potable but often suitable for irrigation. According to him the sub-artesian zone could be substantially developed and utilised. He suggested systematic exploration of the sub-artesian zone to a depth of 2000 ft. by a central organisation with a view to carrying out systematic hydrologic and geological studies of the strata and study the yeid as well as the chemical and bacteriological properties of water from the different zones. This would enable the proper and most economic and maximum utilisation of underground water. He further suggested that the yield of the sub-artesian zones could be boosted up by compressed air.

Shri Deshpande's remarks are well worth consideration and it is upto Government to carry out the necessary investigation along with studies of rainfall and runoff in the areas and the catchment of the alluvium with a view to determine the rate of intake of ground water.

* * * *

The President of the Republic of India, Dr. Rajendraprasad laid the foundation stone of the Mungalal Goenka Institute of Animal Genetics and Nutrition at the Institute of Agriculture, Anand on 16th October. The institute when complete will serve as a centre of research for Animal Genetics and Nutrition. There was a lack of this type of research in our State; and the institute when fully functioning will serve the needs of the Gujarat area. We wish our sister institution success in this direction.

* * * *

The seventh convention of the Deccan Sugar Technologists' Association was held at the college on 14, 15 and 16th October. A large number of agricultural graduates attended the function. The agricultural graduates held a separate meeting of their own and decided to form "The Bombay State Agricultural Graduates' Association". The Association aims to form an organised opinion regarding agricultural problems and to undertake activities in the interest of the graduates. The association intends to publish a "Who's Who" of the members from time to time. A committee under the chairmanship of Dr. M. B. Ghatge, Dy. Director of Agriculture and Shri K. P. Deshmukh as Secretary has drafted the constitution. We wish the association success and trust that all the agricultural graduates will take an active part in its activities by becoming its members.

* * * *

Dr. Ivanov, Dr. Eustropov and Mr. Kouskeovosky, the three Russian delegates for the International Locust Conference held at Delhi, visited the college on 30th November. After visiting the several sections and studying their research activities, the delegates addressed the students on "Education in Russia".

* * * *

Shri A. A. Memon returned from U. S. A. after obtaining M. S. degree in Agricultural Engineering and has joined the section of Agricultural Engineering, Physics and Mathematics.

* * * *

The news of the demise of Sardar Vallabhbhai Patel, Deputy Prime Minister, Government of India, on the 15th December came as a shocking and staggering blow. The members of the staff and the college students met to express their sense of sorrow and loss. The meeting passed the following resolution in reverent silence in memory of the departed soul.

"We the members of the Staff and Students of the College of Agriculture, Poona and officers and members of the staff of the Department of Agriculture,

Poona, assembled at this meeting, express our deep sense of sorrow at the sudden demise of Sardar Vallabhbhai Patel, Deputy Prime Minister In his death the country has lost a foremost statesman, a noble son, and a great patriot. The loss is irreparable and staggering.

We send our heart-felt condolences to the bereaved members of his family."

May his soul rest in peace.

---

# Extension of the Cashew Nut Cultivation and Development of the Cashew Nut Industry in the Bombay State.

By

I. A. SAYED *

The Cashew nut is an important commodity of international trade and the Cashew nut industry became largely concentrated in India where it has developed into a national industry. The future expansion of this exportant and flourishing industry should receive urgent attention of not only the concerned States but also of the Federal Government. In the present note are discussed the various aspects of the Cashew nut industry, the scope for development and the possibilities of extending Cashew nut cultivation in the Bombay State.

**1. The development and the scope of the Cashew nut industry.** The gradual expansion of the cashew nut industry in India and the increasing importance of cashew kernels in world trade, reflect the sustained efforts of growers and business men, extending over a period of over two decades, to develop the industry on sound commercial lines through improved methods of processing and packing to meet stringent requirements of export trade.

* Assistant Horticulturist, Bombay State, Poona 5.

Consequent upon successful popularization of cashew kernels in bakery and confectionery trade in the United States of America, the cashew nut industry in India received so much impetus, particularly after the World War I, that it eventually occupied monopolistic position in supplies of cashew kernels to America and Europe to the extent of over 90%. The United States of America is by far the largest importer of cashew kernels, more than 98% of which are of Indian origin. Cashew kernels are among the few commodities in India which are carefully graded and scientifically packed for export market. It might, however, be emphasized that the volume of trade does not emanate entirely through our own production of nuts and, in order to maintain the export trade level, cashew nuts are required to be imported into India in appreciable quantities (statistics furnished elsewhere) from foreign countries chiefly Portugese East Africa.

Though the trade in cashew nuts has developed appreciably during the last 25 years or so, the possibilities of further expansion, both in production of nuts and consumption of kernels, are immense. In view of the monopolistic position our country occupies in the export of cashew kernels and the fact that more than 98% of the United States of America's total imports of cashew kernels are of Indian origin, there could not be more opportune time than now to reinforce export of cashew kernels to the United States and thus earn the much needed dollars to enhance our trade balances.

2. **Cultural requirements :—** The cashew tree thrives under a wide range of soil and climatic conditions. On the west and east coasts of India, it grows on laterite and sandy soils with an annual rainfall of 120 and 40 inches respectively. It also thrives well on lands reclaimed from the sea. Though least fastidious to soil and climatic conditions, it does not, however, thrive when grown far inland thus retaining its tropical character. The cashew tree grows on poor soils unsuited to most crops and withstands drought remarkably well. It is on account of the latter characteristic that it has come to be regarded as a waste land crop and renders possible its expansion in such areas and in varkas lands. It is, therefore, obvious that with such minimum cultural requirements and very small capital outlay in establishing plantations, it should be possible to extend its cultivation in all possible areas on the west coast of the Bombay State to augment production of this valuable commodity of commerce.

3. **Economic importance of the cashew nut industry :—** The cashew nut tree yields several products of economic importance chiefly (1) the kernels from the nuts (2) the liquid from the Cashew nut shells and (3) vinegar and liquor from the "apple".

(i) **The cashew kernels :—**The cashew kernels is the principal commodity of commerce which is exported, after being properly processed, in large quantities to the United States of America and to a small extent to the continent

of Europe. The consumption of kernels in the United States of America is mostly in the form of salted kernels though a good quantity is also utilized in the production of candy and confectionery. Kernels are also used, to some extent, in bakery and ice-cream products.

(ii) **Cashew nut shell oil :**—Although the cashew kernels are still considered as the primary product of the industry, the cashew nut shell oil came into prominence during the emergency as a strategic war material. It is largely used in resin solutions for impregnating electric coils in the manufacture of brake linings for motor trucks and air craft and molding resins for insulating aviation electric parts The shell oil is a dark viscous substance the principal constituents of which are Cardol and anarcardic acid. The " Cardanol " which is obtained from anarcardic acid is used in several ways as protective coatings, as a platiciser for lacquers and as a fixative in perfumes. It is also used in the preparation of insecticides while fisherman use the shell oil for tanning their nets.

The shell oil represents 35% of the weight of the shell but only 12 to 15% of oil is recoverable by the present crude manufacturing process. 125 lbs. of shells yield $2\frac{1}{2}$ to 3 lbs. of oil. The unrefined shell oil fetches in the American market Rs. 1-15-3 for four gallons.

The shell oil industry of potential industrial value as an ancillary to the cashew kernels industry offers abundant scope for further development through research on the improvement of manufacturing process to recover maximum percentage of oil from the shells and its use for industrial purposes.

(iii) **The cashew apples :**—Cashew "apple" is used, in producing areas, as a fresh fruit and as a vegetable but the total quantity actually used is very small,not exceeding 10-15%, and the rest is practically wasted. The reasons for its limited use are that it remains immature even when three-fourths of the nuts are harvested and the ripe apple is acrid which renders it unpleasant to taste. Its industrial use lies in the production of fermented liquors or wines noted for their high mineral content. However, with the introduction of total prohibition in the Bombay State, the entire produce of " apples " can be utilized for the production of vinegar which will have a ready market. While these uses are, as yet, of local significance, they are potentially of economic importance after the cashew nut industry is completely organised.

(iv) **Cashew peels :**—The kernels obtained after peeling have a thin coat of reddish brown colour which adheres closely and is removed by peeling. The peels constitute about 12% of the weight of kernels. The following analysis shows that the cashew peels form a wholesome poultry feed of high nutritive value.

Water 8·1%, Proteine 7·6%, Fat 12·3%, Carbohydrates 59·2%, Fibre 11·0%, Ash 1·8%.

The peels are, at present, wholly wasted or used as a fuel after mixing with cow dung.

Cashew peels to the tune of 25, 27, 002 lbs. are obtained annually from the total quantity of 7, 02, 19, 520 lbs. of cashew nuts processed in India (1944). Such a huge quantity of peels could be made to yield a substantial income if they are carefully collected and used as a poultry feed instead of this wealth being allowed to be wasted.

(v) **Manufacturing plants** :—Of the 63 cashew nut processing plants in India, 28 are located in the Madras State, 29 in the Union of Travancore and Cochin and 6 in the Bombay State. The annual output from the factories in the Bombay State is estimated at 5,64,000 lbs. It is reported that except four factories which use modern equipment, the processing of nuts in the majority of factories is rather crude and primitive. Recent experiments in mechanising the industry in Brazil and substituting machinery for much of the hand labour hitherto employed have been successful. Should the mechnisation of the industry prove feasible in Brazil where raw material is abundantly available in its tropical regions, Brazilian industry might offer effective competition to the Indian cashew nut industry. There is, therefore, an urgent need for mechanising the industry to augment production of cashew kernels of superior quality and thus counteract potential threat to this industry from its counterpart in Brazil and South Africa.

(vi) **Workers employed in the industry:**—Statistics of workers employed in manufacturing plants in Madras and Bombay States and the Union of Travancore and Cochin are not separately available. It is, however, estimated that the Indian cashew nut industry normally affords employment for some 90 to 100 thousand persons. This indicates how great are the possibilities of developing this industry and the scope it offers for providing employment to large number of workers, thus helping substantially in solving, to some extent, the grave problem of growing unemployment in the country.

**4 International trade in the cashew nut products** :— The international trade in cashew kernels from India to the United State has been considerably stimulated during the last 15 years. This concentration of the industry in India and the expansion of world trade in the cashew kernels are attributed to the increasing interest of American food manufacturers in this commodity as a substitute for almond in confectionery and bakery trades. In order that the present position and the magnitude of this industry might be appreciated, statistics relating to import of cashew nuts for processing in India and export of cashew kernels to America and to the continent are furnished. These figures clearly

indicate the immense scope for further development of this industry and expansion of international trade in the cashew nut products.

(i) **Import of cashew nuts :**—The production of cashew nuts in India is inadequate to maintain the level of export trade in cashew kernels and, therefore, large quantities of cashew nuts are imported every year from Africa for processing and reexporting. India produced 67,200,000 lbs. of cashew nuts in 1944 and imported, in the same year, 3,019,520 lbs. from Portugese East Africa. The imports of cashew nuts from Africa and their value are as follows :—

**Table 1** :—Imports of cashew nuts into India.

| | Quantity in tons | | | Value–Rupees | | |
|---|---|---|---|---|---|---|
| | 1943–44 | 1944–45 | 1945–46 | 1943–44 | 1944–45 | 1945–46 |
| 1. Union of South Africa | 67 | ... | 1 | 1,03,096 | ... | 1,694 |
| 2. Portugese East Africa | ... | ... | 13,404 | ... | ... | 44,19,829 |
| 3. Zanzibar | ... | ... | 214 | ... | ... | 80,593 |
| 4. Keniya Colony | ... | 286 | 401 | ... | 64,771 | 1,63,830 |
| 5. Tanganika Territory | ... | 1062 | 2,137 | ... | 2,76,8 18 | 8,03,606 |

The African nuts are of inferior quality being small and the percentage of high grade kernels obtained from them is relatively low. No custom duty is levied on imported nuts and, therefore, imports are free and abundant. It is apparent from these statistics that there is an urgent need for increasing local production of cashew nuts through extension of area under cashew trees and improving methods of harvesting, collecting etc. It is noted that in several parts of India, immature nuts are picked which affects, appreciably, recovery of kernels from such nuts and the quality of kernels.

(ii) **Export of cashew kernels:**—In view of increasing demand for the cashew kernels as a substitute for almond in confectionery and bakery trade in America and the continent and improvement in packing and transportation, the international trade in cashew kernels has rapidly increased. The quantities and the value of cashew kernels exported from India to different countries are shown in Table 2.

**Table** 2 :—Exports of cashew kernels from India.

| | Quantity in tons | | | Value–Rupees | | |
|---|---|---|---|---|---|---|
| | 1943–44 | 1944–45 | 1945–46 | 1943–44 | 1944–45 | 1945–46 |
| 1. U. S. A. | 2983 | 7325 | 11,541 | 1,19,05,294 | 3,13,80,514 | 5,54,61,304 |
| 2. United Kingdom | 1400 | 540 | 381 | 15,95,467 | 8,70,088 | 13,12,449 |
| 3. Canada | ... | ... | 37 | ... | ... | 168,421 |
| 4. New Zealand | 65 | 28 | 39 | 87,403 | 48,986 | 1,01,500 |
| 5. Australia | ... | ... | 28 | ... | ... | 61,653 |

It might be stated that Brazil has been an irregular exporter of the cashew kernels for some years but commercial development has not progressed substantially because of the competitive advantage of India in its cheap labour. However, with the mechanization of the cashew nut industry in Brazil, it is not known how long India will enjoy this advantage. It must, however, be admitted that Brazil with its abundant resources of raw material is a potential competitor and unless all-out efforts are made immediately to reorganise this industry in all its aspects, our monopoly of cashew kernels might be appreciably weakened.

(iii) **Shell oil** :—The production of shell oil in India has increased appreciably in recent years owing to large scale export of cashew kernels to the United States. The total production of shell oil in 1942 on the west coast of India where the bulk of cashew nuts are processed was estimated at 350,000 gallons. The United States of America is by far the largest importer of shell oil which is utilised in key industries. The quantity and value of shell oil exported from India to the U. S. A. are as follows :—

| Year | Quantity lbs. | Value–Rupees |
|---|---|---|
| 1943 | 6,625,773 | 25,50,831 |
| 1944 | 3,843,164 | 13 63,962 |

In view of importance of shell oil as a strategic war material and its use in the manufacture of several commodities of commerce mentioned before, the shell oil industry needs to be reorganised urgently to increase the production of oil and other by–products chiefly 'Cardanol'. The present crude method of burning shells in a drum for extracting oil must be improved by suitable experiments to obtain maximum recovery of oil of superior quality.

**5. Possibilities of extension of area under cashew nut in the Bombay State** :— The urgency of extending cashew nut cultivation in the Bombay State as an essential prerequisite to the development of the cashew nut industry in India was realised as far back as 1932 when efforts were made to elicit information in regard to the scope for bringing vast areas of varkas land under cashew nut cultivation. The writer was actively associated with a survey of Konkan district to study, among others (a) the soil and climatic conditions under which cashew trees thrive, (b) the economic of cashew nut cultivation and (c) the possibilities of extending cashew nut cultivation in varkas lands of the Konkan districts.

(i) **The present state of cashew nut cultivation** :— The area under cashew nut in the Bombay State, as reported by the Revenue Department, was 3440 acres in 1948–49 but it is observed that this acreage does not represent the correct position in view of fluctuating figures of acreage reported from year to year by the Revenue authorities. It must, however, be admitted that such periodical fluctuations in a perennial crop like the cashew seem highly improbable and the area under cashew trees, promiscuous as they are, must be very large.

The cashew tree grows extensively on the west coast in wild state mixed with mango and other forest trees and shrubs along the hill slopes and at a fair distance from the sea inland.

The principal centres in the Bombay State where cashew trees grow in their natural wild state are the talukas of Malvan, Vengurla, Khed etc. in Ratnagiri district. They are also widely scattered in North Kanara, Thana and Kolaba districts

The whole of the Konkan tract comprising of the districts of Ratnagiri, North Kanara, Thana and Kolaba where cashew trees predominate is climatically admirably suitable for its growth and productivity. As said elsewhere, cashew tree is least fastidious in its soil requirements. The soil in the Konkan varies from the red laterite which is poor but well drained in Southern districts of Ratnagiri and North Kanara to medium black soil in Thana and Kolaba. The rainfall ranges from 150 inches in North Kanara district to 90 inches in Thana. The humidity is always very high. The whole of the Konkan tract is as much a home of the cashew nut as any part of South Africa, Brazil, Philippine Islands, etc., where it grows abundantly

It is strange, indeed, that these natural advantages have never evoked interest of any cultivator to grow cashew trees on a plantation scale as an economical and remunerative enterprise All what he has done is to plant a few cashew trees along the boundary of his field or in his door-yard. The trees are never taken care of and, in consequence, yield an uncertain income. It is, however,

noted that cashew trees in Malvan and Vengurla talukas where they predominate in groups are taken care of only in their bearing season. The state of cashew trees growing promiscuously in the entire Konkan tract is miserable.

There is no ownership of trees growing in the forests and on the road side and, therefore, the trees receive no attention. Nuts and fruits, in the bearing season, are freely availed of by the way-farers who collect nuts and sell them to small dealers or factory agents at a nominal price. The produce of thousands of trees in inaccessible areas is never collected and is wasted.

It is, therefore, apparent that in spite of its being a major and flourishing industry, the cashew nut industry has not been given the attention it deserves. It has been taken too much for granted, presumably because imports of nuts are regular and abundant and adequate attention has not been bestowed on various problems connected with the industry, chiefly cultural, to increase production of nuts.

(ii) **Economics of cashew nut cultivation :**—The cashew nut is a quick growing tree which begins to bear in the second or third year and comes into full bearing in its fifth year.

Economics of cashew nut cultivation on a plantation scale show that the average net income is estimated on the basis of pre-war price of Rs. 4-8-0 per maund, at Rs. 85/- per acre. This income has further increased with rise in prices of kernels. As it is a growing industry, supply will take a long time to exceed demand and, therefore, it is reasonable to expect economical returns from such plantations for at least 15 years. Since economics of cashew nut has not been systematically worked out, it is considered very essential to establish trial plantations in different parts of the Konkan for this purpose.

(iii) **Scope for extension of cashew nut cultivation :**—The varkas lands of the Konkan tract which are situated adjoining the garden lands on a higher level are admirably suitable for growing cashew trees. Sometimes, hill millets are grown in these lands but it pays the owner to allow grass to grow naturally rather than cultivate hill millets.

Out of the total varkas land area of approximately 3,45,132 acres in Ratnagiri district on which Ragi and other inferior millets are grown, at least 5% or 17,000 acres of privately owned varkas land can be brought under cashew nut cultivation. It is estimated that at least 10,000 acres would be also available in North Kanara district for this purpose thus bringing the total area that can be put under cashew trees to 27,000 acres. It should be possible to utilise another 10,000 acres of Government waste lands in the districts of Ratnagiri and North Kanara for extending cashew nut cultivation.

As mentioned above, parts of Thana and Kolaba districts are suitable for cashew nut cultivation and, on a conservative estimate, 5000 acres in each of these districts can be immediately brought under cultivation.

Possibilities of extending cashew nut cultivation are abundant along the western strip of the merged area of Kolhapur State. This area adjoins the Konkan tract and possesses climatic conditions suitable for cashew nut cultivation. The western border of Kolhapur district lies close to the Sahyadri range where the rainfall is as high as 200 inches, annually. Thus, on the basis of rainfall, the area of the district can be divided into the following five regions :—1. Area where the rainfall is above 200 inches. 2. Area where the rainfall is between 60 & 100 inches. 3. Area where the rainfall is between 40 & 60 inches. 4. Area where the rainfall is between 20 & 40 inches. 5. Area where the rainfall is below 20 inches.

It is in the first two regions of high rainfall where the soil is laterite, that extension of cashew nut cultivation is possible. The Revenue reports indicate that 1,50,000 acres are registered as culturable waste while out of the total cultivated area, 87,284 acres are under Tari or Paddy lands. It is estimated that at least 10,000 acres, if not more, of varkas and waste lands can be put under cashew trees. It appears that the cashew nut cultivation in this region will not only be successful but will be a profitable proposition owing to the advantage of the north-east monsoon rains occuring in October and November.

Among the districts on the western border of Bombay state is the district of Surat where cultivation of cashew nut will be possible in those areas where the rainfall is over 60 inches and humidity fairly high. Such areas are not far distant from the sea. While appreciable area would be available for extension of cashew nut cultivation, it cannot, however, be said for certain how much area would be actually available for this development unless a survey is undertaken to elicit this information.

The area under cashew nut can be substantially increased if the Forest Department could undertake to plant cashew trees in unreserves. The scheme of planting cashew trees in unreserves is, I undersand, in operation in South Kanara district.

Summarising, the new area that can be brought under cashew nut cultivation in differnet districts is as follows :—

| | |
|---|---|
| Ratnagiri district | 17,000 acres |
| North Kanara district | 10,000 ,, |
| Thana district | 5,000 ,, |
| Kolaba district | 5,000 ,, |
| Surat district | 5,000 ,, |
| | 42,000 acres. |

If, therefore, an aggregate of from 3000 to 5000 acres in these districts are seeded to cashew nut annually, a target of 40,000 acres would be covered in about eight years depending upon the quantity of seed nuts available for this purpose. The addition of this acreage to the existing promiscuous cultivation will yield sufficient raw material to develop the cashew nut industry to the extent desirable and at the same time ensure economic stability to withstand potential foreign competition.

**6. Conclusion and recommendations :—** Consequent upon the rapid expansion of export trade in the cashew kernels and the shell oil in recent years, the returns from cashew plantations have appreciably increased. But it is strange that this expansion has not stimulated active interest among the growers to plant new areas in compact blocks. They have obviously failed to realise the case and the low cost at which cashew plantation can be established on waste lands and in poor soils unsuitable for growing other perennial crops and also the fact that a cashew plantation is a lucrative source of income. The present large imports from Africa indicate the scarcity of nuts for processing in Indian factories and unless production of nuts is increased to maintain not only the present level of export of cashew kernels and shell oil but also provide for possible expansion of this trade in new foreign markets, India cannot avoid a very keen competition from other tropical countries. Increased production of nuts in producing areas would mean larger exports of kernels and also of shell oil the demand for which is rapidly increasing as a strategic material. Simultaneously with large scale production of exportable commodities, production of other by-products such as vinegar from ' apple ' and peels, as poultry feed of nutritive value would increase proportionately. Thus, these products which have been hitherto wasted will be a source of substantial income.

In this connection, the following recommendations are made which, if properly implemented, will contribute substantially to the development, in all its aspects, of this industry on sound commercial lines and thus increase our dollar earning capacity.

1. The growers may be induced through Departmental agencies, to plant their varkas lands with cashew trees to increase production.

2 The state may consider the advisability of disposing varkas lands to persons interested in the cultivation of cashew nut on easy terms of payment to enable large plantations being established for promoting its cultivation as a remunerative crop.

3. It is necessary to gather exact information with regard to yield of nuts per acre and, for this purpose, a number of trial plantations in suitable areas must be established.

4. Government may advise the Forest Department to plant cashew trees in unreserves as a measure of extending area under cashew nut and increasing production of nuts. This scheme is being worked satisfactorily in South Kanara district.

5. Producers' co-operative societies may be established for collecting nuts and marketing directly to factories for processing. It should be the duty of the collecting agency of the co-operative society to see that only mature nuts are harvested.

6. Government should fix and enforce grade standards for cashew kernels for export trade and for home market. The adherence to grade standards by shippers will not only secure better price but will ensure trade reputation.

7. When home production of nuts has sufficiently increased to meet the needs of the factories, suitable tariff regulations or lagislative measures should be adopted to prevent large scale import of nuts from foreign countries.

8. Manufacturing of vinegar from 'apples' in producing areas may be organised on co-operative lines.

9. Reduction of railway freight on cashew nuts on Indian railways is an urgent necessity to encourage consumption of cashew kernels in India. At present, this consumption is only one tola per head per annum.

10. New foreign markets for cashew kernels and shell oil should be created through our High Commissioners abroad to increase dollar and sterling earnings.

11. There is a very urgent need for mechanizing the cashew nut industry particularly in respect of roasting, shelling and peeling to increase production of kernels of superior quality and thus withstand competition from the mechanized cashew nut industry of Brazil and South Africa.

12. Considering the industrial value of the shell oil and its increasing demand in the markets of the United States of America, immediate investigations should be undertaken by the Industries Department to improve the manufacturing process to recover maximum percentage of oil of better quality. Other industrial uses of the shell oil also need to be explored.

# Controlled Studies on Erosion Permitting and Resisting Crop Strips.

## ( Part I. )

By

J. K. Basu, * N. D. Rege § and R. S. Gajendragad ‡

When the natural vegetation such as grass is removed, soil thus exposed to rain and wind is lost due to rain water flowing down the slope or by being carried away by wind. Ploughing the land further vitiates the natural permeability of the soil by disrupting its normal granular structure. Continued cultivation adds in the destruction of organic matter through processes of attrition and decomposition. Thus the use of land involves its exposition to cultural mild or violent operations. From the stand point of the utility of cultivable land, soil removal to a great extent and the loss of rain as run-off induced by such artificial methods of cultivation are of serious consequences resulting in the lower yields of food crops. The factors affecting erosion are so many and so varied that their importance cannot be studied independently. The major factors out of these are (1) nature of the soil, (2) slope of the land, (3) intensity of rainfall, (4) number of rainy days causing the run-off and (5) The nature and the previous history of the cover crop standing over the land. It is not possible to study these factors individually as these are interdependent and therefore in present paper only the effect of crops grown thereon is studied keeping the slope and soil type constant.

According to Bennett (1) data on soil and water losses reveal the almost universal effectiveness of close-growing vegetation in accelarating infiltration, slowing down run-off, and protecting soil from erosion and run-off. Without exception, it is seen that the average annual soil losses from the areas devoted to clean tilled crops are many times greater than the corresponding losses from the areas heavily covered with protective vegetation. The water losses range from 2·5 to 355 times more in case of cultivated or exposed areas when compared to areas protected with permanent cover.

Kanitkar and his associates (2) have shown in their study of run-off data at Sholapur that if the natural vegetation is allowed to remain as it is, the soil lost due to run-off is only 0·55 tons per acre while rain water lost is only 1·15 inches. But as soon as this natural vegetation is trimmed to imitate over grazing condition the loss of soil and water is 17·7 tons and 4·7 inches per acre. This loss of

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soil and run-off is further enhanced when the land is harrowed, put to thorough cultivation and Rabi Jowar etc. Further more number of years required to remove seven inches of top soil are 1850 in case of natural vegetation while in cases of trimming, harrowing, though cultivation and Rabi Jowar these are 57, 40, 31 and 27 years respectively. These results give us a clear idea as to the serious consequences of the cultural operations as well growing certain crops like Rabi Jowar off and on.

Basu and Sreenivas (2) in their study on the effect of crop on the erosion have observed that if Matki (Phaseolus aconilifolius Jacquin) is grown the losses of soil and run-off are 0·78 tons and 2·08 inches per acre. Further, it is observed that when Ground-nut is grown alone the losses of soil and run-off are 1·62 tons and 5·28 inches per acre. But if the land is kept fallow the losses are 8·46 tons and 8·38 inches per acre. From these as well as the results obtained by Kanitkar and his associates it can be seen that wherever the soil is covered with natural vegetation and cover crops, the losses of soil and run-off are very low. But as it would not meet the food requirements by growing the natural vegetation of crops resembling the natural vegetation (Pulses) alone cereals as well as legumes must be grown in proper proportion. This method would definitely improve the situation both regarding the human needs and soil conservation.

Bearing these results in mind it was proposed to work out a system of cropping known as Field Strip Cropping under controlled conditions and an experiment was laid out as given below and the effect of this cropping system on losses of soil and run-off and combination of erosion resisting and permitting crops was studied.

There were eight plots seven of which were 66 ft. long and 8¼ ft. in width representing 1/80th of an acre. The slope was 1·5% which was the normal slope in this area. The eighth plot was of double the length i. e. 132 ft. long but the width and the slope was the same. The seven plots ( or compartments ) were separated from one another by means of iron plates which helped the water and soil removed from each plot to be separately collected in the tanks thus avoiding the mixture. Each of the seven plots were divided lengthwise into three equal parts i. e. 22 ft. each and the eighth into six parts of 22 ft. each. In the first year the legume crop was at the bottom part of 22 ft. except where the legume crop is grown on the entire length of the plot such as Ground-nut entire length ( plot No. 7) or cereal crop grown on entire plot ( plot No. 2 control ) ( vide Table No 1). The seed rates were two normal and three normal in case of Hulga and Matki. The remaining area 44 ft. was then put to cereals Bajri Tur (3–1 ratio).

In the second year this strip of Matki, Hulga or Ground-nut as the case may be was shifted in the middle 22 ft. part, and in the third year to the top 22 ft. part of the plots. Thus in three years the whole area was covered with the leguminous crop.

The results obtained for loss of soil and run-off were studied separately and also by pooling them together and the effect of this cropping system was studied. From Table No. 1, it can be seen that only about 1·5 tons of the soil and 6·64 inches of run-off was lost when Matki (3N) was grown along with Bajri-Tur. The next best seems to be ground-nut (entire length). The figures of 8·03 inches for run-off is a bit higher than in other cases as the growth of ground-nut in the first year was very patchy on account of untimely rain. Third in line seems to be Hulga (N) with Bajri Tur. These results are further corroborated by the study of the canopy development of the cover crop. It has been observed that in second fortnight of September when the rainfall is very heavy the % age canopy of Matki (3N) is above 80% while that of ground-nut and Hulga (N) vary between 40–50%. Thus it gives us a clear idea of the development of canopy which helps to control erosion (vide graph No. 1).

From the above data it can be seen that it is possible to avoid serious losses of soil and rain-water by selecting a useful cover crop such as Matki and Grount-nut and growing it economically by stripping it with cereal. This method of cropping would not only save the land from utter destruction due to loss of soil etc. but also would help to meet the balanced requirements of cereal and pulses of an average individual.

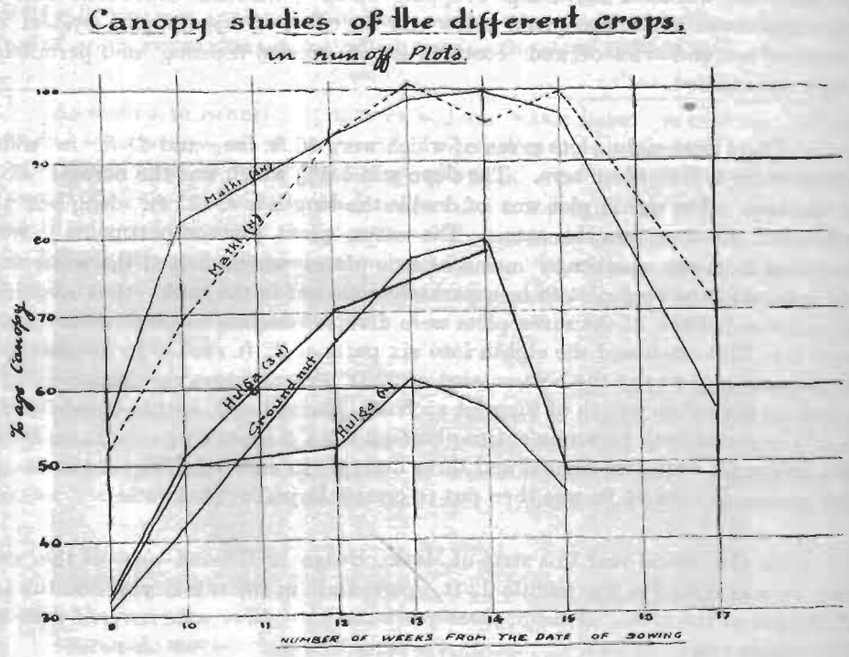
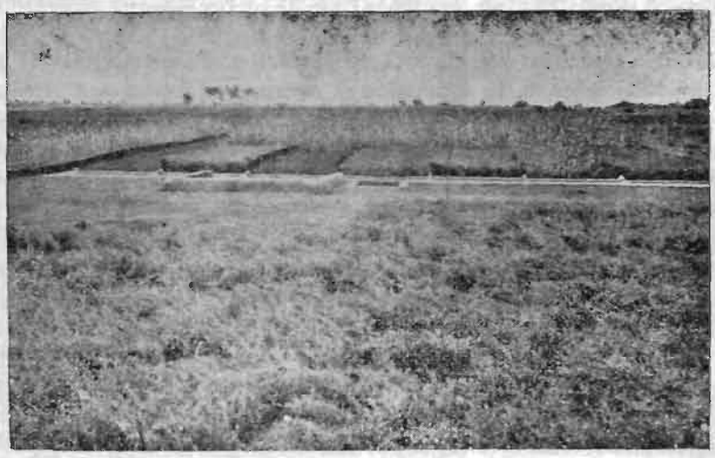


**Table No. 1.**

**Run-off lost in inches and soil lost in tons per acre 1946-49.**

| Plot No. | Treatment | Run-off | Soil | No. of years to remove seven inches of surface soil. |
|---|---|---|---|---|
| 1. | Matki 3 N Bajri Tur | 6·6446 | 1·52703 | 643 |
| 2. | Bajri Tur (Control) | 7·7833 | 7·2538 | 135 |
| 3. | Hulga 3 N Bajri Tur | 6·6703 | 5·0452 | 195 |
| 4. | Matki N Bajri Tur | 7·0195 | 4·3304 | 227 |
| 5. | Ground-nut Bajri Tur | 6·6936 | 4·5609 | 215 |
| 6. | Hulga N Bajri Tur | 7·3286 | 2·7520 | 357 |
| 7. | Ground-nut (Entire) | 8·0370 | 2·4046 | 408 |
| 8. | Ground-nut Bajri Tur | 8·4326 | 7·8333 | 125 |



The run-off plots at the Dry Farming Research Station, Sholapur.

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(Dry Farming Research Station, Sholapur.)

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# Determination of the Moisture Equivalents of Soils by the Bouyoucos Method with slight modifications.

By

[1] V. S. Abhyankar, [2] N. Narayana and [3] J. A. Daji

During a recent investigation of the properties of the trap soils of Bombay Deccan, difficulty arose in the estimation of moisture equivalents of the soils for want of the special centrifuge. A search of the literature revealed that a suction method was first tried and used by Bouyoucos as early as 1929. It was subsequently modified by the same author in 1935. It was, therefore, decided to adopt his method provided it gave satisfactory results.

Preliminary trials showed certain drawbacks in this method. With certain clayey soils, the duplicates varied more than the working error. (Vide Table I)

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**Table I.**

Moisture equivalents of samples of soils as determined by the method described by Bouyoucos (1935).

( *Percent of soil* )

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Medium black soil sample No.1 | 50·30 | 44·31 | 47·03 | 44·78 | 46·05 |
| Medium black soil No. 2 | 54·79 | 48·60 | 43·07 | 46·37 | 47·65 |

Secondly, the author has recommended that a Buchner funnel (5x2·5 cms.) should be filled with soil and kept soaked in water for 24 hours. This unnecessarily delayed the estimations and required a large number of funnels when a series of estimations were required to be made. Experiments varying the quantity of soil, time of filtration, temperature of water, fineness of soil, soil to water ratio etc., were tried. The results showed (a) finer the material, more consistant the results (b) owing to cracking of the soil during filtration the pressure would suddenly fall and more water was retained in the soil (c) there was no advantage of soaking the soil for 24 hours. It was enough to stir the soil for a couple of minutes into a suspension and quickly pour it into the Buchner funnel without allowing any settling in the beaker, (d) using large quantities of soil or water did not greatly increase the accuracy (e) it was sufficient to use the laboratory water pump which gave above 30–40 mm., pressure and (f) between 25° to 30°C temperature, the results did not vary.

The final method adopted may be briefly stated. About 10 gms., of soil passed through 1 m. m. sieve is treated with 20 ml. of water at room temperature (26° to 29°C) and stirred for 10 minutes. A Buchner funnel (5 x 2·5 cms.) is fitted with a hardened filter paper cut to fit the funnel exactly. The filter is moistened and slow suction started. The soil suspension is quickly poured on to the funnel. If this is properly done there will be very few soil particles left behind in the beaker. After 5 minutes the tap is turned on to the full. The vaccuum slowly goes up to 50–60 m. m. As soon as all the loose water in the funnel filters off an inverted glass stopper chosen to exactly fit in the Buchner funnel is placed on the soil and an inverted metallic dish placed on the stopper. The whole is then covered with a piece of moist cheese cloth which helps in preventing direct evaporation by moistening the air drawn through the soil. On the top of all is now placed a a kilogramme weight which compacts the soil and prevents too quick cracking. (See fig. 1) Suction is allowed to continue for exactly 10 minutes beginning with the disappearance of the standing water in the Buchner funnel. The pressure is released and the soil transferred to a tared weighing bottle, by blowing from below and the filter paper lifted off the sample of soil. The weighing bottle is immediately weighed and again after drying in the oven. From the weight of the soil transferred into the weighing bottle and the amount of water lost, the moisture equivalent is calculated.

Using the above method six determinations of moisture equivalents of each of three different types of soils were determined. The results are given in Table II.

**Table II.**

Working error in determinations of moisture equivalents of three soils by the modified method.

( *Percent of soil* )

| Mechanical analysis | Black cotton soil | Laterite soil | Sandy soil |
|---|---|---|---|
| Clay | 53·85 | 58·90 | 32·30 |
| Silt | 9·35 | 10·70 | 1·55 |
| Sand | 24·61 | 23·76 | 49·51 |
| No. of determination | | Moisture equivalent | |
| 1. | 47·31 | 31·74 | 14·34 |
| 2. | 47·84 | 32·70 | 13·35 |
| 3. | 49·94 | 30·80 | 14·33 |
| 4. | 48·85 | 31·18 | 13·21 |
| 5. | 46·72 | 28·50 | 11·69 |
| 6. | 47·44 | 31·11 | 12·25 |
| Standard deviation | 1·2 | 1·39 | 1·09 |

**Comparison with the centrifuge method :**—The moisture equivalents of a few soils as determined by the centrifuge method and the modified method are given in Table III.

**Table III.**

Moisture equivalents of soils by the modified suction method and by the centrifuge method.

( *Percent of soil* )

| No. | Place | Layer | Modified suction method | | Centrifuge method | |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1 | 2 |
| 1. | Murdi | 1st | 20·04 | 20·06 | 18·91 | 20·15 |
| | | 2nd | 13·52 | 13·53 | 14·89 | 15·03 |
| 2. | —do— | 1st | 18·60 | 18·38 | 19·90 | 16·87 |
| | | 2nd | 15·85 | 15·75 | 12·42 | 12·53 |
| 3. | „ | 1st | 20·70 | 22·65 | 21·29 | 21·05 |
| | | 2nd | 21·29 | 20·18 | 19·51 | 17·08 |
| 4. | Anjarla | 1st | 27·67 | 29·56 | 28·71 | 27·13 |
| | | 2nd | 21·35 | 21·46 | 20·30 | 18·37 |
| 5. | „ | 1st | 16·40 | 16·92 | 16·82 | 16·29 |
| | | 2nd | 17·35 | 17·28 | 16·66 | 16·36 |
| 6. | Asad | 1st | 37·53 | ... | 37·00 | ... |
| | | 2nd | 36·34 | ... | 35·34 | ... |
| | | 3rd | 34·46 | ... | 33·98 | ... |
| 7. | „ | 3rd | 34·95 | ... | 35·14 | ... |

It will seen that the moisture equivalents of varied types of soil layers by suction and centrufuge methods agree fairly well. In order to see if the modified method works equally well in other hands moisture equivalent estimations of samples 5, 6 and 7 in the table were carried out by 3 other workers in the laboratory.

## Summary.

A modification of the Bouyoucos method of estimation of moisture equivalents of soils has been described. As modified, the method is cheap, quick, easy of manipulation and yields consistent results. The moisture equivalents of a number of soils as determined by the method described are compared with those by the standard centrifuge method. The results by the two methods agree fairly well.

## References.

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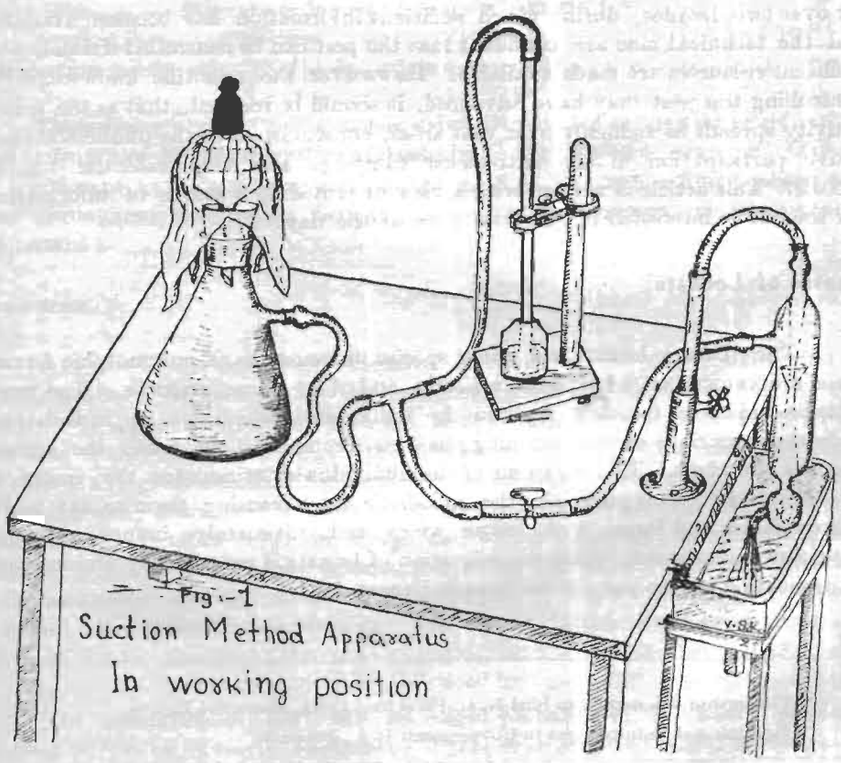

Fig.-1
Suction Method Apparatus
In working position

# Locusts, their activity and control *

## ( with particular reference to Bombay State )

By

G. A. PATEL [1]

There are many species of locusts in the world, out of which three are met with in India. These are *Schistocerca gregaria* Forsk. ( Desert locust ), *Locusta migratoria* L. ph. *solitaria* ( Migratory locust ), and *Patanga succincta* L. ( Bombay locust ). The swarms of locusts recorded from India are generally of the Desert locust and Bombay locust, but the former is far more common than the latter. The Migratory locust nevertheless, is known to occur in the solitary phase throughout the Indian Union.

The locust invasions occur periodically and as the public attention is drawn to this serious pest only occassionally, much confusion arises. This is due to the lack of full facts available to the public, rather than the absence of our knowledge of the habits and the methods of control of this pest. The important species of locusts particularly the Desert locust have been under study for over two decades, during which sufficient information has become available and the technical men are confident that the pest can be controlled if timely and sufficient resources are made available. Howsoever the scientific knowledge for controlling this pest may have advanced, it should be realized, that as the locust activity spreads so suddenly over vast areas, consciousness of the public and their active participation in the anti-locust campaign are very essential for its success. This article is written with a view of providing a source of information for the public interested in this vital topic of the day.

### Phases of Locusts

The Desert locust and other species of locusts have polymorphic forms. These are known as ( 1 ) phase *solitaria* and ( 2 ) phase *qregaria*. The word solitaria indicates the form seen in the individuals which develop in isolation, while the gregarious or the swarming phase is brought about when the species becomes abundant. This crowding of the individuals stimulates the insect to greater activity, thus increasing the metabolic rate, causing them to eat more, to grow faster and larger with longer wings and ultimately induce them to move away in swarms. Thus the migration of locusts is preceded by an increased multiplication of the pest in the breeding areas. ( *3* )

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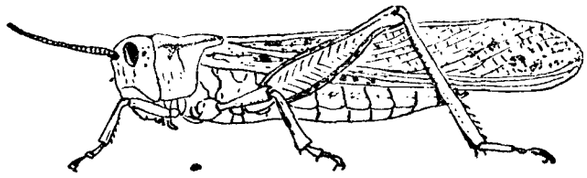
* The author is indebted to Shri N. G. Patel for having drawn the figures.

1 Agricultural Entomologist to Government, B. S., Poona 5.

## Migratory locust (*Locusta migratoria* L.)

### Description

The adult of the solitary phase has variable colour, and is often greenish and sometimes blackish. The hind tibia is almost always red, and the hind femur is longer than half the elytra. The pronotum is strongly compressed laterally but without a constriction in the middle. The median keel is high, roof shaped and has a convex appearance in profile. Its front margin is angulate while the hind angle is acute. The adult male measures 29–35 mm. while the female is 37–60 mm. long. The elytra of the male is 33–43 mm. while that of the female is 40–58 mm. long. ( *6* )



**Migratory locust** (*Locusta migratoria* L.)

### Distribution

The solitary phase of this locust is widely distributed in the Old world, and extends from the Northern borders of Australia to the Western coast of Africa and Northward in the southern part of the U. S. S. R. The solitary phase is found throughout the Indian Union, but is more common in Rajasthan ( Rajputana ).

### Bionomics

*Locusta migratoria* has an extensive distribution in the Indian Sub-continent, but its appearance in the swarming phase has been very rare in our country. It is possible however, that the Madras Locust invasion of 1878 may have been of this species. Though, this species is endemic in our country, it has not been of any great economic consequence, particularly in the swarming phase. In the Bombay State as it is constituted to-day, this locust was observed to breed during October 1937, in Sirohi and Deesa areas of Banaskantha, in Kheralu, Mehsana and Vijapur talukas of Mehsana district and in some villages of Sabarkantha district, and in Matar taluka of Kaira district. The total estimated area where some damage had taken place was approximately 500 acres. ( *4* )

The infestation of 1937 had its origin probably in the heavy rainfall received in Gujarat in early September, when, it is supposed that a fairly good

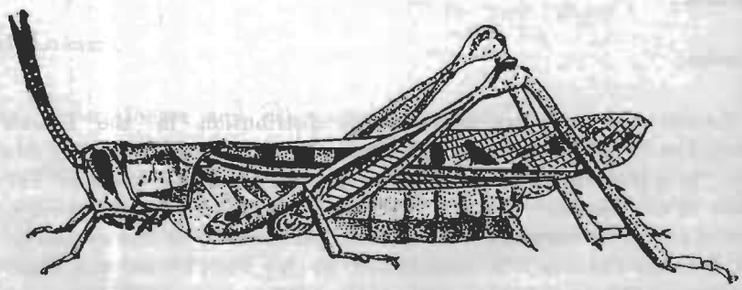
proportion of the large *Locusta* population then obtainable in eastern Rajputana, was carried to Gujarat along with the air currents associated with the storms. The transference of the adult population did not seem to have been in swarms but as large groups of individuals. ( *4* )

*Locusta migratoria* has restricted food habits and as a rule prefers the grass family, consequently in the year 1937, the damage was mainly caused to *bajri*, *jowar* and *barti* ( *Panicum miliaceum* ).

## Bombay Locust (*Patanga succincta* L.)

### Description

The adult insect is pale brown in the solitary phase, and reddish in the migratory stage, which changes to dark brown during oviposition period. Black and yellow streaks are also seen. The pronotum is depressed laterally and somewhat constricted in the front. The median keel is very low, and the upper surface of the pronotum has coarse honey-combed sculpture and its colour is dark with a pale stripe along the median keel; the lateral surface has a black stripe above the middle and a large yellow spot in the middle. The prosternal spine inclines backward and does not touch the mesosternum. Elytra is mainly pale, with ivory-white stripes and black spots along the middle and black narrow streaks in the apical part. Hind femur is pale, and without bands. The male measures about 48–56 mm., female 57–63 mm., and the elytra of the male and the female are 54–59 mm. and 58–70 mm. respectively. (*6*)



**Bombay Locust** (*Patanga succincta* L.)

### Distribution

This species is endemic in India and the solitary phase individuals have been observed in Coimbatore, Nilgiris, Pusa and the Western ghats. Outside India, it is known to occur in Ceylon, China, Java, Sumatra and the whole of south eastern Asia including the Malaya Archipelago. (*4*)

### Bionomics

There has been very few recent observations on this pest, and much of our knowledge of the bionomics of this species dates from 1906, when Lefroy studied this pest. According to him there is a single generation per year and the breeding takes place in open, grassy areas in the midst of forest regions of the Western ghats. (*5*)

The eggs are laid in soil during the months of June and July and the egg stage lasts for about a month and a half. There are 7 to 9 nymphal instars and this stage lasts for about two months. The nymphs do not show swarming tendency but the adults when present in large numbers congregate and migration occurs in October and November after which they remain inactive during winter months. Then a second migration is known to take place and the adults reach maturity sometimes during March to May, after which breeding takes place. As, this pest was studied nearly half a century ago the details given above necessarily need verification.

*

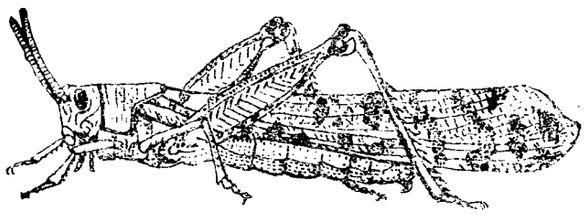
The Bombay locust is endemic in the Western Ghats and under favourable conditions it multiplies in large numbers and migrates to many destricts of Bombay including Gujarat and to Uttar Pradesh, Madhya Pradesh, Bihar, Hyderabad and the northern parts of Madras State. The swarming phase of this pest like other locust species is also periodic and it is known to have occured in 1835-45, 1846-66, 1878-84 and 1901-08. (*5*)

## Desert locust (*Schistocerca gregaria* Forsk.)

Out of the many species of locusts, this species is very widely known and its periodic ravages has been known to occur since the dawn of human history. It is likely that the reference to locusts in the Bible pertains to this species; consequently it is also sometimes known as the Biblical locust.

### Description

The adults of the swarming phase are pinkish with small dark spots during the early period of their development and turn bright yellow when they are sexually mature. Pronotum is distinctly constricted in front of the middle, surface is smooth and the hind angle is broadly rounded. The hind tibia is yellow with spines blackish on the tips. Prosternum has a straight spine with its apex rounded. The male is 46-55 mm. long and the female 57 mm. The elytra of the male is 50-60 mm. while that of the female is 60 mm. long. (*6*)



**Desert locust** ( *Schistocerca gregaria* Forsk. )

The hoppers of the swarming phase are blackish brown and about 8-12 mm. long when just hatched and they have a pale median line on the head, pronotum and abdomen. The second stage nymphs are generally similar to the first but the length is about 12-18 mm. with the colour pattern more distinct and the darker spots are blackish, while the paler spots are yellow or pinkish. In the third stage, the face and the base of antennae are pale orange. The abdomen is yellow or pink with numerous blackish dots and a series of black dots along the middle The length is 18-25 mm. The hoppers of the fourth stage are of rose or lemon-yellow colour with the black pattern conspicuous. Rudiments of elytra and wings are pale and turned up on the back. The abdomen has a sharp broad median stripe. The length of the body is 25-33 mm. The fifth stage or the last stage hoppers are 38-45 mm. long, with yellow or orange-yellow colour. A light colour spot on the pronotum which is present in the earlier stages loses its definite outline and even completely disappears ( *6* ).

The nymphs of the solitary phase are generally greenish in colour with traces of black markings.

## Distribution

The distribution of this species is confined to the Old world and for convenience the areas in which the Desert locust is prevalent are grouped into six zones, ( 1 ) the Moroccan-Senegambian area, ( 2 ) the Algerian-Nigerian area, ( 3 ) the Sudanese-Arabian area, ( 4 ) the Somalia area, ( 5 ) the South African area and ( 6 ) the Indo-Iranian area. In Africa the Desert locust covers very nearly the whole of the continent with the exception of the afforested and humid areas of the west and central Africa ( *7* ).

## Host Plants

Bhatia ( *1* ) had made experimental studies, to determine the host preferences of the Desert locust. According to him plants like *neem* and *ak* are definitely refused by the hoppers, while adults may nibble at *neem* leaves on starvation. *Bordi* ( *Zizyphus rotundifolia* ), *bavuri* ( *Acacia jacquemontii* ), *arni* ( *Clerodendron phlomoides* ), and some others are sparingly eaten while the cultivated plants like, *bajri*, *til*, *muth* and *guar* are consumed without any hesitation. Some wild plants like *wekra* or *bekkar* ( *Indigofera cordifolia* ), *Kanti* ( *Tribulus terrestris* ) are also eaten without any hesitation. For further details the reader is referred to the publication of the said author.

## Periodicity of Desert locust

Since this locust has been an object of special study for several decades, we have a fairly large extent of data. From the available information, it is surmised that the activity of the Desert locust has been observed in 1803, 1810-13, 1821, 1826, 1833-34, 1843-45, 1860-66, 1869-73, 1876-81, 1889-98, 1900-07, 1912-19, 1926-31 and in the begining of the past decade and 1949 onwards. Thus generally there were locust cycles of 5-9 years, interrupted by short locust free periods. (*5*)

The fluctuation in the locust population and the consequent periodicity of out-breaks, has been traced to the variations in the sun-spots. There is an inverse corelationship between locust population and the number of sun-spots, and the breeding of locusts is maximum when the sun-spots are at a minimum. Periodicity of locust out-breaks in India also indicates this inverse corelation. (*5*)

## Cycle of the Desert locust in the Indian sub-continent

The Desert locust hibernates in the adult stage, and overwintering is generally known to occur, in south Punjab, South Mekran, in Sind and Kachh. These adults become active during the spring and begin to breed if favoured by winter rainfall. The adults migrate northward in early spring upto Quetta and North-west Frontier Province (Pakistan). During April-June, breeding occurs in this area, and the new generation migrates eastward into Punjab, Sind and Rajasthan in the early monsoon period. The spring breeding is also known to occur in Punjab, from where the new generation migrates eastward into U. P., Bihar and Bengal. (*5*)

The locust swarms of the spring generation when they arrive in U. P., Rajasthan, Punjab and further eastward and southward, find suitable conditions of breeding in the monsoon-fed region, where eggs are laid and a second generation of locust takes place (*5*). Thus the breeding of the Desert locust in 1950 in the northern districts of Bombay State was of the second generation. If the conditions are not favourable during the monsoon then the second generation may not take place. The adults in the post-monsoon period emerging from this second generation migrate and with the setting of the winter it finds favourable conditions to go westwards along with the prevailing winds. If, however, the wind currents are favourable for its southward or eastward migration some swarms may go south or east but, as suitable conditions are not met with, they do not continue the cycle but ultimately die away; only those swarms which have migrated westward to Iran and Baluchistan area, succeed in breeding during the following spring.

The Indian Council of Agricultural Research has compiled the information on the activity of the Desert locust in India and the following information which pertains to the Bombay State as it is constituted to-day is abstracted therefrom (*2*). It may be pointed out that it has not been possible for the author to look into the details of the infested area during the cycle in the early part of the past decade.

**Table 1**

The activities of the Desert locust in Bombay State
1926–1931

| Date | Area visited by locust | District | Remarks |
|---|---|---|---|
| Nov. Dec. 1926 | Radhanpur | Mehsana | Adult locusts |
| January 1927 | Sanoi | ,, | ,, |
| November 1927 | Radhanpur | ,, | ,, |
| January 1927 | Viramgam, Dhandhuka, Dholka | Ahmedabad | Red and yellow adult locust |
| Feb–March 1927 | Matar | Kaira | Adults |
| | Dhandhuka, Dholka, Viramgam, Sanand | Ahmedabad | ,, |
| | Talodatal | W. Khandesh | ,, |
| Sept. Dec. 1929 | Patdi, Dhandhuka, North-Daskroi | Ahmedabad | ,, |
| | Kapadvanj, Matar, Mehmedabad | Kaira | ,, |
| | Umbergaon | Thana | ,, |
| | Peint taluka, Nasik, Nandgaon, Chandor taluka | Nasik | ,, |
| | Amod-Jambusar | Broach | ,, |
| | Pardi | Surat | ,, |
| | Idar, Prantij | Sabarkantha | ,, |
| | Godhra taluka, Jhalad | Panchmahal | ,, |
| | Baroda | Baroda | ,, |
| | Jalagaon, Yaval & Raver taluka | E. Khandesh | ,, |
| | Dhulia | W. Khandesh | ,, |
| | Akola, Sangamner, Kopergaon | Ahmednagar | ,, |

**Table 1** ( *Continued* )

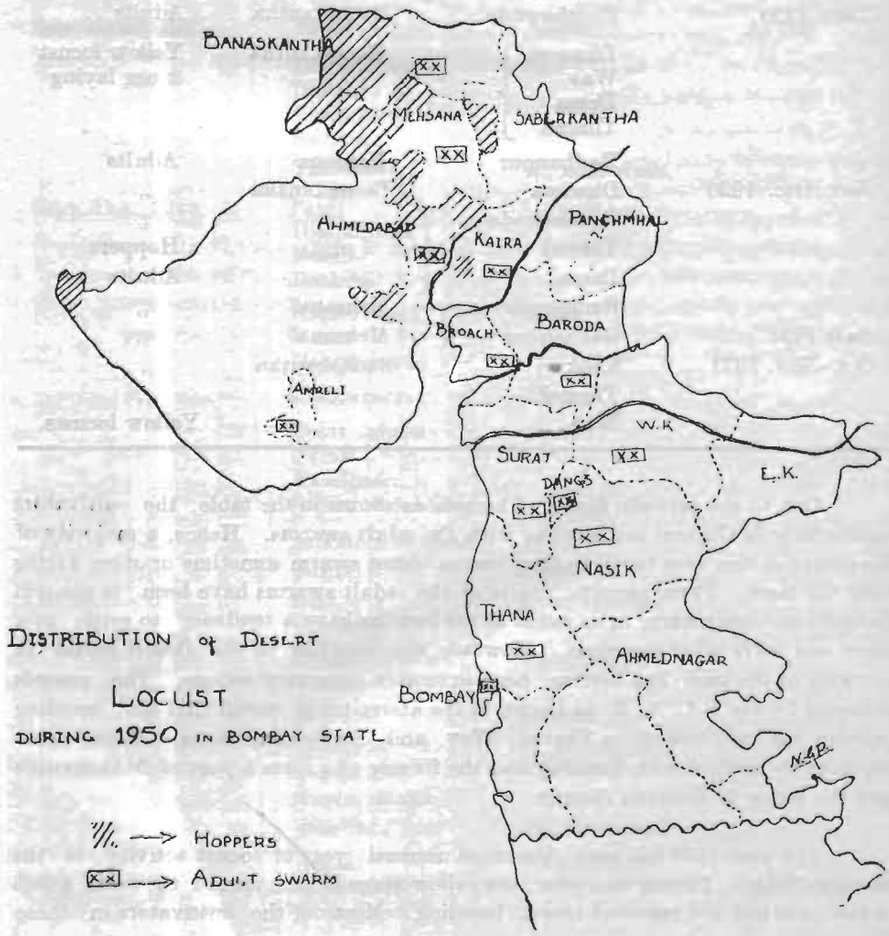
| Date | Area visited by locusts | District | Remarks |
|---|---|---|---|
| Sept. Dec. 1929 | Tharad, Wav, Suigam, Nalodar, Deodar, Kankrej, Gadh, Deesa & Panthawada | Banaskantha | Adults |
| January 1930 | Radhanpur | Mehsana | Yellow locust |
| June 1930 | Panthawada | Banaskantha | Adults |
| | Dhanera, Wav, Deesa, Tharad | Banaskantha | Yellow locust & egg laying |
| | Radhanpur | Mehsana | Adults |
| Nov. Dec. 1930 | Dhanera | Banaskantha | ,, |
| | Panthawada | ,, | ,, |
| | Tharad | ,, | Hoppers |
| | Deesa | ,, | Adults |
| | Radhanpur | Mehsana | ,, |
| July 1931 | Radhanpur | Mehsana | ,, |
| Oct.-Nov. 1931 | Kankrej | Banaskantha | ,, |
| | Tharad | ,, | ,, |
| | Wav | ,, | Yellow locusts. |

Due to the periodic flights of locusts as shown in the table, the cultivators particularly in Gujarat are familiar with the adult swarms. Hence, a majority of the people in this area recall to have seen a locust swarm sometime or other during their life time. These periodic visits of the adult swarms have been in general sporadic and temporary, in as much as the swarms have a tendency to settle at a place and leave after sometime. However, the breeding of the Desert locust in our area in the past has neither been extensive nor very serious. The records collected by the I. C. A. R. as shown in the above table reveal that the breeding activity has been noticed in Tharad, Wav and Radhanpur areas. These areas are recently merged with Bombay and the former two form a part of Banaskantha and the latter of Mehsana district.

The year 1950 has been the most unusual year of locust activity in the Bombay State. During this year, the yellow stage locusts spread to areas which in the past had not reported locust breeding. Most of the cultivators in these

areas and people in general agree that locust breeding was not seen in living history to the extent it was experienced this year. The people in the district of Ahmedabad, Kaira, Sabarakantha and a large part of the cultivated areas of Mehsana district were entirely unfamiliar with the hopper stage of the Desert locust.

The extension of locust breeding to the areas east and south of Tharad, Wav and Radhanpur has been attributed to the favourable condition of moisture in these areas during September, 1950. The whole of north Gujarat received heavy rains in this month resulting in floods in many parts of this region. The rain-fed areas thus provided favourable conditions for the locust to lay eggs and for their further development. The total infested area in this region still remains to be ascertained. Nevertheless the localities in which breeding was noticed have been surveyed, and the accompanying map indicates these areas. The swarms of adult locust in 1950 were quite frequent, and the districts from where they were reported are also shown in the same map.



## Control measures

### Destruction of eggs

Destruction of eggs by exposing them by ploughing and harrowing are important factors in controlling those grasshoppers which oversummer and hibernate in the egg stage. The egg stage of Desert locust however lasts for a brief period of ten to fifteen days, which provides a very short period for its destruction.

In a campaign for the destruction of eggs,the important factor is the survey of the egg laid areas. This is not always correctly possible. Nevertheless, where such information exists and where eggs have been laid in the cultivated areas, harrowing helps to expose the egg masses to the detrimental climatic elements. This method alone cannot be fully relied upon in a large scale campaign for locust control. Besides, the Desert locust is also known to lay eggs extensively in the uncultivated waste lands of the semi-desert areas of Banaskantha and Mehsana districts where it is impracticable to carry out such operations.

### Hopper control

The hoppers of the swarming phase of locusts have the characteristic habit of moving in bands during the day. These bands become inactive and stationary in the evening hours and remain so until the next morning. The early stages of hoppers are not able to migrate long distances, but the later stages do so, with the result that a field infested to-day may be completely free the next day.

The hopper stage can be destroyed by mechanical and chemical measures. The mechanical methods like crushing of hoppers by specially made steel brushes, by trapping them in hopper-dozers, or by dragging tin trays smeared with coal tar or crude oil, have all been used in the past with varying success. Another mechanical method is to dig ditches with vertical walls and drive the nymphal bands into the ditches from where they cannot come out and can be easily buried therein. It is also possible to kill hoppers by providing barriers of metal sheets over which the hoppers cannot jump, and thus direct them to move into pits in which they can be easily buried.

The mechanical methods are useful only for the very young hoppers. These measures are laborious, and hence practicable where cheap labour is available and where the cultivators are willing to do their best. However,this is not the case in the northern districts of the Bombay State where the strong religious sentiment prevents the general public from extending its full cooperation for the destruction of locusts.

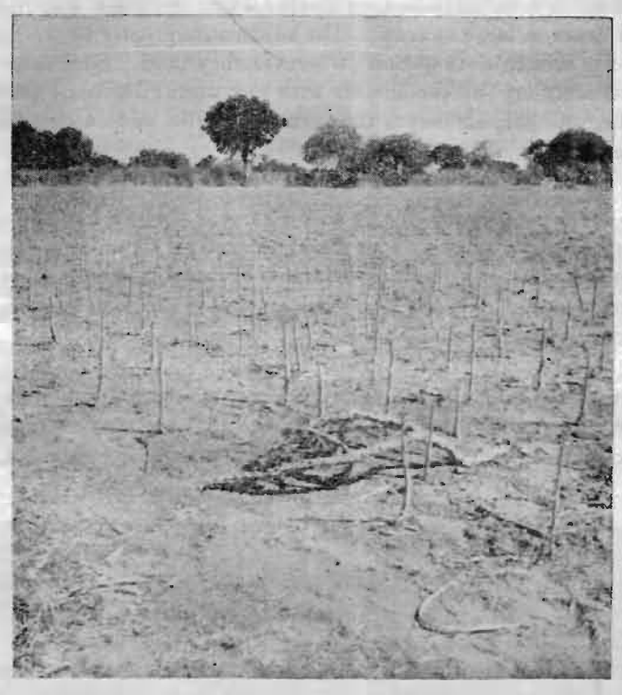
By far the best way of destroying hoppers is by the chemical methods. These include the use of poison baits and dusting of insecticides.

Poison baits are prepared by mixing such materials like, wheat bran, rice bran, pulse husk or even saw dust with stomach poisons like paris green or other arsenates or benzene hexachloride to the extent of 5%. Suitable attractants in the form of molasses are also mixed with the bran. The bait is generally moistened with water, but oil bait and dry baits are also sometimes used. The bait is broadcast on the path of the hoppers which get killed when they feed on the poisoned bait.

The use of poison bait has serious limitation because it is difficult to procure bran or other material in the areas where locust operations are to be conducted. Consequently during this year in the Bombay State the main control measure used was dusting of insecticide — 5% or 10% Benzene hexachloride @ 25–30 lbs. per acre. The earlier stages of locust hoppers are quite susceptible to 5% BHC ( sold under the trade name of Gammexane or Hexidol or Hexyclan ), while for later stages a higher percentage of BHC becomes necessary. During this year 10% BHC was used for the older nymphs with success.

**Locust hoppers on Jowar.**

In the locust operations this year burning of locust by spraying kerosene was also practised to some extent. This method has some advocates, who are



**A case of cent percent damage by Locust hoppers in Mehsana District.**

impressed by the spectacular and the instantaneous kill obtained. Secondly, it is thought that kerosene being a substance of domestic utility can be had locally and the recommendation for its use will encourage the cooperation of the recalcitrant local people for locust campaign. BHC requires about twelve hours for its full effect to show up, nevertheless it gives perfect control and is definitely cheaper by more than 25 percent. Further, it can be used for killing locusts in standing crops.

### Control of winged locusts

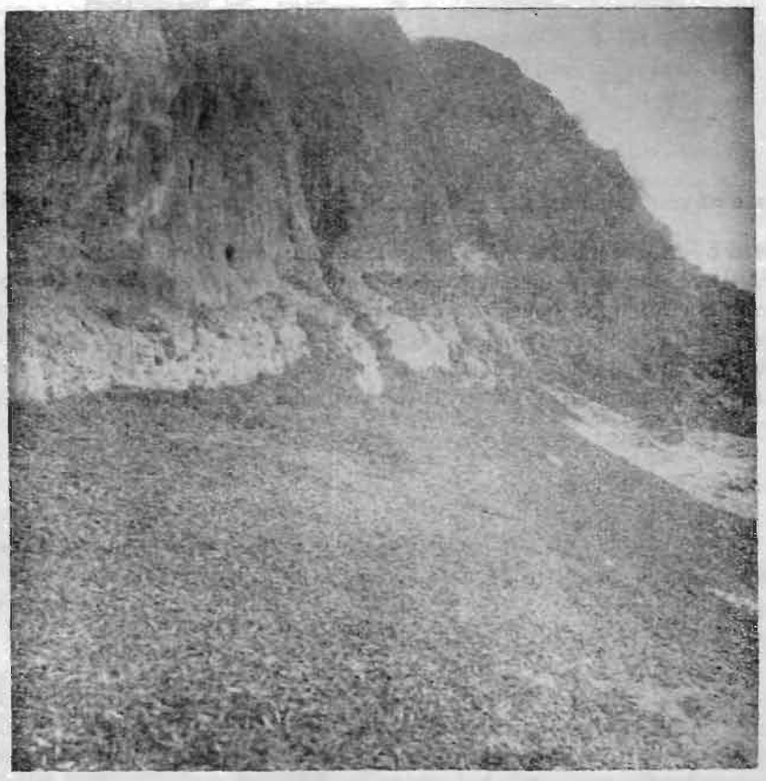
Locust like other insects perceive motion and any movement nearby makes them fly away. This habit of theirs is utilized in preventing the adults from landing in cultivated crops. The farmers get together, and move large white cloth which makes the locusts to remain away.

The freshly moulted adults in the breeding areas, are easily killed by BHC. However, when the adults are a little mature they are not as susceptible, but dusting by 10% BHC gives some mortality and can be tried. When the adults are found in bushes and hedges burning is also practicable.

The adult locusts migrate long distances and on their way, they descend on cultivated areas in large swarms. The swarms frequently cover many square miles, and cause serious devastation wherever they land. Such large invasions, which unfortunately are not predictable with any useful degree of accuracy, often create a feeling of helplessness in the general public, and a commotion in the afflicted areas results.

With our present knowledge of this pest, it is not yet possible to fore-warn the cultivators of any particular spot about the arrival of a swarm, and hence it is not feasible to keep ready the large amounts of insecticide and other appliances at any particular place. Neither it is always possible to rush supplies in time to the area where a swarm has descended.

In view of the difficulties experienced in combating the locusts by destroying the migrating swarms, it is generally agreed that the swarms must be checked in the hopper stage which can be killed easily, and thoroughly. As this is the



**Millions of hoppers in the foreground killed by 10% BHC**

consensus of opinion, various countries including India–where locust breeding takes place–direct their efforts to destroy this pest in the breeding areas. For an all out effort on this international menace, several countries cooperate and chalk out their plans at the International Locust Conference. This year the Conference had met in New Delhi. The Government of India as a cooperating country maintains a Locust Control Organization. Under the existing arrangement this organization controls the pest in the permanent breeding areas of Bombay and other States. Such areas in the Bombay State include Tharad and Wav of Banaskantha and Radhanpur sub-division of Mehsana district. In the other areas of our state the Bombay Government has a trained staff for locust control. The dusting machines and insecticides are given free to those who cooperate and wherever the local cooperation is not forthcoming the Agricultural Department staff themselves carry out the anti-locust operations. It is not feasible here, to describe fully the locust control organization of our State, but as a summary, it can be stated that this year, the organization consisting of numerous graduates and scores of agricultural assistants, who were equipped with hundreds of dust guns and tons of benzene hexachloride, virtually destroyed over 80% of the locusts hatched in our area.

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# A Contribution to the Flora of Simhagadh Hill, Poona District.

By

H. SANTAPAU, S. J. *

Simhagadh Hill is one of those names that I had occasionally read in Cooke's Flora in connection with some of the rarest plants of Bombay. After several years of intense work on the flora of Purandhar, I became convinced that similar hill forts around Poona deserved careful study and exploration. In the case of Simhagadh there has been no organized study, and the number of plants mentioned in available literature as having been found there is rather meagre. Of the better known Bombay botanists, that have at one time or another explored the hill, are Woodrow and Bhiva, whose collections are at present kept in the Agricultural College, Poona. There appears to have been no collection made during the rains, and in consequence some of the common plants are absent from existing herbaria.

The hill fort of Simhagadh rises majestically to a height of 4320 ft. above sea level, and about 2500 ft. over the Poona plains; it is situated SW. of Poona and about 16 miles from that city. A fairly good road leads from Poona along the eastern banks of Khadakvasla Lake to the village of Athkurvadi; a public bus service makes the journey in either direction several times a day. At Athkurvadi the ascent to the hill begins, at first rather gently, later on steeply, but all along the path is good and kept in fairly good repair. Comparing the climb to Simhagadh with that of Purandhar, the former is much steeper and longer, since in the case of Simhagadh the fort is on the very crown of the hill, at Purandhar it is about half way up from the plains.

The fort enclosure is fairly flat, and in outline somewhat resembling the head of a goat, with the snout facing East, and a long neck extending southwards. Entrance to the fort may be effected by the Poona Gate, on the northern side (about half way between the eyes and the nostrils of the "goat") or by the Kalyan Gate (on the neck near the lower jaw of the " goat "). The climb through the Kalyan side is much more gentle, but at the same time it is longer, hotter and botanically much less interesting.

Our party consisted of about 30 persons; Drs. Agharkar and Deora of the Poona Natural History Club were the leaders and organisers. There were several professors and a number of students from several colleges of Poona and Bombay;

* St. Xavier's College, Bombay.

among them the Agricultural College was well represented. The journey was made pleasant and instructive by the learned explanations of Prof. Agharkar, who has carefully studied the history and culture of the district along the route.

At about 8·30 in the morning we left our bus and started the climb. The system followed in the study of plants was that each member of the party went along collecting as many different plants as possible; as soon as they were collected, they were checked by several of us, and only when their identity was satisfactorily decided was the name of the plant in question entered into my list; in all cases of doubt, the plant was kept for further study.

In our party there were several mycologists from the Maharashtra Research Association, whose aim was to gather fungal material; such fungi are not mentioned in this paper. I leave it to the expert mycologists of the party to prepare a comprehensive list of all the fungi gathered.

It only remains for me to thank the officers of the Poona Natural History Club for a most interesting outing, and to hope that their keenness and interest will be kept up among the Poona members, and will at the same time be imitated by the less enterprising botanists of Bombay.

**1. General Aspect of the Vegetation of Simhagadh.** In several of the hill forts of the Deccan which I have explored, I have been forcibly struck by the almost total absence of any real forest. One finds plenty of vegetation, many shrubs and at the most some small trees; the latter often show traces of more or less continuous pollarding or pruning. The reason for this state of affairs seems to be that as long as the forts continued to be used as military strongholds, forests and other obstructions that might afford protection to an invading army were carefully removed. This service of tree removal was often effected by the villagers that lived under the shadow of the fort in question, and in return for this service they were allowed to keep such trees for timber or firewood. When the forts ceased to have any military importance, the villagers continued cutting down trees for firewood, on the plea that such was their immemorial right and privilege. This unfortunate custom explains the rather bare appearance of such hill forts as Purandhar, Lohagad and Simhagadh.

In spite of such a constant deforestation, the northern side of Simhagadh is fairly densely covered with vegetation; there are many small trees and shrubs, but no such giants of the forest as may be seen in other parts of the Ghats. The Eastern and South Eastern side of the hill are much more bare; the two sides are exposed to the intense heat of the dry season, and the sloping nature of the ground prevents underground water from accumulating on the slopes.

**2. From Poona to the foot of Simhagadh.** Leaving aside the cultivated fields on either side of the main road, one cannot but be struck by the masses of *Xanthium strumarium* that grow along the road for several miles up to

Khadakvasla Lake; on the occasion of our visit *Xanthium* was in fruit, and the plants grew in dense patches. After passing Khadakvasla Lake *Xanthium* suddenly and completely disappeared, and its place was taken by an *Ipomoea* that may be *I. muricata* Jacq., a very showy plant with masses of blue flowers; this plant was very abundant along the hedges on either side of the road up to the foot of the hill itself.

As soon as we left our bus, the dominant plant seemed to be *Acanthospermum hispidum* DC., a plant of recent introduction from America. The hedges showed some very fine and tall specimens of *Peristrophe bicalyculata* Nees, *Lagascea mollis* Cav., and at one or two spots, dense clumps of *Crotalaria calycina* with very striking floral heads. All over the district at the foot of the hill there are plenty of *Tectona grandis* trees, probably cultivated, often at a distance appearing rather white on account of the extensive infestation of a fungus, which otherwise does not seem to do much damage to the trees.

**3. The lower part of the Hill.** A few large trees or shrubs, that on account of either their size or numbers, seemed to be the dominant plants in this part of the hill, were noticed. Among them must be mentioned *Anogeissus latifolia* Wall., *Ficus arnottiana* Miq. and *F. glomerata* R., *Hamiltonia suaveolens* Roxb., *Boswellia serrata* Roxb., *Zizyphus rugosa* Lamk., and *Lasiosiphon eriocephalus*, the latter often showing leaves very badly damaged by insects, a rather striking fact, when one keeps in mind the poisonous nature of the plant. Along the sides of the path, among the commonest herbs were several umbelliferous plants, several species of *Pimpinella* being remarkable for their abundance. The ubiquitous *Carvia callosa* Bremek., is one of the commonest shrubs for the lower two thirds of the way, but everywhere was in leaf only; the troublesome *Lantana* is also common along the path up to a little below the fort itself.

One of the good finds of the day was a few plants of *Cephalostigma flexuosum*, a small herb seen on earth banks along the sides of the path; from my experience of Purandhar I did not expect to find the plant at the base of the hill, and on the contrary did hope to see it growing freely above, but in this I was disappointed, for however much I did search for the plant in the upper reaches of the fort I failed to see it again after the initial success.

**4. The Upper half of the Hill.** At about 3500 ft. altitude the vegetation undergoes a slight but in some ways clear change; some new plants suddenly become conspicuous for their abundance. Outstanding both for its abundance and for the showiness of its flowers is *Barleria lawii* which in the upper half becomes undoubtedly the most abundant plant, growing in dense clumps and at the time of our visit in full bloom. Occasionally *Adhatoda vasica* Nees appeared mixed with *Barleria*; *Hamiltonia suaveolens* Roxb. grew in abundance as we went up, until just outside the fort itself it was one of the most noticeable plants in flower, and showed generally white, occasionally blue flowers.

On the upper slopes of the hill *Senecio edgeworthii* became common on rocks and on the walls of the fort; on the latter, however, probably the most common plant was *Nepeta hindustana* Haines, which often grew in almost pure stands. A noticeable absentee from the whole hill was *Plectranthus stocksii*; its near relative *Plectranthus coetsa* was luxuriant and dense just below the outer ramparts, often alternating with fine specimens of *Aerva scandens*. *Kalanchoe olivacea* Dalz. was in bloom high up on the rocks outside the fort, but collection was made difficult by a dangerous array of *Girardinia zeylanica*.

**5. The fort enclosure.** In general the fort is rather dry, and the vegetation is typically xerophitic in character. On the western walls of the fort we found one of the most typical plants of such altitudes, *Campanula alphonsi* Wall., growing in great profusion in practically all the joints of the wall; the plant was in full bloom, but specimens did not reach the bushiness often observed at Purandhar.

Within the fort enclosure there are a number of water tanks excavated in the rock, in the neighbourhood of which some interesting plants were observed. *Veronica anagallis* Linn. was seen in several places near tanks in the fort, growing in dense profusion; *Smithia purpurea*, *Hygrophylla serpyllum*, *Lobelia heyneana* and *Lindernia parviflora* were also common and relatively abundant near tanks; *Polygonum glabrum*, *Dysophylla stellata*, *Lemna* sp. etc., covered the surface of several of the tanks. In the fort enclosure there are a few shallow depressions in the ground, which at the time of our visit showed plenty of *Asteracantha longifolia* etc. *Lavandula perrottetii* was one of the commonest plants in the fort area, on the upper part of walls, on rubbish heaps, etc.

In the fort there are a number of buildings of recent construction; in their neighbourhood we found several commonly cultivated plants such as *Nerium*, *Grevillea*, *Hedera*, *Brassica*, etc. *Eleusine coracana*, *Hibiscus cannabinus*, etc., were evidently under cultivation.

**6 List of plants collected on 19-11-1950.** The following is the complete list of all the plants collected during our excursion; the names are arranged according to the order in Cooke's flora. Where the names are the same as in the latter book, no reference is given to the work where the name was first published; whenever there is a change, complete references are given for the clear understanding of the change. An occasional note is added to the list.

RANUNCULACEAE

1. *Clematis triloba* Heyne.
2. *Clematis hedysarifolia* DC.

MENISPERMACEAE

3. *Tinospora cordifolia* ( Willd. ) Miers.

4. *Cocculus hirsutus* ( Linn. ) Diels in Pfreich. 46 : 236, 1910.
   *Menispermum hirsutum* Linn., Sp. Pl. 341, 1753.
   *Cocculus villosus* DC.
5. *Cissampelos pareira* Linn.

PAPAVERACEAE

6. *Argemone mexicana* Linn.

CRUCIFERAE

7. *Brassica* sp.

CAPPARIDACEAE

8. *Capparis* sp. In hedges at the foot of the hill, in leaf only; it is not possible to identify the species.

FLACOURTIACEAE

9. *Flacourtia* sp. Small trees in leaf only; possibly *F. Ramontchi* L'Her.

POLYGALACEAE

10. *Polygala persicariaefolia* DC.

PORTULACACEAE

11. *Portulaca oleracea* Linn.
    (*Talinum cuneifolium* Willd. Woodrow mentions the plant for Simhagadh but we did not see it during our excursion.)

MALVACEAE

12. *Sida veronicaefolia* Lamk.
13. *Sida rhombifolia* Linn. var. *rhomboidea* Mast. in FBI. 1 : 324, 1874; not mentioned in Cooke.
14. *Hibiscus cannabinus* Linn.

TILIACEAE

15. *Elaeocarpus* sp.
16. *Grewia tiliaefolia* Vahl.
17. *Triumfetta bartramia* Linn., Syst. (ed. 10) 1044, 1759.
    *T. rhomboidea* Jacq , Enum. 22, 1760.

LINACEAE

18. *Linum mysorense* Heyne.

MALPIGHIACEAE

19. *Aspidopteris cordata* ( Heyne ) A. Juss.

OXALIDACEAE

20. *Oxalis corniculata* Linn.

BALSAMINACEAE

21. *Impatiens balsamina* Linn., var. *rosea* Hook. f. in FBI. 1 : 454, 1874.
    *I. balsamina* var. *brevicalcarata* Cooke.

GERANIACEAE

22. *Biophytum sensitivum* ( Linn. ) DC.

BURSERACEAE

23. *Garuga pinnata* Roxb.
24. *Boswellia serrata* Roxb.

MELIACEAE

25. *Cipadessa baccifera* ( Roth ) Miq., in Ann. Mus. Lugd.-Bat. 4 : 6, 1868–1869.
*Melia baccifera* Roth, Nov. Pl Sp. 215, 1821.
*Cipadessa fruticosa* Blume.

CELASTRACEAE

26. *Celastrus paniculata* Willd.
27. *Gymnosporia montana* ( Roxb. ) Benth.

RHAMNACEAE

28. *Zizyphus rugosa* Lamk.
29. *Zizyphus jujuba* Lamk.

AMPELIDACEAE

30. *Cissus elongata* Roxb., Fl. Ind. 1 : 411, 1820.
*Vitis elongata* Wall.
31. *Cissus woodrowii* ( Stapf ) Santapau in Kew Bull, 1948 : 276, 1948.
*Vitis woodrowii* Stapf.
32. *Cayratia carnosa* Gagnep., in Lecomte, Not. Syt. 1 : 347, 1911.
*Vitis trifolia* Linn. ?

ANACARDIACEAE

33. *Mangifera indica* Linn. Only one tree seen.
34. *Semecarpus anacardium* Linn. f.

PAPILIONACEAE

35. *Crotalaria filipes* Benth.
36. *Crotalaria triquetra* Dalz.
37. *Crotalaria albida* Heyne ex Roth.
38. *Crotalaria nana* Burm.
39. *Crotalaria medicaginea* Lamk.
40. *Crotalaria juncea* Linn.
41. *Crotalaria calycina* Schrank.
42. *Indigofera cordifolia* Heyne ex Roth.
43. *Indigofera linifolia* Retz.
44. *Indigofera hendecaphylla* Jacq.
45. *Tephrosia* sp.
46. *Smithia setulosa* Dalz.
47. *Smithia purpurea* Hook.
48. *Alysicarpus tetragonolobus* Edgw.
49. *Desmodium triflorum* ( Linn. ) DC.

50. *Desmodium rotundifolium* Baker.
51. *Mucuna prurita* Hook. Bot. Misc. 2 : 348, 1830–1831.
    *M. pruriens* Cooke, non DC.
52. *Erythrina stricta* Roxb.
53. *Erythrina suberosa* Roxb.
54. *Butea monosperma* O. Kuntze, Rev. Gen. 202, 1891.
    *Erythrina monosperma* Lamk., Encycl. 1 : 391, 1783.
    *Butea frondosa* Koenig ex Roxb. in As. Res. 3 : 469, 1792.
55. *Canavallia sp.* ( *gladiata* DC. ? )
    *C. ensiformis* Baker, non DC.
56. *Phaseolus khandalensis* Santapau in Kew Bull. 1948 ; 276, 1948.
    *P. grandis* Dalz. in Dalz. & Gibs., Bomb. Fl. 72, 1861
    ( non Wall., nec Benth. ).
57. *Phaseolus radiatus* Linn., Sp. Pl. 725, 1753; Piper in Bull. U. S. Dept. Agric. 119 : 16–25.
    *P. sublobatus* Roxb., Hort. Beng. 54, 1814 etc.
58. *Dolichos biflorus* Linn.
59. *Atylosia scarabaeoides* ( Linn. ) Benth.
60. *Rhynchosia bracteata* Benth.
61. *Dalbergia latifolia* Roxb.
62. *Dalbergia lanceolaria* Linn. f.
63. *Cicer arietinum* Linn.

CAESALPINIACEAE

64. *Cassia* ( *pumila* Lamk. ? )
65. *Cassia fistula* Linn.

MIMOSACEAE

66. *Acacia intsia* ( Linn. ) Willd.

CRASSULACEAE

67. *Kalanchoe olivacea* Dalz.
68. *Bryophyllum pinnatum* ( Lamk. ) Kurz., in Journ. As. Soc. Beng. 40 : 309, 1876.
    *Cotyledon pinnatum* Lamk., Encycl. 2 : 171, 1786.
    *Bryophyllum calycinum* Salisb., Par. Lond. t. 3, 1805.

COMBRETACEAE

69. *Terminalia crenulata* Roth, Nov Pl. Sp. 380, 1821.
    *T. tomentosa* Wt. & Arn., pro parte.
70. *Terminalia* sp.
71. *Anogeissus latifolia* Wall.

MYRTACEAE

72. *Syzygium cumini* (Linn.) Skeels, in U. S Dept. Agric. Bur. Pl. Ind. 248 : 2, 1912.
    *Myrtus cumini* Linn., Sp. Pl. 471, 1753.
    *Eugenia jambolana* Lamk.

73. *Myrtus communis* Linn.
74. *Psidium guayava* Linn.

LECYTHIDACEAE

75. *Carica papaya* Linn.

LYTHRACEAE

76. *Ammannia baccifera* Linn.
77. *Rotala tenuis* (Wight) Koehne in Engl. Bot. Jahrb. 1 : 177, 1880.
*Ammannia tenuis* Clarke.
78. *Woodfordia fruticosa* (Linn.) Kurz, in Journ. As. Soc. Beng. 40 : 56, 1871.
*Lythrum fruticossum* Linn., Sp. Pl. 641, 1762.
*Woodfordia floribunda* Salisb.
79. *Lagerstroemia lanceolata* Wall.

ONAGRACEAE

80. *Oenothera rosea* Ait.

CUCURBITACEAE

81. *Cucumis callosus* (Rottl.) Cogn. in Pfreich. 88 : 129, 1924.
*Bryonia callosa* Rottl. in Neue Schrift. Ges. Nat. Freund. Berlin 4 : 210, 1803.
*Cucumis trigonus* Roxb., Hort. Beng. 70, 1814, & Fl. Ind. 2 : 619, 1824.
82. *Cucumis melo* Linn. var. *agrestis* Naud.
83. *Bryonopsis laciniosa* Naud.

CACTACEAE

84. *Opuntia* sp. Planted in the fort as a hedge plant.

UMBELLIFERAE

85. *Trachispermum stictocarpum* ( Clarke ) Wolff, var. *typica* Wolff in Pfreich. 90 : 89;1929
*Carum stictocarpum* Clarke in F.B.I. 2:681,1873.
86. *Pimpinella tomentosa* Dalz.
87. *Pimpinella monoica* Dalz.
88. *Pimpinella multiradiata* Santapau.
89. *Pimpinella adscendens* Dalz.

ARALIACEAE

90. *Hedera* sp.

RUBIACEAE

91. *Oldenlandia herbacea* ( Linn. ) Roxb.
92. *Anotis* sp.
93. *Pavetta indica* Linn.
94. *Borreria stricta* (Linn. f.) Schum. in Pfam. 4 (4) : 143, 1891.
*Spermacoce stricta* Linn. f., Suppl. 120, 1781.
95. *Hamiltonia suaveolens* Roxb.
96. *Rubia cordifolia* Linn.

COMPOSITAE

97. *Centratherum phyllolaenum* ( DC. ) Benth.
98. *Centratherum tenue* ( Wight ) Clarke.
99. *Lamprachenium microcephalum* Benth.
100. *Vernonia cinerea* ( Linn. ) Less.
101. *Ageratum conyzoides* Linn.
102. *Dichrocephala latifolia* DC.
103. *Cyathocline purpurea* (Don) O. Kuntze, Rev. GEn. 338, 1891.
*Tanacetum purpureum* Don, Prodr. Fl. Nep. 181, 1825.
*Cyathocline lyrata* Cass.
104. *Conyza stricta* Willd.
105. *Blumea wightiana* DC.
106. *Blumea malcolmii* ( Clarke ) Hook. f.
107. *Gnaphalium indicum* Linn.
108. *Vicoa cernua* Dalz.
109. *Vicoa indica* ( Willd. ) DC. in Wight, Contrib. 10, 1834.
*Inula indica* Willd., Sp. Pl. 3 : 2092, 1804.
*Vicoa auriculata* Cass.
110. *Lagascea mollis* Cav.
111. *Siegesbeckia orientalis* Linn.
112. *Eclipta alba* (Linn.) Hassk., Pl. Jav. Rar. 528, 1848.
*Verbesina alba* Linn., Sp. Pl. 902, 1753.
*Eclipta erecta* Linn.. Mant. 2 : 286, 1771.
113. *Blainvillea latifolia* ( Linn. f. ) DC. in Wight, Contr. 17, 1834.
*Eclipta latifolia* Linn. f., Suppl. 378, 1781.
*Blainvillea rhomboidea* Cass.
114. *Bidens biternata* ( Lour. ) Merrill & Sherff, in Bot. Gaz. 88 : 293, 1929.
*Coreopsis biternata* Lour., Fl. Coch. 508, 1790.
*Bidens pilosa* auct., non. Linn.
115. *Gynura angulosa* DC.
116. *Tridax procumbens* Linn.
117. *Artemisia parviflora* Buch -Ham.
118. *Artemisia nilagirica* ( Clarke ) Pamp. in Nuov. Giorn. Bot. I tal. 33 : 452, 1926.
*A. vulgaris* L. var. *nilagirica* Clarke, Comp. Ind. 162, 1876.
*A. vulgaris* auct., non Linn.
119. *Emilia sonchifolia* ( Linn. ) DC.
120. *Senecio edgworthii* Hook. f.
121. *Senecio gibsoni* Hook. f.
122. *Tricholepis amplexicaulis* Clarke.
123. *Sonchus oleraceus* Linn.
124. *Sonchus asper* Hill.
125. *Guizotia abyssinica* Cass.

126. *Tagetes* sp.

127. *Acanthospermum hispidum* DC., Prodr. 5 : 522, 1836;
Santapau in Journ. Bomb. Nat. Hist. Soc. 45 : 445.

LOBELIACEAE

128. *Lobelia heyneana* R. & S., Syst. 5 : 50, 1819.
*L. trialata* Buch.-Ham. in Don, Prodr. Fl. Nep. 157, 1825.

CAMPANULACEAE

129. *Campanula alphonsi* Wall.

130. *Cephalostigma* ( *flexuosum* Hk. f. & Th. ? )

PLUMBAGINACEAE

131. *Plumbago zevlanica* Linn.

PRIMULACEAE

132. *Anagallis arvensis* Linn. var. *coerulea* Gren. & Godr., Fl. Fr. 2 : 467, 1852
Pax & Hoffm. in Pfreich. 22 : 323.
*A. arvensis* Linn. & auct. pro parte tantum.

OLEACEAE

133. *Jasminum malabaricum* Wight.

APOCYNACEAE

134. *Carissa congesta* Wight, Icon. t. 1289, 1848; Haines in Ind. For. 45 : 385, 1919.
*C. carandas* auct., non Linn.

135. *Plumeria acuminata* Ait., Hort. Kew. (ed. 2) 2 : 70, 1811.
*P. acutifolia* Poir., Encycl. Suppl. 2 : 667, 1811.

136. *Nerium indicum* Mill., Gard. Dict. ( ed. 8 ) no. 2 1768.
*N. odorum* Ait., Hort. Kew. 1 : 297, 1789.

ASCLEPIADACEAE

137. *Hemidesmus indicus* R. Br.

138 *Cryptolepis buchanani* R. & S.

139. *Calotropis gigantea* ( Linn. ) R. Br.

140. *Tylophora* ( *dalzellii* Hook. f. ? )

GENTIANACEAE

141. *Canscora diffusa* R. Br.

142. *Canscora khandalensis* Santapau in Kew Bull. 1948 : 485, 1949.

BORAGINACEAE

143. *Cordia dichotoma* Forst. f., Prodr. 18, 1786.
*C. obliqua* Willd., Phytogr. 4, t. 4, 1794.
*C. myxa* auct., non Linn.

144. *Trichodesma amplexicaule* Roth, Nov. Pl. Sp. 104, 1821.
*T. indicum* var. *amplexicaule* Cooke.

CONVOLVULACEAE

145. *Ipomoea nil* Roth, Cat. Bot. 1 : 36, 1797.
*I. hederacea* auct , non Jacq.
146. *Ipomoea soluta* Kerr in Kew Bull. 1941 : 18, 1941.
*I. campanulata* auct., non Linn.
147. *Ipomoea* sp.
148. *Argyreia cuneata* Ker-Gawl.
149. *Argyreia setosa* ( Roxb. ) Choisy in Mem. Soc. Phys. Hist. Nat. Geneve 6 : 425, 1827,
*Lettsomia setosa* Roxb., Hort. Beng. 13, 1814, & Fl. Ind. 2 : 80, 1824.

SOLANACEAE

150. *Solanum nigrum* Linn.
151. *Solanum indicum* Linn.
152. *Lycopersicon esculentum* Mill.
153. *Nicandra physaloides* ( Linn. ) Gaertn.

SCROPHULARIACEAE

154. *Verbascum coromandalianum* ( Vahl ) Kuntze, Rev. Gen. Pl 468, 1891.
*Celsia coromandeliana* Vahl, Symb. Bot 3 : 79, 1794.
155. *Lindernia hyssopoides* ( Linn. ) Haines, Bot. Beh. & Or. 635, 1922.
*Ilysanthes hyssopioides* Benth.
156. *Lindernia parviflora* ( Roxb. ) Haines, ibid. 635, 1922.
*Ilysanthes parviflora* Benth.
157. *Veronica anagallis* Linn.
158. *Buchnera hispida* Buch.-Ham.
159. *Striga gesneroides* ( Willd. ) Vatke ex Engler, Abhandl. Preuss. Akad. Wiss. 28, 1894.
*Buchnera gesneroides* Willd., Sp. Pl. 3 : 338, 1891.
*Striga orobanchioides* Benth.
160. *Sopubia delphinifolia* ( Roxb. ) Don.
161. *Lindenbergia indica* ( Linn. ) O. Kuntze, Rev. Gen. 462, 1891.
*Dodartia indica* Linn., Sp. Pl. 633, 1753.
*Lindenbergia urticaefolia* Lehm.

BIGNONIACEAE

162. *Heterophragma quadriloculare* (Roxb.) Schum. in Pfam. 4 (3b) : 243, 1895
*Bignonia quadrilocularis* Roxb., Pl. Cor. 2 : 24, t. 145, 1798.
*Heterophragma roxburghii* DC.

ACANTHACEAE

163. *Blepharis asperrima* Nees.
164. *Asteracantha longifolia* ( Linn. ) Nees.
165. *Hygrophila serpyllum* (Nees) Anders.
166. *Hemigraphis latebrosa* Nees var. *heyneana* Bremek. in mat. Mon. Strob. 139, 1944.
*H. latebrosa* Nees pro parte.

167. *Eranthemum roseum* (Vahl) R. Br., Prodr. 477, 1810.
*Daedalacanthus roseus* Anders.
168. *Carvia callosa* ( Wall. ) Bremek., loc. cit. 187, 1941.
*Strobilanthes callosus* Wall.
169. *Haplanthus verticillatus* ( Roxb. ) Nees.
170. *Haplanthus tentaculatus* Nees.
171. *Barleria lawii* Anders.
172. *Lepidagathis cuspidata* (Wall.) Nees.
173. *Lepidagathis mitis* Dalz
174. *Rungia pectinata* (Linn.) Nees in DC., Prodr. 11 : 469, 1847.
*R. parviflora* var. *pectinata* Clarke.
175. *Rungia repens* (Linn.) Nees.
176. *Justicia* sp. ( Neer *J. simplex* Don ).
177. *Adhatoda vasica* Nees.
178. *Peristrophe bicalyculata* (Retz ) Nees.

VERBENACEAE

179. *Lantana camara* Linn., var. *aculeata* Moldenke in Torreya 34 : 9 1934.
*L. camara* Linn. et auct. pro parte.
180. *Tectona grandis* Linn. f.
181. *Vitex negundo* Linn.
182. *Clerodendrum serratum* (Linn.) Moon, Cat. 46, no. 382, 1824; Sprengel, Syst. 2 : 758, 1825.

LABIATAE

183. *Plectranthus mollis* (Ait.) Spr., Syst 2 : 690, 1825.
*Ocimum molle* Ait., Hort. Kew. 2 : 322, 1789.
*Plectranthus incanus* Link.
184. *Plectranthus coetsa* Buch.-Ham.
185. *Lavandula perrottetii* Benth. in DC., Prodr. 12 : 147, 1848.
*L. gibsoni* Graham, Cat. 149, 1839.
In my Flora of Purandhar I have written on this plant : " The name of this plant is commonly given as *L. gibsoni*, but in my opinion this is scarcely correct. The description given by Graham in his Catalogue is of the briefest and even Graham seems to doubting about the standing of this plant; he writes : " Herbaceous; leaves lyrate. The hill Fort of Pundooghur; requires examination ". In the circumstances I have followed Dal. & Gibs. in using the name L. Perrottetii of Bentham "
186. *Pogostemon parviflorus* Benth.
187. *Dysophylla stellata* Benth.
188. *Colebrookea oppositifolia* Sm.
189. *Anisomeles heyneana* Benth.
190. *Anisomeles ovata* R. Br.
191. *Leucas martinicensis* (Swartz) R. Br.

192. *Leucas montana* Spr.

193. *Leucas lavandulaefolia* Rees, Cycl. 20 : no. 2, 1819.
*L. linifolia* Spr.

194. *Nepeta hindustana* ( Roth ) Haines, Bot. Bih. & Or. 744, 1922.
*Glechoma hindustana* Roth, Nov. Pl. Sp. 259, 1821.
*Nepeta ruderalis* Buch.-Ham.

AMARANTHACEAE

195 *Amaranthus* sp.

196. *Celosia argentea* Linn.

197. *Aerva scandens* (Roxb.) Wall.

198. *Achyranthes aspera* Linn., var. *porphyristachya* Hook. f. in FBI. 4 : 730, 1885.
*A. aspera* auct., pro parte.

199. *Alternanthera sessilis* (Linn.) R. Br., Prodr. 417, 1810.
*Gomphrena sessilis* Linn., Sp. Pl. 225, 1753.
*Alternanthera triandra* Lamk.

POLYGONACEAE

200. *Polygonum glabrum* Willd.

PROTEACEAE

201. *Grevillea robusta* Cunn.

THYMELEACEAE

202. *Lasiosiphon eriocephalus* Decne.

LORANTHACEAE

203. *Taxillus cuneatus* (Roth) Danser in Bull. Jard. Bot. Buitenz. (ser. 3) 10 : 354, 1929.
*Loranthus cuneatus* Roth.

204. *Viscum angulatum* Heyne ex DC.

SANTALACEAE

205. *Osyris wightiana* Wall., Cat. 4036, 1831; Wight, Icon. t. 1853, 1852.
*O. arborea* Wall., Cat. 4035, 1831; DC., Prodr. 14 : 633, 1857.
In my Flora of Khandala I have written the following on the change of name : "The two names, *O. arborea* and *O. wightiana*, were published as "nomina nuda" by Wallich in 1831; examination of Wallich's sheets in Kew Herb. shows that the two plants are synonymous for a very variable plant. Graham in 1839 took up the name *wightiana*, but his description is to meagre too be accepted as valid under the rules; Wight's icon t. 18 3 shows the plant correctly, and has to be accepted as valid under the Rules, Art. 44. The name *O. wightiana*, therefore, is the oldest name effectively published for this plant, and the date of publication must be taken to be 1852, the date of Wight's publication of his Icon for this plant ".

EUPHORBIACEAE

206. *Euphorbia neriifolia* Linn., Sp. Pl. 451, 1753.
*E. ligularia* Cooke.

207. *Euphorbia hirta* Linn., Sp. Pl. 454, 1753.
*E. pilulifera* auct., non Linn.
208. *Euphorbia* sp. ( *microphylla* or *thymifolia?* )
209. *Bridelia squamosa* Gehrm. in Engl. Bot. Jahrb. 41, Beibl. 95 : 30, 1908.
*B. retusa* Cooke, pro parte.
210. *Bridelia retusa* Spr. (non Cooke, nisi pro parte).
211. *Securinega virosa* (Roxb.) Pax & Hoffm. in Pfam. (ed. 2) 19 c : 60, 1931.
*Phyllanthus virosus* Roxb., ex Willd., Sp. Pl. 4 : 578, 1805.
*Flueggea microcarpa* Blume.
212. *Melanthesa turbinata* (Koen. ex Roxb.) Wight, Icon. 5 (2) : 26, t. 1897, 1852 ( ' truncata ' sub tab. per sphalm.).
*Phyllanthus turbinatus* Koen. ex Roxb , Hort. Beng 44, 1814 & Fl. Ind. 3 : 666, 1832.
*Breynia patens* Rolfe in Journ. Bot. ( N. S. 11 : 359, 1882 "*Breynia* J. R. & G. Forst. is illegitimate on two counts. It is a later homonym of *Breynia* L. ( Sp. Pl. 503, 1753 ) and a *nomen confusum*, a mixture of *Breynia* sp. and *Phyllanthus distichus* L., which was rejected by both A. de Jussieu ( Tent. Euph. 22, 1821 ) and Baillon ( Et. Gen. Euph. 633, 1858 )." ( Croizat in Sargentia 1 : 48, 1942 ).
213. *Emblica officinalis* Gaertn., Fruct. 2 : 122, 1791.
*Phyllanthus emblica* Linn.
214. *Ricinus communis* Linn.
215. *Acalypha brachystachya* Horn.

ULMACEAE

216. *Trema orientalis* (Linn.) Blume.

URTICACEAE

217. *Girardinia zeylanica* Decne.
218. *Lecanthus peduncularia* (Wall.) Wedd. in DC. Prodr. 16 : 164, 1869.
*Procris peduncularis* Wall., Cat. 4634, 1831; Royle, Ill. t. 83, f. 2, 1839.
*Lecanthus wallichii* Wedd. & *L. wightii* Wedd.
219. *Ficus retusa* Linn.
220. *Ficus mysorensis* Heyne ( or is it *F. benghalensis* Linn. ? )
221. *Ficus arnottiana* Miq.
222. *Ficus glomerata* Roxb.

ORCHIDACEAE

223. *Dendrobium barbatulum* Lindl.

MUSACEAE

224. *Ensete superbum* (Roxb.) Cheesm. in Kew Bull. 1947 : 100, 1948.
*Musa superba* Roxb.

AGAVEACEAE

225. *Agave* sp.

DIOSCOREACEAE

226. *Dioscorea oppositifolia* Linn.

COMMELINACEAE

227. *Murdannia semiteres* (Dalz.) Santapau, comb. nov.
*Aneilema semiteres* Dalz. in Kew Journ. Bot. 3 : 138, 1851, & in Dalz. & Gibs., Bomb Fl. 254, 1861.
*A. paniculatum* Wall., Cat. 5216, 1828, nomen nudum; Clarke in DC., Mon. Phan. 3 : 215.
*Commelina nimmoniana* Graham, Cat. 227, 1839.
The oldest name for this plant is clearly that of Wallich, but as it is a *nomen nudum* it is invalid according to the Rules, Art. 37; Graham's description is so meagre that it can only be considered as little better than a bare name. The first complete description is that of Dalzell (1851) and in accordance with the Rules of Priority Dalzell's name is the oldest valid one for this species.

228. *Cyanotis fasciculata* ( Heyne ex Roth ) Schult. f.

PALMAE

229 *Phoenix sylvestris* (Linn.) Roxb.

ARACEAE

230. *Colocasia esculenta* (Linn.) Schott, Melet. 1 : 18, 1832.
*Arum esculentum* Linn., Sp. Pl. 965, 1753.
*Colocasia antiquorum* Schott.

231. *Acorus calamus* Linn., Sp. Pl. 324, 1753 ?

LEMNACEAE

232. *Lemna* sp.

GRAMINEAE

233. *Tripogon lisboae* Stapf.
234. *Zea mais* Linn. Cultivated at foot of hill.

ADDENDA

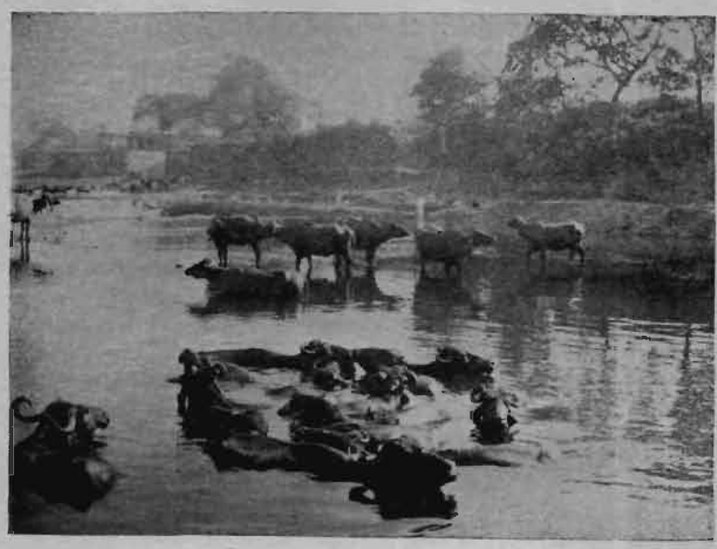
235. *Moringa oleifera* Lamk., Encycl. 1 : 398, 1785; Merrill, Enum. Phil. Fl. Pl. 2 : 213.
*Moringa pterygosperma* Gaerte., Fruct. 2 : 314, 1791.

236. *Meyna laxiflora* Robyns, Tent. Mon. Vang. 228, 1928 ( in Bul. Jard. de l'Etat, Bruxelles, 11 : 228, 1928 ).
*Vangueria spinosa* auct., pro parte.
Robyns has split the complex group usually contained under *Vangueria spinosa* of our Indian floras into two different plants : Flowers always in lax cymes distinctly pedunculate; the flowers long-pedicellate; buds gradually tapering upwards, obtuse at the apex; leaves 1–2 cms. long-petioled; Bombay. *M. laxiflora.* Flowers mostly in fascicles, more rarely in cymes, shortly pedicelled; buds abruptly rounded upwards and distinctly apiculate at the apex; leaves with petioles neves longer than 1 cm. *M. spinosa* and other species from further East than India.

237. *Euphorbia* sp. (prope *E. elegans* Spr.)
238. *Eleusine coracana* Gaertn. Cultivated in the fort area.
239. *Panicum* sp. Cultivated in the fort area.

J-17826

## SNAPSHOT COMPETITION



FIRST PRIZE ] [ Shri S. G. Wasani,
*B. Sc. (Agri.) class.*

SECOND PRIZE ] [ Shri A. G. Naik,
*S. Sc. (Agri.) class.*

# The 42nd Annual Social Gathering, 1950--51.

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*[Photo by*—N. S. Date, Poona 2.

# Simla Seed-Potatoes

By

M. N. KAMAT [1]

## Introductory

" War is sometimes a blessing in disguise ". So was it in relation to the important potato industry of this State The import of Italian white round seed potato virtually had stopped during 1937-43 war period and the industry which gave food to the common man and prosperity to the cultivators of the State was on the verge of ruin. In the absence of renewed and fresh stocks of seed potatoes from Italy, the farmer had to be content with the local seed supply, which on account of repeated cultivation in the warm regions of the Deccan showed rapid deterioration, gave reduced yields, lowered keeping quality and showed progrossively high infection with such diseases as viruses and bacterial ring. The soils in many places got heavily contaminated with the ring organism and virtually became unfit for potato cultivation. The position became critical and needed a remedy not only from the point of view of " Grow More Food Campaign" but also the economic amelioration of the potato cultivators who in the absence of a disease-free seed potato found themselves on a " *horns dilemma* ". Moreover, potato formed an important rotational crop with bajri which gave heavier yields as a result of residual effect of manuring.

Happily enough, this war period synchronised with the advent of the first Congress Government in the State, which insisted on having a suitable seed potato *grown* and *bred in India,* satisfactorily answering the main requirements, viz , (1) freedom from disease, (2) high performance and (3) high keeping quality.

## History

Attempts to discover a good seed potato suited to the Bombay tract date as far back as 1916 when the then Director of Agriculture, Dr. H. H. Mann carried out intensive investigations and experiments on this problem with the help of Dr. W. Burns, the then Economic Botanist and other co-workers (1). These trials bore no fruit and had to be abandoned since the concept of virus and ring diseases affecting the quality, performance and keeping nature of potatoes and the pre-eminent value of obtaining our seed potato from altitudes and regions not amenable to such diseases did not appear to have been fully appreciated at that time. The recommendation made by these investigators ( pp. 102-110 ) about " the establishment of *pedigree* seed, selected and grown *here* from generation to generation until free from disease ( ring ) " as a remedy to overcome bacterial ring and

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other major diseases that affected the potato crop and to solve the vital problem of seed potato is an ample testimony to the non-appreciation of real issues involved and provided a real obstacle to the discovery of a seed potato of Indian origin for the Bombay tract in those days.

## Varietal Trials

Preliminary trials, started in 1937-38 at three important potato growing regions of Poona district, viz. Manchar, Khed and Chakan, consisted of investigation, under field conditions, into the comparative performance of several varieties of seed potatoes obtained from different regions. Large scale trials with statistical design were then made during 1939-43 with the special purpose of evaluating the performance of various types of seed potatoes obtained from several regions and altitudes like Nilgiris, Meerut, Darjeeling, Simla, Patna (Behar), Kumaon Hills, Burma and Kenya with special reference to (a) incidence of disease, (b) yield, (c) keeping quality, (d) cooking quality and (e) flavour.

These results (2) showed conclusively the superiority of Simla seed potato (now wellknown as *Numbri*) over the then cultivated Italian white round variety. Numbri, Sitbo, Darjeeling Red and Magnum bonum gave higher yields varying from 8000 to 12,000 lbs. per acre while the local Italian yielded 3000-4000 lbs. The other varieties were low yielders and highly susceptible to Jassid attack; the Great Scot (Nilgiris) showed higb bacterial ring infection and was thus unsuitable as seed potato. Of the four high yielders, Numbri satisfied the standard in every respect. Magnum Bonum and Darjeeling Red were not favoured by the cultivators and the consumers on account of their longish shape and red colour respectively. Sitbo, though compared very favourably with Numbri, came from Burma and therefore did not answer the main purpose. The trials and tests with keeping and cooking quality of Numbri also gave highly satisfactory results. Numbri with its shallow eyes was more economical and better peeling than the Italian white round, which had deep sunken eyes and was thus difficult to peel and resulted in waste of food material. The crop continued its freedom from the two major diseases mentioned above during the period of trials, which proved beyond doubt, the suitability of the Simla seed potato over others for the Poona tract. Observations made from time to time showed that the Numbri potato is susceptible to indiscrimate flooding in the early stages but responded very well to water in most soils of Poona district, after the first two waterings which need be well regulated and moderate.

## Simla Seed Potato

The potatoes grown in Simla hills at varying altitudes of 4000 to 7500 ft. above sea level consist of mainly three varieties viz. Numbri ( Up-to-date), *Phool* ( magnum bonum ) and Phulwa ( Patna ). While Numbri has given excellent results in medium black soils of Deccan, *Phool* is well suited to river and sandy light soils of Gujarat and Saurashtra. Experience and observation have shown

that potatoes grown at low altitude are unfit for seed purposes as they usually carry infection by several fungus, bacterial and virus diseases adversely affecting the yield and quality. "*High grown*" or "*Snow grown*" potatoes obtained from altitude above 7000 ft., on the other hand, are best for seed purposes as they are free from such diseases due to low temperatures obtained during the growing period.

**Conclusion**

Simla seed potatoes (*Numbri* and *Phool*) have thus established their suitability as class seed potatoes in varying soil and climatic conditions of the State. It has, not only spread to all parts of the State, but also to Saurashtra, where it is now grown on a very wide scale completely replacing the Italian white round variety. This discovery, outstanding as it is, has successfully solved the most urgent problem of seed potato of Indian origin and thus has made this State independent of foreign seed potato. It has also saved the country from immense drain on her financial resources and has brought in occupation and prosperity to the Simla potato growers who find ready market for their potatoes in all parts of the Indian Union and Pakistan. It also paved the way to the successful control of major potato diseases that annually took heavy toll of our crop in this State in pre-war days. The credit for a successful solution of this baffling situation is richly deserved by the first Congress Government, specially Hon. Shri. Morarji Desai, the then minister for Agriculture and Dr. B. N. Uppal, the then Plant Pathologist and now the Director of Agriculture, B. S., Poona, for their foresight and resourcefulness.

**References**

(1) Bull. No. 102. Bombay Dept. Agri. 1920.
(2) Progress reports of Potato Varietal Trial Scheme (unpublished).

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# Powdery Mildew on Convolvulus Arvensis L. Caused by Oidium Species

By

B. G. NIKAM B. Ag., M. Sc., (Agri.) [1] F. K. PAWAR B. Sc. [2]

In March 1947, number of of creepers *Convolvulus arvensis L.* (fig. 1) growing in the Tomato plots on Central Experimental Farm, Gwalior, were found to be affected with powdery mildew. Attacked leaves were covered with innume-

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2 Student-Victoria College, Gwalior.

rable spores (conidia) & mycelium of the fungus, and disease was caused by a species of *Oidium*. This fungus in not recorded on this species, therefore, it was studied. A short account of the organism and the disease caused by it, is given below.

**Symptoms :**— The disease is found only on the leaves and not on any other parts of the host. The disease is easily recognised by the appearance of white powder on the upper as well as on the lower sides of a leaf. Upon the affected leaves the disease first manifests itself in small white felt-like patches ( irregular in outline ) of fungus growth. As the disease advances these fungus patches rapidly enlarge and soon cover the entire leaf giving an appearance to the leaf being coated with some white powder without causing any noticeable injury to the host. Affected creepers are found to grow healthily to maturity and to yield normal fruits and seeds. Defoliation also is not noticed.

**Morphology of the fungus :**— The vegetative mycelium of the fungus is superficial and consists of delicate, hyaline, septate hyhae frequently branched and more or less interwoven, ranging in diameter from 3·42/u to 10·80/u ( fig. 7 ). From the under-surface of hyphae slender tubes which arise, at once pierce the cuticle and after entry into the interior of the epidermal cells, swell into globular sacs, the haustoria ( fig. 6 ).

Appressoria also develop from the hyphae at point where the latter are closely attached to the surface of the leaf ( fig. 2 ).

Sometimes two appessoria may arise at the same point on the opposite sides of a hyphae ( fig. 2 ).

The superficial mycelium gives rise to conidiophores which are erect, simple and usually 2-3 septate (fig. 3). These measure 36·0 to 112·5 u long and bear on their ends conidia. The conidia are unicellular, hyaline, and barrel-shaped and measure 30·24-67·33 x 10 70-19·63 u and easily fall of when mature ( fig 4 ).

Conidia are produced in large numbers and freely germinate by protrution of a germ tube ( fig. 5 ); but in one case it is observed that the conidium has germinated by protrution of (8) eight germ tubes ( fig. 5 ). They are short lived and lose their power of germination when exposed to hot and dry conditions. The germinating percentage of conidia on a dry slide kept in a moist chamber at room temperature of 35·0° C. for 24 hours was from traces to 3 percent.

Only conidial stage is observed on the host.

**Host relation of the fungus :**—Observations had shown that the fungus is found only on *Convolvulus arvensis* and not on tomato,peas and other weeds like

*Cyperus rotundus, Cynodon dactylon, Chenopodium album, Amaranthus viridis, Digera arvensis, Trianthema-monogyna, Launea asplenifolia* and *Euphorbia hirta* growing with it

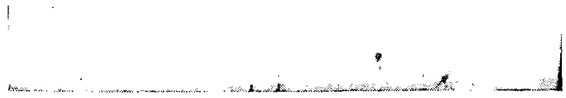

Fig. 1. Convolvulus arvernsis L. Fig. 2. Appressoria on superficial hyphae. Fig. 3. Conidiophores bearing conidia. Fig. 4. Conidia showing shapes and sizes. Fig. 5. Germinating conidia. Fig. 6. Transverse Section of an infected leaf showing a globular haustorium. Fig. 7. A portion of leaf showing mycelium, conidiophores, and condia.

Authors are thankfull to Shri. N. M. Deshmukh, Director of Agriculture, Madhya Bharat Government, Gwalior for providing the facilities during the course of investigation and to Dr.B.B. Mundkur for reading the paper and giving valuable suggestions and guidance. Thanks are also due to Shri. K. N. Pawar, Chief Chemist, Agricultural Res. Lab., Gwalior ( R. L. ) and to Shri. R. L. Pradhan, Artist, Agricultural Dept., Gwalior for the help they rendered.

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# Supplementary Food Crops----a Way to Fight Food--Crisis


By

G. R. Koppikar, B. Sc. (Agri.) Class.


Food-scarcity in India is too much expressive and evident to need any emphasis. Food being the prime necessity of every member of the entire living part of the world, even a slight deficit in the matter of this item of the various needs of the human being, claims a serious attention of the sufferer. To-day, throughout India, hardly a single part can be pointed out which enjoys the freedom from the food-crisis which has so very readily become a rule.

Naturally, everyone of the persons connected with the welfare of the Indian nation in the matter of its food problem, has been driven by the headache created by the unfortunate situation to think in terms of finding out ways and means to fight the situation by supporting his ideas on the knowledge he has acquired in the field of the relation of food with man in various aspects. But a matter of common experience brings home to us the fact that commonly almost all such ideas and suggestions suffer from one kind of draw-back or the other. Some suggestions hint at long term plans in the sense that their actual achivement and the desired fruits therefrom will require an intolerably considerable period to serve the

suffering human being. The mere nature of the difficulties, in various forms, in the quick production of the necessary food crops as is demanded by the fast deteriorating situation, should not be an excuse in obviating or even in lessening the gravity of the situation. The seriousness of the food-situation expects experts to bring forth such suggestions as will be approached by the common man without any undue difficulties, and with the confidence necessary to bring the suggestions into practice by himself without having to wait for a long time to see his efforts emerged into fruitfulness.

Whatever the various reasons may be, among which the common ignorance about the nutritive value and hence the common tendency of indifference to think the importance of foodstuffs in terms of the amount of nutrition they supply to the consumer is the one, it is a matter of common experience that the quantity of a foodstuff that is consumed and not the quality, that claims the consumer's interest first in India to-day. This wrong approch to the food consumption is largely responsible, among the other causes, for deteriorating the food-sitution in India. Hence, the propaganda in the direction of laying a stress upon the nutritive values of the different items of food should form an important item in fighting the difficult situation, and guided by the nutritive values of the food-items the masses in India should be made to change their food habits. With this as the basis, the cultivation and usage of certain crops as food would be, in the humble opinion of the writer, a pratical proposition. Such crops form the subject matter of this paper.

The importance to these crops does not, in any way, lessen the important position occupied by what are called as the staple crops or the cereals. These crops are only meant to supply the necessary nutrition to some extent and thus qualitatively replace the staple crops to some degree, and thereby to reduce the pressure of the demand on the staple grain crops whose scarcity has been a serious threat in India to-day. This obviously leads them to be recognized as Supplementary Crops. Apart from the modern Western countries the commonly called backward countries of the East, namely China and Burma, have long back widened the field of their supplementary crops to mushroom culture, sea-weed industry and fish-culture. But the increasing difficulties of theoritical as well as pratical nature that are likely to attend the adoption of such supplementary crops in India at present advise to postpone their inclusion to more favourable circumstances in future. Hence it is thought advisable to dwell upon such crops whose cultivation, management and use is of an easy adoption, and the cultivation of some of which has been a hobby of some of the bungalow-owners.

Apart from their being "supplementary" to the staple cereals they offer an added advantage to the cultivator by their adaptability of growth on small areas such as corners, uneven surfaces such as raised portions or pits, a feature rarely compatible to the staple grain crops.

The following table will depict the food value of some of the members of the crops that can be taken to supplement the staple grains in food :—

| Name of Crop | Moisture % | Protein % | Carbo-hydrates % | Fat % | Mineral matter % | Calorific value per 100 gms. % | Fibre % | Calcium % | Phosphorus % | Iron, mgm. per 100 gms. |
|---|---|---|---|---|---|---|---|---|---|---|
| Tapioca | 67·83 | 0·81 | 29·63 | 0·58 | 0·44 | 127·0 | 0·71 | * | * | * |
| Tapioca flour | 12·90 | 2·18 | 80·24 | 1·58 | 1·19 | 343·9 | 1·91 | * | * | * |
| Tapioca starch | 11·56 | 0·20 | 88·15 | ... | 0·09 | 353·4 | ... | * | * | * |
| Yam | 71·23 | 1·73 | 25·43 | 0·03 | 0·96 | 108·9 | 0·62 | * | * | * |
| Sweet potato | 81·01 | 1·40 | 15·99 | 0·22 | 1·21 | 71·5 | 0·17 | * | * | * |
| Beans | 88·82 | 1·40 | 7·28 | 0·10 | 0·94 | 35·6 | 1·46 | * | * | * |
| Shevri | 88·94 | 1·67 | 7·01 | 0·20 | 0·72 | 36·5 | 1·46 | * | * | * |
| Drumstick | 89·30 | 2·21 | 4·54 | 0·11 | 0·95 | 34·7 | 2·89 | * | * | * |
| Bread fruit | 73·70 | 1·94 | 21·95 | 0·51 | 0·79 | 100·0 | 1·11 | * | * | * |
| Young Jak | 86·45 | 1·78 | 8·89 | 0·47 | 0·76 | 46·9 | 1·65 | * | * | * |
| Matured Jak | 67·83 | 2·33 | 27·76 | 0·12 | 1·06 | 121·4 | 0·90 | * | * | * |
| Alu (corn flour) | 12·09 | 2·45 | 82·00 | 0·25 | 1·00 | * | 1·00 | * | * | * |
| Shingada | 10·20 | 8·28 | 72·44 | 0·60 | 1·22 | * | 2·00 | * | * | * |
| Amaranthus species | 87·45 | 3·46 | 4·97 | 0·18 | 2·63 | 35·30 | 1·31 | 0·295 | 0·07 | 6·30 |
| Tandulja | 87·14 | 4·53 | 3·28 | 0·19 | 2·80 | 33·00 | 2·08 | 0·248 | 0·076 | 9·23 |
| Math | 86·45 | 4·05 | 4·89 | 0·31 | 2·38 | 38·60 | 1·93 | 0·179 | 0·048 | 17·46 |

* The figures are not available.

Even though, as has been expressed above, these supplementary crops do not exert a pressing need for much care on the part of the cultivator, a systematic and judicious cultivation and management of these crops are always associated with better results which should always be the goal characteristic of a good cultivator.

**Situation :**—The crops mentioned above do not need any special type of situation except for the well-drained nature of the soil. Shingada, Alu and

Breadfruit bring forth better results if they are situated in low-lying areas with obvious advantages of more water-supply. Shevga or Drumstick, Shevri, Tur ( perennial ), and Jak by virtue of their tall and broad vegetative growth claim a place along the boundaries or borders of bungalow gardens. This also makes them serve as a wind brake and thus to conserve soil-moisture, aided by the moderate shade they offer.

**Watering :**—Arrangements should be made to collect all the waste water from kitchen and bathroom in a common gutter such that the flow of water should be in the direction of the wind, by giving the gutter a slight slope in the desired direction of the winds during most of the parts of the year. The gutter should be built up by the suitable material impervious to water in order to prevent the loss of water. To this gutter, the water channels leading to the crops should be connected. The watering of all the crops should be done at proper intervals. The various crops should be brought into a certain number of groups, each group having a combination of the crops some of which require much water and others, capable of pulling on in comparatively drier soil-conditions. The number of each of these two varieties of crops in each group should be decided after a proper estimation of the amount of water available on each day. Each group should be supplied with water on days at the fixed interval. The smaller the distance of the crop from the main gutter, smaller are the subsequent water channels and hence less is the wastage of water through absorption in the soil.

**Manuring :**—If all the waste water, as mentioned above, is supplied properly without allowing any portion of it to be absorbed and wasted during the course of its flow from the source of water to the crop proper, manuring is automatically done with every doze of watering. But certain crops may require some additional manure. This need may be met successfully by an annual doze of a little farm yard manure or sheep-foldings. If the cultivator possesses some cattle, the cattle-urine which is usually being wasted by throwing away, may be carried through properly built gutters, and thus it can be supplied to each group of the crops at regular intervals. This regular application of cattle-urine at proper intervals has not been observed to exert any deleterious effect on the crop-growth.

**After-care :**—The area around the crops should be kept clean by the removal of weeds and the collection of dried leaves and other wastes. Proper aeration and sunshine should be provided in order to bring forth healthy growth of crops, and to check the growth of insects and pests. If observed any, they should be promptly dealt with by the use of the common insecticides such as tobacco decoction or soap-solution. Personal attention to the management of the crops once in a day or two has been found to keep the whole affair go on smoothly.

It is worthwhile, at this stage, to describe some practical aspects in connection with the crops in a little detail.

**Tapioca or Cassava** (*Manihot utilissimus*) :—It has made a considerable headway in Konkan and Kolhapur districts. It is propagated by sets. Sets of 9 to 12 inches length are planted in a well pulverised soil. Within 6 to 7 months after planting it can give out as many as 9 roots. Well developed roots are used in food as vegetables, or after pounding them to flour, or extracting starch from it, the starch powder can be used. Within 6 to 7 months each plant yields 2–3 lbs. of flour. It can be cultivated twice a year—in the beginning of monsoon and in October to November. It can be grown anywhere provided it gets some open space and water-facilities. It forms a very good catch crop if grown on the ridges with sugercane as the chief crop.

**Shingada** ( *Trapa bispinosa* ) :—This can be grown in low-lying areas with the provision of much water. It can be grown even in ponds. It yields a large amount of starch.

**Alu** ( *Colocasia antiquorum* ) :— In the Bombay State it enjoys a wide cultivation in the zone of sure and heavy rainfall namely, North Kanara district, Konkan, Malenad or Maval, and some parts of Belgaum district. But it can be grown in shallow ponds anywhere with sufficient facilities of water. It is propagated by corms and grows best in monsoon. Thereafter, if corms are given rest by storing in cool, dark place upto March, it puts forth a vigorous growth. It offers a ready response to manure and water. Its leaves and stalks are used as vegetables. Well matured leaves along with stalks are harvested keeping two leaves on the plant, one of them being the main stalk.

**Tondli** ( *Coceinia cordifolia* ) :—It is propagated in the monsoon by sets. It requires a support of a stick and thereafter, of a mandap. It gives fruits for several years. Its leaves are also used as food. It requires pruning and removal of dried parts in May. It is manured in monsoon.

**Tur** ( *Cajanus indicus* ) :—The variety yielding white seed is a perennial variety and yields for 4 to 5 years. It grows into a big plant with a profuse vegetative growth. It requires to be pruned before monsoon.

**Shevga or Drumstick** ( *Moringa oleifera* ) :—It grows into a big tree. Its fruits, seeds and flowers are used as vegetables. Its leaves form a good fodder for cattle. Pods are rich in proteins and are a good source of vitamin C.

**Yam** ( *Dioscorea sativa* ) :— It grows well on raised beds and when a support is given. It can be grown by the side of other trees which serve as a support to it. It is propagated by stem-cuttings with buds on, i. e. with the outer surface of the stem.

**Sweet Potato** ( *Ipomea batatas* ) :— It also grows well on raised beds. It is propagated by sets. The creeper requires to be lifted up and placed again on the ground after every 15 days lest it should form a tiny root at each junction of the creeper with the soil.

**Bread fruit** ( *Artocarpus incisa* ) :—It grows into a big tree. Its fruits resemble those of the Jack. Fruiting is throughout monsoon. Its varieties are mainly two. The fruits and seeds are used as vegetables.

**Jack** ( *Artocarpus integra* ) :—It also grows into a big tree. Its seeds are used as vegetables apart from the raw ripe sweet pulp.

**Shevri** ( *Sesbania aegyptica* ) :—It is a big plant. It can be used as a wind-brake and its flowers, as vegetables.

**Beans :**—These include—(1) Double bean, (*Phaseolus lunatus*) (2) varieties of Lima beans, (*Phaseolus lunatus*), (3) Abai (*Canovalia ensiformis*), (4) Wal papdi ( *Dolichos lablab* ), and (5) Choudhari bean (*Psophocarpus tetragonobus*). All these require the support of a mandap. All these can yield pods for 2-3 years if properly managed. Abai yields long pods. In addition to these, there are some weeds having a food value, that grow profusely in various seasons of the year. These may be allowed to grow except when they trouble the crop proper, until they mature, and then they may be uprooted and be given a place in the kitchen as leafy vegetables. These weeds are—(1) Math ( *Amaranthus polygamus* ), (2) Kate Math ( *Amaranthus spinosus* ), (3) Tandulja ( *Amaranthus paniculatus* ), (4) Pathari ( *Lactuca runcicata* ), (5) Ghol ( *Portulaca oleracea* ), (6) Chil ghol ( *Portulaca qudrifida* ), (7) Kena ( *Commulina bengalensis*), (8) Takla ( *Cassia tora* ), and (9) Kurdu ( *Cilosia argentia* ).

Takla and Kurdu can be used as leafy vegetables when they are young and tender. Shevga, Shevri, Bread-fruit and Jack fruit start yielding fruits after a few years from their plantation. But they continue to be productive for many years and this long period of their productivity pays for the first few years spent in waiting for the fruits.

Wastage of food is very common in the Indian methods of cooking. If the wasting tendency accompanies the usage of supplementary crops, it threatens to defeat the purposes of the cultivation of supplementary crops. Hence by putting a check to the wastage of food the fact that " food saved is food grown " should be realized in the actual practice, e. g. the Mango stones when dried and broken, yield a pulp rich in proteins to the extent of 8·5%, and it has been estimated that the pulp from 100 average-sized mango stones equals the protein value of 80 lbs. of Oat. Further, the experience that the flour prepared out of this pulp can be mixed with the flour of the staple grains with good results in the preparations of

various food-items, should lead us to hold the rich source of protein in a high esteem in its inclusion in our daily diet. The recognition of proteins as the criterion of the nutritional standard of food-stuffs at present as manifested by the importance attached to " Food Yeast " throughout the world, amply signifies the inclusion of an adequate amount of protein-rich diet at least in the present food crisis in India.

Thus, supplimentary crops, if given a proper and serious consideration, should readily relieve the much felt pressure of the demand on the staple food grains, and it should never be too much to expect the change-over taking place in the flower gardens of bungalow-yards and open and waste space elsewhere, in favour of the teeming supplementary crops in the near future throughout India.

**References**

(1) Tropical Agriculturist — Volume XC, Number 1.
(2) चित्रमयजगत् — November 1949.

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# Do Improved Sugarcane Varieties Deteriorate ? [1]

By

N. R. BHAT [2]

I have been hearing of deterioration having occured in the outturns of Co. 419 variety of sugarcane in Deccan since about the year 1944. I have, as yet, no clear idea on what basis this contention is being made. I imagine that it is on the grounds of lesser stands of the crop observed and lower tonnages realised from year to year by some sugarcane growers, since, so far as I know, a regular scientific enquiry has not been made. Probably, because the irrigational and manurial practices followed are, in general, considered to be satisfactory for raising a good crop and also for maintaining soil fertility, it is presumed that the cane variety itself must have been deteriorating.

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1 Talk given at the Seventh Convention (1950) of the Deccan Sugar Technologists' Association.

2 Statistical Officer with the Dy. Director of Agriculture, (Crop Research), B. S., Poona.

In my opinion, the question is too serious to be so lightly dealt with. For a real study of the problem we have first of all to see whether there has been an all round progressive fall in the outturns of Co. 419 variety in Deccan. For this purpose, a random sampling survey over a series of seasons may be worthwhile. As a less expensive alternative, it is worthwhile studying the data of yields realised, for at least 4 to 5 seasons, in a large number of plots situated in various soil types of the tract, which have been constantly receiving the same irrigational and manurial treatments from season to season. If in spite of not particularly worsening season and nonprevalence of disease and pest epidemics, there is a progressive fall in yields of almost all the plots, deterioration may be accepted as a fact. I believe, such a study is overdue.

Progressive deterioration, if established, can either be in the cane or in soil fertility. The fertility of the soil in its turn will depend upon its physical condition and chemical constituents. As all of you are well aware, both these latter factors are very important in the case of a heavily irrigated and heavy feeding crop like sugarcane and it is not easy to maintain them in ideal conditions.

As tonnage is very much dependent on the stand of the crop, deterioration in yields should manifest itself through reduction in vigour of the cane as could be observed through lower amount of tillering, lesser heights, thinner canes, etc. The reduction in vigour may be observed either in the entire crop or in only a certain proportion of the plants. In the latter case again two distinct categories may exist, viz. (i) the first in which the two groups, when merged together, result in only one series of plants that can be continually graded in respect of vigour and (ii) the second in which the two groups, while being distinct from each other, would be more or less uniform within themselves.

Out of the cases mentioned above, it is only this last one that is, in my opinion, likely to arise from degeneration of the cane variety.

To make you think for yourself whether deterioration can take place in sugarcane and, if so,whether it can be appreciable, I would like to discuss, in brief, how deterioration usually takes place in plants. You are, probably, aware that sexual organs, male and female, of plants are located in their flowers. Here it is that the blood of different varieties can get mixed due to the pollen (male) of one plant fertilising the ovules (female) of its neighbour to produce hybrid seed. It is worthwhile to remember that the hybrid blood does not permeate the vegetative parts of the contaminated plant. When the seed of the plants raised from the hybrid seed is sown in its turn different types of plants combining the good and the bad qualities of the two original plants in various proportions come into existence. Deterioration of a noble variety propagated by seed can, therefore, take place through the contamination of its blood with that of an inferior variety in its vicinity. Such a deterioration is unthinkable in the case of sugarcane as it is propagated by setts. Vegetative propagation is, in fact, the shield against

breaking up and or deterioration of a sugarcane variety. As you are probably aware the improved variety Co. 419 is possessed of the blood of three different species and, but for its propagation by setts, would have broken up into numerous types and would have been equally liable to deterioration through contamination.

Sometimes ago, I happened to read in an issue of the " Shetki and Shetkari " an extract from a paper, " Are the cane varieties in Deccan pure? " quoted in the report for 1948 of the Sugar Technologists' Association. It was reported that the author of the paper observed considerable variation in the vigour of Co. 419 variety by studying 6 important characters. While not denying the existence of such a variation, I would not, for reasons stated above, attribute it to the contamination of the improved variety with the inferior local variety as seems to have been implied by the author of the paper. Probably, all the variability observed, very striking as it well might have been, could be accounted for as due to changes in soil fertility and inequalities of treatments combined with chance variation. I am sure, the author will profit himself and us all by a more thorough study of the data.

As far as is known, there is only one way in which a cane variety can deteriorate. It is due to undesirable new types coming into existence through bud mutation. But, such bud sports arise at the rate of less than one in a million and the probability of their being undesirable ones is about half as much. In his latest book on plant breeding, Hagedoorn, the renowned Dutch breeder states, " I may add here that there is very little chance of finding new clones in the better known and highly cultivated potatoes, sugarcanes, etc., as in this material every commercial kind is genetically pure, in so far as admixtures of different clones are concerned." Inferior bud mutations, if and when they occur, would therefore result in only a small fraction of the crop becoming inferior, in course of time. This is the category of fractional deterioration of the crop which I previously described as due to degeneration of the cane variety.

If the deterioration is wholesale, I, personally, would not consider it to be in the cane variety. Both on practical and theorotical grounds, I do not think it to be possible. Nowhere except in the Deccan has a sugarcane variety been reported to have deteriorated. Theorotically also, we cannot accept the possibility of such an occurence unless we disbelieve in the genetical theory established through innumerable experiments outside the U. S. S. R. To acquaint you with the theory pertaining to the question, I would quote Dr. R. H. Richens of the Cambridge School of Agriculture, who in discussing Lysenko's (Soviet Geneticist) hypothesis of Degeneration and Rajuvination (Vide 'New Biology-Issue No. 8), observes: " Although the belief that plant varieties degenerate with time, especially when the varieties are self-pollinating or vegetatively reproduced, is widespread, detailed investigation has not supported this view. It has been shown that in potatoes, for instance, lowered yields accompany the spread of virus diseases, which, given time, attack almost every new variety. Also, new cross-

bred varieties have often a certain degree of hybrid vigour, which is lost after some years have elapsed. But *no loss of vigour in a pure-bred variety due entirely to continued self-fertilization or vegetative propagation has yet been discovered outside the Soviet Union.*" (Italics mine).

It would both be out of place here and unnecessary to discuss the merits of the contradicting theories, as a simple, practical experiment would easily give us the clues to our problem. It is to conduct statistically laid out comparative trials of what is thought to be the degenerated cane side by side with the stock of the Experimental Station both at Coimbatore as well as in the various soiltypes of Deccan. I learn that a few trials have been undertaken in the Deccan. I wish they have been properly laid out; otherwise, instead of giving us correct guidance they may mislead us.

If the deterioration of the crop is wholesale (or even franctional) and is established not to have resulted from the degeneration of the cane variety, as I expect it will be, it would be evident that it is due to the deterioration of the soil, either physical or chemical. I do not propose to enter this alien province. However, as a layman, I may casually hint that in respect of chemical deterioration of the soil one may look for either the progressive deficiencies of the essential trace elements or accumulations of toxic substances resulting through the raising of the sugarcane crop from season to season.

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# Scientific Agriculture Seen Ending India's Food Deficit [1]

Washington, Oct. 25—The application of modern agricultural practices to even half of India's farms would eliminate the nation's 10-percent food deficit.

This opinion was expressed in an article printed in "*Foreign Agriculture*", a publication issued by the United States Department of Agriculture. The author is Henry W. Spielman, formerly Consul (Agricultural) at the American Consulate General in Bombay, and at present Agricultural Attache at the American Embassy in Karachi.

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1 American Newsfile—Agriculture Supplement of 25th October 1950.

The article, in part, follows: " Many aspects of Indian life have combined to give credence to the widespread belief that India's farms can never produce enough food for all its people. The population is increasing by roughly four million a year, most of the good land is now being farmed, agricultural production methods and tools have changed but little over the centuries, and farmers resist change. Nevertheless, India's agricultural scientists believe that the nation can feed itself. In its agricultural experiment stations it has the knowledge, and on its farms it has resources that are not fully utilized. In those areas where the two potentials have been brought together, farm productivity has been increased by 60 percent to as much as 400 percent. And a 10 percent increase is all that India needs to become self-sufficient.

" The system of agricultural experiment stations throughout India has been in operation for a number of years. Many of the stations are staffed with specialists trained in the United States or Europe and all of the stations have been highly successful. They have developed new crop varieties, improved plowing and cultural practices, developed water-and soil-conservation services and drainage programs, and introduced irrigation farming and land reclamation.

" Station experiments have shown that by using improved varieties, farmers can increase yields by an average of 12 percent. If they also use manures and commercial fertilizers, they can increase them 25 to 75 percent. And if, in addition, they use slightly improved indigenous farm implements, space crops in accordance with rainfall and soil conditions, and plant and cultivate at the proper time, they can increase output 20 to 50 percent more. When all improved methods were used on one plot of an Indian farm, production was increased by 400 percent.

" The Sholapur experiment station in the Deccan area of India reports an interesting example in its cooperative arrangement with a farmer on a dry hill-side nearby. The farmer agreed to follow the station's recommendations in his 15- acre grain sorghum field, from which he had been getting an average yield of 150 pounds an acre. He was to use his own equipment.

" His first step was to terrace the field to conserve both the soil and the moisture. Next, he prepared it for contour planting. Then he planted seed of the improved variety furnished by the station and spaced both the rows and the plants in the rows as recommended. Compost and chemical fertilizers were applied. When the crop was harvested, the farmer was amazed at the yield--660 pounds an acre.

" The director of the station is convinced that simliar results could be obtained by most farmers in the Deccan area.

" India's agricultural scientists, then, do have the know-how for solving the country's food problems. The question remains how to bridge the gap between the experiment station and the farmer. The answer, of course, lies in extension services. These, too, India has, but thus far they have reached few farmers.....

" In Bombay Province there is an agricultural agent and three or four assistant agents in each of the 19 districts. Each assistant supervises three to five village workers, who live with the farmers and pass along the latest recommendations of the Department of Agriculture. Because of the limited number of extension workers, only a small percentage of Bombay's farmers can be reached. Those who are getting up-to-date farming information and learning to use it are getting increased yields well above those of their nonparticipating neighbors. Undoubtedly production of all types of food grains could be increased in a few years if there were enough trained extension workers.

" Although India's farmers tend to cling to the traditional ways, Indian agriculture is not so static as it might appear to a casual observer. Changes are taking place. For example, 10 years ago, farmers of the Gujerat district of Bombay Province were raising their own bullocks. Now they get them from commercial cattle raisers because farmers realize that, with young bullocks requiring four years of costly care and training before they can be of use, it is cheaper to buy them already trained. Another example is to be found in the region around Anand, also in Bombay Province. Ten years ago, this area was producing only enough milk for local consumption. Last year, even in the February-March off season the region sent 57,000 pounds of milk daily to the Bombay city market.

" All this evidence of progress and change indicates that India is moving toward a modernized agriculture and a solution to its food problem. It will not be an easy or quick solution, however. India has 340 million people to feed, and the population increases by about four million a year.

" In India as a whole, food grains probably represent 60 to 75 percent of the diet. In some areas they make up 90 percent and in others about 45 Other sources of food are merely supplementary. Therefore most of the increased production will have to be in food grains.

" Another custom that affects the general productivity of Indian farms is that of maintaining thousands of unproductive cattle on them.

" The fragmentation of Indian farms too has some effect on agricultural efficiency and therefore on the country's ability to feed itself. Few farms are a single unit. The farmer with five acres may have five different plots of land

scattered over two square miles. He spends considerable time and animal power moving from one plot to another. Some of the Provinces have passed legislation to correct this waste. Bombay Province, for example, has fixed five acres as the minimum size of a plot. This law also provides that when a holder sells his land, if it is smaller than that minimum and his neighbors also have less than the fixed minimum, he must sell to one of his neighbors.

" Indian farms vary in size with the kind of principal grain they produce. The average rice farm in Bombay Province is five acres, while most jowar-grain sorghum farms consist of 30. Of course, in many places rice farms may be only two or three acres or, sometimes, only one. Generally a family farm is the size that an able-bodied man with a grown son and two pairs of oxen can farm. Indian agricultural specialists believe that with the present type of farm power, this small unit is the most economic.

" Many of the aspects of Indian life that stand in the way of a highly efficient agriculture are rooted deep in religious beliefs and in tradition, and the Government will not find them easy to change. But increasing production to a level of self-sufficiency would not necessarily require any radical change in the social or economic conditions of the farmer. It calls only for making better use of his resources. India's food deficit is only 10 percent of total production. If the improved methods can be used on 50 percent of the farms, the country could feed itself. The other problems will eventually have to be faced and solutions found before agriculture can be on a continuously sound basis. The immediate problem is making two blades grow where one grows now. And this can be achieved by extension services that can effectively get the results of research from the experiment station to the farm. "—USIS

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# Crop-Use Research in the United States [1]

By

DR. G. E. HILBERT

During the past 15 years great advances have been made in the United States in crop-use research—research to promote the wider and more efficient

1 Reprinted from " Chemurgic Digest " taken from " American Newsfile-Agriculture Supplement ", September 6, 1950.

utilization of farm products. The U. S. Department of Agriculture agency which is responsible for research on crop utilization has investigations in progress on al the major domestic crops. Two fields of crop-use research are of special interest, because they both have considerable significance for chemurgy.

One field is research on practical disposal methods for dealing with certain waste products-what might be called the " wet wastes "—of the fruit and vegetable processing industry. Processing plants in the United States are now taking a much larger proportion of the total crop of fruits and vegetables than they did a few years ago. In 1937 they processed about 9,000,000 tons of these products. Now they are processing more than 15,000,000 tons a year, or about half the production of fruits and vegetables.

This means that wastes which formerly went into family garbage pails are now piling up at processing plants. It is this concentration that creates the problem. They amount to 30 percent of the total tonnage of fresh fruits and vegetables entering the processing plants. These wastes poison streams and create health hazards.

The chemical nature of these wastes is about 88 percent water and 12 percent dry solids. The annual 5,000,000 tons of fruit and vegetable waste contains about 600,000 tons of solid material. Many wastes have only 10 percent dry solids. About 60 percent of the solid material is carbohydrates—sugars, starches, cellulose. The remaining constituents include proteins, fats, oils, waxes, organic acids, and other common plant materials.

In the Bureau of Agricultural and Industrial Chemistsy of the U. S. Department of Agriculture these wastes have been considered in three main categories: i) wastes from which edible products can be recovered that are suitable for human consumption; ii) wastes which can be made to yield products useful to industry or for livestock feed; and iii) wastes which are merely a disposal problem from which it is not feasible to recover solid constituents.

Examples of what can be done with the first two categories are found in the Bureau's work to develop methods for utilizing wastes from pear canneries. The three Pacific Coast States of California, Oregon, and Washington pack about 90 percent of the canned pears consumed in the United States. The wastes from their operations—cores, peels, and trimmings-amount annually to some 140,000 tons.

The common method of disposing of these wastes has been to dump them into streams or on waste land. These practices are unsatisfactory, and sewage systems would require large capital outlays plus continuing high service charges. The Bureau of Agricultural and Industrial Chemistry has been working on two possible solutions.

At a large cannery in Oregon a process was developed for the recovery and purification of an edible juice from pear waste which provides the sirup in which the pears can be canned. Waste pear juice contains as much sugar as the juice from sugar cane. Packing pears in sirup made from the waste juice, instead of in the water sirup ordinarily used, permits the plant to use about 30 percent less sugar in its operations. The saving thus made will apparently be more than enough to pay for recovering juice from the pear waste.

This process appears feasible only at large canning plants where the waste is plentiful, can be kept clean and uncontaminated, and can be processed as part of the canning operation as rapidly as it is produced. Pear waste normally contains inedible fruit, and the simplest procedure is to treat it as garbage. Under these circumstances it is impossible to prevent spoilage or contamination, and a different kind of nonfood waste-utilization procedure is needed. Such a procedure was developed at San Jose, California.

In this alternative process, the whole garbage is converted into products suitable for animal feed, industrial fermentation, and other nonfood uses. The method involves pressing the ground waste after it has been limed under carefully controlled conditions. The pressed material is dried to pomace and the juice is concentrated to a sirup. During the 1949 canning season, several tons of dried pear pomace were produced for evaluation as livestock feed and as a soil conditioner, as well as large quantities of sirup concentrate, intended as a raw material for fermentation to industrial alcohol. The value of these by-products will enable the San Jose canneries to dispose of their wastes satisfactorily at less cost than they are now paying for the undesirable practice of dumping the wastes on unused land.

The third category of wastes includes those which constitute a disposal problem pure and simple. Wastes of this kind are normally so dilute that it is not feasible to attempt recovery of by-products from them. One of the most troublesome of these is milk waste. This waste comes chiefly from washing milk cans, bottles, and dairy equipment. Most dairies expect to lose as waste about one percent of the milk they handle. Milk is about 90 percent water, and in the highly dilute milk waste the content of dry milk solids is only about one-tenth of one percent. In spite of its highly dilute nature, milk waste has about 10 times the biochemical oxygen demand of ordinary sewage. In other words, its ability to polute streams is 10 times that of ordinary sewage and, generally speaking, it is 10 times as difficult to dispose of.

Milk is highly nutritious. Microorganisms thrive on it as well as babies. That is the reason that milk wastes are so toxic in streams. Milk-fed microbes multiply rapidly and consume the dissolved oxygen in the streams. Fish and other animal life dies, and the stream becomes putrid. Milk's excellence as a food is

precisely what makes it such a big pollution problem. The Bureau's work has been concentrated on developing a rapid, simple fermentation process which will adequately treat this waste.

Research has led to development of a mixed culture of microorganisms which can convert the soluble sugar and protein of milk waste by aerobic fermentation to insoluble yeast cells. The yeast, which may have some use as fertilizer, can then be readily separated from the effluent by centrifuging. This method reduces the oxygen demand of milk wastes and makes them relatively easy to dispose of as sewage. The yeast organisms remove the lactose and soluble protein rapidly and almost completely from the solution to produce cell tissue. About half the organic matter is oxidized to carbon dioxide and water to gain energy for this synthesis, and all but two or three percent of the remaining solids is converted into yeast.

The second important field of crop-use research is waste in food processing. During the last few years the United States has seen the advent of a new kind of frozen-food product that offers a partial solution to the high cost storage of frozen fruit juices: frozen concentrated orange juice, a product which has had truly remarkable success. It has virtually solved the orange-surplus problem in the southern state of Florida. Now the mathod is being extended to the production of concentrated juices from grapes, grapefruit, apples, and other fruits. The principle of concentration is a new and important one for the frozen-foods industry. It offers particular promise to fruit growers in areas far from major markets, because it will enable them to reduce their shipping costs.

Another development in the field of concentrated food products, which involves another new principle of food preservation, is the production of volatile fruit essences and nonfrozen concentrated juices flavored with them. It is fairly simple to concentrate fruit juices by evaporation to a fraction of their original bulk, but during this process the volatile flavor constituents which give the juices their distinctive taste are lost. The trick is to recover these elusive substances so that they can later be returned to the juice or to other processed food products. The Bureau of Agricultural and Industrial Chemistry has developed equipment and mathods for accomplishing this, and a large number of companies are now engaged in commercial production of volatile flavor essences from various fruits.

In the case of apples, most of the flavor constituents are contained in the most volatile 10 percent of the juice. A single-stage evaporation process can be employed to produce both the flavor essence and a concentrated, more or less flavorless juice. By properly mixing the two, one obtains a full-flavored, concentrated juice. When diluted with water, this concentrate produces apple juice comparable in flavor to the fresh product. The concentrate will keep for some time in ordinary storage without spoiling.

In the case of grape juice, it was found that its flavor constituents occur in all the volatile fractions. The Bureau worked out a two-stage process for the production of grape essence and grape-juice concentrate which permits the full recovery of the flavor components of this fruit.

The problem of flavor loss through evaporation is present also in the production of frozen concentrated orange juice. Here the fresh juice is concentrated to one-sixth or one-eighth its original bulk. Then fresh juice is added in an amount equal to that of the concentrate, in order to restore the natural orange flavor. The product is then frozen as a 3-to-1 or 4-to-1 orange concentrate.

There is one more recent development in food processing—the use of antibiotics for preserving foods. This has many potential uses and enormous implications for all methods of food processing. It is a novel and perhaps revolutionary technique for food. Very little effort has so far been devoted to the application of these substances in food processing, although many of them are effective against the microorganisms that cause foods to spoil.

The Bureau has become interested in this general field. Preliminary screening assays showed that the antibiotics subtilin, which was discovered at the Western Regional Research Laboratory of the U. S. Department of Agriculture in California, is apparently as active against common food-contaminating organisms as any antibiotic available. A combination of subtilin and mild heat is effective in preserving foods. It seems that subtilin destroys those food-spoiling organisms that are resistant to heat, while mild heat destroys those that are resistant to the antibiotic. Only minute amounts of subtilin need to be added to food products, and it is of course undetectable by the consumer. Vegetables canned with five to 10 parts per million of added subtilin and subjected to a mild heat treatment —amounting to 5 to 15 minutes at the boiling point of water-were effectively sterilized and have kept without spoilage for periods up to eight months.

Extension of this new treatment to the preservation of milk, poultry, fish, and meats is obvious and preliminary studies along this line are under way. All the tests made indicate that subtilin is a nontoxic substance.

The waste-disposal problems and advances in food processing discussed here are essentially chemurgic in nature. There are signs of a maturing chemurgy which is mindful of the contribution it can make toward improving American standards of public health and the nutritional welfare of the United States. These developments are basic to the economic welfare of the food-processing industry and therefore directly affect markets for agricultural products. They are important to both farmers and consumers. The techniques being developed for recovery and worthwhile utilization of by-products from agricultural wastes should certainly prove of interest for all chemurgic enterprises.

# Gymkhana Report.

The Gymkhana started its activities in right earnest from the beginning of the second term. The remaining College Annual Sports i. e. tennis and ploughing were held in the second term.

As usual a large number of students had taken part in ploughing competition this year and Shri. Koratkar won the championship.

From this year our enthusiastic Hon. Secy. for tennis had started 2 tennis courts viz. A and B and the college annual tournaments of both the courts were held separately. 'B' court tournaments were held in the last week of November and Shri. A. V. Ghate won the 'B' court singles championship and Messrs Pinto brothers won the 'B' court doubles championship. 'A' court tournaments were held in the 1st week of January and Shri. M. H. Gursahani won the championship in singles and Messrs Gursahani brothers won the doubles title.

**Inter Collegiate Sports Prize Winners 1950–51**

*Sitting in Chairs (L. to R.):*—Shri K. A. Gursahani *(Champion in tennis doubles)*, Shri M. H. Gursahani *(Champion in tennis doubles)*, Shri V. P. Mane *(Champion in wrestling below 112 lbs.)*, Shri S. N. Dharu *(Champion in weight lifting below 121 lbs )*

*Standing (L. to R ):*— Shri G. B. Kasad *(Runner up in Boxing below 126 lbs.)*, Shri F. F. Pinto *(Champion in javelin throw)*.

In the Inter Collegiate Sports Messrs Gursahani brothers represented our College in tennis and I am very much pleased to note that they brought glory to the college by winning the doubles championship after a lapse of 24 years.

It is a matter of pride that Shri. V. P. Mane won the Inter Collegiate wrestling championship in his own class weight and he was sent for Inter Group Competition and now he has been selected for the All India Inter- University Sports by the Poona University. Thus he brings credit to our college, and we wish him the best of luck.

Shri. S. N. Dharu got the Inter Collegiate Championship in weight lifting in his own class weight. Shri. F. F. Pinto had shown his good style in javellin throw this year also, and got the first prize.

Shri. G. B. Kasad also put up a very good show in boxing. He was the only student who represented our College in boxing this year and was runner up in the event.

Our college cricket team took part in the Maharashtra Gymkhana Open Cricket Tournaments and reached the finals. But in the finals unfortunately we were not able to put up our whole team due to sickness and injuries to some of our players. So naturally we were runners up.

These achievements, though few and far between are of an outstanding nature. There is no doubt that given more time and leisure for practice, the students of this college can make still better contribution to this important sphere of College and University activity.

My best thanks are due to those members of the College Staff and my Colleagues who gave their fullest co-operation and help in the different tasks of carrying out Gymkhana activities.

Our heartful congratulations to those who won and best wishes to the rest.

## Our Sports Achievements in 1950-51.

MAHARASHTRA GYM. OPEN CRICKET TOURNAMENTS.

*Cricket* :— Runners up.

## Inter Collegiate Sports.

*Weight lifting* :— Shri. S. N. Dharu, Champion below 121 lbs.
*Wrestling* :— Shri. V. P. Mane, Champion in fly weight.

*Boxing* :— Shri. G. B. Kasad, Runner up below 126 lbs.
*Athletics* :— Shri. F. F. Pinto, Champion in Javelin Throw.
*Tennis* :—Shri. M. H. Gursahani, ,, K. A. Gursahani, } Champions in Doubles.

**Inter-Group University Sports.**

Shri. V. P. Mane, Runner up below 123 lbs.

**U. R. Pawar**
*Hon. Gen. Secretary,*
Agri. College Gymkhana, Poona 5.

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# Book--Review

**Regional Survey of Economic Resources, Kolhapur: By Rao Bahadur Dr. P. C. Patil: Rs. 24: pages 448.**

This book is practically the *magnum opus* of Dr. P. C. Patil who needs no introduction. The object of the book is "to make a beginning in Regional or Provincial Surveys of economic resources." The author rightly contends that technical improvements in growing crops cannot change the condition of the agriculturists so much as changes in other economic and social factors such as the size of the farm, marketing etc.

This book is undoubtedly important as a source of information on all aspects of agriculture in Kolhapur. It covers a wide variety of topics and contains much useful information in its 26 chapters of varying length and importance. Its material is backed substantially by equally useful statistical data in the form of nearly 46 different " Statements. "

The book embodies also what the author describes as " twelve actual investigations" on different rural problems dealt with in the chapters. Among such problems we have farm indebtedness; extent of tenancy; milk supply; food problem; a study of five holdings regarding size, number of fragments and their arrangement; number of holdings in different size-groups in 17 selected villages, etc.

It is interesting to note for example that in 1945-46 over 71 pc. of the land holdings in Kolhapur were below 5 acres whilst holdings of 50 acres or above

constituted only 1·5 pc. of the total. Within a short period of 4 years the average size has fallen from 6·8 acres to 5·6 acres.

The author has shown clearly enough how absentee ownership of land must go though he has added that in an old country like ours we should not neglect the condition of the small landowner when we talk of tenancy legislation. As an example of the latter, the author refers to village *balutedars* who have been given small pieces of land. Since these lands are " too small to sustain the owners, if they devote themselves entirely to agriculture ", they are leased to others. The author feels that the balutedars would suffer if there was tenancy legislation since it would prevent this leasing of the lands and therefore also the earning of a supplementary income by the owners. What is true of *balutedars is* also held to be true about lands held by " clerks, school teachers, men in Police, peons in offices ", etc. This perhaps is stretching the argument too far. However though we may differ in matters and conclusions such as this there is much that is really worthy of notice in this interesting book. To give another example, the author tells us that " in Kolhapur, the general practice of irrigation is most laborious and more costly than in any other part of India ".

Like Dr. Patil who is himself a pioneer among agricultural economists this regional survey is a pioneer among such surveys. The author may well be congratulated for this excellent production in his advanced age. Unfortunately the book is priced at Rs. 24 and this is much too high a price even for a bulky volume of this type.

10th January, 1951. **(P. N. Driver )**

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## — मराठी-विभाग —

# अहमदनगर जिल्ह्यातील ऊंसाची लागवड

( लेखक :- **रा. मु. जगधने**, तृतीय वर्ष. )

ऊंस ! ऊंसाला आज महत्व आले आहे ते त्यापासून मिळणाऱ्या साखर व गूळ हे आपल्या आहारांतील आवश्यक अन्न म्हणूनच नव्हे-कारण साखर व गूळ ही नेहमींच चौरस आहारांत गणली जाणार आणि समाजाच्या सुधारणेबरोबरच गूळ आणि त्यापेक्षां साखर अधिकाधिक आवश्यक होणार. परंतु आज गूळ साखरेस व्यापारी दृष्ट्या महत्व वाढले असून चहा-कॉफी-कापूस याप्रमाणें कोणत्याही देशाची किंवा त्याच्या विभागाची आर्थिक परिस्थिती व घडी ठरविणारी मुख्य बाब आहे आणि साखर तर आंतरराष्ट्रीय व्यापारी उत्पादन ( Commercial product ) बनलें आहे.

**महाराष्ट्रांतील साखर कारखान्याचे** नकाशावर स्थान पाहिले तर असें स्पष्ट दिसून येतें कीं, जें प्रदेश एकेकाळीं प्रतिकूल भौगोलीक परिस्थितीमुळें उजाड दुष्काळी म्हणून नावांजले होते तेथेंच आहे. जमीन चांगली असली तरी हवामानाची वक्र दृष्टी झाली कीं सर्वच कार्यभाग आटोपला. अशा भागांत नगर जिल्हा अग्रगण्य. जमीन पुष्कळशी चांगली पण शेतीचा मुख्य आधार पाऊस अपुरा आणि तोही अनियमित. त्यामुळें शेती पिकली गेली नाहीं आणि शेतकरी नेहमींच दरिद्री राहिला. वासुदेव बळवंताच्या बंडाची हीच ती पार्श्वभूमी होती.

परंतु कालव्याच्या पाण्यामुळें शेती व शेतकऱ्यांची आर्थिक परिस्थिती पार बदलून गेली आहे. एकेकाळचा दुष्काळी प्रदेश आज "कुबेर नगरी" म्हणून संबोधला जात आहे. या कुबेराच्या संपत्तीचा पूर यायला येथील लोकांनी केलेली ऊंसाची लागवड—गूळ आणि साखरेचे उत्पादन हेंच होय.

मुंबई राज्यातील ऊंसाचें मुख्य उत्पादन महाराष्ट्रांतच. महाराष्ट्रांतील एकूण १५ साखर कारखान्यापैकीं सहा नगर जिल्ह्यांत आहेत आणि दोन निघण्याचें मार्गावर आहेत. ऊंसाखालीं एकूण ४४२०० एकर जमीन म्हणजे मुंबईराज्याच्या एकूण क्षेत्राच्या ३४ ते ३५ टक्के एकट्या अहमदनगर जिल्ह्यांत आहे. महाराष्ट्रांतील पहिला साखर कारखाना नगर जिल्ह्यांत निघाला. ऊंस पिकविणें हा नगर जिल्ह्यांतील लोकांचा हातचा मळ बनला आहे. सहाजिकच असा प्रश्न उद्भवतो कीं, ह्या भागांत लोक लागवड कशी करतात ?

**जमीन** :— ऊंसास लागणारी भारी आणि मध्यम प्रतीची जमीन कॅनॉलचे भागांत आहे. त्याबरोबरच मुरुम साधारण ३ ते ५॥ फुटांवर असल्यामुळें पाण्याचा निचरा होतो. बारामती भागांतील जमिनीसारखी पाणथळ जमीन होत नाहीं.

**हवामान** :— हवा उष्ण व समुद्रापासून दूर असल्यामुळें कोरडी आहे. त्यामळें सुमात्रा, जावा बेटांतील हवामानाइतकीं चांगली नसली तरी बिहार, उत्तर प्रदेशापेक्षां चांगली आहे आणि ती पिकास मानवतें.

**पाणी पुरवठा** :— बारमास वाहणाऱ्या गोदावरी प्रवरा नद्यांचें कॅनॉल्सनें पाणी बाराही महिने मिळण्याची व्यवस्था केलेली आहे.

**लागवड** :— ह्या भागांत ऊंस पिकविण्याचें पद्धतींत दोन प्रकार. एक शेतकऱ्याची व दुसरी मोठ्या शेतकऱ्यांची व कारखानदारांची.

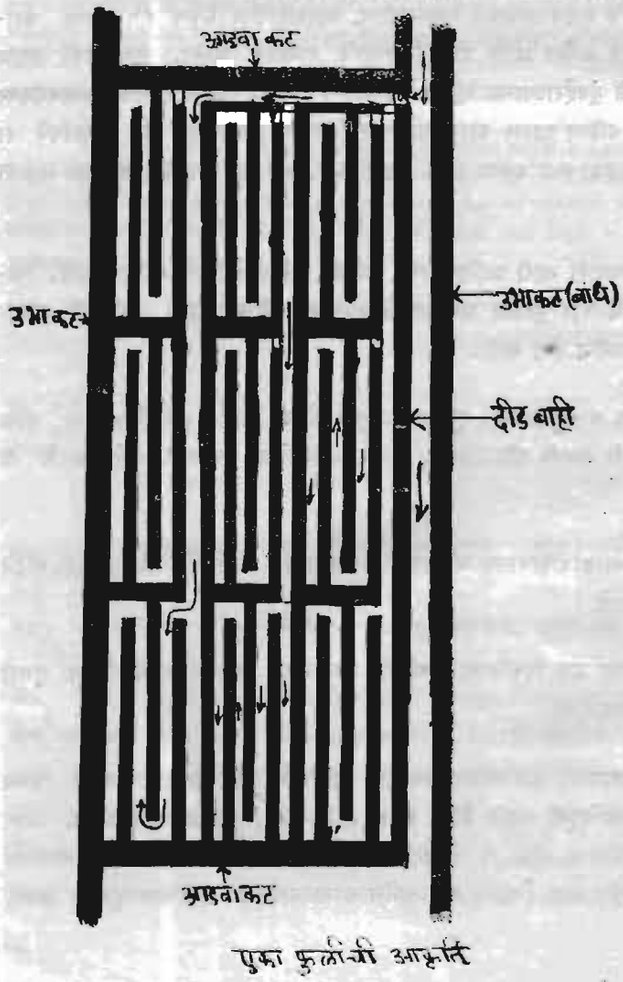
मोठ्या प्रमाणांवर कारखानदार ऊंस लावत असल्यानें त्यांना माशिनरी वापरणें परवडतें. प्रथम तें ट्रॅक्टरनें जमीन नांगरतात. त्याचेपूर्वी एकादे वेळेस ताग (Sann hemp) गाडणेंसाठीं घेतात. नंतर ट्रॅक्टरनेंच ढेकळें फोडतात ( Cold crushing ). ट्रॅक्टरचे सहाय्यानें उभे कट घालतात. साधारण अर्ध्या एकराचा एक प्लॉट पडतो. नंतर ट्रॅक्टरचे सहाय्यानेंच सऱ्या पाडतात. सरी चार फूटांवर असतें.

येथपर्यंतच शेतकऱ्यांच्या पद्धतींत फरक आढळतो. शेतकरी प्रथम किर्लोस्कर नंबर नऊनें ( सहा बैली ) जमीन नांगरतो. नंतर जमीन जरा शेकून देतो. नंतर लोडानें ( Maind ) ढेकळे फोडतो. ह्यानंतर १०–१५ गाडी शेणखत पसरतो. आणि खत पसरल्यावर दुसऱ्यांदा आडवी ( Crosswise ) नांगरणी करतो. परत एकदां जमीन व्यवस्थित सपाट करतो. नंतर अर्ध्या एकराचे उभें **' कट '** प्लॉट घालतो. आणि मग रिजरनें ( ४' ) सरी पाडतो.

**रान बांधणें** :– ( Lay cut) वरीलप्रमाणें रान तयार झाल्यावर त्याची बांधणी करावी लागते. उभ्या अर्ध्या एकराचे प्लॉटमध्यें आडवे कट टाकतात. इरिगेशनचे नियमानुसार हे ४०–४५ फूट अंतरावर टाकावेच लागतात.

आडवा कट घातल्यावर एक फुली तयार होते. ती साधारण २ ते ३ गुंठ्याची होते. रान बांधणी ही वाफ्यांत नागमोडीच्या पद्धतीनें ( Surpantine method inveds ) केलेली असते.

( बाजूची आकृती पहा )




एका फुलीची आकृती

**लागण** :– रान बांधून झाल्यावर बेणें (Sets) पसरतात. बेण्याकरितां ऊंस साधारण ९॥ते१० महिन्याचा निवडतात. एका टिपरावर (Set) तीन डोळे (eyes) असतात. बेणें सरीच्या माथ्यावर रांगेंत मांडतात. ते रांगेंत मांडतांनाच सवाई किंवा दिढीनें मांडतात.

लागण साधारण दोन प्रकारें करतात. कोरडी लागण आणि ओली लागण किंवा पाण्यांत केलेली लागण.

आडसालीं साधारण जूनमध्यें लावतात. त्यावेळेस जमीन ओलसर असते. तेव्हां सरीच्या बगलेस कोली घेऊन त्यांत टिपरू (Set) टाकून झाकतात आणि मग पाणी देतात. हिला '**कोली लागण**' म्हणतात. '**सुरू**'ची लागण ही पाण्यांत करतात. म्हणजे अगोदर दोन चार वाफे पाण्यानीं गच्च भरतात आणि मग टिपरू डोळे बाजूस येतील अशा तऱ्हेनें धरून पायानें जमीनींत दाबतात. सुरू (सालीं) डिसेंबर, जानेवारींत लावतात.

जर अमोनियम् सल्फेट मिळत असेल तर लागणीचें वेळेस एक पोतें (२२४ पौंड) घालतात. तिसरे दिवशीं दुसरें पाणी देतात. त्याला आंबवणी व सातवें दिवशीं देतात त्याला चिंबवणी म्हणतात. साधारण २१ दिवसांत लागण '**तासी**' लागते. तासी लागणे म्हणजे संपूर्ण उगवणें.

**नंतरची मशागत** :– एक महिन्यानें पहिली खुरपणी देतात. नंतर पाणी देऊन वापसा आल्यावर म्हणजे सव्वा महिन्यानें ७ ते ८ पोतें शेंगदाण्याची पेंड एका एकरास देतात. [ १ टन= १४ पोते = २२४० पौंड. १ पोतें = १६० पौंड = ८० शेर ] तिला "**कोली पेंड**" म्हणतात. ऊंसाचें रांगेच्या बाजूस लहानशी नळी कुदळीनें घेतात आणि मग पेंड टाकून बुजवून टाकतात. मध्यें नंतर एक खुरपणी होतें. एकूण साधारण तीन खुरपण्या होतात.

ऊंस २, २॥ महिन्याचा झाल्यावर ४ पोतें पेंड देतात. अ. सल्फेट मिळत असेल तर १ ते १॥ पोतें एकरास देतात. ह्यावेळेस कुदळीचें सहाय्यानें "**जारवा**" (Root hairs) तोडतात. ह्याला "**तगारणी**" किंवा "**भूजवटा**" म्हणतात. ह्यामुळें ऊंसाची वाढ जोमानें होतें.

नंतर ३॥ ते ४ महिन्यांनीं औत कामास सुरवात होतें. प्रथम किर्लोस्कर शंभर नंबरनें (दोन बैली) सरीच्या दोन्हीं बाजूची बगल फोडतात. बराचसा माथा (Ridge) फुटून जाते. नंतर कल्टीव्हेटर (Showel Cultivator) चालवून राहिलेला माथा सपाट करतात. कल्टीव्हेटरनें गुंदून राहिलेली सर्व जारवा मोकळा होतो.

नंतर ऊंसाचे बुंध्याजवळ ८ पोतें एकरी पेंड घालतात आणि त्यानंतर रिजर चालवून सरी (जिथें पूर्वी माथा होता तिथें) निर्माण करतात.

औत काम केल्यामुळें सर्व रान बांधणी मोडले असतें तें व्यवस्थित भक्कम बांधून घेतात. उभे कट पण उंच करून घेतात.

वरील सर्व औतकाम, पेंड घालणें, रान बांधणें एका इरिगेशनच्या पाळीत ( Turn ) मध्यें करावी लागतात. त्यावेळेस फारच चपळाई करावी लागतें.

नंतर ५ ते ५।। महिन्याचा ऊंस झाला म्हणजे खांदणी (Earthing up) देतात. ह्यावेळेस ८ पोतें पेंड एकरी घालतात. तगारणी व औत काम केल्यामुळें जमीन पुष्कळ भुसभुशीत झालेली असतें. त्यामुळें खांदणी विशेष कठीण जात नाहीं. ह्यावेळीं जारवा तोडला जातो आणि सरीची खोली वाढविली जातें. कारण ऊंसाची पाण्याची तहान आता वाढलेली असते.

खांदणीपर्यंत पाणी हें "**हातवाऱ्यानें**" देतात. पण नंतर "**उपळाचे पाणी**" देतात, म्हणजे प्रत्येक वाफ्यास बारे न ठेवतां फुलीस बारे ठेवतात. वास्तविक ह्यामुळें जमिनीची नासाडी तसेंच पाणी पण वाया जातें. परंतु मजूर टंचाईमुळें आणि पाण्याचें महत्व शेतकऱ्यांस न समजल्यामुळें अशीच पद्धत चालूं आहे. त्यांत थोडीशी काटकसर व्हावी, शेतकऱ्यांनीं लवकर लवकर पाण्याकडें लक्ष ठेवावें म्हणून इरिगेशन खात्यानें फुलीचें क्षेत्रफळ जवळ जवळ म्हणजे ४० ते ४५ फुटावर आडवें कट घालून कमी केलें आहे.

**ऊंस ९–१० महिन्याचा** वाढ बरीच पडतो ( lodging ) त्यासाठीं बांधतात. ऊंसाच्या पानांनें लहान लहान मोळ्या फुलीच्या चोहोबाजूनें बांधतात आणि आंत ( फुलीमध्यें ) लोटतात. ह्यामुळें ऊंसाचें पिकांत वारा ( जोरात ) शिरत नाहीं आणि ऊंस पडला जात नाहीं. शिवाय पाणी देतांना फुली पाण्यानें भरली की नाहीं हें पाहण्यास सोपें जातें. साधारण ऊंसाची वाढ पूर्ण झाली म्हणजे गुऱ्हाळे लावतात. ऊंसाची वाढ संपूर्ण झाली की नाहीं हें शेतकरी खालील पद्धतीनें आजमावतात :— (१) **ऊंस १२ महिन्याचा** झाल्यावर, (२) वाढे जुळणें, (३) गोडी ( Sweetness ), (४) तोडल्यास दोन पेऱ्यामध्यें ताबडतोब तुटतो, (५) डोळे फूटूं लागतात, (६) खणखण आवाज (Metalic sound), (७) तिरपा तोडलेला भाग उन्हांत धरल्यास साखरेप्रमाणें चमकतो इ.

गुऱ्हाळें साधारण जानेवारी, फेब्रुवारीत लावतात. आडसालीं ऊंस असल्यास नोव्हेंबरमध्यें लावतात. चुलाण साधारण पुरेरी धर्तीवर असतें. ७–८ एकरच्यावर ऊंस असलेलें बागाईतदार कमाल किसान सारखे पॉवरक्रशर वापरतात.

**ऊंसाच्या जाती** :– साधारण खालील जाती लावतात. (१) कोईमतूर ४१९, ४७५, ४२१, पी.ओ.जे. २८७८. एक्या (E K.) व पुंड्या ह्याची लागवड जवळ जवळ करतच नाहीं.

**उत्पादन** :– ४५ ते ५० टन ऊंस व ४२ ते ४५ पल्ले गूळ इतकें एकरी उत्पादन निघतें. साखर साधारण ३। ते ३।।। टन निघतें.

**रोगराई व त्यावर उपाय** :– लहानपणीं म्हणजे १।। ते ३ महिन्याचा असतांना ऊंसास

खोड किडयापासून ( Stemborer ) फार त्रास होतो. साधारण ज्वारी, बाजरीच्या पिकानंतर जर ऊंस घेतला तर नक्की त्रास होतो. टोळ (Locust) आणि पाकोळया (Pyrilla) ह्यापासूनही त्रास होतो.

ह्यावर उपाय व संशोधन करण्यासाठीं किटक शास्त्रज्ञांचें एक ऑफिस श्रीरामपूर येथें आहे. शिवाय अहमदनगरला क्रॉप प्रोटेक्शन ऑफिसरचे ऑफिस आहे. आणि त्याद्दष्टीनें निरनिराळे शोध चालूं आहेत.

**पिकावरील खर्च :–** ( Cost of Cultivation ) ह्या भागांत ऊंसामधील सर्वच कामें **"उक्ती"** (Contract basis) देतात. आणि प्रमाणें एकूण लागणारा खर्च खालीलप्रमाणें देत आहे.

| | रु. आ. पै |
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| १) नांगरणी करणें दोन वेळेस (एका एकरास १८ रुपये प्रमाणें) | ३६–०–० |
| २) ढकळे फोडणें आणि जमीन सपाट करणें | १०–०–० |
| ३) सरी पाडणें ( १० रु. एकराप्रमाणें ) | १०–०–० |
| ४) रान बांधणें | ६०–०–० |
| ५) बेणें | २००–०–० |
| ६) खुरपणें तीन वेळेस दर ८ रुपये एकर | २४–०–० |
| ७) औत काम, ऊंसातील नांगरणें, कल्टीव्हेटर, सरी इत्यादि | २५–०–० |
| ८) औत कामामुळें मोडलेले रान बांधणें | १०–०–० |
| ९) पेंड आणि सल्फेट घालणें ४ वेळेस ( प्रत्येकी ६ रुपये एकर ) | २४–०–० |
| १०) तगारणी करणें | १५–०–० |
| ११) खांदणी | ३०–०–० |
| १२) पेंड पोतें २४ ( दर १९ रु. प्रमाणें ) | ४५६–०–० |
| १३) सल्फेट १।। पोतें ( दर ४० रु. प्रमाणें ) | ६०–०–० |
| १४) पाणी देणें आणि ऊंसांतील किरकोळ कामें, फुटतुट, बुजणें वगैरे | ५०–०–० |
| १५) पाणी पट्टी ६० रु. एकर प्रमाणें | ६०–०–० |
| १६) जमीन पट्टी | ६०–०–० |
| १७) गलीत खर्च, रविस १२ आधनास (१५० रु. प्रमाणें) ४० आधनास | ५००–०–० |
| १८) इतर गुऱ्हाळ खर्च | ५०–०–० |
| १९) चरक भाडें आणि वाहातूक | २००–०–० |
| एकूण रु. | १९८०–०–० |

सरासरी उत्पादन ४२ पल्ले गूळ. भाव ६० प्रमाणें. ४२×६०=२५२० रु. जमा अंदाजे.

# मूर्घास ( Silage )

( लेखक :– **जी. आर. कोप्पीकर**, तृतीय वर्ष. )

भारतांत आज सर्वत्र अन्न टंचाईनें थैमान घातलें आहे. मनुष्य प्राण्याची सर्वांत महत्वाची गरज भागवितां भागवितां प्रत्येकाच्या नाकीं नऊ येत आहेत. ह्या कठीण परिस्थितीस अन्नवस्त्रादि वस्तु कच्च्या स्थितींत पिकवून त्या सर्वांना पुरविणारा शेतकरीसुद्धां अपवाद राहिला नाहीं. सर्व प्राण्यांमध्यें श्रेष्ठ असा मनुष्यप्राणी अशा रितीनें चिंतेंत बुडून गेला असतांना इतर प्राण्यांच्या अन्नाच्या गरजांविषयीं जरूर ती काळजी घेण्यांत न आली तर, त्यांत विशेष अनैसर्गिक असें कांहीं वाटण्याचें वास्तविक कारण असूं नये; पण हिंदी शेतीची स्थिती कांहीं निराळीच आहे. आज जगांतील बऱ्याच शेतकीप्रधान देशांत शेतीचें यांत्रिकीकरण झालें आहे, व होतही आहे. पण अनेक प्रकारच्या अडचणींमुळें व प्रतिकूल परिस्थितीमुळें भारतांतील शेतीमध्यें यांत्रिक युग मोठ्या प्रमाणावर उगवलेलें नाहीं, व तें नजिकच्या भविष्यकाळांत उगवण्याची शक्यताही दिसत नाहीं. म्हणून अनेक शतकांपासून भारतीय शेतीशी असलेला बैलांचा निकट संबंध आजही तसाच कायम आहे व शेतीच्या कामांत–विशेषतः मेहनतीच्या कामांत–प्रत्यक्ष शक्ति (Power) पुरविणारें मुख्य साधन ह्या नात्यानें भारतीय कृषिकर्मांत अत्यंत मानाचें स्थान बैलांनीं पटकावलेलें आहे. त्याच्याशिवाय शेतीवरील प्रमुख कामेंच होणें शक्य नसल्यामुळें, स्वतःच्या गरजांमध्यें आपल्या बैलांच्या गरजांनाही प्राधान्य देणें हिंदी शेतकऱ्यांचें कर्तव्य आहे. सध्यां हिंदमधील बैलांची सर्वसाधारण स्थिती निकृष्टच म्हटली पाहिजे. अलीकडे शास्त्रीय संशोधनामध्यें असें आढळून आलें आहे कीं, केवळ खुराकाच्या बाबतींत (Feeding) जर योग्य त्या सुधारणा केल्या गेल्या तर जनावरांची स्थिती ५० टक्क्यांनीं सुधारतां येणें शक्य आहे.

सर्वसाधारणपणें जनावरांच्या अन्नाचें वर्गीकरण केल्यास प्रामुख्यानें त्याचे दोन भाग करतां येतील–(१) अन्नसत्त्वांचें प्रमाण जास्त असलेलें अन्न (Concentrates), व (२) अन्नसत्त्वांचें प्रमाण कमी असलेलें अन्न (Roughages). यापैकीं दुसऱ्या भागांत वाळलेला चारा व ओला चारा असे दोन प्रकार येतात; त्यांत ओल्या चाऱ्याचें महत्व फार आहे. धडधाकट व निरोगी जनावराला मोकळ्या वातावरणांत स्वच्छंदपणें पुरेसा ओला चारा मिळूं शकल्यास भरपूर अन्नसत्त्वांनीं युक्त असें अन्न देण्याची गरज भासत नाहीं, कारण ओल्या चाऱ्यांत शरीरपोषणास जरूर तीं अन्नसत्त्वें योग्य प्रमाणांत नैसर्गिकरीत्याच निर्माण झालेलीं असतात. ओला चारा हें जनावरांचें नैसर्गिक अन्न आहे. तें रुचकर असून जनावरांची पचविण्याची शक्ति, आरोग्य व कोणत्याही बाबतींत त्यांची कार्यक्षमता वाढविण्यास समर्थ आहे. म्हणून योग्य त्या प्रमाणांत आपल्या जनावरांना ओल्या चाऱ्याचा पुरवठा करून त्यांना इतर खुराक देण्याची विशेष गरज भासूं न देण्यांत काटकसरीच्या दृष्टीनें शेतकऱ्याचें हित आहे.

पण पावसाच्या दृष्टीनें हिंद दुर्दैवी आहे. भारतांतील पावसाळ्याचा हंगाम केवळ ३ ते ४ महिन्यांपुरताच आहे. ह्या अवधींत नैसर्गिकरीत्या उगवलेलें गवत व इतर योग्य तो झाडपाला सोड-

ल्यास वर्षाच्या इतर हंगामांत सर्वसाधारण हिंदी शेतकऱ्याच्या गुरांना वाळलेल्या गवतावरच निर्वाह करावा लागतो. कारण, दारिद्र्यानें गांजलेल्या हिंदी शेतकऱ्याची जमीन योग्य त्या प्रमाणांत नसल्याची परिस्थिती आज बहुतेक ठिकाणीं दिसून येते. अशा स्थितींत स्वतःच्या जनावरांच्या अन्नाची तरतूद करण्याकरितां स्वतंत्र गायरान राखण्याची गोष्ट त्याच्या शक्तीपलीकडे आहे. सहकारी तत्त्वावर ही गोष्ट साधण्याचें महत्त्व जाणण्याइतपत त्याचें ज्ञान वाढलेलें नाहीं, व इतर अनेक अडचणींमुळें अशा प्रकारचें सहकारी तत्त्व अंमलांत आणणें कठीण आहे. म्हणून अशा स्थितींत हिंवाळ्यांत व उन्हाळ्यांत गुरांना पुरविण्याकरितां म्हणून पावसाळ्यांतच पिकविलेला ओला चारा योग्य अशा कृत्रिमरितीनें ओल्या स्थितींतच राखून ठेवणें हा एकच उपाय दिसतो. मूर्घास (Silage) तयार करण्यामागें हाच उद्देश आहे, व वरील उद्दिष्ट साधण्याचा हा एक उत्तम मार्ग आहे.

मूर्घास तयार करण्यामागील तत्त्वें संक्षिप्तपणें खालीलप्रमाणें आहेत :– (१) ओल्या चाऱ्याचें अन्नदृष्ट्या असलेलें महत्त्व कायम राखणें व अशा रितीनें त्यांतील मूळ ओलावा व जीवनसत्त्वें यांचा पुरवठा जनावरांना कायम करणें. (२) ओला चारा नैसर्गिकरीत्या उघडा टाकल्यानें व अव्यवस्थितपणें एके ठिकाणीं सांठविण्यानें वाळण्याची व सडण्याची (Putrefaction) जी भीति असते ती नाहीशी करणें.

अशा रितीनें पावसाळ्यांत ओला चारा पिकवून तो व्यवस्थितपणें सांठवून ठेवल्यास हिंवाळ्यांत व उन्हाळ्यांत पावसाच्या व पाणी पुरवठ्याच्या अभावामुळें जेव्हां ओला चारा पिकविणें शक्य नसतें किंवा परवडत नाहीं, तेव्हां सांठवून ठेवलेला चारा जनावरांना पुरवितां येतो.

मूर्घास अशा रितीनें पद्धतशीरपणें सांठविण्याकरितां तयार केलेल्या विशिष्ट कोठाराला सायलो (Silo) असें म्हणतात. कोठारें निरनिराळ्या प्रकारचीं असतात. हें प्रकार (अ) मूर्घास सांठविण्याचा काळ, (ब) कोठार तयार करण्याच्या कामीं उपयोगांत आणलेल्या वस्तु, व (क) हवामान, जमिनींतील पाण्याची पातळी (Water table) वगैरे गोष्टींवर अवलंबून असतात.

मूर्घास सांठविण्याच्या काळाच्या अनुरोधानें (१) तात्पुरतें व (२) कायम असें दोन प्रकार असतात. ह्यापैकीं तात्पुरतें कोठार फक्त एका हंगामांतील (Season) उपयोगासाठींच असतें. म्हणून तें लाकडी फळ्या लोखंडी तारांनीं एकत्र बांधून तयार केलेलें असतें. सर्वसाधारणपणें प्रत्येक फळी ६ते८ फूट लांब व ६ इंच रुंद असते. ह्या फळ्या एकास एक लागून उभ्या करतात व शेवटची फळी पहिल्या फळीस आणून लावून एकंदर कोठार गोलाकार करतात. हिंदसारख्या ऊष्ण देशांतील हवामानामुळें ह्या लांकडी फळ्यांवर आकुंचन प्रसरणाचा परिणाम होऊन कोठार पूर्णपणें हवाबंद राहूं शकत नाहीं. म्हणून ऊष्ण हवामानांत तात्पुरतें कोठार इष्ट नाहीं. याउलट कायम कोठार एकाहून जास्त हंगामांत मूर्घास सांठवून ठेवण्याकरितां असतें. म्हणून त्याच्या बांधकामाकरितां सिमेंट, चुना वगैरे दीर्घकाळापर्यंत हवामानाच्या परिणामांना दाद न देणाऱ्या वस्तूंचा उपयोग करतात.

बांधकामांत उपयोगांत आणण्याच्या वस्तूंच्या अनुरोधानें कोठाराचे ( १ ) कच्चें व ( २ ) पक्के असे दोन प्रकार पडतात. कच्चा कोठाराच्या भिंती बांधण्याकरितां गवत, मातीचा चिखल, शेण, गव्हाचा भुसा वगैरे एकत्र मिसळून त्या मिश्रणाचा उपयोग करितात. ह्या भिंती ६ ते ८ फूट उंच व कोठाराचा व्यास ( Diameter ) १० ते १२ फूट असतो. भिंतीच्या व मूर्घासाच्या वजनामुळें भिंतीच्या जमिनी लगतच्या भागावर जास्त दाब पडतो. म्हणून वरून खालपर्यंत भिंतीची जाडी क्रमानें जास्त बनवितात. भिंतीच्या वरील टोकाची जाडी ९ ते १० इंच व खालच्या टोकाची जाडी दीड फूटांपर्यंत असते. भिंती कच्चा असल्यामुळें फारशा टिकाऊ नसतात, व त्यांना वरील बाजूंस छप्पर किंवा अन्य तऱ्हेनें पावसापासून संरक्षण द्यावें लागतें. जेव्हां जनावरांची संख्या कमी असते तेव्हांच ह्याचा उपयोग फायदेशीर होतो. पक्क्या कोठाराची माहिती ' टॉवर सायलो ' खालीं दिली आहे.

हवामान, जमिनींतील पाण्याची खोली (Depth) वगैरेंच्या अनुरोधानें बांधलेल्या कोठारांचे दोन प्रकार आहेत :– (१) टॉवर सायलो व (२) पिट सायलो.

**टॉवर सायलो :–** हे जमिनीवर बांधलेले असतात. ह्यांत वर वर्णिल्याप्रमाणें कच्चे व पक्के सायलो असे प्रकार असतात. पक्के सायलो हें सुद्धां गोलाकार असतात. भिंतीबाहेरील हवेचा दाब व आंतील मूर्घासाचा दाब यापुढें टिकाव लागण्याच्या दृष्टीनें त्यांच्या भिंती पुरेशा जाड व बळकट बांधाव्या लागतात. अशा जाडीमुळें भेगांपासूनही कांहींसें संरक्षण मिळूं शकतें. भिंतीची सर्वसाधारणपणें उंची ३० फूट, वरील टोकाची जाडी ९ इंच व खालील टोकाची १५ इंच असते. भिंतीची आंतील बाजू जमिनीच्या पृष्ठभागास काटकोनांत (Perpendicular) असते. फक्त बाहेरील बाजू वरील टोकापासून खालील टोकापर्यंत उतरती (Sloping) असते. आंतील बाजूस, मूर्घासांतील रस भिंतीमध्यें शोषला जाऊं नये म्हणून डांबर किंवा अन्य पदार्थांचा लेप देणें जरूर आहे. ज्या जमिनीवर हें कोठार बांधावयाचें असेल ती जमीन टणक नसेल तर ४ इंच जाडीचें बांधकाम प्रथम करून घेऊन त्यावर हें कोठार बांधावें, म्हणजे कोठाराला चांगला आधार मिळतो. मूर्घास वेळोवेळीं काढण्याकरितां इष्ट त्या अंतरावर भिंतीवर उभे दरवाजे एकाखालीं एक असे असतात. भिंती कॉंक्रीटच्या बांधलेल्या असतात.

**पिट सायलो :–** हे जमिनीच्या पृष्ठभागाखालीं असतात. ह्यांत दोन प्रकार असतात :— (१) विहिरीच्या नमुन्याचें कोठार (Well tpye), व (२) चरांचें कोठार (Trench type).

(१) **विहिरीच्या नमुन्याचें कोठार :–** हा प्रकार सर्वांत सोइस्कर व फायदेशीर आहे. कारण जमिनीच्या नैसर्गिक भिंतीमुळें बाहेरील दाब व हवामान ह्यांपासून साहजिकच जास्त संरक्षण मिळतें. ह्याची जास्तींत जास्त खोली ३० फूट व व्यास १५ फूट असतो. वरील टोकाकडील व्यास खालील टोकाकडील व्यासापेक्षां जास्त असावा; कारण, त्यामुळें चारा भरून तो दाबून आंतील हवा काढून टाकण्याचें काम जास्त सोपें व चांगलें होतें. भिंतीच्या आंतील पृष्ठभागावरील खांचखळगे भरून व खडबडीतपणा नाहींसा करून सर्व पृष्ठभाग गुळगुळीत करावा. पृष्ठभाग ठिसूळ असल्यास चुना किंवा कॉंक्रीटचा थर द्यावा. विहिरींप्रमाणेंच ह्याच्या भिंती जमिनीच्या पृष्ठभागावर बांधून जमिनीवर वाह-

णाऱ्या पाण्याच्या प्रवाहापासून मूर्घासाला संरक्षण द्यावें. मूर्घास बाहेर काढण्याच्या कामीं वरील बाजूस एक खिराडी (Pulley) बसवून त्यावर दोर लावून बैलांकरवीं मूर्घास ओढून काढण्याची पद्धत आहे. ज्या प्रदेशांत खूप पाऊस पडतो, व जेथें जमिनींतील पाण्याची पातळी (Level of water table) जमिनीच्या पृष्ठभागास फार जवळ असेल, तेथें ह्या प्रकारचें कोठार इष्ट नाहीं. कारण मूर्घासाचा पाण्याशीं संपर्क होऊन मूर्घास खाण्यालायक रहात नाहीं.

**( २ ) चरांचें कोठार:**—हा प्रकार सर्वसाधारण शेतकऱ्याला परवडण्यासारखा व फायदेशीर आहे. नांगराच्या किंवा इतर सांधनांच्या सहाय्यानें जमिनींत लांब चर खणतात. त्याच्या बाजूंचा उतार ( Stope ) ४ : १ ( 4 Vertical : 1 Horizontal ) ह्या प्रमाणांत असावा. सर्वसाधारणपणें ह्याची लांबी २० फूट वरची रुंदी ८ फूट असते. ह्यांतील तीन्ही पृष्ठभाग पुरेसें टणक करण्याकरितां ते चुन्यानें बांधून घेणें इष्ट आहे.

जनावरांच्या नेहमींच्या आहारांत जीं पिकें व गवतें येतात त्या सर्वांपासून मूर्घास तयार करतां येणें शक्य आहे. अशा पावसाळी पिकांमध्यें मका ( Zea mayse ), ज्वारी ( Sorghum species ), बाजरी ( Pennesetiem typhoideam ), नाचणी ( Eleusin Coracana ) वगैरें येतात. जेव्हां त्यांत दाणा भरून तो दुधासारख्या रसाच्या स्थितींत ( Milk Stage ) येतो तेव्हां त्यांची कापणी व बारीक तुकडे करून ते लगेच कोठारांत भरावेत. त्या अगोदर कोठारांत वाळलेलें गवत किंवा पालापाचोळा यांचा पुरेसा थर भरावा. दर फूट जाडीचा थर भरल्यावर वरून तुडवून त्यावर दाब द्यावा व त्यांतील हवा काढून टाकावी. तुडविण्याची क्रिया कोठाराच्या मध्यभागीं न करतां, त्याच्या कडेकडेनेंच करावी, म्हणजे दाबून बसविलेला थर कोणत्याही बाजूंस घसरण्याची भीति नसते. सर्व कोठार भरून झाल्यावर वरून सर्व कोठारावर तुडवून दाब द्यावा. ह्या शेवटच्या तुडवणीस बैलांचाही उपयोग करतां येतो. नंतर वाळलेल्या गवताचा किंवा पालापाचोळ्याचा पुरेसा थर देऊन व नंतर कोठार मातीच्या चिखलानें लिंपून तें हवा बंद करावें. जर मूर्घास तयार होतां होतां पहिल्या कांहीं दिवसांत चाऱ्याची उंची कमी झाली तर पुनः चिखलानें पृष्ठभाग लिंपून मूर्घासाचा एकंदर वरील पृष्ठभाग जमिनीच्या पृष्ठभागापेक्षां ३ ते ४ फूट उंच करावा.

कोठार उघडून मूर्घास बाहेर काढावयास सुरुवात केल्यापासून दररोज निदान २ इंच जाडीचा थर काढलाच पाहिजे; कारण तो तसा न काढल्यास मूर्घासांत एका प्रकारच्या सूक्ष्म वनस्पतींची ( Mould ) वाढ होते व मूर्घास खाण्यालायक रहात नाहीं. दर दिवशीं जरूर तितकेंच मूर्घास काढून कोठार पुनः पूर्ववत् हवाबंद करावें. प्रत्येक गाईला किंवा बैलाला दर दिवशीं २५ पौंड व म्हशीला ३० पौंड मूर्घास इतर अन्नाबरोबर, पण दूध काढल्यानंतर द्यावें. दूध काढण्याच्या अगोदर तें दिल्यास दुधास मूर्घासाचा वास येण्याचा फारच संभव असतो.

एकदां कोठार भरून झाल्यावर त्यांतील चाऱ्यांत पुढीलप्रमाणें क्रिया होतातः— जरी पीक कापून त्याचे पुनः तुकडे केलेले असले तरी त्याचा जीवनरस पूर्वस्थितींतच असल्यामुळें त्यांतील जीवित कार्यें

चाळूंच असतात. श्वसन व ज्वलनाच्या क्रियेमुळें, कोठारांतील सूक्ष्म प्रमाणांत राहिलेल्या हवेंतील प्राणवायू ( Oxygen ) शोषला जाऊन कर्बद्विप्राणिद वायु ( Carbon Dioxide ) बाहेर सोडला जातो, व कोठारांतील उष्णतामान वाढतें. हें वाढतें उष्णतामान इष्ट त्या सूक्ष्म वनस्पतींच्या ( Bacteria ) वाढीला व क्रियांना अनुकूल असतें. त्यामुळें त्या वनस्पती लॅक्टिक व ॲसेटिक आम्लें ( Lactic acid and Acetic acid ) तयार करतात. ह्या आम्लांमुळें अनिष्ट अशा सूक्ष्म वनस्पतींवर ( Moulds ) प्रतिकूल परिणाम होऊन त्या मरतात. कांहीं एक प्रमाणाबाहेर जसजसें ह्या आम्लांचें प्रमाण वाढत जातें, तसतसे त्याचे इष्ट वनस्पतीवरही प्रतिकूल परिणाम होतात व शेवटीं त्याही मरतात. अशा रासायनिक क्रियांमुळें वनस्पती–पेशींचें ( Plant cells ) स्वरूपही बदलून त्या पचविण्यास हलक्या बनतात. आम्लांमुळें चारा खाण्यालायक स्थितींत राखला जातो. चाऱ्यांतील पिष्टमय पदार्थांचें ( Starches ) एका प्रकारच्या साखरेंत रूपांतर होतें व प्रथिनांचें ( Proteins ) साध्या स्वरूपांत रूपांतर होतें. अशा रितीनें चारा पचविणें जास्त सुलभ होतें. रसायनिक क्रियेशिवाय वरून दिलेल्या दाबामुळें चाऱ्याचे तुकडे चेपले जाऊन मऊ होतात व जास्त रुचकर होतात. कोठारांतील उष्णतेचीही ह्या बाबतींत मदत होते. पुरेसा दाब न दिल्यामुळें व इतर कारणामुळें कोठारांत इष्ट प्रमाणाबाहेर हवा राहिली तर ज्वलनाची क्रिया जास्त प्रमाणांत होऊन उष्णता फार वाढते व चाऱ्यावर भाजण्याची क्रिया होते. ह्यामुळें चाऱ्यांतील जीवनरस व इष्ट त्या सूक्ष्म वनस्पतींवर अनिष्ट परिणाम घडतात व इष्ट त्या रसायनिक क्रिया होत नाहींत. पचविण्याच्या व रुचीच्या बाबतींत हा चारा अपायकारक ठरतो, व त्यांत दुर्गंध निर्माण होऊन तो जनावरांना नकोसा होतो. योग्य रितीनें केलेलें मूर्घास पिवळट तपकिरी रंगाचे व एका विशिष्ट वासाचें असतें. त्यावर कोणत्याही प्रकारच्या वनस्पतींची वाढ झालेली नसते.

मूर्घासासंबंधींच्या वरील विवेचनांत त्याचे अनेक फायदे नमूद केले गेले आहेत. याशिवाय इतर फायदे खालीलप्रमाणें आहेत:––

चारा ओल्या व अन्नसत्त्वांनीं युक्त स्थितींत सांठवून जरूर त्यावेळीं जनावरांना खाऊं घालतां येतो, कडबीच्या बाबतींत हे फायदे नसतात; कारण त्या बाबतींत दाणा तयार होऊन तो काढल्यावर वाळलेल्या स्थितींत चारा सांठविला जातो, त्यामुळें बहुतेक अन्नसत्त्वें दाण्याच्या रूपानें निघून गेलेलीं असतात व चाराही ओल्या स्थितींत नसतो. नैसर्गिक स्थितींत मिळणारा कांहीं प्रकारचा ओला चारा व गवत हीं कांहीं वेळां जनावरांना आवडत नाहींत. पण त्यांचेंच मूर्घासांत रूपांतर केल्यास तोच चारा जनावरें आवडीनें खातात असा अनुभव आहे. कडबी व मूर्घास यांमध्यें असलेला आणखी एक फरक म्हणजे सारख्याच जागेंत सांठविलेल्या कडबीपेक्षां मूर्घासाचें वजन जास्त भरतें. उदा०–१ घनफूट जागेंत ४५ पौंड मूर्घास भरतें, तर तेवढ्याच जागेंत फक्त ५ पौंड कडबी सांठवितां येते. याशिवाय, चोर व आगींपासून कडबीच्या सांठ्याला जी भीति असते, ती मूर्घासाच्या बाबतींत मुळींच नसते. सर्व देशभर पसरण्यासारखें गुरांचे रोग एकाएकीं फैलावले असतां जनावरांचें आरोग्य सुधारण्याकरितां मूर्घास हें एक उत्तम अन्न ( alterative ) मानलें गेलें आहे.

मूर्घास तयार करण्यासंबंधीं खालील गोष्टी लक्षांत घेणें जरूर आहेः—( १ ) ज्या चाऱ्याचा सांठा करावयाचा असेल, तो ओला व स्वच्छ असला पाहिजे. तो थोडासा वाळल्यास त्यावर पुरेसें पाणी मारणें जरूर आहे. कोठारांत टाकण्यापूर्वी दर १०० पौं. चाऱ्यास $\frac{1}{2}$ औंस मीठ धातल्यास मूर्घास रुचकर व पचण्यास हलका होतो. कोठारापासून जवळच चाऱ्याचें पीक असावें.

( २ ) कोठार बांधण्यापूर्वी जनावरांची संख्या, शेतकऱ्याची आर्थिक परिस्थिती, मूर्घास सांठविण्याचा काळ, हवामान, जमिनींतील पाण्याच्या पातळीची खोली वगैरे सर्व मुद्यांचा विचार करून योग्य त्या प्रकारचें कोठार बांधलें पाहिजे.

( ३ ) जमिनीच्या पृष्ठभागावरील पाण्यापासून संरक्षण देण्याकरितां कोठार उंच जागीं बांधिलें पाहिजे.

( ४ ) कोठाराच्या भिंती बळकट, टिकाऊ व हवाबंद असाव्या.

( ५ ) हवाबंद स्थितींत चारा सांठवावयाचा असल्यानें पुकळसा चारा एका कोठारांतच सांठविला पाहिजे. एका कोठारांत कमीत कमी २०,००० पौं. ओला चारा सांठावला पाहिजे.

( ६ ) भिंतीची आंतील बाजू जमिनीच्या पृष्ठभागास काटकोनांत व भिंतीचा आंतील पृष्ठभाग सपाट व गुळगुळीत असावा. जरूर तर तो बांधून घ्यावा.

( ७ ) दररोज निदान २ इंच जाडीचा मूर्घासाचा थर काढलाच पाहिजे.

( ८ ) एकच मोठें कोठार असण्याऐवजीं अनेक लहान कोठारें बांधणें इष्ट.

( ९ ) कोठाराचें खालील टोक जमिनींतील पाण्याच्या पातळीपासून ५ फूट उंच पाहिजे.

( १० ) कोठारांत चारा भरल्यावर योग्य रितीनें व पुरेसा दाबावा, व अशा रितीनें त्यांतील उष्णतामान १२०° फॅ पेक्षां जास्त वाढूं देऊं नये.

( ११ ) चारा भरण्यापूर्वी त्याचे बारीक बारीक तुकडे करावे; कारण खातांना जनावरांना त्रास न पडतां मूर्घास व्यर्थ जाणार नाहीं, व कोठारांत चारा दाबण्याचें कामही चांगलें होतें

( १२ ) मूर्घासाकरितां निवडलेला चारा जनावरांना कांहीं इजा न करणाऱ्या व उपयुक्त अशा द्रव्यांनीं युक्त असा असावा. त्यात प्रथिनांचें ( Protein ) प्रमाण फार असूं नये; कारण, सांठविल्यानंतर प्रथिनांमुळें सडण्याची क्रिया ( Putrefaction ) होऊन मूर्घास अपायकारक होतो. उदा० —लसूणघास ( Medicago sativa ) तसेंच ज्या चाऱ्यामध्यें पोकळ जागा फार असत, त्यांतील हवेमुळें सुद्धां वरील अनिष्ट प्रकार होण्याचा संभव असतो; म्हणून गहूं ( Triticum Sativum ), ओट ( Avena Sativa ) यांसारख्यांचा मूर्घास करण्याच्या कामीं सहसा उपयोग करूं नये.

( १३ ) मूर्घास तयार करण्याकरितां निवडलेल्या पिकांत दाणा भरलेला असला पाहिजे; पण तो पूर्णपणें घट्ट झालेला नसावा; व दाणा दाबल्यास दुधासारखा पदार्थ बाहेर यावा. फारच रस-युक्त हिरव्या चाऱ्यापासून आंबट मूर्घास होतें. याउलट प्रमाणाबाहेर वाळलेल्या चाऱ्याचा उपयोग केला असतां कांहीं रसायनिक क्रिया होऊन मूर्घासावर भाजण्याची क्रिया करण्याइतपत उष्णतामान वाढतें.

हिंदमध्यें मूर्घास तयार करण्याच्या बाबतींत सर्वसाधारण शेतकऱ्याच्या मार्गांत दोन अडचणी प्रामुख्यानें येतातः—( १ ) योग्य त्या आकाराचें कोठार आपल्या गरजेच्या मानानें फायदेशीर रीत्या बनविणें. ( २ ) कोठार व मूर्घास तयार करण्याकरितां लागणारी सामुग्री मिळाविण्याच्या बाबतींत अडचण.

सध्यां बांधलीं जाणारीं कोठारें गरजेपेक्षां जास्त मोठीं असल्यामुळें त्यांचा खर्च सर्वसाधारण शेतकऱ्याच्या आंवाक्याबाहेरचा असल्याचें आढळून आलें आहे. दर दिवशीं २ किंवा ३ इंच जाडीचा मूर्घासाचा थर काढावयाचा असतो. मूर्घासाच्या उपयोगाचें क्षेत्र ६ महिन्यापर्यंत किंवा १८० दिवसांपर्यंत असें सर्वसाधारणपणें गृहीत धरल्यास, दर दिवसाच्या २ इंच जाडीच्या हिशेबानें कोठाराची उंची ( १८० × २ ) म्हणजे ३६० इंच किंवा ३० फूट लागेल. हीच जाडी ३ इंचांची धरल्यास, किंवा २ इंच थर व ९ महिन्यांचा काळ घेतल्यास ही उंची ४५ फूट भरेल. ३० फूट उंचीकरिता तीन प्रकारचीं कोठारें बनवितां येण्याची शक्यता आहेः—( १ ) ३० फूट उंचीचें एक कोठार, ( २ ) १५ फूट उंचीचीं दोन कोठारें, किंवा ( ३ ) १० फूट उंचीचीं तीन कोठारें.

पण ह्या तीन्ही प्रकारांतील मूर्घासाचें वजन सारखेंच राहणार नाहीं; कारण जसजसा चारा भरण्यांत येईल व दाब देण्यांत घेईल तसतसा खालच्या थरांवर जास्त जास्त दाब पडत गेल्यानें जास्त जास्त जागा निर्माण होईल, व म्हणून तीन १० फूट खोल किंवा उंच कोठारांत, दोन १५ फूट उंच कोठारांपेक्षां कमी, व दोन १५ फूट खोल कोठारांत एका ३० फूट खोल कोठारां-पेक्षां कमी मूर्घास मावेल. म्हणून जरूरीपुरतेंच मूर्घास फायदेशीरपणें करावयाचे झाल्यास १० फूट खोलीचीं तीन कोठारें बनविणेंच इष्ट आहे.

प्रत्येक कोठाराचा किमान व्यास ( Diameter ) ५ फूट असावा. अशा कोठाराच्या आडव्या छेदाचें क्षेत्रफळ ( Cross-sectional area ) १९·६ चौ. फूट भरेल. म्हणजे अशा कोठाराच्या १ फूट खोलींत १९·६ घनफूट मूर्घास मावेल. दररोज २ इंच मूर्घास काढावयाच्या हिशेबानें वरील १९·६ घनफूट मूर्घासाचा ६ वा हिस्सा म्हणजे ३·२७ घ. फू. मूर्घास दररोज बाहेर काढावा लागेल. १ घ. फू. मूर्घासाचें वजन सुमारें ३० पौं. असतें. म्हणून ३·२७ घ. फू. मूर्घासाचें वजन सुमारें १०० पौं. होईल यावरून असा निष्कर्ष निघतो कीं, दररोज निदान १०० पौं. मूर्घास वापरण्याची जरूरी असेल तरच मूर्घास तयार करावें.

कोठारांची एकंदर खोली ४५ फू. घेतल्यास त्यांतील एकंदर जागा सुमारें ९०० घनफूट भरेल, म्हणून त्यांतील एकंदर मूर्घासाचें वजन ( ९०० × ३० ) किंवा २७००० पौं. भरेल. दर

एकरी मक्याच्या ओल्या चाऱ्याचें वजन ३०,००० पौं. सरासरीनें धरल्यास वरील प्रकारचें कोठार भरावयास मक्याचें एक एकर शेत पुरेसें होईल. दररोज १०० पौं. मूर्घास काढावयाचें झाल्यास वरील प्रकारच्या कोठारांतील मूर्घास ९ महिनेपर्यंत पुरेल. म्हणून ५ फू. व्यास व एकंदरीनें ४५ फू. खोल अशीं कोठारें बांधून त्यांतील मूर्घासाचा उपयोग करणें ५–७ एकर जमीन असणाऱ्या व ४ जनावरें बाळगणाऱ्या सर्वसाधारण शेतकऱ्याला सहज शक्य आहे.

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**आधारित पुस्तकें:—**

( 1 ) Leaflet No. 2 of 1938—Department of Agriculture, Bombay.
( 2 ) Indian Farming—Volume VI, Number 6.

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# वनस्पती झोंप घेतात काय ?

लेखक :– **श्री. ल. मा. चव्हाण,** तृतीय वर्ष ( कृषि. )

निद्रा, ही जीवनसृष्टीला ईश्वरानें दिलेली एक अद्‌भूत देणगी आहे. निद्रा ही वास्तविक चैन नसून एक आवश्यक गरज आहे. झोपेचें महत्व झोपमोड होणाऱ्या मनाच्या अवस्थेवरून सहज कळून येईल. ज्याप्रमाणें शरीरावयवांची हालचाल प्रकृति सुदृढ रहाण्यासाठीं आवश्यक, तद्वत् नियमितपणें व कांहीं ठराविक मर्यादित काळ शरीरावयवांची हालचाल मुळींच नसणें हेंहि आवश्यक आहे. दिवसभर श्रम करून थकल्यावर रात्रीं विश्रांती घेणें फार जरूरीचें असतें. श्रमामुळें आलेला थकवा झोपेनें नाहींसा होतो व दुसऱ्या दिवशीं पुन्हां काम करण्यास शरीर व मन पूर्ववत् उत्साही बनतें.

मनुष्य झोपतो म्हणजे तरी काय ? सर्व अवयव व सर्व संस्था (Systems) यांना पूर्णपणें विश्रांती मिळणें म्हणजे झोप नव्हे, तर ती काळझोप आहे. मेंदू, श्वसनसंस्था, रुधिराभिसरण संस्था, मज्जासंस्था यांची कामें झोपेंतहि चालूंच असतात. तरीपण बाह्यजगाचा संबंध साधारणपणें सुटलेला असतो. कारण ज्ञानेंद्रियेंच पुष्कळ अंशी विश्रांती घेत असतात.

वनस्पती झोप घेतात कीं नाहीं हा एक विवाद्य विषय आहे. निरिक्षणान्तीं असे म्हणतां येईल कीं, वनस्पतिसुद्धां झोप घेतात. परंतु त्यांच्या झोपेंत अन् मनुष्याच्या झोपेंत बराच फरक आढळतो. मनुष्याचा मोठा मेन्दू झोपतो म्हणून बाह्य जगाचा संबंध तितकासा रहात नाहीं. पण वनस्पतींना मेन्दूच नसतो त्यामुळें बाह्य जगाशीं संबंध तुटण्याचा प्रश्नच उद्‌भवत नाहीं.

'दिवसा काम अन् रात्रीं विश्रांती' याप्रमाणें वनस्पतीही दिवसाचें मुख्य कार्य–'सूर्य-प्रकाशाचें सहाय्यानें हवेंतील कार्बन शोषून घेणें'–रात्रीं थांबवितात म्हणण्यापेक्षां आपो-आपच थांबतें. कारण सूर्यप्रकाश रात्रीं मिळूं शकत नाहीं. म्हणजे सक्तीची विश्रांतीच मिळते. दिवसां

सूर्यप्रकाशांत वनस्पती पानांच्या द्वारें हवेंत असलेला कार्बन–डाय–ऑक्साइड घेतात, व मुळांनीं शोधून घेतलेल्या पाणी व क्षारांचें सहाय्यानें त्यांतील कार्बनच तेवढा बाजूस काढून त्यांचे साखर, स्टार्च आदि पदार्थांत रूपांतर करतात. सूर्य मावळला कीं ही चमत्कृतिजन्य रासायनिक क्रिया थांबते आणि वनस्पती झोपतात. तरीपण श्वासोच्छ्वास, अन्नद्रव्यांचा वापर, क्षार, पाणी आदींचे शोषण या क्रिया रात्रींही चालूंच रहातात. झोपेंत मनुष्याच्यासुद्धां श्वसन, पचनादि क्रिया रात्रींहि चालूंच असतात की नाहीं ?

लहान मुलांच्या शरीराची वाढ साधारणपणें निद्रावस्थेंत होत असतें, म्हणून लहान मुलांना झोंप जास्त लागते. हीच गोष्ट वनस्पतींचे बाबतींतहि आढळून येते. लहानशी कोवळी रोपटीं, रात्रीचे वेळींच अन्नद्रव्यांचा उपयोग आकारवाढीसाठीं जास्तींतजास्त प्रमाणांत करतात.

उन्हाळ्यांत सूर्यप्रकाशाचा जितका भरपूर फायदा वनस्पतींना मिळतो तितका हिंवाळ्यांत मिळत नाहीं. हिंवाळ्यांत झाडांचीं पानें गळून पडतात हें आपण पहातोंच. अर्थात् पानें गळून पडली कीं साखर, स्टार्च, मध इत्यादि पदार्थ तयार होत नाहींत त्यामुळें ही सुद्धां वनस्पतींची एक प्रकारची झोपच आहे. पण या झोपेव्यतिरिक्त दिवसाच्या चोवीस तासांतसुद्धां कांहीं वेळ झोप घेणें वनस्पतींना आवश्यक असतें व ती मिळतेही. मनुष्य कितीहि सशक्त असला तरी नेहमीं जाग्रणें केल्यानें त्याची प्रकृति जशी खालावत जातें, तशी वनस्पतींनीं झोंप घेतली नाहीं तर ती वनस्पती पानें, पुष्पें, फळें यांनीं समृद्ध राहूं शकणार नाहीं.

साधारणपणें फुलें सूर्योदयानंतर उमलतात. पण कांहीं रात्रीं उमलणारीं फुलेंही आहेत. फुलें रात्रीं उमलली म्हणून वनस्पती रात्रीं जाग्या झाल्या असा अर्थ काढणें मात्र चुकीचें ठरेल. कारण रात्रीं त्यांचे कार्बन शोषणाचे कार्य (Carbon assimilation) बन्दच असतें. एवढे फार तर म्हणतां येईल कीं रात्रीं फुलें उमलणाऱ्या वनस्पती डोळे उघडे ठेऊन झोप घेतात. कांहीं माणसें नाहीं कां डोळे उघडे ठेऊन झोपत ?

कांहीं वनस्पतींचे बाबतींत सकाळीं फुलें मिटतांना आढळली व पानें दुमडलेली आढळली म्हणून वनस्पती झोपीं गेली असे मात्र नव्हें. फुलांच्या पाकळ्या मिटतात व पानें दुमडली जातात तीं केवळ उष्णतेमुळें वनस्पतींमधील पाण्याचे बाष्पीभवन होऊं नये, ओलसरपणा कायम टिकावा एवढ्या-करितांच. झोप म्हणजे विश्रांती ! वनस्पती जेव्हां काम थांबवितात तेव्हांच त्या झोपीं गेल्यात असे म्हणणें युक्त दिसेल; एरव्ही नाहीं.

मनुष्याची झोप हा एक मजेदार अनुभव आहे. जागृतावस्थेंतील कांहीं मनावरील परिणाम झोपेंत स्वप्नसृष्टी निर्माण करूं शकतात. मेंदू पूर्णपणें निद्रिस्त होत नाहीं. अर्धवट जागृतीमुळेंच स्वप्नें निर्माण होण्यास मदत होते. तशी स्वप्नसृष्टी वनस्पती झोपेंतहि निर्माण करूं शकत नाहींत, कारण त्यांना मेन्दू नसतो. विचार करण्याची कुवत नसते.

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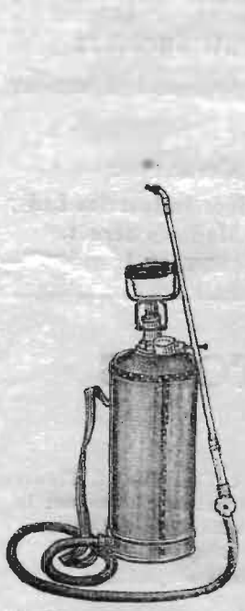

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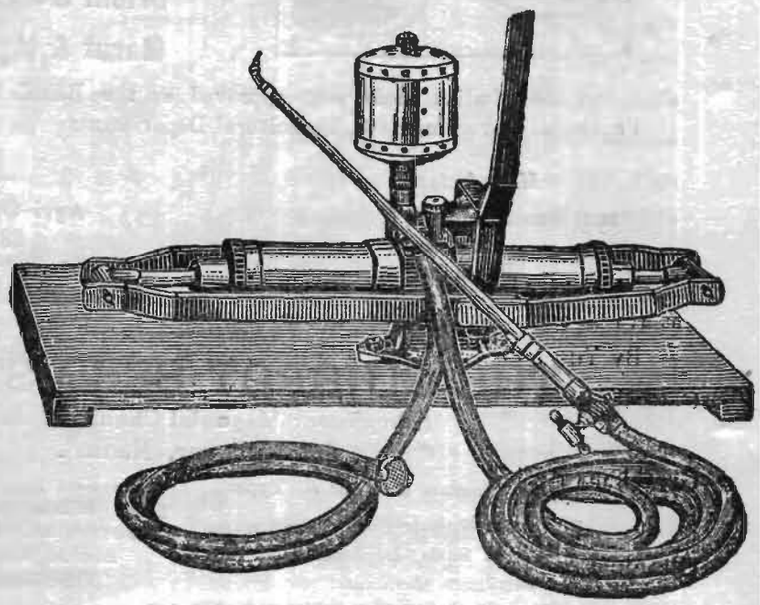

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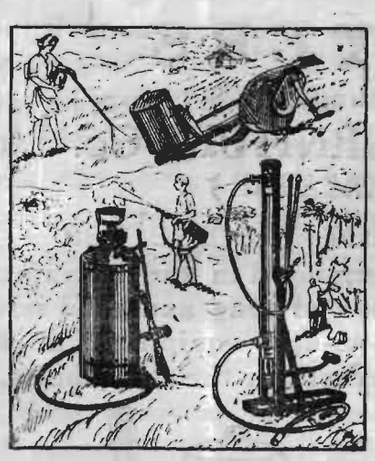

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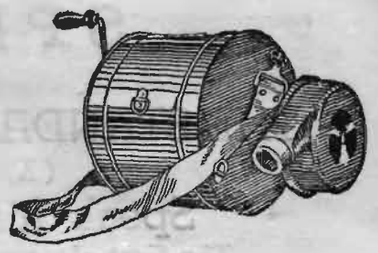

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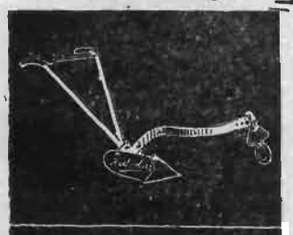

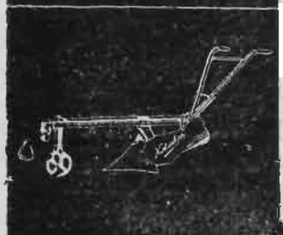

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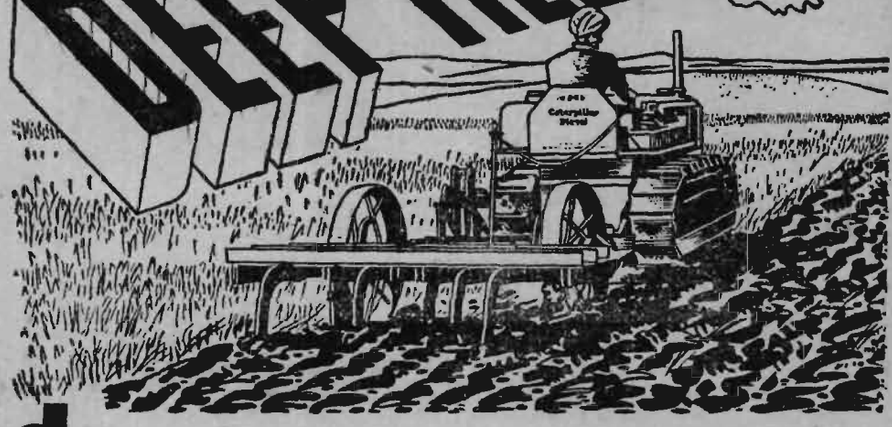

Deep tilling with a chisel cultivator as shown above increases the soil's capacity for storing water. It penetrates and loosens the soil to a depth of up to 15 inches, thus allowing the roots of the next crop to obtain the maximum nourishment from the earth. Deep tilling is essential if the land is to produce the amount of food the nation so urgently needs.

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