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## 1996-97

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# DARE/ICAR
# Annual Report
# 1996-97

Department of Agricultural Research
and Education
Ministry of Agriculture
Government of India

Indian Council of Agricultural Research
New Delhi

## Indian Council of Agricultural Research

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|---|---|---|
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# Foreword

Development of agricultural sector cannot be achieved in absence of a strong research backing. As an apex body of the National Agricultural Research System (NARS), the Indian Council of Agricultural Research (ICAR) is entrusted with national agricultural research agenda and it has satisfactorily carried out its mandate of providing guidance and leadership in agricultural research, education and extension. Our agricultural scientists have always risen to the occasion and have provided valuable and viable solutions as per the need of the hour. Only a total commitment and dedication to the cause could have permanently shed the begging-bowl status of our country, for which the agricultural scientists deserve all appreciation.

Following the success of Green Revolution in the rich-resource endowment areas, the Council has directed its research efforts towards amelioration of small and marginal farmers in 70% of the area that could not get benefits of the Green Revolution for obvious reasons. A second Green Revolution is needed for making grey areas green. The existing bottlenecks withholding technological, socio-economic and infrastructural advances in unfavourably placed rainfed areas, especially in eastern India, will have to be removed to clear the way to an evergreen revolution. I am glad to see that there is a visible impact of agricultural research in these areas during the last few years.

As we are marching into the 21st Century, I visualise that in addition to improving food and nutritional security, agriculture would be guided by concerns for environmental protection, sustainability of production and supply as well as profitability of farm enterprises. Following the General Agreement on Tariffs and Trade (GATT), liberalization process and globalization of markets would call for competitiveness and efficiency in agricultual production, and the agriculture sector will have to face a challenging situation on the ecological, climatic, economic, equity, social justice, energy and employment fronts.

The success of modern agriculture in a free and competitive national or international market would be resultant of the complex gamut of inetracting activities such as continuous identification of

problems under changing environment, and development and marketing of appropriate technology, which is consistent with sustainable agriculture and effective technology transfer activity through various ways and means.

Today we are emerging as major exporters of agricultural products, but we have still to exploit our competitive advantages fully. The centre of the global economic activity is shifting towards South and South-East Asia, wherein India has to become a major player in the changing scenario. We must capitalise on the situation to become a substantial gainer in the enviornment of economic liberalisation and free world trade. In this context, I feel that the work culture needs a total transformation. I appreciate the various steps taken by the ICAR like initiating a process of modernisation and renewal, formulation of perspective plans, National Agricultural Technology Project (NATP) to bridge the critical gaps in the research and the technology generation, assessment, refinement and transfer, administrative and financial reforms, introduction of partnership, training, consultancy, contract research/contract service for additional resource generation, invigorating incentive and reward systems, establishment of agricultural research information system, strengthening of the publications and information programmes, agricultural human-resource development and social audit of the various projects and programmes. I hope that these programmes as also the recommendations of various committees will be implemented in true letter and spirit to realise the national goals. The National Agricultural Research Project (NARP) funded by the World Bank, concluded recently, will help in creating infrastructural facilities even in remote tribal areas. I am looking forward now to realise the vast potential of the National Agricultural Technology Project, whose success will be judged mainly by the quick and effective transfer of income-generating technologies from laboratories to land. It must improve the functional literacy skills of the poorest section of the farm population through a massive national effort of tiding over the adverse and challenging constraints. The ensuing Ninth Five-Year Plan envisages to optimise the use of resources through planning, laying priorities and co-ordination to foster sustainable agricultural development for ensuring food and nutrition security of the present and future generations of our vast country. I have no doubt that our scientists have all the skill, knowledge and talent needed to provide food for all.

Chaturanan Mishra

**(Chaturanan Mishra)**
President, ICAR Society and
Minister for Agriculture

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## The Mandate of the Indian Council of Agricultural Research

(*i*) To plan, undertake, aid, promote and co-ordinate education, research and its application in agriculture, agroforestry, animal husbandry, fisheries, home science and allied sciences.

(*ii*) To act as a clearing house of research and general information relating to agriculture, animal husbandry, home science and allied sciences and fisheries through its publications and information system, and instituting and promoting transfer of technology programmes.

(*iii*) To provide, undertake and promote consultancy services in the fields of education, research, training and dissemination of information in agriculture, agroforestry, animal husbandry, fisheries, home science and allied sciences.

(*iv*) To look into the problems relating to broader areas of rural development concerning agriculture, including post-harvest technology, by developing co-operative programmes with other organizations such as the Indian Council of Social Science Research, Council of Scientific and Industrial Research, Bhabha Atomic Research Centre and the universities.

(*v*) To do other things considered necessary to attain the objectives of the Society.

# 1. Introduction

**DARE**

The Department of Agricultural Research and Education (DARE) was established in the Ministry of Agriculture in December 1973. The subjects allotted to the DARE as per the Government of India (Allocation of Business) Rules are specified in Appendix 1.

The Indian Council of Agricultural Research (ICAR) is an autonomous body under the Department of Agricultural Research and Education. The Secretary to the Government of India in the DARE functions as the Director-General of the ICAR. The Financial Adviser of the DARE is the Financial Adviser of the ICAR. Generally single-file system is followed between the DARE and the ICAR.

The DARE has 10 Group A, 14 Group B, 15 Group C and five Group D employees. The recruitment to the posts in Groups A, B and C is being made centrally, either through the Department of Personnel and Training or through the Department of Agriculture and Cooperation, depending on the level of the post. The DARE makes direct recruitment only to Group D posts. Such recruitments are being made in accordance with the orders of the Government of India regarding reservations for scheduled castes, scheduled tribes and other backward classes. Presently the DARE has seven scheduled caste employees and one scheduled tribe employee.

A detailed break-up of the posts and names of the important functionaries is given in Appendix 2 and that of financial requirements in Appendix 3.

**ICAR**

The Indian Council of Agricultural Research is the apex organization at the national level for the promotion of Science and Technology Programmes in the areas of agricultural research and education.

The ICAR was set up on 16 July 1929 as a Registered Society under the Societies Registration Act, 1860, on the recommendations of the Royal Commission on Agriculture (Appendix 1). It was reorganized twice—in 1965 and 1973. The headquarters of the ICAR is located at Krishi Bhavan, New Delhi.

The Minister of Agriculture is the President of the ICAR. Its principal executive officer is the Director-General. He is also the Secretary to the Government of India in the Department of Agricultural Research and Education.

The General Body is the supreme authority of the ICAR. It is headed by the Minister for Agriculture, Government of India. Its members are the Ministers for Agriculture, Animal Husbandry and Fisheries, and senior officers of various state governments, representatives of the Parliament, industry, educational institutes, scientific organizations and farmers (Appendix 1).

The Governing Body (Appendix 2) is the chief executive and decision-making authority of the ICAR. It is headed by the Director-General. It consists of eminent agricultural scientists, educators, legislators and representatives of farmers. Its present strength is 23 members. It is assisted by the Standing Finance Committee (Appendix 3), Accreditation Board (Appendix 4), Regional Committees (Appendix 5), Policy and Planning Committee, several Scientific Panels and a Publications Committee.

The Director-General of the IACR functions as the Principal Adviser to the Government of India in all matters concerning research and

education in agriculture, animal husbandry and fisheries.

In scientific matters, the Director-General is assisted by eight Deputy Directors-General—each in charge of (*i*) Crop Sciences, (*ii*) Horticulture, (*iii*) Soils, Agronomy and Agroforestry, (*iv*) Agricultural Engineering, (*v*) Animal Sciences, (*vi*) Fisheries, (*vii*) Agricultural Education, and (*viii*) Agricultural Extension. The DDGs are responsible for the institutes and projects in their respective fields. The senior officers posted at the headquarters are listed in Appendix 6.

The ICAR receives funds from the Government of India and from the proceeds of the Agricultural Produce Cess.

It is the endeavour of the ICAR to develop technologies and to disseminate knowledge to the farming community not only for increasing yield levels of crops but also for alleviating its economic status. The ICAR has established 9 National Research Centres during the Eighth Five-Year Plan, upgraded the Directorate on Pulses to an Institute, and the All-India Co-ordinated Research Project (AICRP) on Biological Control as well as that on Maize to a Project Directorate, initiated the National Institute of Animal Nutrition and Physiology, National Research Centre on DNA Finger-printing, Network on Animal Genetic Resources, Crop-based Animal Production System and Embryo Transfer. The National Research Centre for Women in Agriculture for developing and testing women-specific technologies attuning to the New Economic Policy was also approved. The Publications and Information Division of the ICAR was upgraded to the level of directorate, the Directorate of Publications and Information on Agriculture.

The research set-up includes 45 Central Institutes (Appendix 7), four National Bureaux (Appendix 8), 10 Project Directorates (Appendix 9), 30 National Research Centres (Appendix 10), and 86 All-India Co-ordinated Research Projects (Appendix 11). Apart from financing research schemes through the United States-India Fund, 13 externally aided projects are in operation (Appendix 12).

The ICAR also sanctions research projects to national professors, national fellows and emeritus scientists, whose existing strength is given in Appendix 13. Research programmes are given the required thrust by holding workshops, seminars, summer institutes etc. The details of the summer institutes or short courses are given in Appendix 14.

For higher education in agriculture and allied fields, the ICAR has four deemed universities, viz. Indian Agricultural Research Institute, Indian Veterinary Research Institute, National Dairy Research Institute and Central Institute of Fisheries Education, which undertake specialized training mainly at the post-graduate level. The National Academy of Agricultural Research Management (NAARM) of the ICAR imparts training to new entrants in the Agricultural Research Service (ARS) and orientation to scientists and administrators.

The ICAR also promotes research, education and extension education through 28 state agricultural universities along with a Central Agricultural University for North-Eastern Hills Region, by providing financial assistance in different forms (Appendix 15).

For effective communication of research findings among the farmers, the ICAR maintains an effective network of 261 Krishi Vigyan Kendras and 8 Trainers' Training Centres (Appendix 16) along with 8 Zonal Co-ordinating Units (Appendix 17).

The total sanctioned as well as existing strength of employees of the ICAR system including that of scheduled castes and scheduled tribes is given in Appendix 18.

The ICAR also has 9 incentive schemes in different categories to award its meritorious scientists (Appendix 19).

Thus with an extensive network of research infrastructure, backed by excellent teams of scientists and other employees, the ICAR is making rapid strides in the field of agricultural research—poised and determined in this Golden Jubilee year of Indian Independence to lead India ahead in the Twenty-first Century.

# Overview

In the golden jubilee year of Independence, the country can be proud of achievements in the field of agriculture. Mahatma Gandhi mentioned as far back as 1930 that Indian Agriculture will continue to stagnate unless brains and brawns are married in the countryside. This could be achieved only after Independence when India's first Prime Minister Pt Jawaharlal Nehru said in 1948, "Everything else can wait but not agriculture". He initiated a process of institution building, introduction of science and technology in various facets of production, and promoted practices of improved management. The introduction of improved varieties that respond well to good irrigation and soil fertility management led to the realization of enhanced productivity and production. The foodgrain production increased from about 50 million tonnes in 1950-51 to approximately 190 million tonnes in 1996-97. The yield of wheat and potato increased nearly 9 times since 1951, maize 6 times, and rice, sugarcane, cotton and sorghum 3.5 times. A record in agricultural export was achieved during the year 1996-97 by earning about Rs 77.77 billion worth of foreign exchange in addition to more than $ 1 billion earned through export of fish and sea-foods.

The Second International Crop Science Congress (ICSC-II) was held from 17 to 24 November 1996 at New Delhi. Jointly organized by the ICAR and the National Academy of Agricultural Sciences, the Congress was attended by about 1,500 delegates from more than 70 countries, including the eminent stalwarts such as Nobel Laureate Dr Norman E. Borlaug, Dr M. S. Swaminathan, Dr Edouard Saouma, Dr Ismail Serageldin, Dr G. S. Khush, Dr Maria Jose de O'Zimmermann and Dr W. J. Peacock. The Congress was inaugurated by the Hon'ble President of India, Dr Shankar Dayal Sharma. The inaugural function and other related events were given wide coverage by media. A daily newspaper *Sasya Shyamala* brought out during the Congress and a book *50 Years of Crop Science Research in India* received wide appreciation. The ICSC-II reviewed the current status of the food security, agricultural sustainability and environmental health, and analysed the role of science in ensuring food and nutritional security for the mankind. The various presentations and discussions revealed that the world's natural resources, if managed suitably, should be able to meet the food demand towards the year 2020 A.D. and beyond. Judicious harnessing of new and emerging technologies hold great promise for alleviating hunger from the face of the earth.

One of the important achievements of the year was commissioning of world's largest genebank at NBPGR, New Delhi with the capacity of 1 million samples. It was inaugurated by the Hon'ble Vice-President of India, Shri K R Narayanan.

On the basis of the trends in the consumption level and pattern, the estimated total requirement of foodgrains for India is at 220.5 and 243.2 million tonnes for 2001-2 and 2006-7 A.D. respectively. Its break-up would be 94 and 103.5 million tonnes rice, 75.7 and 84.3 million tonnes wheat, 32.6 and 34.4 million tonnes coarse cereals, and 18.4 and 21.5 million tonnes pulses for the two periods respectively. Future increases in the production of food and non-food agricultural commodities have to be achieved essentially through increase in per unit pro-

ductivity. Therefore our primary focus of agricultural research has to be on technologies that can increase the productivity per unit area based on the concept of integrated resource management at farmer's level.

Evaluation of plant and animal genetic resources and their conservation becomes the main thrust of the research mandate. Collection, characterization, evaluation, documentation and conservation of plant genetic resources is a very important activity for maintaining biodiversity and broadening the genetic base of the improved modern varieties to increase unit productivity. During 1996-97 more than 657 accessions of various agri-horticultural crops were collected from different parts of the country including North-Eastern Hills. Under the programme of the exchange of germplasm, 28,122 samples of different agri-horticultural crops were received from 18 countries, including IRRI and CIMMYT.

National Genebank received 5,121 germplasm accessions of various agrihorticultural crops for long-term conservation. As a support to this activity, the National Research Centre for DNA Finger-printing was established during the year and it has started characterization of a number of crop plants and animals. This facility has been linked to three bureaux of the Council, i.e. NBPGR, NBAGR and NBFGR.

**Varietal Improvement**

In **rice** eight new varieties ('Nidhi', 'Pusa 677', 'ASD 19', 'ADT 42', 'PMK 2', 'TPS 3', 'Shyamla' and 'Purnima') and two new hybrids ('CORH 1' and 'PHB 71') were released. Under **wheat**-improvement programme, 'Ganga' was released for irrigated late-sown conditions of North-Eastern Plains Zone and 'DDK 1001' for irrigated timely-sown conditions of Peninsular Zone. 'DDK 1001' is the first semi-dwarf variety ever released anywhere in the world. Wheat Workers' Workshop identified three *Triticum aestivum* varieties and one *T. durum* variety for release in favourable environment and five *T. aestivum* varieties for suppressive environment. A catalogue of wheat varieties was released with characterization of 153 varieties so far released by the Central Variety Release Committee.

In **barley** three varieties ('RD 2503', 'RD 2508' and 'BCU 73') were released. Two **maize** hybrids ('KH 5981' and 'KH 5901') were released for cultivation, whereas five hybrids were notified provisionally. They have built-in tolerance to major diseases and pests. In **sorghum** grain hybrid 'CSH 15R' was released for *rabi* season in addition to grain variety 'Sel 3' (for *rabi*), and 'DSV 3' and 'JJ 938' (for *kharif*). The *chapati*-making qualities of 'CSV 15', 'SPV 1025' and 'CSH 9' were found to be superior in taste, whiter in colour and better in puffing. A multicut fodder hybrid 'PCH 106' with 70 tonnes green forage/ha in 3 to 4 cuts was identified for release.

In **pearl millet** two new hybrids ('RHB 58' and 'Pusa 444') were released for general cultivation for all pearl millet-growing areas of the country. Two varieties of **finger millet**, and one each of **little millet**, **foxtail millet** and **kodo millet** were released.

Underutilized Crops Programme developed improved technologies for crops with future promise such as pseudocereals, job's tears, minor pulses and legumes, minor oilseed plants/trees. Over 1,800 accessions of underutilized crops were evaluated. In **ricebean** 'RBL 6' and in **fababean** 'Vikrant' varieties were released.

Among forage crops, three varieties of **sorghum**, one variety each of **fodder cowpea**, **fenugreek**, **lucerne**, **guinea grass**, **ricebean**, **shaftal**, **oat**, **teosinte** and **maize** were released in addition to two each for **gobhi sarson** and **fodder guar**.

In **pulses**, **chickpea** variety 'DCP 92-3' was released with a yield potential of 20-25 q/ha for North-Western Plains Zone. Genotypes for low temperature tolerance were identified. In **pigeonpea** a new hybrid 'RAUPH 9406' recorded 44.3% more yield over the best check 'Pusa 9'. Two varieties each for **mungbean** and **urdbean** were identified for pre-release seed multiplication. A bold-seeded rust-resistant lentil variety 'DPL 62' was identified for release in North-Western Plains Zone.

Among **oilseeds** the protocol for efficient and novel methods of inducing multiple shoots

from somatic embryos rather than one-to-one direct conversion of somatic embryos to seedlings was developed in **groundnut**. High yielding advanced cultures were identified for rainfed areas. Two new **sunflower** varieties ('AKSF 9' and 'PKVSH 27') were released; 44 new accessions of ***toria*** and 16 of **yellow sarson** were collected from Himachal Pradesh and Punjab; and two new varieties of **mustard** were identified for release. Sustained efforts for improvement of quality traits have opened new opportunities to improve the status of oil of rapeseed-mustard.

Four improved varieties of **soybean** ('Ahilya 1', 'Ahilya 2', 'Ahilya 3' and 'PK 1042') were released.

A number of varietal trials were conducted in **niger** for improving yield in tribal areas. In **safflower**, variety 'AKSF 68' with 5-7 days earliness in maturity gave better yield among spiny varieties. The newly developed non-spiny male-sterile line showed high combining performance.

In **cotton** 23 high-yielding hybrids/varieties were released for cultivation in different zones. Complete plants were obtained from the multiple shoots by repeated subculturing and incorporation of changes in the media. The protocol for *Agrobacterium*-mediated transformation utilizing **Bt** gene into cotton explants is being standardized.

Four new strains of **sugarcane** were found promising in different zones. The variety 'Co 86032' was found suitable for Tamil Nadu and Karnataka states. Four new FCV varieties of **tobacco** were identified for release in Andhra Pradesh and Karnataka. One *Corchorus olitorius* variety and two new *C. capsularis* varieties were released.

**Seed Production and Seed Technology**

A total of 2,624.6 tonnes of breeder seed was produced during the year, covering different crop varieties. The overall availability of quality/certified seed for the farmers, after eventual follow-up of seed- production chain in the country, now stands at about 0.7 million tonnes. Planting ratios for the optimization of hybrid seed production were standardized in pearl millet and sunflower hybrids.

**Biological Control**

*Compoletis chlorideae* and *Diadegma argenteopilosa* were reared successfully in the laboratory host, *Corcyra cephalonica*. An artificial diet with cabbage leaf powder as phagostimulant proved good for rearing *Spodoptera litura*. Some fungal antagonists were isolated from sunflower and rice ecosystems. Seventy-six shipments of parasitoids and 12 shipments of host cultures were sent to co-ordinating centres and other research organizations for field trials and experimentation. Agronomic practices were perfected to use bio-control measures for checking pests in sugarcane, cotton, pigeonpea, chickpea, fruit crops, vegetable crops and for controlling weeds.

**Honeybee Research**

Research on honybee has shown that there was resource partitioning in different *Apis* species. Flora with longer corolla tubes are availed by *Apis mellifera* in comparison with small-flowered plants liked by *Apis indica*. Apple orchards need eight colonies per hectare for pollination to achieve average fruit set of 48%, whereas in Kiwi-fruit the fruit-set was increased to 67-97% by placing bee colonies for pollination. Intensive bee pollination has also shown to increase seed-set in hybrid sunflower.

**Pest Control and Pesticide Residues**

No detectable residues of chlorpyriphos were present in tobacco leaves, indicating that it can be safely recommended for control of pests on tobacco. Repeated and excessive spraying of insecticides should be avoided in grapes and no spray is to be given 1 month before harvest of mango fruits. Most of the 2,500 samples of fruits and vegetables analysed had pesticides within the permissible limits. Sorghum as screen around maize fields was found effective in reducing parakeet damage to ripening maize in Punjab. Seven entomogenous nematode species belonging to two genera, *Heterorhabditis* and *Steinernema*, were found to be effective against other soil insect pests like cutworms and wireworms, giving up to 80% mortality. Two deep ploughings after harvest of summer fodder

crop in August exposed the whitegrubs to predatory birds and reduced the grub population by 70%.

**Horticulture**

In mango several hybrids were developed with export potential, regular bearing and late harvesting. In banana two improved cultivars ('Karpuravalli' and 'Monthan') were selected for low input conditions. A hybrid banana 'H 9' developed at Kanara was found highly promising. In grape 'Flame Seedling', an introduction from California, was identified for 10-day late ripening and better fruit quality than 'Perlette' for cultivation in Punjab. Thirteen hybrids were selected for their fruit quality, table purpose, juice and wine-making. Rough lemon 'Australia' was found highly tolerant to salt. A high-yielding, disease-tolerant acid lime selection, 'Sai Sharbati', was supplied to the growers. In orchards drip irrigation was found superior to sprinkler irrigation. Fungicides have shown complete inhibitory effect on apple scab. A high-yielding selection of guava, 'CISH-G 1', has deep red fruits with attractive shape for export. An early-bearing ber, 'CHES 1', was identified for release. In *Annona* an improved hybrid 'Arka Sahan' was developed. 'H 7' is a promising hybrid of pineapple. In papaya a hybrid 'CP 81' was identified for high yield and quality. 'PKM 3' sapota was released.

Modified atmosphere packaging (MAP) technology was found to increase the keeping quality up to 1 month in mango, banana and citrus fruits. On-farm storage technology for fruits and vegetables using evaporative cold chambers was standardized at different agroclimatic locations. Technology for low-cost preservation and processing of fruits and vegetables was developed. Several innovative products were also developed and standardized.

In vegetable crops one hybrid and five varieties of brinjal were identified for release. In tomato one hybrid and three varieties were identified. 'Pusa Hybrid 1' was identified in pumpkin. Two varieties of chilli, and one each of bittergourd and okra were also identified for release.

In potato a new technique for germplasm distribution has been evolved by nutrient incapsulating *in-vitro* nodal cuttings in sodium alginate to avoid spoilage during transit. The encapsulated propagule can be regenerated on incubation under light. Fourteen potato hybrids were developed possessing different characteristics. Several potato-based cropping systems were identified, giving income of Rs 30,000 to Rs 47,000 per hectare. Eco-friendly biocontrol schedules could save potato crops from diseases and pests.

Five improved varieties of cassava were identified for short duration and higher tuber yields. A motor-driven chipping machine has been fabricated as an improvement over the pedal-operated chipping machine. Three high-yielding hybrids have been identified in yams. In *taro* seven hybrids recorded fairly good yield.

A new edible fungus *Neopaxillus echinospermum* growing on the upper hills of Assam was recorded for the first time in India. Two high-yielding strains of *Agaricus bitorquis*, 'NCB 6' and 'NCB 13', showed superiority in fruit-body quality and size of mushroom. Coir pith has proved as a promising viable casing medium for button mushroom cultivation. Thirty species of oyster mushroom have been tried for year-round cultivation. A large number of agro/agro-industrial wastes were tested as a substrate for oyster mushroom cultivation.

**Floriculture**

Three promising rose hybrids have been identified for release. Four hybrids of gladiolus were found promising. A new variety of chrysanthemum ('White Charm') was released at Lucknow. In China variety of aster, 'Kamini' and 'Purnima', proved promising at Bangalore. Four varieties of gerbera, viz. 'Tropical Panama', 'Pendora', 'Carona' and 'Ludukimari', were found promising for commercial cultivation.

**Plantation Crops**

'Philippines Ordinary' was found superior and was recommended for commercial cultivation in the West Coast, including Konkan region, and East Coast (Andhra Pradesh and West Bengal). Cultivating coconut with organic manures gave higher nut yield. A nitrogen-fixing

bacterium, *Beijerinckia indica*, was grown in coir pith in combination with farmyard manure and soil to produce a biofertilizer for coconut. ELISA test was developed to detect root-wilt in coconut. In oilpalms plantlet development from leaf calli was achieved through both somatic embryogenesis and direct organogenesis. Tenera hybrids recorded highest yield in farmers' fields in Andhra Pradesh. Twenty four new cultivars of cashew were clonally multiplied and added to the National Genebank. A hybrid cashew has been identified for higher yield. Two high-yielding varieties of arecanut, 'Cal 17' and 'SAS 9', were released for Andaman islands and hilly area of Sirsi respectively.

New high-yielding varieties of spices belonging to ginger ('IISR Varada'), turmeric ('IISR Prabha' and 'IISR Pratibha') and cinnamon ('IISR Navashree') were released by the IISR, Calicut. Micropropagation protocol clones of cinnamon, camphor and several herbal spices were developed.

Protoplast isolation and regeneration of callus was achieved in *Piper colubrinum*. Nine cardamom collections with high volatile oil were identified. Three high-yielding cultivars were identified in black pepper. A new coriander variety 'RCr 20' was recommended for south-eastern Rajasthan.

**Soils**

The soil-resource maps of 8 states were digitalized and thematic maps on important soil parameters such as soil depth, texture, pH, erosion and drainage were prepared. Mulching through intercropping of sunnhemp as a green-manure crop in maize proved highly efficient in reducing run-off and soil loss on slopy lands and in improving crop yields. Optimal farm plans with improved technologies were developed for small and medium farm groups in outer Himalayas to maximize farm income and minimize soil loss. Vegetative barriers were assessed for soil and water conservation on slopy lands.

A technology of integrated plant-nutrient supply and management system for sustainable productivity of soybean-wheat cropping system covering 4 million ha area of the black soils of the country, was developed. Sulphur status of Indian soils showed deficiency from 11 to 64% in different soils. Red and laterite soils of Chhotanagpur in Bihar showed 58% deficiency. Widespread deficiency of zinc has also been indicated. Integrating organic manure (FYM) with recommended NPK fertilizer doses sustained higher level of productivity while maintaining soil fertility in most of the cropping systems. Phospho compost was produced using different organic wastes, supplemented with small amount of cattle dung, soil, manure, compost and slurry of Mussoorie rock phosphate.

The system of broad furrow and ridge was developed for shallow Vertisols to conserve moisture. It helped in excellent growth of pigeonpea in rainfed areas.

Highly promising cropping systems were developed and recommended for different ecosystems. Sunflower is gaining ground in Indo-Gangetic plains of Haryana, Punjab and parts of western Uttar Pradesh. At Ranchi, agroclimatic conditions revealed that it is not useful to sow rice beyond second fortnight of July, as the late-sown crop will experience a moisture-stress during reproductive stage and was prone to higher disease intensity. In Brahmaputra *diara*, intercropping rajmah in sweet potato increased the yield by 38.5% over sole crop of sweet potato and 36.6% over sole crop of rajmah, whereas in Ganga *diara* three hand-weedings and hoeing behaved alike in wheat; the chemical methods were superior. In soybean highest grain yield was recorded with the use of herbicides. Neem-cake + *Trichoderma viride* could inhibit the germination and seedling vigour of *Phalaris*. Marigold grown in association with *Parthenium* reduced the latter's height and root length.

**Water Management**

Artificial recharge of ground water is one of the promising options to augment the depleting groundwater in over-exploited regions. At Ludhiana it was possible to recharge aquifer by 1,144 m of run-off water in one season through one cavity well. A collaborative ICAR-MNES Network Project on performance, evaluation and optimal utilization of water of solar photovoltaic pumping system is under operation at 10 centres.

The Project Directorate (Water Management) has been shifted from Rahuri to Patna.

For the efficient use of sodic or alkaline waters, passing water through gypsum-beds is essential. Yield improvement of 3 to 16 times was observed in pearl millet with gypsum application. Gypsum beds improved yields of paddy and sorghum by 20 to 30%. The technique of abstraction of freshwater floating over the saline ground waters in the coastal sandy soils was successfully adopted by farmers.

Rice variety 'CSR 13', with long slender grain and better cooking quality, has been recommended for salt-affected soils throughout the country. Considerable saving of irrigation water as well as increase in economic returns were obtained by introducing water-efficient crops such as oilseeds, pulses and vegetables in traditional cropping systems.

**Farm Implements and Machinery**

To sustain productivity in rice-wheat systems a strip-till-drill was developed at the PAU, Ludhiana, and no-till-drill at the GBPUAT, Pantnagar. Both the drills are operated by 35 hp tractor and can sow wheat directly in fields where paddy has been grown earlier. The Punjab government is subsidizing this drill. A six-row manually operated paddy transplanter is being manufactured and is getting popular. CRIDA has developed an animal-drawn drill plough with various attachments, costing around Rs 1,000. The Government of Andhra Pradesh is subsidizing the cost by 50%. A high-capacity multicrop thresher developed at the CIAE, Bhopal, is able to thresh soybean, sunflower, Bengal gram and wheat. A six-row manual mat-type paddy transplanter and self-propelled reaper have also been developed at the CIAE. The institute supplied 1,200 prototypes of improved implements to farmers, private parties and government institutions. The IISR, Lucknow, has developed a sugarcane sett-cutter planter.

A high-capacity groundnut decorticator has been developed and tested at Bhopal. At Udaipur a hand- and power-operated garlic bulb-breaker was developed, tested and released for manufacture. A mini *dal*-mill suitable for pigeonpea and greengram was developed at the PKV, Akola, and released for manufacturing. Soy-whey has been used as fermentation medium and a *poha* recipe with 8.75% protein has been developed using puffed rice. A pilot plant was fabricated at the PKV, Akola, to process kaghzi lime waste for production of citric acid granules. A laboratory-scale rice polisher was developed at the IARI, New Delhi. Several designs of low-cost greenhouses have been tested. Energy use patterns for major crop rotations, fruits, dairy and poultry products have been studied for saving energy. Low-cost diesel engine safety device and energy-efficient reflex valve have been developed at the PAU, Ludhiana.

A solar-energy based onion-flake dehydration plant of 100 kg per batch capacity was developed in SPRERI, Vallabh Vidyanagar, Gujarat, and was used for 'Nasik' variety. SPRERI has also developed a 20 kW capacity rice husk-based gasifier system for power generation. Air-dried mango leaves, chopped rice straw and soybean straw were successfully utilized as slurry absorbent for composting.

A procedure has been developed to estimate run-off from daily rainfall data. A network of subsurface clay tile drainage system was developed for tea plantations in north-eastern India. It eliminated the problem of maintenance and increased the tea yield by 30%. A package of practice for Kusumi broodlac as well as sticklac production on *kusum* host has been developed, providing multifold increase in profitability compared with traditional practices. A continuous lac scraping machine has been developed at the CIPHET, Ludhiana.

The CIRCOT, Mumbai, conducted trials on pure Indian cotton varieties for the production of combed yarns. A shell fish by-product, chitosan, was used for pretreatment of cotton to make it receptive to lac dye.

**Animal Sciences**

The project to evolve a national milch breed, 'Frieswal', capable of producing 4,000 kg milk in a mature lactation of 305 days, is yielding good dividend. So far 119,010 doses from 35 bulls (Frieswal 32 and Sahiwal 3) were frozen and 67,755 doses distributed to various military farms for breeding this genotype. Under the

Indigenous Breeds Project, the Germplasm Unit distributed 2,050 doses of Ongole bull semen to various herds. In buffaloes, 34,983 doses of semen were frozen from elite young bulls. Different breeds of sheep are being improved through selection and *inter-se* mating for wool and mutton production.

Emphasis is being given for improvement of goat through farmers' participation. Superior bucks were provided in adopted villages for breed-improvement programme. The farmers' participation in the adopted villages has been highly satisfacatory. To improve production under Indian condition, seven genotypes were generated through AICRP on Pigs, which are under test. On the basis of a wide survey of population in North-Eastern Hill states, mithun was classified into two breeds, namely 'Arunachalees' and 'Nagamees'. In poultry, many pure indigenous stocks excelled their crosses in respect to fertility and hatchability.

A data bank on animal genetic resources was developed on livestock breeds recording their stock management practices, physical characteristics, performance traits and breeding farms. Observations on socio-economic status of yak farmers, their husbandry practices, types of yak etc. were recorded under a pilot survey on yak of Arunachal Pradesh. Molecular genetic and immuno-genetic characterization of farm animals was also undertaken. The blood group system of mithun closely resembled that of cattle. A major network project for strengthening the NBAGR has become operational during the current year.

It has been decided to locate animal component of National Research Centre on DNA finger-printing at the National Bureau of Animal Genetic Resources (NBAGR). The component on *ex-situ* conservation of breeds of livestock has been strengthened in the Bureau in association with species institutes.

A large-scale national survey conducted among cattle and buffaloes in 22 states indicated prevalence of brucellosis in 1.7 and 2.3% animals respectively. A general-purpose computer-based disease-forecasting system was developed. The viral agent responsible for a new emerging viral disease, infectious body hepatitis (IBM), commonly known as 'Leechi disease', occurring in broiler farms in Uttar Pradesh, Andhra Pradesh and Haryana was isolated and successfully grown in cell culture. Brucellosis ELISA kit is now available for testing more than 0.15 million animals and will be released through the national network. This indigenously developed ELISA kit has a good commercial potential. A vaccine against *Babesia bigemina* was produced by MASP culture technique. Cost effective techniques were developed for the treatment of ailments of musculo-skeletal system, nerves and bone fractures. A major success was achieved in tendon reconstruction. Different grafts and implants were successfully used; however, carbon fibres proved superior to all.

The high-security animal-disease laboratory (P-5 facility) at Bhopal is nearing completion at a cost of Rs 300 million.

A National Institute on Animal Nutrition has been established at Bangalore with the major mandate to initiate basic research in biotechnological approach : (i) to release energy from crop residues (plant cell-wall) by microbial intervention to break lignocelluloses into carbohydrates; and (ii) to separate incriminating factors from oilcakes, oilmeals and tree leaves in order to make available bound protein for livestock feed.

A balanced concentrate ration was formulated using mustard-cake, rice *churi*, rice grit and pulse *churi*, which are by-products of main crops. To spare cereal grains for human consumption, low-grain and grainless diets were developed for livestock consumption. In poultry, neem kernel-meal, a protein-rich by-product of neem oil extraction industry, was successfully utilized in the diet of layer hens without any adverse effect.

A new large dairy plant run on commercial lines jointly by NDDB and NDRI was commissioned during the year in order to provide hands on training to dairy managers and technologists for upgrading their working skill in management of new technologies.

Microwave technology was successfully used for manufacture of ghee from high-fat cream/ butter. Microwave treatment causes the least damage to water-soluble vitamins in milk.

The NRC on Equines has developed a field-

oriented immunostick ELISA kit for the detection of EHV-1 and EHV-4 antibodies for better management of latent infection in thoroughbred horses.

The NRC on Camel has generated scientific data on Indian camels, especially genetic resources, calf mortality, camel genetics and breeding, draughtability, nutrition, reproduction, physiology, milk and hair, and behaviour.

The NRC on Yak has been undertaking genetic resource survey programme for yaks. In the NRC on Mithun, necessary infrastructure is being developed for undertaking basic and applied research on mithun.

**Fisheries**

Artificial insemination of tiger prawn has been achieved and thus the country is many steps ahead in solving the problem of spawning of unfertilized eggs due to non-mating and non-deposition of spermatophores.

A comprehensive survey of impact assessment due to shrimp farming has been launched in Nellore district in Andhra Pradesh and several positive socio-economic indicators were noticed, e.g. higher level of employment for the village people, increase in income and increase in the consumption-pattern index. As a result of the Supreme Court judgment, this project has been strengthened.

Pen culture of giant freshwater prawn was undertaken successfully in tidal wetland, i.e. *bheri*. This method has become very popular among the local *bheri* owners and has the potential of mass-scale adoption in the coastal West Bengal. A viable hatchery technology of the giant freshwater prawn was developed and standardized. A biological treatment complex for treatment and utilization of domestic sewage comprising duckweed and fish culture system was established. A feed comprising groundnut cake, roasted soybean meal, rice bran, fish meal, vitamin-mineral premix and an attractant was formulated for grow-out carp culture. Feeds for shrimps were also developed using indigenously available raw materials.

The Central Institute of Fisheries Education was strengthened to modernize the infrastructure of research, teaching and training. For extension of new technologies, various training programmes and technology-transfer programmes were conducted for fishermen, farmers and entrepreneurs. Consultancy services are also being provided to various commercial companies and organizations in addition to private entrepreneurs. By the end of the IX plan, it is planned that CIFE will be largest University on Fisheries.

To exploit coldwater fishery resources, technologies for intensive production of fry of Himalayan mahseer have been standardized and the rearing of fry and fingerlings of snow-trout on artificial feed is being done under cemented pond environment.

To strengthen the databank on fish germplasm resources of India, a compendium entitled *Fish Biodiversity of India* has been finalized. Work on genetic improvement of carps through gene manipulation is also progressing well.

In an attempt to improve harvesting technology, resource-specific gears for squid, quality fishes and prawns were identified for in-shore and offshore waters. A collagen-chitin membrane prepared was found to perform satisfactorily as 'artificial skin' for covering burns and wounds.

**Agricultural Statistics and Economics**

The National Research Centre for Agricultural Economics and Policy Research was further strengthened for evolving policy guidelines to job-led growth of Indian agriculture through pro-poor, pro-women and pro-environment technologies.

A study of 16 districts in nine states of the country revealed that the main constraints in adoption of new crop technologies were inadequate water, lack of funds and ignorance of plant-protection methods. Keeping goats, sheep and rabbits provide additional source of income. The benefits of co-operative agricultural credit are not reaching the small and marginal farmers. Preharvest forecasting of inland fish can be made 3 months before harvest. Studies made on public expenditure by centre as well as states on research and education concluded that larger share of national resources are needed for Bihar,

Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal. Another study on policy analysis for sustainable resource use in rice-wheat cropping system showed that the conflict between social objective of maximizing water-use efficiency and the farmers' objective of maximizing stable income can be resolved through a systems approach. Analysis of diversification of agriculture in Punjab suggested that gradual shift to the extent of 15% of the area under foodgrains by the year 2000 A.D. and 28% by the year 2020 A.D. would not jeopardise the country's food security as long as the rest of the states continue to grow their output at the rate experienced during the last decade.

**Agricultural Education**

An all-India competitive examination for admission to the under-graduate and post-graduate level was conducted to reduce in-breeding and promote national integration. First All-India Entrance Examination for committing 15% seats of the under-graduate (UG) course in SAU was conducted, in which 1,300 candidates qualified. Similarly, for the post-graduate (PG) courses, 800 students were selected for admission in 25% seats in SAUs.

The Second All-India Examination for admission in UG courses has been announced. The examination is scheduled on 25 May 1997.

Computerisation and networking has been taken up in a big way, so that the students and scientists could be able to have access to latest information. The West Bengal University of Animal and Fishery Sciences has been accorded recognition. Laboratory facilities were strengthened in 14 states. Many sophisticated equipment have been funded by the ICAR to facilitate better research quality. Full 100% grants were given to SAUs for construction of girls' hostels. Fourteen SAUs were helped in establishing Computer Centres for use by students and faculty members. Modernization and computerization of P.G. school libraries and renovation of hostels and libraries were supported in all four deemed universities, namely IARI, IVRI, NDRI and CIFE. The government of Sikkim has agreed to transfer land near Majithar and Rangpoh for the College of Engineering and Post-Harvest Technology, to be established as a part of central agricultural universities system. Support was also provided to 35 Centres of Advanced Studies in the different SAUs. A total of 850 scientists were trained and provided latest information in their areas of specialization. Training programmes on hybrid technology for rice, millets, pulses, oilseeds, cotton and forage crops were conducted.

The National Dairy Research Institute, Karnal, a deemed university, offers academic programmes both at under-graduate (B. Tech. in Dairy Technology) and post-graduate (Masters and Ph.D. programmes in Dairying) levels in the field of Dairy Science and Technology.

The Agricultural Human Resource Development Project launched with the assistance of the World Bank is being implemented in three states, viz. Andhra Pradesh, Haryana and Tamil Nadu, and their respective state agricultural universities (APAU, Hyderabad; CCS HAU, Hisar; TNAU, Coimbatore, and TNVASU, Chennai).

Accreditation Board was constituted by the Council in place of Norms and Accreditation Committee, to advise the Council (*i*) in evaluating standards for accreditation of colleges and institutions, and (*ii*) in evaluating academic programmes and periodically assessing the course curriculum to maintain standard of agricultural education in the country.

The agreement for overseas training has been signed with FAO and about 80 faculty members/scientists would be sent abroad for training in different areas during this financial year.

The Third Deans' Committee Report has been submitted and the recommendations have been sent to all the Vice-Chancellors. Apart from increasing the practical training to 50% of the course work, a Rural Agricultural Work Experience (RAWE) has been proposed for a period of 6 months as an integral part of the graduate degree. This is in operation in a few universities but will be implemented in all the SAUs in IX Five-Year Plan. The Council will bear 50% of the fund requirement of this activity. An attempt has been made to have a uniform course curriculum to facilitate movement of teachers and students among SAUs. This will

improve academic standards and reduce inbreeding.

The Best Teacher Award has been instituted by the Council with the objectives to provide incentive and encouragement for good teaching, to recognise outstanding teacher and also to promote the art of teaching, leading to academic excellence and improvement of Department/ Faculty/Institution and other seats of higher learning and teaching. All the teachers/scientists/extension specialists working under universities shall be eligible to apply. The Council has awarded Best Teacher Award to the teachers in IARI, New Delhi, TNVASU, Chennai, and OUAT, Bhubaneshwar, this year.

Nutritional evaluation of various unconventional/lesser-known foods revealed that all the foods were good source of dietary fibres. To cater to the needs of infants and pre-school children of subsistence farm families, a system of Community Child Care Centre was introduced on the basis of community participation. Blends of red palm oil and sunflower oil were separately used to prepare 40 different food items. These can be used as a good supplement of vitamin A under rural community nutrition programme.

**Transfer of Technology**

At present there are 261 Krishi Vigyan Kendras and 8 Trainers' Training Centres. The Pilot Project on Technology Assessment and refinement through Institution-Village-Linkage Programme (IVLP) has been implemented at 34 centres. In this project the methodology of agro-ecosystem analysis using PRA tools has been used instead of conventional questionnaire scheduled survey approach. About 22,000 farm families were selected under the IVLP. More than 10,000 training courses were organized for the benefit of about 0.25 million farmers to impart improved technologies. The impact studies revealed 23 to 100% adoption of different skills/ technologies among the trained people. About 47,000 rural youths were trained in more than 2,000 long-term vocational courses. In addition, 1,000 training courses were conducted for more than 21,000 grass-root level extension and develoment personnel from government and non-government organizations. Potential of improved technologies was demonstrated in about 3,400 ha, involving 7,000 farmers and field-days, farmers' fairs, Kisan goshthies, farm women fairs, agricultural exhibitions, clinical camps, video and film shows, and radio as well as TV programmes were organized throughout the year.

National Research Centre for Women in Agriculture (NRCWA) started functioning at Bhubaneshwar from April 1996.

**Research for Tribal and Hill Regions**

The ICAR Research Complex in North-Eastern Hills Region has developed promising cropping systems to raise the income of the people of this region. Intercropping of maize with groundnut was found most remunerative. Several varieties of paddy were identified to be promising for natural farming under wetland conditions. Application of FYM and zinc sulphate was recommended to increase the production of groundnut. Neem formulations sprayed at silking stage and 15 days after silking resulted in 85% decrease in larval populations of cob-borer of maize. Timely baiting with zinc phosphide resulted in reducing rodent damage, which is very high in rice-growing areas of Meghalaya. Various agroforestry systems, paddy-cum- sericulture and paddy-cum-fish culture were developed for valley lands. Pineapple in paired rows with guava and turmeric resulted in more income. Piggery, poultry and rabbit farming were recommended for mixed farming.

Various intercropping systems were developed for growing fruits and vegetables in Andaman and Nicobar islands. Poly-culture of air-breathing fishes and mullet culture practices were improved by developing and popularizing new technologies. The problem of infertility in crossbred cows is being tackled. A disease-resistant bird has been identified to check the outbreak of IBD in layer chicks. Forty bacterial isolates from mangroves are being analysed to find bioactive compounds. For northern hills an awnless high-yielding variety of wheat 'VL Gehun 738' was identified in addition to garden pea 'VL 6'. Mulching with pine-needles was found to be

as effective as one irrigation for vegetable pea in Uttar Pradesh hills.

**International Co-operation**

A new era of international co-operation in emerging new technologies and frontier areas was opened up with signing of agreements and memoranda of understanding with many countries. These include the USA, Russia, Australia, Japan, Tunisia, Israel, Trinidad and Tobago, Uzbekistan, Nepal and Mongolia. The collaborative research with CGIAR system was further strengthened with signing of MoUs with the International Centre for Living Aquatic Resource Management (ICLARM), International Plant Genetic Resources Institute (IPGRI), International Livestock Research Institute (ILRI), International Irrigation Management Institute (IIMI) and International Centre for Genetic Engineering (ICGE). A work plan was signed for co-operation among SAARC countries. India contributed towards development funds of CGIAR, CABI, APAARI, NACA, CGPRT, ISTA and CHF. These incentives will help in the real globalisation of agricultural research and development. A demonstration farm is being established at New Delhi with the help of Israeli experts.

**Publications and Information**

In view of the great importance of communication of research findings among scientists and farmers, the Publications and Information Division was upgraded to the level of directorate. The Directorate of Publications and Information on Agriculture started functioning with modern computerized facilities, from August 1996.

During this period, besides 9 regular periodicals, 21 titles in English and 10 in Hindi were published. At the time of ICSC-II, a series of new publications were brought out. The main ones in English are : (*i*) *50 Years of Crop Science Research in India;* (*ii*) special issue of *Indian Farming*, depicting the achievements of research in crop science; and (*iii*) a new vision of ICAR, entitled *ICAR : Now and Ahead ...* , giving the history, growth and development of Indian Agriculture through ICAR and what we propose to do in future. Similarly, in Hindi we published *Badalte Parivesh me Krishi Anusandhan evam Vikas ke Naye Aayam, Sabji Vigyan* and *Phal Vriksh Pravardhan.* Special issues of popular periodicals were brought out on other occasions too, like World Food Day, XX International Congress on Poultry Science, when a special issue of *Indian Farming* was brought out depicting the achievements of Indian poultry science. The ICAR participated in 12 exhibitions during the year. The Directorate is now functionally autonomous and has added new dimension to agricultural communication. It has added a media unit, strengthened ARIC as a national informatics bureau and abstracting centre for FAO, UNDP and SAARC. The editorial units have been strenthened and computerized.

**Perspective Plan, Administrative Reforms and New Initiatives**

Eighty-four perspective plan documents were finalized for the respective research institutes and centres of ICAR, giving details of research priorities according to the population growth and food demand of 2020 A.D. Forty-six documents have been approved for printing. The objectives, roles, activities and accountabilities of each of the constituents of the National Agricultural Research System (NARS) have been set to put them in motion with an accelerated velocity. This will take care of agricultural challenges of the first quarter of next century.

The draft proposal of National Agricultural Technology Project (NATP) is under active consideration of the World Bank. It will bring about Rs 8 billion worth of grant to finance the technology refinement and intervention programmes for minimizing regional imbalances.

A committee was constituted under the chairmanship of Dr H. K. Jain to review the All-India Co-ordinated Research Projects; it has submitted a draft report to revamp the whole system of AICRPs.

**Social Audit of Research and Development Programmes**

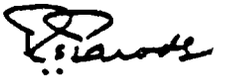
To assess the impact of developments in agricultural research and technologies on socio-economic conditions of farmers of the country, especially small and marginal farmers, and to remove the impediments on extending the investment made in agricultural sectors to the

intended beneficiaries, the Council has decided to conduct social audit of technologies developed and adopted by farmers in various parts of the country. The social audit is being undertaken in 11 research and development programmes

**Agricultural Research Information System**

This project aims to bring the information management culture to every agricultural scientist, so that the person can carry out research more effectively, using modern tools. Every campus including SAUs and their ZRSs as well as ICAR institutes have been provided with a LAN server and a number of PC workstations with associated software packages. All KVKs and AICRPs have been included in the list of sites to be connected with WAN for e-mail and other services. Training on day-to-day use of computers has been imparted to a large number of officers/staff from ICAR headquarters, ICAR Institutes and SAUs. LANs have been created at the ICAR headquarters (Krishi Bhavan and Krishi Anusandhan Bhavan). The IARI has access to World Wide Web, and e-mail connectivity has been established at 69 ICAR institutes.

Diversification, value addition and concerns for sustainable agriculture, environmental protection and globalization of agriculture would require necessary adjustments in our research prioritization and planning. Time is ripe to move fast to re-orient our efforts to meet future challenges successfully. This eventually would ensure a bright future for our younger generation. This is by no means a small task, and we must move, and rather move fast. The key to the future success would largely depend on the 'Renewal of our National Agricultural Research System (NARS) — a goal towards which we all must aim as 'partners' in order to effect the much-needed change; obviously a change for the better.



**(R S Paroda)**

# Administration and Finance

## ADMINISTRATION

The Director-General is assisted by the Secretary (who is also the Joint Secretary to the Government of India in DARE), Directors of Personnel, Finance and Works, and other administrative officers and staff at different levels. The Joint Secretary (Finance) in the DARE is also the principal financial adviser in matters of finance of the ICAR. In matters relating to publications, publicity and information, the Director-General is assisted by a Director (Publications and Information).

In the ICAR concerted efforts were made towards removal of anomalies and disparities in the system in terms of recruitment rules, service conditions, pay scales of some administrative posts at headquarters and institutes under the Council. To this end, the recommendations of the High-Power Dr K.V. Raman Committee, appointed in 1995 to take up a comprehensive review of the ICAR system, were further refined, processed and given a practical shape prior to placing before the Governing Body in its meeting held on 17 October 1996. While approving the recommendations relating to parity in pay scales, service conditions and recruitment rules in respect of some posts at headquarters and institutes in principle, the Governing Body referred the other issues to a Subcommittee consisting of Dr Asim Bala, M.P. and Member, GB, ICAR, as Chairman and Shri Ramendra Kumar, M.P. and Member, GB, ICAR, and Dr Venketaraman, Member, GB, ICAR as Members, and the Secretary, ICAR, as the Member-Secretary. The Subcommittee has given its recommendations, to be considered further by the Governing Body in its next meeting. Separate Cadre Review Committees with the following constitution have already been constituted by ICAR for cadre review in respect of posts and cadres in Groups 'A', 'B' and 'C' posts of administrative category at the Council's headquarters and its research institutes :

**A. Cadre Review Committee for Review of Cadres and Posts under Group 'A'**

| | | |
|---|---|---|
| 1. | Dr Kirti Singh<br>Member, ASRB | Chairman |
| 2. | Shri G S Sahni<br>Secretary, ICAR | Member |
| 3. | Shri N Parthasarathy<br>FA (DARE/ICAR) | Member |
| 4. | Director, IASRI<br>New Delhi 110 012 | Member |
| 5. | Shri B S Gaira<br>Deputy Secretary, CSIR<br>Rafi Marg, New Delhi 110 001 | Member |
| 6. | Director (P), ICAR | Member-Secretary |

**B. Cadre Review Committee for Review of Cadres and Posts under Groups 'B' and 'C'**

| | | |
|---|---|---|
| 1. | Director (DARE)<br>Krishi Bhavan,<br>New Delhi 110 001 | Chairman |
| 2. | Director (F), ICAR | Member |
| 3. | Deputy Secretary (AS),<br>ICAR | Member |
| 4. | Deputy Secretary (Admn),<br>ICAR | Member |
| 5. | Joint Director (Admn), IARI,<br>New Delhi 110 012 | Member |
| 6. | OSD (WS), ICAR | Member-Secretary |

These committees have to give their recommendations within 6 months. The Committees will among other aspects consider provision of minimum promotional avenues in the system, removal of stagnation and minimum desirable functional support at different levels in terms of administrative and financial management. Detailed exercise had been taken up for restructuring and strengthening of the legal set-up at headquarters to cope-up with the increased workload effectively and systematically. As a result, two posts of Junior Law Officer (Pay Scale Rs 1640-2900) have been upgraded to Assistant Legal Adviser (Pay Scale Rs 2000-3500) and one of these has already been filled-up by promotion of an eligible Junior Law Officer. Proposal for creation of 12 additional senior and middle-level administrative posts through redeployment of some vacant posts of scientific category at headquarters for strengthening the headquarters set-up of ICAR to cope-up with the increased work over the past about a decade mainly in terms of the monitoring and servicing functions is already in process at the highest level with the Ministry of Finance, Department of Expenditure. About 5% posts in different categories (administrative, technical, supporting and auxiliary), numbering 1,393, have already been surrendered and abolished for effecting economy in establishment expenditure in pursuance of the directive of the Ministry of Finance for 10% cut in posts in different categories. Besides, concerted efforts have also been made to fill-up the vacant posts of administrative category in different grades, particularly going by the critical requirement areas.

Some details of promotions, direct recruitment, limited departmental examinations etc. are given in the box.

**Promotion**

| | | | |
|---|---|---|---|
| 1. | Director (Personnel) | : | 1 |
| 2. | Deputy Director (P) | : | 2 |
| 3. | Controller of Examinations, ASRB | : | 1 |
| 4. | S.A. to Chairman, ASRB | : | 1 |
| 5. | Deputy Director (OL) | : | 1 |
| 6. | Assistant Director (OL) | : | 1 |
| 7. | Assistant Legal Adviser | : | 1 |
| 8. | Under Secretary | : | 1 |
| 9. | Desk Officer | : | 2 |
| 10. | Junior Analyst | : | 1 |
| 11. | Private Secretary | : | 2 |
| 12. | Senior Personal Assistant | : | 3 |
| 13. | Chief Admn. Officer | : | 1 |
| 14. | Senior Admn. Officer | : | 9 |
| 15. | Admn. Officer | : | 5 |
| 16. | Chief Finance and Accounts Officer | : | 1 |
| 17. | Senior Finance and Accounts Officer | : | 2 |
| 18. | Finance and Accounts Officer | : | 3 |
| 19. | Section Officer | : | 6 |
| 20. | Chief Publicity and Public Relations Officer | : | 1 |
| 21. | Assistant | : | 20 |
| 22. | U.D.C. | : | 26 |
| 23. | Steno. Grade III | : | 4 |
| 24. | P.A. | : | 2 |

**Limited Departmental Examination**

| | | | |
|---|---|---|---|
| 1. | L.D.C. | : | 04 |

**Direct Recruitment**

| | | | |
|---|---|---|---|
| 1. | Section Officer<br>Recommended by ASRB on the basis of Combined Competitive Examination | : | 15 |
| 2. | Assistant<br>(ASRB has nominated 25 candidates, out of which 3 have already joined. Pre-appointment formalities are being completed in respect of others). | : | 25 |
| 3. | Junior Law Officer | : | 1 |
| 4. | Hindi Translator | : | 1 |
| 5. | Record Keeper | : | 1 |
| 6. | L.D.C. | : | 11 |
| 7. | Driver | : | 1 |
| 8. | Peon | : | 1 |

**Research Management Posts**

| | | | |
|---|---|---|---|
| 1. | Director | : | 7 |
| 2. | A.D.G. | : | 3 |
| 3. | Project Coordinator | : | 5 |

**Scientific Posts**

| | | | |
|---|---|---|---|
| 1. | Principal Scientist | : | 4 |
| 2. | Senior Scientist | : | 4 |
| 3. | Scientist | : | 122 |

**Technical**

The information is being procured.

## Important Decisions

### *A. Administrative Category*

1. During the years 1986-89 some Section Officers who were promotees had been promoted to the posts of Under Secretary by counting their ad-hoc services in the grade of Section Officer towards length of service

for eligibility on the basis of a special dispensation/relaxation to that effect in the recruitment rules of Under Secretary then accorded by G.B. of ICAR. As a result the Section Officers who had been senior to them then but recruited through LDE or Direct Recruitment but not eligible at that time and therefore were not considered were representing all along to also allow them the benefit of consideration when their juniors had been so considered. They had also filed a case in Hon'ble tribunal Principal bench, New Delhi. Going by that and the specific interim directions of Hon'ble tribunal in case OA No. 2406/88 the ICAR processed for such one time relaxation in their case and placed the same before GB in its meeting held on 11 June 1996, which was approved to rectify the anomalies created without adversely affecting the officers who got the benefit in pursuance of the earlier concession.

2. In Recruitment Rules of the posts of Under Secretary, Senior A.O. and Senior Finance and Accounts Officer, the administrative posts in the pay scale of Rs 3000-4500 were updated in terms of DOP&T guidelines and a note was inserted in the Recruitment Rules for consideration of eligible seniors when their juniors are considered for promotion. The same has already been notified as per approval of GB, ICAR and brought into effect from 2.12.1996.
3. Recruitment Rules of the post of F&AO have been updated through an amendment with the approval of GB, ICAR in terms of revised educational/professional qualifications in the particular context of present-day job requirement. The revised recruitment rules were notified vide ICAR No.14-4/96-E I dated 26.7.1996.
4. Revision and updating of recruitment rules of administrative posts of different grades both at institutes and headquarters have already been taken in process in pursuance of the recommendations of High-Power Dr K. V. Raman Committee report and approval in principle by GB, ICAR to that effect in its meeting held on 17 October 1996.
5. Training of administrative manpower in computer operations/handling, data entry, retrieval and basic computer software has been taken up in regular phases/batches to complement the office automation process and to facilitate quick information processing and retrieval through computerization in administrative functioning.

### *B. Scientific Category*

1. With the approval of the Governing Body, the upper age limit for appearing in the ARS Examination was enhanced to 33 years from 30 years for the candidates who hold Ph.D. degree. Consequently the upper age limit for SC/ST and OBC candidates holding Ph.D. was also increased to 38 years and 36 years respectively. The number of attempts for appearing in the ARS examination has been limited to three for all candidates including the in-service candidates of ICAR. This restriction, however, will not apply to SC and ST candidates who are otherwise eligible.
2. The discipline-wise cadre strength of Scientists in various grades has been fixed for each institute/headquarters of the Council.
3. A decision has been taken to extend the benefit of judgement delivered in the Court case filed by Rameshwar Singh and others (O.A. 1027/91) and consequently, allowing the revision of pay scales on UGC pattern also in those cases where the Scientists were on Study Leave as on 1.1.1986. Hence the Council has been able to remove anomalies that emerged on account of this judgement.
4. All the Scientists recruited in the erstwhile grade of S-2 as per old recruitment rules until 17.9.90 have been uniformly designated Senior Scientists irrespective of holding Ph.D. degree by them to remove major anomalies.

## RESERVATION OF POSTS FOR SCHEDULED CASTES AND SCHEDULED TRIBES

The following are the reservations in force in respect of Scheduled Castes/Scheduled Tribes in filling up vacancies:

| Recruitment | SC | ST |
|---|---|---|
| Direct recruitment as on All-India basis: | | |
| (a) By open competition (i.e. through the UPSC or by means of open competitive test held by any other authority) | 15% | 7-½% |
| (b) Otherwise than at (a) above Direct recruitment to Group C and Group D (Classes III & IV) posts, normally attracting candidates from a locality or a region | 16-2/3 % In proportion to the population of SC & ST in the respective States/ Territories | 7-½% |

These reservations have been made applicable to the ICAR and its research institutes and centres. The position regarding the percentage of Scheduled Castes and Scheduled Tribes at the ICAR headquarters and its research Institutes/National Research Centres/Project Directorates is indicated below during the year 1995-96.

| Category of posts | Percentage of SC | Percentage of ST |
|---|---|---|
| Scientific | 6.32% | 0.59% |
| Technical | 18 58% | 5.63% |
| Administrative | 18.03% | 5.58% |
| Supporting Staff (excluding safaiwala) | 30.37% | 5.88% |
| Supporting Staff | 82.93% | 1.03% |
| Auxiliary | 21.19% | 10.64% |

A statement showing the total number of employees in the ICAR and its research institutes and number of Scheduled Castes and Scheduled Tribes amongst them for the year 1995-96 is appended.

## PROGRESSIVE USE OF HINDI

During 1996-97, under the Rule 10(4) of Official Languages Act, 1976, nine Institutes/ Centres of the Council, viz. CMFRI, Cochin; IIPR, Kanpur; NRC for Oilpalm, Eluru; CPRI, Shimla; NRC for Citrus, Nagpur; NRC for Camel, Bikaner; NRC for Cashew, Puttur; NRC for Mushroom Research and Training, Solan; and Project Directorate on Cattle, Modipuram (Meerut) were notified in the gazette of the Government of India till date.

Joint Official Language Implementation Committee of the DARE and the ICAR, constituted under the Chairmanship of the Joint-Secretary, DARE/Secretary, ICAR, is meeting every quarter regularly. Instructions have been issued to all the institutes for similar action. As a result, 54 institutes have so far constituted such committees and are holding their meetings. The remaining institutes have also been asked to constitute immediately such committees.

Roasters have been maintained for Hindi, Hindi typing and Hindi stenography training of the non-Hindi knowing officers and staff, Junior clerks and Stenographers respectively, and they are being deputed for training every year in January and July.

Hindi fortnight was celebrated during 16 to 30 September 1996 at the ICAR headquarters and its institutes. Other Institutes/Centres and Bureaux of ICAR also celebrated Hindi fortnight, during which various competitions were organized. During the prize-distribution function, colourful cultural programmes were organized by different institutes.

Cash awards were given away to five staff members of ICAR for doing their maximum possible Official Work in Hindi during 1995-96. Two First Prizes worth Rs 500 each and three Second prizes worth Rs 300 each were awarded. These awards were presented to the winners on 25 October 1996, on the closing ceremony of Hindi workshop.

During this year till now three workshops have been organized to overcome the hesitation of officials in doing their official work in Hindi. Besides section officers/technical officers, assistants and upper division clerks of the Council also participate in these workshops.

The Central Institute for Fisheries Education, Mumbai, gave away the first prize of Rs 500 to one of its non-Hindi speaking students for submitting his dissertation in Hindi.

'Aashirwad' an institution dedicated to Literature, Art and Culture, awarded second prize to the Central Institute for Cotton Research Technology, Mumbai, for conducting their maximum official work in Hindi. The Indian Research Institute for Lac, Ranchi, was awarded second prize by the Town Official Language Implementation Committee for excellent work done by them in Hindi during 1995–96.

To review the progressive use of Hindi in the Official work till now, six Sections of the Council, viz. Per. I/II/III; Gen. Admn. I; Institute Administration IV; and Estt. V were inspected. Similarly, IISR, CISTH, Lucknow; CSSRI and NDRI; Karnal; DWM, Rahuri; CSWCRTI, Dehra Dun; and IVRI and CARI, Izatnagar; have also been inspected so far.

Official Language Implementation Committee of the Council has decided to award shields/ trophies from 1997–98 onwards to the institutes of the Council which do their maximum Official Work in Hindi.

## VIGILANCE

In DARE, the Joint Secretary (DARE) is the Chief Vigilance Officer for the employees. The Director (DARE) has been designated as Director (Vigilance). All the cases of vigilance and disciplinary proceedings are processed through him.

Presently no vigilance case is pending so far as the DARE is concerned.

In ICAR, the Secretary, ICAR and Joint Secretary, DARE, function as Chief Vigilance Officer (CVO) in respect of the ICAR employees. The Chief Vigilance Officer is assisted by Director (DARE)—who also functions as Director (Vigilance)—Under Secretary (Vigilance) and Desk Officer (Vigilance).

As on 2 December 1996, all the 817 court cases (tentative) were pending, out of which 96 related to scientific category, 117 each to technical and administrative category, and the rest to labour, land acquisition etc. Among institutes, total 400 court cases were pending, the maximum being at the IVRI, Izatnagar.

## FINANCE AND AUDIT

### Financial Outlay

The Ministry of Finance approved the following Budget Grant for the Indian Council of Agricultural Research as reflected in Demand No. 3-DARE (Appendix 3 : DARE).

The total allocation of Rs 528.90 crores for 1996-97 has been reduced by the Ministry of Finance by Rs 16.17 crores than the allocation for 1995-96 (B.E.).

The ICAR is allowed to utilize its internal resources such as revenue receipts and recoveries of loans and advances for meeting the Non-Plan expenditure. These are taken into account for formulating the Non-Plan budget.

(Rs in crores)

| | Budget estimates 1995-96 | Revised estimates 1995-96 | Budget estimates 1996-97 |
|---|---|---|---|
| 1. Non-Plan (excluding A.P.Cess collections) | 221 57 | 226 00 | 226 00 |
| 2 Plan | 309.50 | 289.60 | 288.90 |
| 3. A.P Cess collections | 14.00 | 14 00 | 14.00 |
| Total (1 to 3) : | 545.07 | 529.60 | 528.90 |

The break-up of ICAR's Internal Resources available as additional resource for 'Non-Plan' expenditure is given below.

(Rs in crores)

| | Budget estimates 1995-96 | Revised estimates 1995-96 | Budget estimates 1996-97 |
|---|---|---|---|
| i) Revenue receipts | 11.50 | 12.70 | 15.00 |
| *Interest earned on short term deposits of surplus funds by all respective Institutes/ NRCs/PDs, etc. | | 3.30 | |
| ** Income from interest on Short-term deposits of surplus funds in SBI as per Ministry of Finance instructions. | | 6 98 | |
| ii) Recoveries of loans and advances | 5.00 | 5.00 | 5.00 |
| Total (i to ii) : | 16.50 | 27.98 | 20.00 |

The Budget Estimates were approved by the Standing Finance Committee on 16.10.1996 and by the Governing Body on 17.10.96.

**Audit Observations**

A total of 304 Audit Reports with 1,640 Audit Paras relating to 85 ICAR institutes including its headquarters office, were outstanding as on 31 March 1996. The zone-wise break-up details of the outstanding Audit Reports/Audit Paras are as given below.

| Sl.No. | Name of Zone | Number of Institutions | Number of Audit Reports | Number of Audit Paras |
|---|---|---|---|---|
| 1. | West Zone | 8 | 36 | 193 |
| 2. | South Zone | 26 | 98 | 312 |
| 3. | East Zone | 14 | 63 | 290 |
| 4. | North Zone * | 37 | 107 | 845 |
| | Total | 85 | 304 | 1640 |

* Position as on 31 March 1995

Directors/Project Directors of the various Institutes/NRCs/PDs have been urged to take special efforts to ensure speedy clearance of the pending Audit Reports/Paras on priority basis.

## AWARDS

**Incentives and Rewards during 1996**

An appropriate incentive and attractive reward system in an organization makes the service efficient, productive, exciting and satisfying to the employees. The personal job satisfaction is clearly reflected in achieving the goals set by the organization.

During 1996, 32 scientists, 13 of their associates and four teachers were honoured with ICAR awards for their outstanding contribution in various disciplines of agricultural research. These scientists are pursuing agricultural research and extension activities in the ICAR institutes. One State Agricultural University and three ICAR Institutes have bagged the Best institution Awards instituted by the ICAR for the first time. Two Krishi Vigyan Kendras (KVKs) have been chosen for the Best KVK Awards.

Shri Chaturanan Mishra, Union Agriculture Minister and President of the ICAR Society, gave away these prizes on 16 October 1996 at Vigyan Bhavan Annexe, New Delhi.

**Best Institution Awards, 1995**

The Punjab Agricultural University, Ludhiana has bagged this award in the category of State Agricultural University. Two awards have gone to ICAR Institutes, one to the Indian Agricultural Research Institute (IARI), Pusa and another jointly to the Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad and the Central Potato Research Institute (CPRI), Shimla. This award carries a prize money of Rs 1 lakh and is instituted for the first time and is given on the basis of preceding 10 years' performance of the institution.

The Best Institution Award, 1995, was given to PAU, Ludhiana

The Punjab Agricultural University (PAU) has made valuable contributions in various disciplines of agriculture and has released 36 improved varieties/hybrids of cereals, 15 of pulses, 16 of oilseed crops, 36 of vegetable crops, 12 of horticultural crops and six of ornamental crops during 1984–1995.

The Best Institution Award for the year 1995 is awarded to the Indian Agricultural Research Institute, New Delhi. The widely popular world's first high-yielding dwarf Basmati is from this institute. About 45% of the nation's area under

pearlmillet hybrids is seeded by the hybrids developed by IARI. The institute has made significant contributions in other disciplines also, such as water management, biofertilisers and integrated pest management.

The Best Institution Award for the year 1995 is jointly awarded to the Central Potato Research Institute (CPRI), Shimla and the Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad. The CPRI was given this award for its pioneering research work in developing high-yielding pest-resistant, short duration potato varieties, low-input technologies, and feasible potato-based cropping systems for different parts of the country. The institute has also perfected a low investment-high return production technology based on true potato seed.

The CRIDA was given this award for its valuable contributions in dryland agriculture. The institute has made outstanding contribution to basic and applied sciences in important disciplines, which have paved the way for research and development of strategies for improving the productivity, ecological security and income generation for the dryland farmers in rainfed areas.

**Rafi Ahmed Kidwai Memorial Awards for Agricultural Research for the Triennium 1993–95**

Nine prizes of Rs 1 lakh each have been given to scientists in seven categories. The award for Crop Improvement has gone to Dr E A Siddiq, DDG (Crop Science), for his significant contribution in the field of Hybrid Rice Research. His contributions have earned for India the distinction of being the second country to usher in the 'Hybrid Era' after China. The award for Crop Protection has been given to Dr Tewari, Senior Scientist, CRRI, Cuttack, for his significant research for the control of a major fungal pathogen of rice.

The award in the category of Horticultural Science has been bagged jointly by Dr Sant Ram, Dean, G.B. Pant University, and Dr S S Negi, Director, CISTH, Lucknow. Dr Sant Ram has developed technology for regular and sustainable high productivity in mango by high density orcharding and control of alternate bearing and malformation in mango. Dr Negi has developed four varieties of grapes, seven varieties of gladiolus and three varieties of chrysanthemum.

Dr N K Tyagi, Director, CSSRI, Karnal, has got the award in the category of Natural Resource Management for his outstanding contribution towards Irrigation Water Management in Saline Environment.

Dr V M Mayande and Dr J C Katyal of CRIDA, Hyderabad, have got the award for Engineering and Technology for developing time-saving seeding and ploughing devices with modifications and improvements.

In the category for Animal Sciences, the award has gone to Dr N D Khanna and his associates, Dr A K Rai, Dr S P Agarwal and Dr V K Agarwal for conducting investigations on camel reproduction physiology for raising their population in India. The second award in the category of Animal Sciences has gone to Dr P K Sanyal and Dr D K Singh for their work towards developing self-medication devices for convenient and economical treatment and control of worm infection in ruminants.

Dr K Gopakumar Panicker has got the award for his outstanding contribution in the field of Fish Processing technology. The award in the category of Social Life Sciences has gone to Dr R Sathiadhas and his co-worker Dr K K P Panikkar for their outstanding research in the field of Fishery Economics.

**Fakhruddin Ali Ahmed Awards for Outstanding Agricultural Research in Tribal Areas for the Biennium 1994–95**

The award in the category for Agricultural Sciences has gone to Dr K Amrendra Singh and his co-worker Shri Indra Prasad Pradhan of ICAR Research Complex for NEH Region, Barapani, Meghalaya, for the research work for enhancement of forage resource availability for the livestock which is the mainstay of the economy of the North-Eastern Hills (NEH) Region.

The award for Animal Sciences has gone to Dr R B Rai and his associates Dr S Senani, Dr S P S Ahlawat, Dr A K Bandyopadhyay, Dr S Michael Raj and Dr M K Padhi of the Central Agricultural Research Institute, Port Blair. They have got the award for their significant work towards developing/modifying technologies for

qualitative and quantitative increase of livestock productions which helps in the upliftment of rural tribal people in Andaman and Nicobar Islands.

The award carries a cash amount of Rs 50,000.

**Vasantrao Naik Award for Research Application in Agriculture, 1995**

The Rs 1 lakh annual Vasantrao Naik Award for 1995 has gone to Dr B S Rana and Dr (Mrs) Swaranlata Kaul of National Research Centre for Sorghum, NRCS, Hyderabad for their significant contribution in developing sorghum varieties and hybrids for both *kharif* and *rabi* crops in dryland areas of the country. The award is given to a scientist or extension worker for outstanding contribution in the area of water conservation and dryland farming.

**Jawaharlal Nehru Awards for Outstanding Post-graduate Agricultural Research, 1995**

Fourteen Jawaharlal Nehru Awards in eight categories have gone to various young scientists. Dr V Dinesh Kumar and Dr S Leena Kumari have got the award for their significant contribution in Plant Genetics. Dr A S M Varshadhara Wesley has got the award for significant research in Microbiology; Dr R Selvaraju for his contribution in Soil Science; Dr Ramesh Kumar Sharma for Agricultural Physics; Dr D P Kumar and Dr Bhoopal Singh Tomar for Horticulture; Dr Saroj Kumar Nanda and Dr P K Gupta for Agricultural Engineering; Dr S S Mishra for Animal Health; Dr Kaushalya Kumari Naik and Dr H Shivananda Murthy jointly for Aquaculture; Dr N Nagaraj for Agricultural Economics; and Dr Bibudha Parasar for Agricultural Extension.

**Outstanding Woman Agricultural Scientist Award, 1995**

Dr (Mrs) Renu Khanna Chopra has bagged this award for her significant research contribution on various facets of plant metabolism. Dr Chopra has shown the use of osmotic adjustment as a selection criterion for breeding for stable yields in stress environment. The various physiological parameters emerging from Dr Chopra's work should be assessed by plant breeders, agronomists and other production scientists for developing efficient and widely adopted genotypes and resource management practices. This award carries a cash prize of Rs 25,000.

**Best Krishi Vigyan Kendra Awards for the Biennium 1994–95**

These awards are instituted for the first time and consist of two awards of Rs 50,000 each to be given away in alternate year, and given on the basis of the last 5 years' performance. The KVK Godipalli Krishi Vigyan Kendra, Nalgonda, A.P., and Krishi Vigyan Kendra, NDRI, Karnal, have bagged this award. KVK, Nalgonda, has excelled in Distant Learning Programme on "Training-

Dr (Mrs) Renu Khanna Chopra is receiving Outstanding Woman Agricultural Scientist Award, 1995. The award has been instituted for the first time.

cum-Production" of hybrid rice seed production and fruit plant nursery to generate revenue to the farmers. The Kendra has trained a large number of school drop-outs in nursery programmes and developed infrastructure for taking forestry programmes. KVK, NDRI, has restructured the traditional rural marketing system in the field of Dairy Processing in the district.

**Outstanding Extension Scientist/Worker Awards for the Triennium 1994–95**

Four awards for Rs 10,000 each are being given away for the first time to the outstanding scientists/workers for their innovations in developing extension education programmes, adopting extension methodologies and creating impact of the programme on the farming community. Dr (Mrs) Krishna Srinath of CIFT, Cochin; Dr D Somasundaram, TNAU, Kallikulam; Dr M P Srivastava, HAU, Hisar; and Dr K C Bhardwaj, CIAE, Bhopal have got this award for 1993–95. Dr (Mrs) Srinath has made significant contribution in Fisheries Extension Education and services to the socio-economically backward communities in Cochin. Dr Somasundaram's main contribution has been with regard to the innovative extension education programmes in Oilseeds and Pulses. Dr Srivastava has developed extension education programme for disease management in crop cultivation and mushroom. Dr Bhardwaj has made innovative contributions in Agro-Industrial Extension.

**National Awards for Outstanding Teachers for the Biennium 1994–95**

Dr S K Arora, HAU, Hisar; Dr Y Rathaiah, AAU, Jorhat; Dr Mahendra Pal Bansal, IVRI, Izatnagar and Dr (Mrs) K Saroja, UAS, Dharwad have bagged this award, which carries a cash prize of Rs 20,000 each. The award has been given for the first time to provide encouragement for good teaching and to recognize outstanding teachers in the field of agriculture.

## PERSPECTIVE PLANNING

The following plans were formulated in the Planning Unit of the ICAR.

**Perspective Plans**

In the present competitive world, consistent endeavors to attain an extra edge and to harness benefits from one's strength is of paramount importance. This objective pre-emptively requires realization of strong and weak areas in one's field. With added value of commerce in agriculture, development in the country would be guided not only by the compulsions of improving food and nutritional security, but also by the concerns for environmental protection, sustainability and profitability. In the coming years, agriculture will face challenging situations on the ecological, global climatic, economic, equity, social justice, energy and employment fronts. This would necessitate reorientation of the institutional set up, and the mandate envisaging the existing and upcoming teaching, research and extension needs. The system has to be forward looking, visible, competitive, effective, efficient and relevant. It is in this background that formulation of a perspective plan for each of the ICAR Institutes, National Research Centres, Bureaux and Directorates was conceived by the Council during 1994.

Preparation of a perspective plan visualizing a situation 25 years hence calls for a serious introspection of past performance and clear assessment of the present to place the future on a sound plan, obviously keeping in view strengths, weaknesses, opportunities and threats. With the detailed guidelines formulated and provided, the draft perspective plan of 84 institutes was prepared and subjected to peer review. The perspective plans of 46 institutes have been approved for printing. Thereafter, the perspective plan was made with a time frame up to 2020 AD, with clearly spelt out options and likely changes, and putting the changes in the right perspective to capitalize on each of our strengths. It includes sections such as mandate, growth, research attainments, impact assessment, scenario, perspective, issues and strategies, programmes, resource generation, review, reporting, evaluation arrangements etc. It is hoped that the perspective plans formulated after 2 years of concerted efforts once implemented would be a path-breaking milestone in the history of Indian agriculture.

## NATIONAL PRIORITIZATION OF PRODUCTION SYSTEMS

| Production system | National Food Security | House-hold Food Security, Poverty Alleviation and Equity | Environment and/or Biodiversity Conservation | Sustainability issues | Product diversi-fication potential | Tribal/Gender Benefits | Commercial and/or Export |
|---|---|---|---|---|---|---|---|
| Arid Agro-ecosystem | | | | | | | |
| – Agri-silvi-horti-pastoral | ** | *** | *** | *** | ** | ** | ** |
| – Livestock & Fish | ** | *** | * | * | *** | * | ** |
| Coastal Agro-ecosystem | | | | | | | |
| – Fish & Livestock | ** | *** | * | *** | ** | * | *** |
| – Agri-horticultural | * | ** | ** | *** | *** | * | ** |
| Hill & Mountain Agro-ecosystem | | | | | | | |
| – Agri-horticultural | ** | *** | *** | *** | ** | *** | *** |
| – Livestock & Fish | * | ** | ** | ** | ** | ** | * |
| Irrigated Agro-ecosystem | | | | | | | |
| – Rice-wheat | *** | * | ** | *** | *** | * | ** |
| – Cotten based | * | * | ** | ** | ** | * | ** |
| – Sugarcane based | ** | * | ** | *** | *** | * | ** |
| – Dairy | * | *** | * | ** | *** | * | ** |
| Rainfed Agro-ecosystem | | | | | | | |
| – Arable | ** | *** | ** | *** | *** | ** | * |
| – Agro-forestry | * | *** | ** | ** | *** | ** | ** |
| – Livestock based | * | ** | ** | *** | ** | ** | ** |

Key: * moderate relevance to indicate national priority
** high relevance
*** very high relevance

**National Agricultural Technology Programme**

India possesses one of the largest and most complex public systems for the generation, testing and transfer of agricultural technology. While the complexities of technology generation and transfer are increasing, the resources which India can afford to devote to public research and extension are declining in real terms. Infrastructure and equipment are degenerating. Programmes are jeopardized by lack of operating funds, and incentive and job satisfaction for the staff are eroding. Often human resource development programmes have emphasized numerical targets at the expense of quality. Modern information technology to improve policy planning and management has not been adequately tapped.

In this background, the overall objective of the NATP is to fill the critical gaps to augment the national capacity and efficiency in agricultural research, technology, development and technology transfer for increasing agricultural productivity, sustainability, profitability and equity. This is expected to be achieved through improving the congruence between policy goals and overall resource allocations for agricultural technology generation, assessment and transfer; enhancing the relevance and efficiency of technology processes through improved policy planning, management procedure and participatory approaches; developing adequate and quality human resources at various levels; and strengthening infrastructural and institutional milieu for research and extension.

Priority setting and marix driven programme prioritization cutting across crops, commodities and disciplines are finalized. The first draft NATP document was prepared in June 1996, and the actual project document is finalized for pre-appraisal by the World Bank. The project is likely to have an outlay of about Rs 9,000 million as a loan assistance from the World Bank for 5 years. The National Prioritization of Production Systems (p. 24) are made and commensurate research programmes are contemplated. Apart from programme mode of operation, mission mode approach is put in place besides centres of excellence approach for strategic and upstream research and human resource development. Innovative models for technology assessment, refinement and transfer through an interface mechanism are envisaged. It is hoped that the whole programme after final agreement with the World Bank would be put to operation during 1997 and once implemented it would provide a cutting edge to science, technology generation and dissemination processes.

**ADMINISTRATIVE REFORMS 1996-97**

During the last 1 year, the ICAR has steadily moved on consolidating and continuing on renewal process, as evidenced from the following achievements/progress.

1. An all-round development and strengthening of linkages with the development departments/agencies has taken place both at the Central and State level, including the NGOs and Private Sector. The DAC-ICAR Interface has achieved newer heights. The Vice-Chancellors of the State Agricultural Universities are also invited to provide their inputs at both the Rabi and Kharif Campaigns. The Regional Committees have become effective instruments for setting up the regional research and development agenda, where active participation of State-line departments has been witnessed in recent meetings. New Joint Panels have been set up with the Department of Food, Department of Food Processing, CSIR, MNES, NABARD, etc. Sub-group II of the Planning Commission Working Group on Agricultural Research and Education for IX Five Year Plan has further identified area of cooperation and linkages with sister R&D organisations and State Sector. At the initiative of the Hon'ble Agriculture Minister, the ICAR has set up 11 Social Audit Teams involving Members of Parliament and Members of State Legislative Assemblies, which will provide further fillip and interface with political leadership and representatives of people at the grass-root level.

2. Dr G V K Rao Committee recommenda-

tions, which had been pending for a long time, are at the final phase of implementation. Similarly, the Tata Consultancy Report on restructuring the ICAR Headquarters has been receiving utmost attention. During the year all the PIC/EFC meetings for VIII Five Year Plan have been completed and all the pending proposals based on the projections of VIII Plan have been cleared.

3. The new schemes/programmes of national importance such as IVLP and Hybrid Vegetable Seed Production Programmes have made significant achievements at the field level. The Revolving Fund Schemes have been processed and sanction orders issued. However, fresh proposals are not coming up to the expectations both in number and quality.

4. Based on the Perspective Plan and the Planning Commission Working Group Report on Agricultural Research and Education for IX Five Year Plan, each Institute/NPC/PD/AICRP is to formulate the Five Year Plan document.

5. In pursuit of decentralization, powers have been further delegated to Joint Directors, Heads of the Divisions, Project Coordinators and the Principal Investigators of ICAR Ad-hoc schemes. To bring about new perceptions and new style of management, a meeting had been held with all the Administrative Officers and Finance & Accounts Officers to impress upon the implementation of new policies and programmes.

6. During the year, Rules governing RACs and SRCs were amended. A meeting of all the Chairmen, RACs was held to work out the modalities for smooth and effective functioning of RACs and SRCs. Based on these recommendations, further changes are on the anvil.

7. There have been a number of initiatives for improving the service conditions/removing the anomalies in the scientific/technical/administrative services of the Council. An amendment to 'Study Leave' has been issued. The 'Sabbatical Leave' system has been introduced for the first time in the ICAR. The age limit of ICAR employees holding Ph.D. degree has been enhanced to enable them to appear in the ARS examination. The anomaly in the date of increment on introduction of Fourth Pay Commission for ARS Scientists has been removed. Appointments of T-5 to T-6 under 'Promotions Quota' have been made, thereby removing the stagnation in Technical Services. Similarly, category bar for I to II has been effected with certain stipulations; DPCs were held for clearance of EB in respect of 16 Officers, promotion of 7 A.A.O.s to A.O., two Section Officers to Desk Officers and six assistants to ad-hoc Section Officers.

8. The Agricultural Research Information System (ARIS) has also posted significant achievements in Computer Networking with the ICAR headquarters.

9. Construction work has begun on National Agricultural Science Centre and Krishi Anusandhan Bhavan II. The office space in Sections is being modernized and rearranged division-wise for smooth functioning at the ICAR headquarters.

10. Indo-Russian and Indo-Mongolian work plans were signed for mutual cooperation in Agriculture.

11. The Council has also received highest national and international recognition. The ICAR was bestowed the Indira Gandhi Rajbhasha Award for 1994–95 by the President of India. The Asia and Pacific Seed Association Award, Sir Chhotu Ram National Award, Borlaug Award, World Food Day Award, PPIC-FAI Award, IWSS Award are among some of the awards which were bestowed to ICAR scientists. In addition,

the Council has also bestowed its own several awards to the best institutions as well as to the scientists. These include Best Institution Award, Best KVK award, Outstanding Extension Worker Award, Outstanding Teacher Award, Outstanding Women Agricultural Scientist award, in addition to its several existing prestigious awards, viz. Rafi Ahmed Kidwai Awards, Fakhruddin Ali Ahmed Awards for Agricultural Research in Tribal Areas, Vasantrao Naik Award for Research Application in Agriculture and the Jawaharlal Nehru Awards for Best Ph.D. thesis.

12. *ICAR News* and *ICAR Reporter* have achieved tremendous visibility and have become effective means for mass communication within the ICAR family and outside. To provide large platform for its multifacet activities, the P&I Division has been given the status of a directorate, the Directorate of Publications and Information on Agriculture.

# Agricultural Scientists' Recruitment Board

The major initiatives/achievements of Agricultural Scientists Recruitment Board are given below.

***1. Agricultural Research Service/National Eligibility Test/Senior Research Fellowship Examination, 1995*** : The result of National Eligibility Test on the basis of the Agricultural Research Service/National Eligibility Test/Senior Research Fellowship Examination held in October 1995 was declared by the Board. Viva-voce in all the disciplines where vacancies are available in the ARS were conducted during June-July 1996. The result of ARS and Senior Research Fellowship is yet to be declared for want of information from the Personnel Division and Education Division of the ICAR regarding category-wise reservation of posts/seats in each of these disciplines.

***2. Agricultural Research Service/National Eligibility Test/Senior Research Fellowship Examination, 1996*** : The Agricultural Scientists Recruitment Board announced the National Eligibility Test/Senior Research Fellowship Examination, 1996 in April 1996. More than 6,000 applications were received in response to the advertisement. Subsequently, the Council sent indent to fill up vacancies of ARS in 34 disciplines and it was decided to hold a combined examination for ARS/National Eligibility Test/Senior Research Fellowship in December 1996. Accordingly a separate notification was issued for ARS examination in September 1996. In response to both the notifications around 10,000 applications were received. All arrangements for holding the examination at 25 centres from 27 to 29 December 1996 have been completed by the Board. Admission certificates have also been issued to the candidates.

***3. Examinations for Administrative Posts, Combined Competitive Examination for Section Officers and Assistants at ICAR Headquarters*** : The result of the Combined Competitive Examination for Section Officers and Assistants, held in December 1995 has been declared by the Board. For the post of Section Officer 15 candidates and for the post of Assistant 25 candidates have been recommended for appointment. The result was sent to the Council on 7 October 1996.

***4. Limited Departmental Examination for Recruitment of Personal Assistants (Stenographer Grade II)*** : The result of this examination, conducted by the Board on 24 and 25 July 1995 has since been declared. Out of the 27 candidates appeared for the examination, only two candidates were declared successful after assessing their performance at the written examination, shorthand test and evaluation of annual confidential reports. The recommendations were sent to the Council for making appointment.

***5. Limited Departmental Examination for recruitment of Section Officers at ICAR*** : A Limited Departmental Competitive Examination for recruitment of four posts of Section Officer was conducted by the Board from 22 to 24 October 1996. In all 23 candidates applied for the examination, out of which 12 actually appeared. After assessing their performance at the written examination and evaluation of confidential reports, the Board declared four candidates (two General, one Scheduled Caste and one Scheduled Tribe) successful for appointment to the post of Section Officer. The result is being processed.

***6. Limited Departmental Competitive Examination for Recruitment of Assistants at ICAR Headquarters*** : The Board conducted a Limited Departmental Competitive Examination for recruitment of nine posts of Assistant at

ICAR headquarters on 22 and 23 October 1996. In all 50 candidates applied for the examination, out of which 32 appeared. After assessing their performance at the written examination and evaluation of Annual Confidential Reports, the Board declared eight candidates (six General and two Scheduled Caste) successful for appointment to the post of Assistant. The result is being processed.

**7. *Direct Recruitment*** : Interviews for Direct Recruitment to 82 posts were held and the recommendations sent to ICAR. These posts (listed in box) include 77 scientific and five technical (T-6). For the remaining posts already advertised, the process of arranging the interviews is going on.

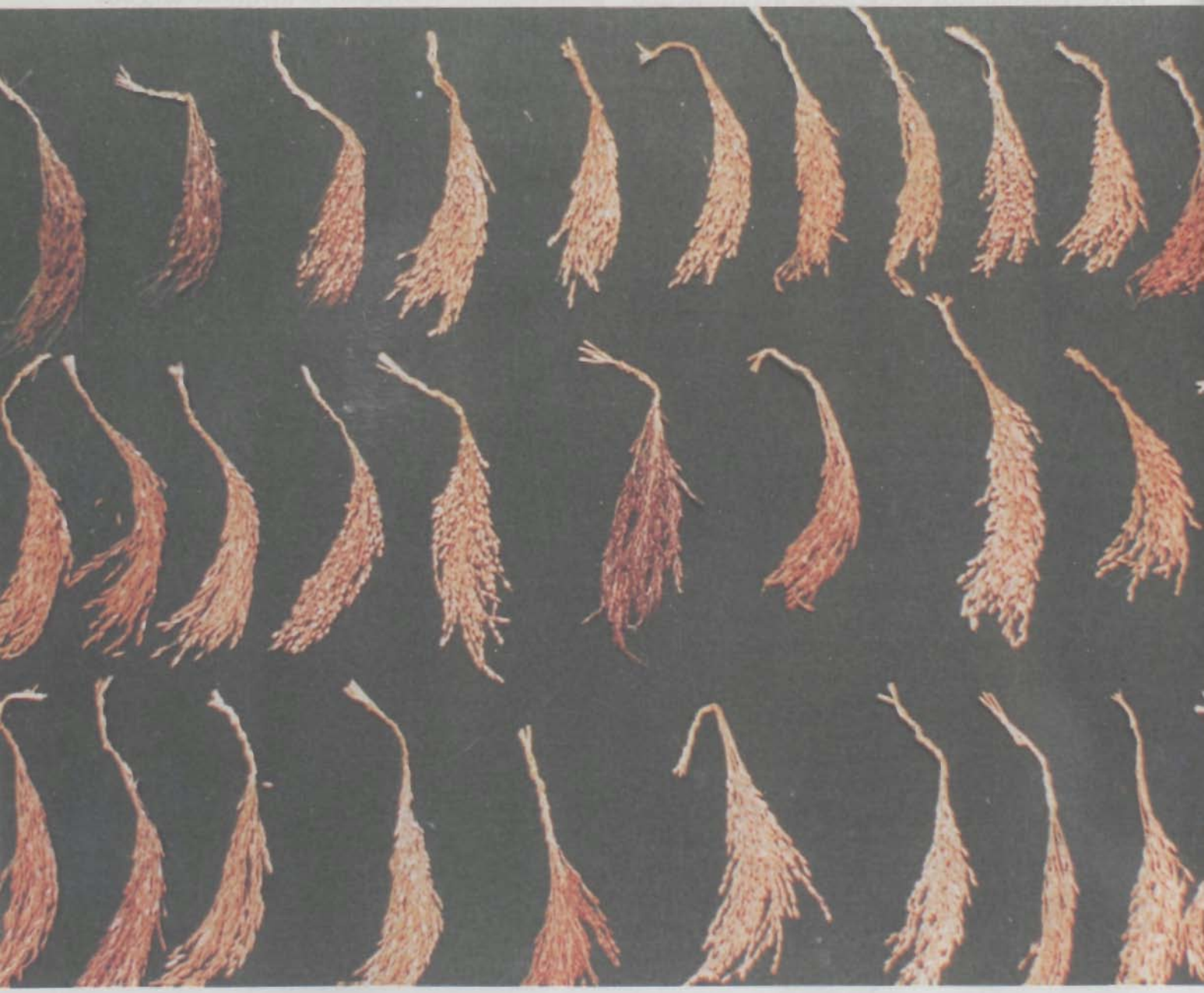
| | |
|---|---|
| Deputy Director-General | 1 |
| Assistant Director-General | 5 |
| Joint Director | 7 |
| Project Co-ordinator/Director | 11 |
| Director | 5 |
| Director (National Level Inst ) | 1 |
| Zonal Co-ordinator | 1 |
| Head of Division | 46 |
| Technical | 5 |
| Total posts | 82 |

**8. *Advertisement of Posts*** : During the period under report two advertisements were issued, covering 94 posts, which included 63 posts of Research Management position and 30 posts of Head of Division of institutes and one Technical post. The applications received in response to advertisement have been or are being processed and interviews are being held.

**9. *Assessment Review/Assessment Induction*** : As many as 10 cases of scientists from various disciplines were assessed. During this period three cases of RMP grade induction to ARS were processed and one case of induction of S-2 grade was processed and its recommendations were sent to ICAR.

# Major Research Achievements

## Crop Sciences



Rich landrace genetic diversity occurs in rice in Chhotanagpur plateau

# 2. Major Research Achievements

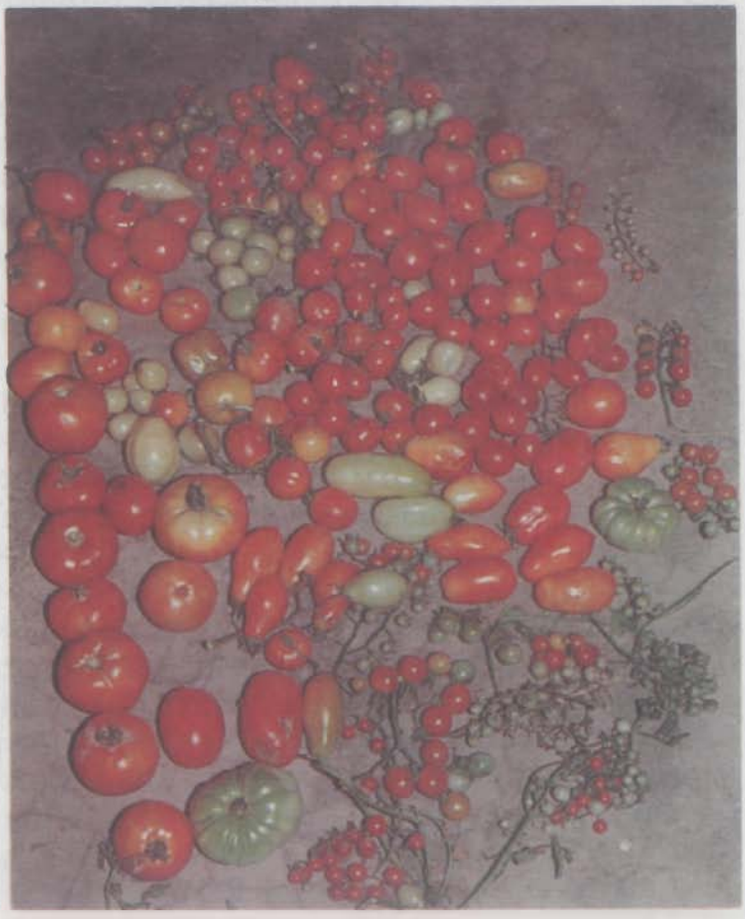
## Crop Sciences

### Conservation of Plant Genetic Resources

The National Bureau of Plant Genetic Resources, in-line with its mandate of activities, is engaged in augmenting its germplasm holdings through continued explorations and germplasm collection, exchange of germplasm with institutions in other regions of the world, quarantining of incoming and outgoing plant materials, besides characterization, evaluation and documentation of germplasm and its conservation as seed and other planting materials.

- Collected over 657 accessions of various agri-horticultural crops, and received 28,122 samples of crops from 18 countries
- Evaluated a total of 860 accessions, comprising 705 of chillies, 5 of *Ficus* and 150 of medicinal and aromatic plants
- Received 5,121 accessions in genebank for long-term conservation

Germplasm variability in tomato, managed at the NBPGR



**Exploration and Germplasm Collection**

To enrich plant-genetic resources, 5 explorations were undertaken in diversity-rich, under-explored areas. Over 657 accessions of various agri-horticultural crops were collected. During 1996–97 diversity belonging to the following crops/crop groups was collected.

***Lasora* (*Cordia myxa*).** A total of 45 samples exhibiting variability in plant habit, branching, stem girth, leaf size and shape, fruit size, shape, weight, colour and total sugar were collected from the drier parts of Haryana in collaboration with the CCS HAU, Hisar.

***Pulses.*** Germplasms of cowpea (25), urdbean (blackgram) (16), mungbean (greengram) (8), pigeonpea (23), horsegram (15) and lablab bean (40), exhibiting variability in grain size and shape, were collected from tribal tracts of Khammam and Nalgonda in Andhra Pradesh.

***Mango.*** Eighty accessions, belonging to 47 polyembryonic types, were collected from the parts of Thrissur and Palakkad (Kerala).

An exploration was also undertaken for jackfruit collection in Lohardaga, Palamau (Daltonganj) and Garhwal, and Gumla and Ranchi districts of south Bihar. Eighteen samples of jackfruit and one sample of *barhal* (*Artocarpus lakoocha*) were collected. *Rohina* (early-maturing type), *Savania* (medium -maturing type) and *Bhadia* (late-maturing type), the 3 local types of jackfruit, were common in these areas. Another local type, known as *Barahnasya*, bearing fruits round the year, was also collected from Lohardaga.

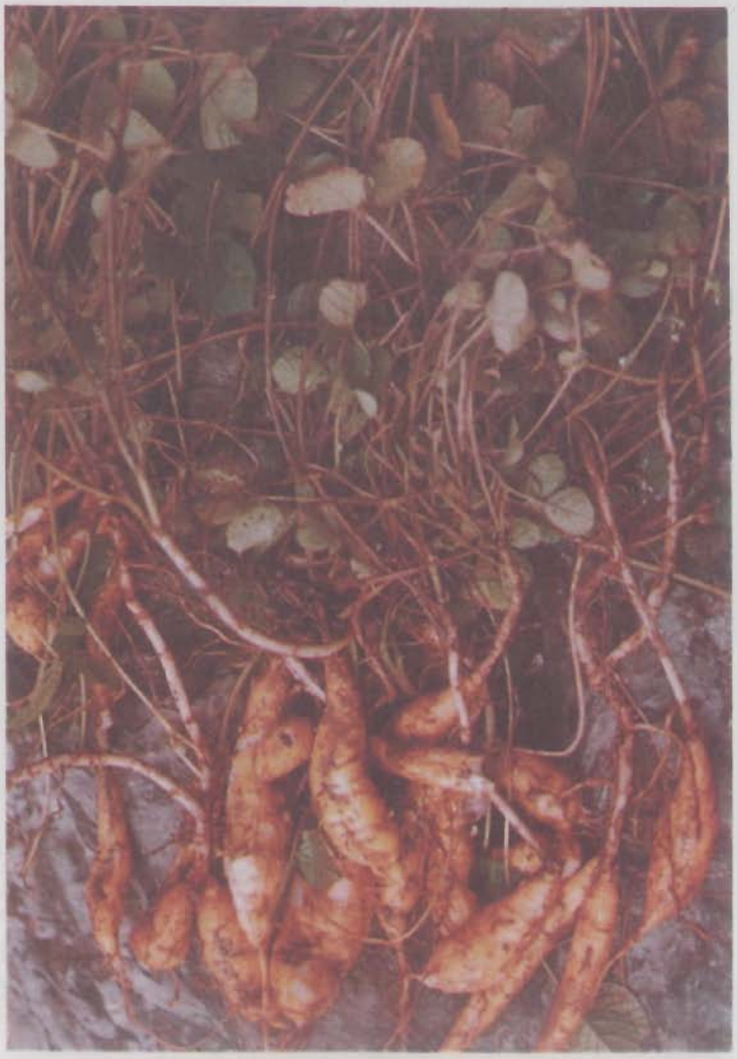
In pointed-gourd (*Trichosanthus*), 66 accessions were collected from West Bengal and parts of south Bihar. One exploration was also made for collection of banana and *taro* germplasm from Mizoram. Parts of Aizawl, Lunglei and Longtlai subdivision of Saiha were surveyed, and a total of 124 accessions were collected. Variability was also collected in indigenous wild species of *Musa*—locally known as *Changvandawf, Changthir, Changpui, Changpawl* and *Lairawk*. High-yielding local varieties were also collected from Champhai area of Aizawl.

Seed samples of *Cicer arietinum, Vigna radiata, Cajanus cajan, Eleusine coracana, Setaria italica, Capsicum annuum* and *Solanum melongena* were received from Hyderabad Station (Andhra Pradesh). Reference samples of these have been cryopreserved. *Geranium lucidum, G. robertianum, Digitalis viridiflora, D. trojana* and *D. grandiflora* and species of *Carthamus* received through Germplasm Exchange Division are also represented in the seed museum. *Lathyrus, Lens and Cicer* were received through Exchange Division of the NBPGR and *Eremostachys superba* from the Cryopreservation Section.

**Germplasm Exchange**

About 28,122 samples of different agri-horticultural crops were received from 18 countries. These include 13,280 samples of rice trials and nurseries from the IRRI, the Philippines, and 10,886 samples of maize trials from the CIMMYT, Mexico. Some introductions with desirable traits include: soybean EC 391305-352

Tuberous roots of *Moghania vestita* from Garhwal Himalayas. These roots are edible and have high nutritive value



from the USA, having resistance to bacterial pustules, insect pests, powdery mildew, soybean mosaic virus, crown rot, stem canker, frog-eye leaf-spot, with bold seeds, high oil/protein content, short duration and photo-thermoinsensitivity, soybean EC 393220-21 from Australia and EC 399011-12 from the Philippines with resistance to rust; high-yielding, disease-resistant varieties of mungbean, urdbean, mothbean, ricebean and cowpea (EC 390990-1009) from Taiwan; tomato EC 391024 from Australia with long-storage life, and resistance to *Fusarium* wilt, TMV and nematodes; small- to medium-size, round/oval red-fleshed fruits of watermelon EC 393240-43 from the USA; wild brinjal EC 393238-37 from South Africa; 4 species of *Cicer* EC 393761-75 from Syria; and 8 species of *Sorghum* (EC 393054-99) from Australia; high-yielding, long-duration as well as short-duration varieties of mungbean (EC 396097-150) from the AVRDC Centre, Thailand, and large-seeded and long-podded types with synchronous maturity (EC 393407-10) from Bangladesh; soybean with low lipoxygenase activity (EC 396424-25) from the USA; high-yielding lentil varieties (EC 397181-814) from Slovakia; local high-yielding good quality varieties (EC 393723-50) of apple, pear, peach, cherry, plum and olive from Iran. Besides, wild species of *Linum* (5), *Carthamus* (4), *Sorghum* (10), *Cicer* (8) and *Helianthus* (15 species) from the USA, Australia, ICARDA, Syria and Yugoslavia have also been introduced.

Under the germplasm-exchange programme, 424 samples of different agri-horticultural crops were exported to 13 countries. These include accessions of wheat, rice, maize, castor, sesame, soybean, *Lathyrus*, lentil, potato, sweet-potato, *Citrus*, *Amaranthus*, cotton, *Moringa*, groundnut, safflower, sunflower and potato.

Also, promising accessions of various agri-horticultural crops available at the Bureau were supplied to breeders and researchers of the private research institutes and seed companies and progressive farmers in the country. In total, 6,302 samples were supplied from the Headquarters and 2,036 samples were supplied by the regional stations of the Bureau.

**Plant Quarantine**

A total of 57,619 samples of agri-horticultural crops were received for quarantine examination and clearance. Out of these, 56,593 samples were imported from different countries and 1,017 samples were meant for export. Detailed examination revealed that 111 samples were infested with insects and mites, 5,710 with nematodes and 396 with pathogens. Infested/infected samples were salvaged through mechanical cleaning, fumigation, X-ray radiography, pesticidal spray/dip and hot-water treatment. Paddy samples (8,894) were given prophylactic hot-water treatment at 52°C for 30 minutes. Nematicidal-dip treatment was given to yam-tubers (one sample) against *Rhabditis*. Trisodium phosphate treatment (10%) was given as a prophylactic measure to tomato (32) and *Capsicum* (163) against TMV virus, known to be seed-borne. Only 10 samples of soybean infested with *Peronospora manshurica* were rejected. A total of 15 phytosanitary certificates were issued for consignments under export. Some interceptions of economic significance in imported germplasm included the following.

***Insects and mites.*** *Acanthoscelides* in *Leucaena* seeds from the UK; *Systole* in *Coriandrum sativum* seeds from Denmark and the USA; unidentified bruchids (immature stages) in *Acacia*, *Rhynchosia* and *Vigna* seeds from Australia, the USA and Nigeria, respectively; *Bruchus* in *Lens*, *Phaseolus* and *Vigna radiata* from Syria.

***Nematodes.*** *Aphlenechoides besseyi* in rice from the IRRI, and *Aphelenchus* and *Rhabditis* in yam-tubers from Taiwan.

***Pathogens.*** *Alternaria brassicicola* on *Brassica napus* seeds from the USA; *Colletotrichum gloeosporioides*, *Fusarium solani* and *Macrophomina phaseolina* on *Leucaena* seeds from the UK; *Drechslera sorokiniana* on *Hordeum vulgare* and *Drechslera oryzae* on *Oryza sativa* from Denmark and Philippines, respectively; *Peronospora manshurica* on *Glycine max* seeds from the USA; *Alternaria brassicae* and *A. ricini* on *Brassica rapa* and *Ricinus communis* from Canada and the USA, respectively; *Cercospora*

*corchori* on jute from Bangladesh, *Drechslera sorokiniana* on *Cenchrus* from the USA; *Fusarium solani* on *Vigna radiata, Leucaena leucocephala* and *Carthamus tinctorius* from Thailand, the UK and USA, respectively; *Phoma lingam* on *Brassica rapa* from Canada; *Phomopsis* on *Vigna radiata* and *L. leucocephala* from Thailand and the UK, respectively; *Puccinia carthami* on *Carthamus tinctorius* seeds from the USA.

Legume samples multiplied in Post Entry Quarantine Nursery (PEQN) and eventually cleared for release include: pea (22), beans (73), *Phaseolus acutifolius* (9) and *Lathyrus* (1). In legume international trials, pea (69; 23 each for three indentors), *Vicia ervilia* (15), *V. sativa* (15), *V. narbonensis* (15) and *V. villosa* subsp. *dasycarpa* (15) and soybean (37) samples were released.

A total of 1,030 lines of legume samples were grown in PEQN during *kharif* for detection of seed-borne viruses, which included *Glycine max* (191), *Glycine* (304), *Vigna aconitifolia* (4), *V. mungo* (4), *V. radiata* (240), *V. umbellata* (4), *V. unguiculata* (241), *V. unguiculata* subsp. *unguiculata* (4), and *Vigna* spp. (38); 73 samples of soybean were released after obtaining undertaking from the NRC, Indore.

Groundnut seeds from China were subjected to ELISA and grown for 4 weeks in nethouse and later in post-entry quarantine field. Three plants showed PSTV-like symptoms. Each and every plant from the 16 samples were subjected to ELISA in order to remove infected plants. *Simarouba glauca*, an introduced oil-yielding plant, was found infested with bark-eating caterpillar *Inderbela quadrinotata* . This is the first report of this pest on *Simarouba*, which causes severe damage to many fruit-trees and shade-trees in India.

About 14,469 samples were processed in quarantine at Hyderabad which included 7,163 imports from 5 countries and 7,306 exports to 48 countries. Important interceptions made were: *Fusarium oxysporum* in *Flemingia* from Australia; *Drechslera setariae* in minor millets from China; *Phoma medicagenis* on chickpea from Pakistan; *Callosobruchus chinensis* on pigeonpea from the USA; *Macrophomina phaseolina* and *Colletotrichum graminicola* on sorghum from the USA.

**Germplasm Evaluation**

A total of 3,850 germplasm lines of different crops were evaluated. In pulses—chickpea : NIC 18834, 23668, 23671, 23677 and 23679 for bold seeds, pea : EC 269538, EC 341985, NIC 11200 and 11248 for grain yield; in vegetables — tomato : EC 257463, 368951, 385670 and 386022 for fruit yield, brinjal : EC 381023, 382587, IC 89823 and 136364 for yield and clustered bearing; in oilseeds — mustard: IC 147843 and 147848 for bold seeds, toria: IC 147907 for early-dwarf type, sunflower : EC 376180-84 and 386357 for seed yield; in medicinal plants : *Catharanthus roseus* : IC 49581 and EC 120837 for high-yield of leaflets and roots, *Ocimum* : EC 338788, and 338794-95 for linalool-rich lines and EC 338775 and 338781 for methyl chavicol-rich lines and *Psoralea* : IC 111239, 111254 for seed yield proved promising lines.

At Bhowali Station, wheat (264) from the USA, erstwhile USSR and other countries and wild species (51) of *Aegilops, Triticum, Avena, Secale* and *Hordeum* were evaluated for resistance to various diseases — wheat (*Triticum aestivum*) EC 339630, *Aegilops binuncialis* and *A. triastata* were found immune to *Puccinia striiformis, Puccinia recondita, Puccinia graminis-tritici* and *Erysiphe graminis-tritici*; *Triticum boeoticum* (EC 374933), *Hordeum bulbosum* (EC 328175) and *H. brachyantherum* (EC 328194) were found free from diseases of wheat; *Avena uniaristata, A. strigosa, A. brevis, A. fatua* and *A. longiglumis* were found susceptible to yellow rust and powdery mildew; *Secale cereale, S. montanum* and *S. ancestralis* were found susceptible to *Helminthosporium* blight. In lentil *(Lens culinaris)*, a total of 551 accessions were evaluated and promising accessions identified are : EC 78410, 78412-13, 78429, 78451-A, 78452, 78484, 78490, 78503-A, 267590-9 and 267593 for yield (24 q/ha) and EC 225452, 267525-A and 267632 for bold seeds.

A total of 860 accessions were evaluated, comprising 705 of chillies, 5 of *Ficus* and 150 of medicinal and aromatic plants. Preliminary characterization of 64 accessions of exotic rice germplasm, received from the IRRI, Philippines, was undertaken at Cuttack. Promising lines

identified were EC 391260 and 391261 (early flowering, in 46 days), and EC 391246 with long grains (14mm).

**Germplasm Conservation**

A total of 5,121 germplasm accessions of various agri-horticultural crops were received in genebank for long-term conservation. About 3,424 germplasm accessions were processed, packed and added to the base collection for long-term storage (–20°C). Around 72 germplasm accessions of indigenous voucher-specimens were received and these after physical verification were added to medium-term facility. The samples conserved in the base collection consist of : cereals (64,988), pseudocereals (763), millets and minor millets (16,270), oilseeds (24,707), pulses (26,542), fibre crops (4,690), vegetables (8,646), medicinal and aromatic plants (216), forage crops (24), narcotics (778), released varieties (reference samples) (949), and safety duplicates (IARCs) (8,749). Standard germination algorithms were developed for seeds of *Mucuna pruriens* and *Solanum viarum*, both having medicinal value.

*National Facility for Plant Tissue Culture Repository*

Species conserved as *in-vitro* cultures include *Allium sativum* (85), *Allium* spp. (14), *Ipomoea batatas* (260), *Dioscorea* spp. (31), *Curcuma* spp. (24), *Zingiber* spp. (120), *Musa* spp. (250), *Piper* spp. (6), *Citrus aurantifolia* (1), *Vitis* spp. (3), black berry (4), strawberry (2), raspberry (1), *Rauvolfia serpentina* (5), *R. canescens* (1), *Saussurea lappa* (1), *Tylophora indica* (2), *Picrorhiza kurroa* (1), *Gentiana kurroo* (1), *Pogostemon patchouli* (2), *Coleus forskohlii* (7), *Podophyllum hexandrum* (1), and other medicinal and aromatic plants (8).

*In-vitro* shoot multiplication was achieved in *Allium lineare*, obtained from the Bhowali Regional Station. Efforts were initiated to establish new accessions of *Kaempferia*, *Mentha* and *Allium*. Banana plantlets (23) were supplied to the IIHR, Bangalore, for field-evaluation and breeding purposes. New additions include Pisang Ceylon (EC 392194) received from the INIBAP, Belgium, and sweet-potato (3) from Georgia, Griffin, in the form of cultures, established and multiplied in *in vitro*. Two new accessions of banana, comprising synthetic hybrids with disease resistance to Black Sigotioka, obtained from the INIBAP, Belgium, were added to the existing *in-vitro* collection. A new variety of strawberry (Howard), procured from the Bhowali Regional Station, was also established in *in vitro* for multiplication and conservation. Attempts have been made to establish in *in vitro*, 6 species of *Curcuma* and 5 accessions of ginger. Seed samples belonging to medicinal and aromatic plants (31) were processed for cryopreservation. Recalcitrant seeds of *Quercus* were also successfully cryopreserved.

**NRC for DNA Fingerprinting**

The National Research Centre for DNA Fingerprinting was established in 1995 to develop DNA fingerprints as unique markers for Indian released and notified varieties/breeds, elite genetic stocks and landraces of plants, animals, poultry and fish. The Centre has a mandate to characterize all genetic resources including plant, animal and fish by using recent techniques like Polyacrylamide Gel Electrophoresis (PAGE), Restricted Fragment Length Polymorphism (RFLP) and Random Amplified Polymorphic DNA (RAPD).

Fruits of lesser known *Cotoneaster microphyllus*. These fruits are collected and eaten by local inhabitants of North-Western Himalayas. The wood of the plant is also used for making walking-sticks

# Food Crops

## RICE

### Crop Improvement

Two new varieties Nidhi (IET 9994) and Pusa 677 have been released by the Central Sub-Committee on Varietal Release and Notification. In addition, 6 varieties and hybrids released by the State Varietal Release Committees have been notified.

Flash flooding has been found detrimental at active tillering stage and at maximum tillering stage. Though tiller mortality was same (17-20%) in both, drymatter production reduced by 49% at the active tillering and it increased by 40% at the maximum tillering stage. Consequently, the grain yield decreased by 5% at the maximum tillering stage and 10% at the active tillering stage. Among the semi-dwarf to semi-tall varieties, Gayatri and Panidhan showed better flood tolerance and were more suitable than tall elongating and flood-escaping types, Amulya and Champaisali, in flood-prone intermediate lowlands. In hybrid-rice breeding programme, CMS lines Pusa 5A and Pusa 3A of basmati background have been developed. These lines have high outcrossing tendency.

### Biotechnology

Two temperature-sensitive, genic male sterile lines F 61 and ID 24, which appear promising, are found primarily influenced by temperature, but may interact with photoperiod also to some extent. Random Amplified Polymorphic DNA (RAPD) analysis was carried out to identify gene(s) specific for TGMS, and it has been found that a fragment of 1.9 kg with OPS1 primer is specific to TGMS lines.

### Crop Production

For hybrid rice, seedling density of 10-15 g/sq m nursery, and planting of one or two seedlings/hill in mid-July have been found optimum for high grain yield. N response was significant up to 150 kg N/ha, and application in 3 splits (50% basal + 25% tillering + 25% booting stage) was the best management prac-

- Released two new rice varieties Nidhi (IET 9994) and Pusa 677
- Developed CMS lines Pusa 5A and Pusa 3A for hybrid-rice breeding programme
- Released wheat HD 2643 (Ganga) and DDK 1001 for various agroclimatic zones
- Wheat lines PBW 343, PBW 373, GW 281, HD 2671 and HW 3005 showed resistance to all present-pathotypes of yellow rust, including P + *Yr9*
- Developed a *durum* identification kit to facilitate identification of *durum* grain at the market place
- Maize hybrids KH 5981 and KH 5991 released for cultivation in different parts of the country
- SSV 84, sweet-stalked sorghum, released
- New hybrids RHB 58 and Pusa 444 of pearl millet released for general cultivation
- Brought out a germplasm catalogue of 3,940 fingermillet accessions on 37 descriptors
- Field-evaluated over 1,800 accessions of underutilized crops

Pusa 677, a cross between Pusa 312xTKM 9, is found suitable for irrigated, transplanted areas of Tamil Nadu, Karnataka, Andhra Pradesh and Madhya Pradesh. It shows resistance to neck blast, leaf scald and moderate resistance to leaf blast, brown spot and sheath rot

tice in Vertisols. Nitrogen increased grain yield of selected basmati types significantly up to 90 kg N/ha. Kasturi and Pusa Basmati 1, among the dwarf-scented rice varieties, recorded superior quality characters. Highest grain-quality parameter values were recorded in the crop planted from 16 to 30 July.

Integrated management of organic and fertilizer-nitrogen in shallow-water areas showed that FYM alone could not increase grain yield of rice significantly. But *in-situ* green manuring was found as efficient as chemical-nitrogen (urea) applied in splits. Application of N, 50% through green manuring and the rest in 2 equal splits as chemical-nitrogen (urea) at active tillering and panicle initiation stages was as effective as chemical-nitrogen applied in 3 splits (50 + 25 + 25), and sometimes even proved better. N uptake and use efficiency was more with inorganic plus organic sources than with inorganic fertilizers alone. Medium- and late-duration rice varieties (Pranava, Salivahana) were found to derive more soil-N and yielded better than short-duration varieties (Aditya, Prasanna), which mainly depended on fertilizer-N. Calcium carbide applied at the rate of 30 kg/ha, not only conserved N by reducing losses through volatilization but also increased N recovery by 7%.

For weed management, Aniloguard was found most effective in transplanted-rice ecosystem, followed by Hoe-95404 + Anilophos. In direct-sown rice, under puddled conditions, Butachlor + Safener, Pretilachlor + Safener and Anilophos + 2,4-D EE were promising in controlling weeds. Experiments on rice-based cropping systems for 3 years showed that although dual-purpose grain-cum-green manure crops like greengram were found to give more economic returns, but the sole green manures (*dhaincha* and sunnhemp) with their superior biomass improved soil structure, and thus enhanced productivity of soil for sensitive crops like groundnut.

**Varieties of rice released and notified**

| Variety / hybrid | Cultural conditions, and area/state for which released |
|---|---|
| ***Variety*** | |
| Nidhi | RTV endemic areas in Tamil Nadu, Andhra Pradesh, Pondicherry and West Bengal |
| Fusa 677 | Irrigated, transplanted areas in Tamil Nadu, Karnataka, Andhra Pradesh and Madhya Pradesh |
| ASD 19 | Irrigated, transplanted areas of Tamil Nadu |
| ADT 42 | Irrigated areas of Tamil Nadu |
| PMK 2 | Rainfed areas of Tamil Nadu |
| TPS 3 | Rainfed areas of Tamil Nadu |
| Shyamla | Rainfed and irrigated areas of Madhya Pradesh |
| Poornima | Rainfed and irrigated areas of Madhya Pradesh |
| ***Hybrid*** | |
| CORH 1 | Tamil Nadu |
| PHB 71 | Tamil Nadu, Karnataka, eastern Uttar Pradesh |

CSR 10 is a high-yielding, salt-tolerant rice variety, developed at the CSSRI

## Crop Protection

Assessment of 9,000 germplasm against insect pests and diseases resulted in identification of many resistant accessions.

**Number of rice accessions found promising to insect pests and diseases**

| Year | No. of accessions | Insects and diseases | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | BPH | SB | GM | LF | PH | BI | BLB | ShB |
| 1993-94 | 2,970 CRRI | 6 | 54 | 69 | 4 | - | 18 | 5 | 7 |
| 1994-95 | 3,030 Raipur | 93 | 20 | 149 | 4 | 146 | 65 | | 3 |
| 1995-96 | 3,000 Raipur | 7 | 11 | 9 | 22 | 73 | 30 | 6 | 6 |

BPH - brown planthopper; SB - stem-borer; GM - gall-midge; LF - leaf-folder; PH -planthopper; BI - Blast; BLB - bacterial leaf blight; ShB - sheath blight

On-farm trials, to show the impact of natural biological control for pest management, demonstrated that no insecticide application throughout the crop growth (NBC), as compared with need-based protection (NBP) and schedule-based protection (SBP), was very effective in pest control, besides increasing yield.

Seventy-two *Xanthomonas oryzae* pv. *oryzae* isolates collected in 1994-95 from 20 different locations in India have been analyzed by DNA fingerprinting. Three separate repeat element probes from *Xanthomonas. oryzae* pv. *oryzae* genome have been used. The vast majority of the isolates are found closely related, comprising a single lineage. Pathotype analysis using differential rice cultivars indicates that isolates of dominant lineage belong to pathotype I of *oryzae* pv. *oryzae*.

## WHEAT

### Crop Improvement

During 1996, wheat HD 2643 (Ganga) and DDK 1001 have been released for various agroclimatic zones and production conditions.

In addition, 9 varieties have been identified for release during 1995-96 Wheat Workers' Workshop.

To identify superior germplasm for various biotic and abiotic stresses, 6 breeding nurseries were constituted under the All-India Co-ordinated Wheat Improvement Project (AICWIP) to evaluate 720 entries at selected sites. Accessions received from Japan, USA, Algeria, Australia and Mangolia were characterized and examined for utility in breeding programme.

### Methane Emission from Rice Fields

Measuring methane in rice field

Based on the estimates at 18 locations under the National Methane Campaign and at 4 centres under the ICAR Co-ordinated Project, the mean methane emission from irrigated and rainfed lowland systems in India has been estimated around 4.0 Tg/year (million tonnes/year).

Methane flux reaches maximum at and around the reproductive stage of the plant. Its emission is highest in the afternoon (12.00 noon - 3.00 pm) and declines to minimum at around midnight. Peak emissions in afternoon and at the reproductive stage have been correlated with low root oxidase activity (based on α-napthylamine oxidation). Addition of green manure increases methane emission from flooded rice fields, even after 115 days of its application. Among fertilizer sources, methane emission is more with application of green-manure, followed by prilled urea, farmyard manure and in control, un-amended. There is an evidence, but not conclusive, to suggest that methane emission is positively correlated with biomass produced.

Detailed characterization of 153 varieties notified and released by the Central Varietal Release Committee (CVRC) was generated to prepare catalogue of wheat varieties released by the AICWIP, and a computerized data-base has been completed for 1,950 accessions evaluated under a Cess Fund Project.

## Crop Production

The optimum sowing time for *durum* wheat has been found as first fortnight of November in Central India and the last week of October to first week of November in North-Western Plains. In Central India, the optimum dose of fertilizer was found as 120:30:20 kg NPK/ha, and in North-Western Plains response could be observed up to 160 kg N, 60 kg $P_2O_5$ and 40 kg $K_2O$/ha with a yield gain to the tune of 0.3 tonne/ha as compared with 120:60:40 kg NPK/ha.

Wheat HD 2643 is suitable for the irrigated, late-sown conditions of the North-Eastern Plains Zone

**Wheat varieties released during 1995-96 for various agroclimatic zones and production conditions**

| Varieties | Parentage | Production conditions | Zone |
|---|---|---|---|
| HD 2643 (Ganga) | VEE'S'/ HD2407/HD2329 | Irrigated, late-sown | NEPZ |
| DDK 1001 | Local dicoccum*4/Local dicoccum/Raj1555 | Irrigated, timely sown | PZ |

**Wheat varieties identified during 1995-96 Wheat Workers' Workshop**

| Variety | Production conditions | Zone | Special features |
|---|---|---|---|
| | | **Favourable Environment** | |
| ***aestivum*** | | | |
| HP 1761 | Irrigated, timely sown | NEPZ | *Lr*9 for rust resistance |
| HP 1744 | Irrigated, late-sown | NEPZ | Leaf rust resistant |
| DL 788-2 | Irrigated, late-sown | CZ | Leaf- and stem-rust resistant |
| ***durum*** | | | |
| MACS 2846 | Irrigated, timely sown | PZ | Black-rust resistant |
| | | **Suppressive Environment** | |
| ***aestivum*** | | | |
| PBW 396 | Rainfed, timely sown | NWPZ | Resistant to all rusts |
| JWS 17 | Rainfed, timely sown | CZ | *Sr2+* for stem-rust resistance |
| VL 738 | Rainfed as well as irrigated, timely sown | NHZ | Yellow rust and brown rust resistant |
| JOB 666 | Saline and alkali areas | All zones | Karnal bunt, leaf-spot and brown-rust resistant |
| RAJ 3777 | Irrigated, very late-sown | All zones | Resistant to all rusts |

In basmati-growing areas of the north-western India, sowing of wheat is delayed by 1-2 weeks. To overcome this, sowing of wheat under zero tillage is recommended. However, all varieties do not perform well under this system. UP 2338 could yield better with 25% higher seed rate and nitrogen @ 150 kg/ha. In addition to overcoming delayed sowing, this practice resulted in a net saving of Rs 1,750 per hectare on the cost of cultivation. In very late-sown areas of NWPZ and NEPZ, application of NPK @ 80:40:30 kg/ha and seed rate at 175 kg/ha were found promising.

*Phalaris minor*, a grassy weed, can be successfully controlled, in most of the situations, through post-emergence application of Isoproturon @ 0.75 kg a.i./ha at 2-to 3-leaf stage i.e. 30-35 days after sowing, when soil moisture is near field capacity. To avoid development of resistance in *Phalaris minor*, herbicides like Stomp (Pendimethalin), Isoguard Plus and Isoproturon should be alternatively used.

**Crop Protection**

A new virulence (*Yr9*) of *Puccinia striiformis* has been detected in samples from Himachal Pradesh, Haryana and Punjab. Based on the multilocation testing at hot-spot locations, genotypes have been selected possessing multiple resistance to diseases. Lok 1, PDW 232 and K 900 for shootfly and CPAN 2092 and ISW 38 for brown mite have been identified as confirmed sources of resistance.

Studies on gene postulation and virulence testing in yellow rust indicated that there is a diversity on the resistance available against *Yr9* virulence.

The PAGE test (polyacrylamide gel electrophoresis ), applied to geographically different isolates, revealed presence of 3 distinct populations of Karnal bunt pathogen *Neovossia indica* (ET1, ET2 and ET3), prevailing in Himalayan foot-hills, central Punjab and western Uttar Pradesh.

Investigations on the Rice -Wheat IPM have shown the common pests of the 2 crops. These include army-worm *Mythimna separata*, stem-borer *Sesamia inferens* and an important fungus *Helminthosporium sativum* (isolated from soil).

**Genetic resources of wheat confirmed during 1996**

| Nursery | Genetic resource | Desirable trait |
|---|---|---|
| National Genetic Stock Nursery | CPAN 4038 | Resistant to all rusts |
| | CPAN 4042, CPAN 4033 | Resistant to yellow rust |
| Yield Component Screening Nursery | WR 196 | High grain weight/ear |
| | DL 153-2 | High grain weight/ear |
| | PBN 1286 | High grain number/ear |
| | AKW 2344 | High tillering |
| Salinity/Alkalinity Screening Nursery | NW(S) 93-9, NW(S) 93-11 | High degree of salt tolerance |
| Drought and Heat Tolerance Screening Nursery | RS 63 | Early heat and drought tolerance |
| Late-Sown Short Duration Nursery | P 10988 | Early maturity |
| | DL 218-6 | Early maturity |
| | UPAU(P) 1426 | High grain weight |
| | WR 251 | High grain weight |
| Quality Component Screening Nursery | WR 544 | High protein |
| | PR 12 | High protein |
| | PR 19 | High protein |
| | RD 410 | High protein |
| | RD 1363 | High protein |

**Wheat genotypes showing resistance to diseases**

| Genotype | Diseases |
|---|---|
| HS 361 | Leaf blight, Karnal bunt, powdery mildew and hill bunt |
| PBW 343 | Three rusts and leaf blight |
| Raj 3856 | Three rusts and Karnal bunt |

**Grain Quality**

Keeping in view the increasing importance of grain quality for both domestic and export market, the Quality Laboratory has been equipped with all the necessary instruments needed to determine physico-chemical and rheological properties of wheat.

To facilitate identification of *durum* grain in the market itself, a "*Durum* identification kit" has been developed. Using this user kit, the yellow-berry affected kernel can be scored instantly. To identify if there is any admixture of bread wheat in *durum* sample, a phenol-based test is provided in the kit. Within 4 hours of soaking in solution and drying it on filter-paper, extent of bread wheat admixture can be determined, as it develops deep-black colour.

## BARLEY

Under barley-network programme, special attention is being paid to develop superior malting-type varieties combining high yield and disease resistance. Both, 2-rowed and 6-rowed types are being developed.

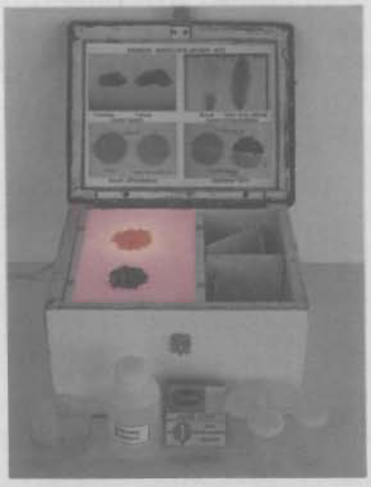
## MAIZE

Two maize hybrids KH 5981 and KH 5991 have been released for cultivation in different parts of the country. KH 5981 is suitable for *rabi* cultivation in Delhi, Haryana, Punjab, western Uttar Pradesh and Peninsular India. KH 5991, a medium-maturing hybrid, is recommended for cultivation in eastern Uttar Pradesh, Bihar, Assam, Orissa, Rajasthan, Madhya Pradesh, Gujarat and Peninsular India.

Five hybrids viz PAC-IP 12, PAC 35003, HA 003, F 720 and F 733 have been provisionally notified. Besides, new hybrids DEH 20294, EH 50511, ICI 701, MMH 69, KH 9451, SSF 9374, Pro 303 and JK 2492 have been identified for cultivation in different maize-growing areas. All these hybrids possess high yield potential in addition to built-in tolerance to major diseases and pests prevalent in the areas, for which they have been recommended. Special emphasis has been given to develop dual-purpose composites and hybrids; grain-cum-fodder composites and hybrids to cater to the needs of the harsh ecosystems and remote tribal/hilly areas of the country. Inducer lines which consistently yield haploids at high frequencies of 5-6% have also

Rust resistant HW 2004 wheat. Wheat rusts are one of the major constraints in realization of the potential yield of wheat. A rust-resistant variety HW 2004 has been specifically bred and recommended for general cultivation in rainfed, timely sown areas of Central Zone, comprising Madhya Pradesh, Gujarat, Rajasthan and parts of Uttar Pradesh. This variety has been identified to carry multiple resistance for rusts conferred by *Lr24, Sr24, Yr2*+genes. The average yield of HW 2004 is at a par with Sujata

***Durum* Identification Kit**



Prevalence of yellow berry in *durum* wheats brings down their industrial as well as nutritional quality in the end-products. Irregular protein synthesis is said to be the cause of yellow-berry disorder. Relationship between protein and yellow berry has been established based on the analysis of 149 grain samples of *Triticum durum*. As the protein content increases, yellow-berry incidence decreases drastically. The results of field experiments have shown that yellow-berry disorder can be contained by application of higher doses of nitrogen-fertilizer (150 kg N/ha), spraying of molybdenum @ 1.0 kg ammonium molybdate/ha at tillering and flowering stages, and proper irrigation scheduling (not more than 4 irrigations).

| Barley varieties released | | | |
|---|---|---|---|
| **Varieties** | **Parentage** | **Production conditions** | **Zone** |
| RD 2503 | RD 103/BH153/RD 2046 | Irrigated, timely sown | NWPZ |
| RD 2508 | RD 2035/P490 | Rainfed, timely sown and irrigated, late-sown | NEPZ rainfed, NE and NW for late-sown conditions |
| BCU 73 | WUM 143 (Introduction from the ICARDA) | Irrigated timely sown (malt-barley) | All barley-growing areas, except NHZ |

been developed. Among different cross-combinations, haploid frequency of as high as 17% has been recorded.

## SORGHUM

### Crop Improvement

Sorghum-improvement programme was aimed to develop dual-purpose varieties and hybrids.

The efforts made to diversify CMS base in hybrid breeding have been successful in developing new hybrids. Promising hybrids SPH 723, SPH 821 and SPH 840 are based on new CMS lines 27A and AKMS 70, and two superior hybrids SPH 843 and SPH 826 are based on CMS lines PM 3 and PM 52. The grain-yield increase in these hybrids in the initial tests has been significantly superior to CSH 9.

*Chapati*-making quality of sorghum variety is important for its consumer acceptability. Water absorption of genotypes ranged from 13.7 to 20.0%. The dough-rolling (11.0 - 12.9 cm) was relatively more in JJ 938 and SPV 1025. The *chapaties* of CSV 15, SPV 1025 and CSH 9 were found superior in taste, were whiter and with better puffing. The keeping-quality of *chapaties* made of JJ 741, JJ 938 and CSH 9 was tested, and they were found very soft.

The varietal improvement in *rabi*-sorghum aims at a higher level of biomass productivity with resistance to pests, comparable to M 35-1. CSH 15R maintains its yield superiority over check M 35-1. It has higher panicle weight, higher energy status of water, higher photosynthetic rate, low CSI, indicating more drought tolerance in *rabi*. Of the 22 tissue-culture mutants of SPV 462 and SPV 475, 6 progenies are early maturing (90 days) with an yield advantage over parents. Among the charcoal-rot resistant selections derived from *in-vitro* selec-

BCU 73 is a new malt-barley variety for all barley-growing areas, excepting the Northern Hills Zone

Paras is the first yellow single-cross maize hybrid notified and released for Punjab in *kharif*. It has a yield potential of 9-10 tonnes/ha and is resistant to important diseases and insect-pests

**Sorghum varieties/hybrids released and notified in 1995**

| | Season | National/state release | Area of adaptation | Special features |
|---|---|---|---|---|
| | | | **Grain-sorghum hybrid** | |
| CSH 15R | *Rabi* | National | Maharashtra, south-eastern Karnataka, adjacent parts of Andhra Pradesh | Bold grain, shootfly tolerance and improved yield potential |
| | | | **Grain-sorghum varieties** | |
| Sel 3 | *Rabi* | State | Maharashtra (shallow soils) | Early and drought resistant |
| DSV 3 | *Kharif* | State | Karnataka (midge-endemic areas) | Midge resistant |
| JJ 938 | *Kharif* | State | Madhya Pradesh | Dual purpose |
| | | | **Forage sorghum** | |
| HC 6 | *Kharif* | National | All sorghum -growing areas of India | Foliar disease tolerance |

tions, using culture-filtrate technique, one selection CRR 80 showed significantly higher resistance compared to checks.

## Crop Production

In different sorghum-based cropping systems, a combination of the 50% of the recommended dose of fertilizer with FYM has been found as effective as full dose of fertilizer. *Kharif*-sorghum was found to respond significantly to Zn and Fe. Soil application of $ZnSO_4$ @ 25 kg/ha appeared very effective to promote maximum nutrient utilization. Performance of rainfed *rabi*-sorghum improved with deep placement of seed and fertilizer.

## Crop Protection

Promising experimental entries possessing field tolerance to shootfly and stem-borer include: SPV 1041 and SPV 1198 in AVT; RM 47 and SSH 1 in ASSVT; and RS 608 and GSSV 236 in ISSVT. Among pest-resistant nurseries, PB Nos 15833-3-1H and 15881-3 have shown resistance to shootfly on a par with checks ICSV 700 and ICSV 705. Resistance to midge has also been located in SR 361, ICSV Nos 93-73 and 88-41, which is on a par with checks DSV 3 (ICSV 745) and DJ 6514. Low-grain damage due to head-bug has been recorded in IS 21443 and IS 19950, and it is on a par with checks IS 17610 and IS 21444. In *rabi* season, SPV Nos 655, 1090

CSH 15R sorghum is a high-yielding, bold-seeded, shootfly-tolerant hybrid for *rabi* cultivation

and 1167, hybrid CSH 15R, SPH Nos 921 and 925 and parental lines SPV 492, SPV 727 and SPV 839 have shown high degree of resistance to shootfly. Resistance to sugarcane aphid has been recorded in SPV 655, SPV 1085 and also in CSH 15R. Effective chemical control of shootfly was achieved with seed-soaking in Endosulfan 35 EC or Curacron 50 EC spray or with seed treatment with Imidacloprid 5 or10 g per kg seed. As shootfly damage can be minimized by early planting with onset of monsoon in *kharif*, the chemical control is only useful for late-planting situation and in seed-production blocks.

Genotypes of sorghum identified for multiple disease resistance are SPV 881, SPV 1041, SPH 723, SPH 821 and SPH 843. Parental lines SRT 18B, SB 1085, RS 29, MR 750, CS 3541, TNS 30 showed resistant to grain-moulds and MR 750, 2219 A and B, RS 29 to downy mildew, and SRT 18B, NSV 13, RS 29, SRT 26B CS 3541, SR 423B were found tolerant to sugary disease. The resistance to anthracnose has been located in IS 8354, IRAT 204, IS 854 and IS 12467. Screening for charcoal-rot resistance has enabled to identify few promising entries, CRP Nos 3, 4, 23, 24, 27, 29, RSCR Nos 6-3-1, 7, 14, RSP 48-1 and BRJ 62.

Examination of non-viable seeds of above sorghum genotypes showed predominance of *Aspergillus flavus*, followed by *Fusarium moniliforme*, *Curvularia* sp. and *Helmintho sporium* sp. Spray of neem-leaf extract (30%) twice on 296B in field though reduced earhead bug damage, but did not minimize grain-mould incidence.

**Sorghum for Alternative Uses**

Seven sweet-stalked sorghum MS lines developed have shown high *per se* biomass and stalk-sugar productivity with modest grain yield. Ethanol production process from sorghum juice has been developed. A sweet-stalked sorghum variety SSV 84 has already been released, and ethanol production from its juice is 15.25%. More than 50 sorghum genotypes have been assayed for sorghum diastatic units (SDU). The diastatic activity ranged from 16 to 200 SDU and the malting loss from 6.9 to 39.3%. Accessions with 60 to 70 SDUs and above are suitable for production of good malt. A multicut hybrid, PCH 106, with 70 tonnes of green forage/ha in 3-4 cuts, has been identified for release.

## PEARL MILLET

Two new hybrids RHB 58 and Pusa 444 have been released and notified for general cultivation for all pearl-millet-growing areas. These hybrids combine superior yield with resistance to downy mildew. Four hybrids and two populations have been identified for release by the Varietal Identification Committee. The hybrids are MLBH 33 and Pusa 325 for Zone A and Nandi 30 and AH 903 for Zone B and two populations are CZIC 923 and Pusa Bajri 266. Screen-

Pusa 444 pearl millet is a high grain and fodder variety, which is based on a new male-sterile line 189A. It is recommended for all pearl-millet-growing areas of the country

ing for downy-mildew resistance, identified MH 657, MH 665, ICMP 92777 and ICMP 92888 as free from disease. Application of 2.5-5.0 tonnes of FYM in combination with 40 kg N/ha resulted in significantly higher yields than FYM or N alone. Pearl millet intercropped with clusterbean/greengram in paired-row planting (30/60 cm) has been found very remunerative.

## SMALL MILLETS

More than 11, 000 accessions of exotic and indigenous germplasm of six small millets are being maintained. A germplasm catalogue on fingermillet for 3,940 accessions on 37 descriptors has been brought out. A high-yielding, blast resistant variety GPU 28, maturing in 105-110 days, has been released for Karnataka as a replacement to the ruling, susceptible variety Indaf 5. Another blast-resistant variety GPU 26, maturing in 95-100 days, has been identified for growing in place of Indaf 9. Little millet variety TNAU 63 for Tamil Nadu, Karnataka and Gujarat; and foxtail millet TNAU 43 and kodomillet Vamban 1 (KMV 20) for Tamil Nadu have been notified, and released for cultivation in respective states.

Callus induction and regeneration of plants from different explants and their establishment in the field have been successful in fingermillet, little millet and proso-millet. More than 1,500 progenies in $R_2$ generation have been studied in Hullubele and Purna fingermillet for somaclonal variations. The progenies exhibited large variability for yield and other agronomic attributes, offering scope for selection; this can be used as a novel tool for generating new variability.

In Bihar and Orissa, transplanted fingermillet + pigeonpea in 8:2 row proportion gave higher monetary returns. The profitable intercropping systems identified for other small millets are pigeonpea + kodomillet (2:1) in Madhya Pradesh;

GPU 26 is a blast-resistant, early-maturing ragi. It is identified for growing in places of Indaf 9

Krishnadevaraya foxtail millet in farmer's field

**Mean seed yield (kg/ha) in front-line demonstrations of fingermillet**

| | Karnataka | Bihar | Andhra Pradesh | Orissa | Uttar Pradesh |
|---|---|---|---|---|---|
| Improved practice | 2,729 | 1,849 | 4,132 | 2,580 | 2,513 |
| Farmer's practice | 1,829 | 1,414 | 2,746 | 1,671 | 1,938 |
| % increase over farmer's practice | 44.2 | 30.8 | 30.5 | 54.4 | 29.7 |

pigeonpea + foxtail millet (5:2 proportion) in Andhra Pradesh and soybean + little millet (2:1 proportion) in Madhya Pradesh. In Uttar Pradesh hills, fingermillet and soybean in 9:1 combination with 75% of the recommended nitrogen dose (45 kg N against 60 kg N) recorded highest grain yield as well as land equivalent ratio of 1:3. The yield maximization studies conducted over 3 years in Bihar have demonstrated that in proso-millet change of variety alone resulted in 47 % increase in seed yield over local. Recommended cultivation practices resulted in 32 % higher yield over farmer's practice.

In the National Screening Nursery (NSN) of fingermillet, 7 new accessions GE 3060, IE 2081, IE 2885, IE 2897, IE 2912, IE 2930 and IE 2968 have been found highly resistant to both neck and finger blast. Kodomillet PAC 1, KK 1 and TNAU 42 showed resistant to head smut.

A total of 114 front-line demonstrations were conducted over 57.4 hectares involving 144 farmers. The demonstrations were conducted in Andhra Pradesh, Bihar Karnataka, Orissa, Madhya Pradesh, Uttar Pradesh and Tamil Nadu.

In fingermillet, adoption of improved practice significantly increased seed yield by 44 % in Karnataka, 31 % in Bihar and Andhra Pradesh, 30 % in Uttar Pradesh (Hills) and 54 % in Orissa. Similar increases were also noticed in other small millets which ranged from 42 to 136% in little millet; 37 to 42% in kodomillet; 36 to 68% in foxtail millet; and 65% in proso-millet in different states.

## UNDERUTILIZED CROPS

Underutilized Crops Programme is engaged in developing improved technology for crops of future promise such as pseudocereals, job's tears, minor pulses and legumes, minor oilseeds and other indigenous or exotic economic plants. Over 1,800 accessions of underutilized crops have been field-evaluated. These include grain-amaranths at Akola (1,134), Ranichauri (200) and Bangalore (63), *Chenopodium album* at Ranichauri (25), job's tears at Shillong (31), ricebean at Ranichauri (73), winged-bean at Akola (242), *Atriplex* at Jodhpur (14) and jatropha at Akola (28). Lines having above 16.5% protein have been identified in grain-amaranth (IC 35761 and IC 35618 , 16.7% each; and IC 35754 , 16.5%) and above 19% in ricebean (RBL 16, 19.6%; and RB 73, 19.25%).

RBL 6 ricebean with a yield potential of 1.8 tonnes/ha (20% higher yield than RBL 1) has been identified for the north-western and north-eastern regions. It is a photosensitive variety, with spreading habit, resistance to yellow mosaic virus and with acceptable seed size, colour (pale-green) and quality. Another ricebean PRR 8801 has been identified for release at the state level in Uttar Pradesh hills for its suitability at mid-hills to high-hills, beyond 1,500m elevation. Ricebean is highly suited to these hills where urdbean (blackgram) and mungbean (greengram) cannot be grown.

Fababean VH 82-1 (Vikrant) has been identified for northern plains. It is yet not consumed as a pulse in this part, but has a possibility of being consumed as *dal*, *besan* and fried products. It has a very high yield potential (4.2 tonnes/ha) and protein content (24.85%) along with better tolerance to chloride and sulphate salinity than chickpea.

For grain-amaranths third week of October has been found better suited for its planting in north-western parts of the country. A linear response to irrigation treatments resulted in highest yield of 3.62 tonnes/ha at 0.8/IW/CPE and at 60 kg N/ha.

Variability in grain-amaranth

# Forage Crops

**Crop Improvement**

Many varieties of forage crops have been released and notified by the Central/Seed Sub-Committee on Crop Standards, Notification and Release.

**Production Technology**

Application of *Azotobacter* in Dinanath-grass and maize, *Azospirillum* in *bajra*-napier hybrid and VAM + vermi-compost in *Stylosanthes scabra* has been found to increase yield. Growing of sorghum- chickpea sequence in 4-m apart alleys of sesbania yielded higher green forage (156.1 tonnes/ha) and dry matter (41.6 tonnes/ha), besides considerable yield of chickpea-grain and fuel, as compared to sole sorghum-chickpea sequence (green matter yield 26.1 tonnes, dry matter yield 6.5 tonnes and chickpea 2.0 tonnes/ha). In another experiment, berseem-maize sequence was taken in 4-m apart alleys of sesbania and results revealed that berseem and maize gave considerable yields in addition to highly nutritious forage yields of sesbania. In rainfed areas, mixed-cropping systems of *Cenchrus ciliaris*, *Chrysopogon fulvus* and *Dicanthium annulatum* (range grasses), and *Stylosanthes hamata* (stylo), *Macroptelium atropurpureum* (siratro) and *Cajanus cajan* (range legumes), grasses produced higher biomass than legumes after third year of establishment.

Intercropping of sorghum or maize with cowpea, lowered incidence of pests in cowpea as compared to sole crop. Sorghum lowered number of holes by flea-beetle and percentage of leaf damage by defoliators to the extent of 22.4% and 16.2% and maize by 11.95% and 7.72%. An increase of 36.9% in green fodder yield was also obtained from the protected crop.

# Pulse Crops

**CHICKPEA**

Chickpea DCP 92-3 has been identified for release for high-input management conditions of the North-Western Plains Zone of the country. It has resistance to *Fusarium* wilt, tolerance to

* Application of *Azotobacter* to Dinanath-grass and maize, *Azospirillum* to *bajra*-napier hybrid and VAM+vermi-compost to *Stylosanthes scabra* increased yield
* Intercropping of sorghum or maize with cowpea lowered pest incidence on cowpea

RL 88 is a very good perennial variety of lucerne, recommended for all-over the country. It is fairly resistant to downy mildew, root-rot and wilt

IGFRI hay drier

* Chickpea (gram) lines GL 769, Phule G5 and ICC 4958 showed drought tolerance at Kanpur
* Intercropping of pigeonpea Pusa 9 with groundnut Chitra in 5:2 proved very productive
* Identified a bold-seeded, resistant to rust lentil DPL 62 for release for the North-Western Plains Zone

**Varieties of forage crops notified and released**

| Crop | Variety | Area | Special characteristics |
|---|---|---|---|
| Fodder sorghum | HC 308 | Entire country | Resistant to leaf diseases and tolerant to major insect pests. Yields 40-55 tonnes of green forage/ha in a single cut |
| Sorghum | CSH 13R | Entire country | Primarily released for *rabi* but promising for *kharif* also as a dual-purpose. It is a tall hybrid, fairly resistant to foliar diseases, and yields 50-55 tonnesof forage/ha and 1.8-2.5 tonnes of grains/ha |
| Sorghum | SPV 946 (CSV 15) | Entire country | Dual-purpose, tall variety, yielding 3.0 to 3.6 tonnes of grains/ha and 110-120 tonnes of dry forage/ha |
| Fodder cowpea | UPC 8705 | Entire country | Resistant to root-rot and collar-rot, yields 30-42 tonnes of green forage/ha in 60 days |
| Gobhi sarson | HPN 1 | Himachal Pradesh | Suitable for sub-tropical hilly region, yields about 20-25 tonnes of green forage/ha and is moderately tolerant to aphids |
| Gobhi sarson | GSL 1 | Punjab | Primarily released as grain material but is also suitable for fodder (20-35 tonnes of green forage/ha) and is comparatively free from foliar diseases |
| Lucerne | RL 88 | Entire country | Very good perennial variety, suitable for 4-5 years. It is fairly resistant to downy mildew, root-rot, wilt, and is tolerant to major insect pests, and is very good seed producer, yielding 300-400 kg of seed/ha, and produces 100-130 tonnes of green forage/ha |
| Fodder fenugreek | ML 150 | Punjab | Very good fodder variety, yielding 30-40 tonnes of green forage/ha, and is fairly resistant to major diseases and pests |
| Fodder guar | IGFRI 2395 2 | Entire growing area (Bundelguar 2) | Resistant to *Xanthomonas* and *Alternaria*, and its green forage yield is 25-45 tonnes/ha |
| Fodder guar | Guara 80 | Punjab | Moderately resistant to bacterial leaf blight, and yields 35-40 tonnes/ha |
| Guinea-grass | PGG 101 | Punjab | High-yielding (70-90 tonnes of green forage/ha) and is a good seed producer (1.5-2.0 tonnes/ha). It is suitable as annual or perennial crop, no diseases and pests are reported |
| Ricebean | RBL 1 | Punjab | Released as a grain variety but is also suitable for forage production (20-30 tonnes of green forage/ha) |
| Shaftal | SH 69 | Punjab | Almost free from major diseases and pests, is suitable for high rainfall areas, acid soil, hilly sub-temperate areas It yields 80-105 tonnes of green forage/ha |
| Oats | OL 125 | Punjab | Yields 35-50 tonnes of green forage/ha, and is tolerant to major diseases and pests |
| Teosinte | TL 1 | Punjab | Yields 38-50 tonnes of green forage/ha, and is free from major diseases and pests |
| Fodder maize | J 1006 | Punjab | Yields 35-45 tonnes of green forage/ha, and is resistant to maydis blight and brown stripe and downy-mildew disease |

pod-borer and matures in 150-160 days. Its yield potential is 2.0-2.5 tonnes/ha. Chickpea BG 362, ICCX730020-11-2-11H, PDE 5-1, PDE 7-1, PDE 1-2 and PDG 84-16 exhibited 30-50% lower pod damage by gram pod-borer *Helicoverpa armigera* in comparison to checks K 850 and L 550. Under the integrated pest management approach, use of 1.0% Achook, 0.4% Nembecidine and 1.0% Repelin (all neem-based formulations) has been found at a par with Endosulfan 0.07%, and significantly superior to untreated check against *Helicoverpa armigera*-infesting chickpea.

Random surveys in Kanpur have revealed association of root-knot, lance-, stunt- and lesion- nematodes with wilt-affected chickpea plants. Incidence of these nematodes was severe at the early stage of wilt. A number of genotypes of chickpea have been identified for tolerance to *Meloidogyne javanica*. Out of the 74 lines found resistant to wilt, 10 genotypes have shown stable resistance. Studies on variability of wilt pathogen *Fusarium oxysporum* f. sp. *ciceri* have indicated occurrence of at least 6 pathogens (possible races) across different chickpea-growing areas of the country. Kanpur pathotype has been found distinct from other pathotypes.

A field experiment involving 13 genotypes of chickpea, grown in irrigated and rainfed areas, has revealed that the functional traits imparting drought tolerance in the plant are slow rate of leaf senescence, high root biomass, increased rooting depth and faster rate of grain growth. Phule G 5, RSG 143-1 and Pusa 362 have showed consistent increase in nodulation up to flowering under limited water. Loss in seed yield due to soil-moisture stress varied with genotypes, from 40 to 60% over control. Computation of drought tolerance index (DTI) has revealed that positive DTI indicated higher tolerance of genotypes to soil-moisture stress and negative DTI showed drought susceptibility. Lines GL 769, Phule G 5 and ICC 4958 showed drought tolerance at Kanpur.

Low temperature during flowering and pod initiation has been observed to be detrimental for pod setting and seed filling in many genotypes. ICCV 88506 and ICCV 88503 set pod at 4°C thus indicating the possibility of their use as donor parents in breeding for low-temperature tolerance.

## PIGEONPEA

In a late-maturing hybrid pigeonpea trial, a new hybrid RAUPH 9406 (2,889 kg/ha) recorded 44.3% more yield over best check Pusa 9. In a early-maturing hybrid trial, hybrid MS Prabhat DT x UPAS 120 (1,464 kg/ha) gave significantly superior yield over best check UPAS 120. In pigeonpea and groundnut intercropping, pigeonpea cv. Pusa 9 and groundnut cv. Chitra in 5:2 row ratio have been very productive (4,422 kg/ha pigeonpea equivalent yield), followed by Bahar + Chitra in 5:1 row ratio. Inoculation of pigeonpea with *Rhizobium* and sorghum with *Azotobacter* in pigeonpea and sorghum intercropping system in rainfed areas increased seed yield. However, highest seed yield of pigeonpea (501 kg/ha) and sorghum (2,230 kg/ha) could be noticed only when dual inoculation was done. Dual inoculation with *Rhizobium* + *Azotobacter* also produced highest pigeonpea equivalent yield (1,244 kg/ha).

Micronutrient studies in pigeonpea-wheat rotation revealed that residual effect of Zn, B and Mo recorded significantly higher yield of wheat (5,208 kg/ha). Combined application of these nutrients recorded highest yield (1,207 kg/ha) of pigeonpea and pigeonpea equivalent yield (2,864 kg/ha), registering a increase of 16.8% compared to control (2,481 kg/ha). In pigeonpea SL 21-9-2, SL 12-3-1, PDA 89-2E, PDA 92-2E, PDA 92-3E showed high level of resistance against podfly *Melanagromyza obtusa*. Selection PDA 89-2E showed resistance to *Melanagromyza obtusa* as well as grain pod-borer *Helicoverpa armigera*. In a short-duration pigeonpea, on an average, 40-60% of pod damage is caused by pod-borer complex, consisting mainly of *Maruca testulatis*, *Helicoverpa armigera*, *Eucasma critica*, *Lampides boesticus* and *Melanagromyza obtusa*. Population dynamics of vector *Aceria cajani* of sterility mosaic revealed that vector population was negatively correlated with minimum and maximum temperatures, and positively with minimum and maximum relative humidities and rainfall. A temperature range of 10-25°C minimum and 25-35°C maximum and relative humidity above 60% were congenial for build-up of vector population.

Early-duration genotypes exhibited higher mortality percentage over medium-duration genotypes in waterlogged areas. Amongst early-duration genotypes cv. AL 15 and amongst medium-duration genotypes cv. ICPL 366 have been found tolerant to excessive moisture.

### URDBEAN AND MUNGBEAN

Two varieties of mungbean (greengram), TARM 1 for *rabi* and HUM 1 for spring, have been identified for pre-release seed multiplication. TARM 1 is resistant to powdery mildew and HUM 1 is resistant to yellow-mosaic virus. In urdbean (blackgram) WB 3 and WBG 26 have been identified for prerelease for *kharif* for Central and South Zones.

In sunflower and mungbean intercropping, PS 16 mungbean and Morden sunflower in 6:2 row ratio were most productive (1,804 kg/ha), followed by intercropping of PDM 84-139 mungbean in the same ratio. Highest land equivalent ratio of 1.19 was recorded in mungbean (PS 16)-sunflower intercrops.

Seed-filling period has better association with seed yield as compared to 50% flowering and maturity. Leaf area duration at 50% flowering and net assimilation rate at 10 days after flowering showed closer relationship with seed yield. Mixing of lime powder and anona seed powder at 2% with mungbean seed, meant for storage, resulted in low bruchid damage (6.0%, 3% weight losses, respectively) compared with control (68.0%, 67.5%).

### LENTIL

A bold-seeded lentil DPL 62 has been identified for release for the North-Western Plains Zone. It is resistant to rust and is tolerant to wilt. Its potential yield is 1.2-1.8 tonnes/ha. IPL 74, an extra bold genotype and DPL 61, a high-yielding genotype (extra bold), is under testing for Northern Hills Zone.

Among various rice-based cropping systems, rice-lathyrus gave highest rice-equivalent yield and was found most profitable with a net returns of Rs 31,632/ha, followed by rice-lentil and rice-linseed on sandy loam soils of central Uttar Pradesh. Tillage practices did not show any significant effect in terms of net returns from the 3 crops, which suggests that relay sowing of lathyrus, lentil and linseed may be done by broadcasting their seeds in standing crop of rice 2-3 days before its harvesting; but chickpea, fababean and fieldpea in rice-cropping systems performed better after land preparation. Seven entries of lentil (DPL 42, DPL 51, NDL 63, L 4147, L 4601, LH 90-54 and PL 88-54) were found resistant and 28 including some promising lines (DPL 56, DPL 60, DPL 61, DPL 62) moderately resistant to rust disease. Ten lines from the ICARDA also exhibited resistance to rust. Early-sown crop( first week of October) escaped serious damage from rust in the North-Eastern Plains Zone.

### RAJMAH AND FIELDPEA

A promising line of rajmash IPR 96-3 has shown yield superiority by 18-36% over the best check PDR 14.

Dwarfpea responded to nitrogen application up to 20 kg/ha. Application of one irrigation at pod formation has been optimal. Four entries DPPP 3, DPPP 4, DPPP 15 and DPPP 17 have been identified as resistant to powdery mildew.

## Oilseed Crops

### GROUNDNUT

In rainfed yield trials, advanced cultures of groundnut PBS 101 and M13 x R33-1D significantly out-yielded (20% and 16%) best check Kadiri 3. Cultures IR6, PBDR 32, PBS121 and CIV are promising for seed viability. PBS 192 has recorded high oil content (53.4%) and PBS 33, PBS 70, PBS 138 PBS and PBS 100 have been identified as lines tolerant to iron chlorosis. Ninety $F_1$ hybrids of 8 different interspecific crosses, 60 cultivated forms derived from spontaneous allohexaploid hybrids and 28 wild *Arachis* species have been field-evaluated. Crosses were made to transfer rust resistance through interspecific derivative CT 7-1 to culture J 11. To recover interspecific hybrids in field in shortest possible time, vegetative propagation by micro-cutting has been standardized. In an attempt to produce intersectional hybrids, a nullisome from J 11 has been identified. A

protocol for inducing multiple shoots on somatic embryos, rather than one-to-one direct conversion of somatic embryos to seedlings, has been developed.

Cultures SQ 84, ICGS 44, 5-S and SB XI have shown higher thermostability. Genotypes DRG 101, RG 378, and RG 335 and ICG 3098, RG 332, RG 141, RG 337, JL 220, ICG 86635, ICG 3826 and TKG 19 A have tolerance to high temperature at Jaipur and Hanumangarh during pod-formation stage.

Application of Fe, Zn and B through drip irrigation increases haulm yield, shelling percentage and kernel weight and hence seed yield significantly over their soil and foliar applications. It is found that the application of different sources of iron could reduce occurrence of iron-deficiency chlorosis, even when applied in soil. Pods of *rabi*-summer produce, when dried by new drying method, developed by the NRCG, and stored with desiccants like silica-gel and $CaCl_2$, retained more than 70% germinability with high seedling vigour even after 12 months of storage. Spanish accession Nos 2410, 7323, 4080, 2443, 7506, and 201 have shown high degree of fresh seed dormancy. Seed treatment with Carbendazim 50 WP @ 2g/kg seed not only improved plant stand by 12% but also reduced intensity of early leaf-spot by 57 %.

Summer groundnut in Saurashtra region of Gujarat is very remunerative wherever irrigation is available in plenty. Experiments at the NRCG have shown that if wheat-straw is used as a mulch after sowing of groundnut in summer, soil temperature raises by 2-3°C, resulting in advancement of germination by 2-3 days. On the other hand, at the time of pod development, when temperature is high, mulch reduces soil temperature by 3-5°C. Mulching helps in moisture conservation, weed control and reduces water requirement also. A 20% increase in pod yield was obtained by wheat mulching.

## SUNFLOWER

Sunflower AKSF 9 and PKVSH 27 have been released for cultivation in Vidarbha region of Maharashtra. LS 11, which is resistant to downy mildew, has been developed at Latur Centre. It is a suitable replacement to Morden in Marathwada region and is also accepted for pre-release multiplication. In *rabi*/summer sunflower cropping system, maximum net returns were obtained in sunflower-groundnut sequence (Rs 25,875/ha), followed by sunflower-sorghum sequence (Rs 13,656/ha). In *kharif*-sunflower-based cropping system also, yields of groundnut and sorghum were higher than other crops. Sunflower seed equivalent yields worked out for *kharif* crops were maximum for groundnut, followed by sorghum. The mean net returns of 2-crop cycle were higher from sunflower-groundnut, followed by sunflower-sorghum in rainfed areas.

Higher monetary returns were realized from sunflower + pigeonpea (2:1) intercropping compared to sole crop of sunflower. Lodging of sunflower plants was less in this intercropping than sole sunflower and sunflower+groundnut

* Field-evaluated 90 $F_1$ hybrids of 8 different interspecific crosses, 60 cultivated forms and 28 wild species of groundnut
* AKSF 9 and PKVSH 27 sunflower released for cultivation in Vidarbha region of Maharashtra
* LS 11 sunflower, which is resistant to downy mildew, found suitable to replace Morden in Marathwada region
* PBR 97 and RAUDYS 89-115 mustard identified for release
* Promising strains EC 287711, PBCM 3590 of *Brassica juncea*, possessing low erucic acid, developed
* High-yielding soybean Ahilya 1, Ahilya 2 and Ahilya 3 and PK 1042 released
* Soybean line TG x 885 53D found possessing antixenosis type of resistance against tobacco caterpillar
* Niger and kodornillet in 2:2 in Chhindwara and niger and horsegram in 4:2 Igatpuri proved promising intercrops
* Seventeen pistillate lines with significant differences in initial and final flowering of spikes and seed yield of castor identified at Hyderabad

intercropping. Vermicompost @ 2tonnes/ha has been found to increase yields of sunflower by 48% (Akola) to 66 % (Coimbatore) and FYM @ 5 tonnes/ha by 22% (Coimbatore) to 43 % (Akola).

**RAPESEED-MUSTARD**

Forty-four new accessions of *Brassica campestris* var. toria and 16 of yellow sarson have been collected from Himachal Pradesh and Punjab, thus making a total of 4,483 accessions of oilseed brassicas.

A total of 569 brassica accessions have been evaluated at the NRCRM, Bharatpur. These include *Brassica juncea*(360), *Brassica campestris* ssp. *oleifera* var. brown sarson(90), yellow sarson(90) and *Brassica napus*(29).

Two new varieties of mustard have been identified for release. PBR 97 has recorded an average of 1.8 tonnes of seed yield/ha in rainfed areas and it has been recommended for pre-release multiplication for Punjab, Haryana, Delhi and northern Rajasthan. It matures in 136 days and has 41.0% oil content. RAUDYS 89-115 is a yellow sarson variety, giving on an average a yield of 1.5 tonnes/ha. It has been recommended for pre-release multiplication at the national level for irrigated areas. It matures in 102 days and has 44.5% oil content.

Mustard Rajat (PCR 7), with an yield of 1.9 tonnes/ha, which was earlier recommended for irrigated areas of western Rajasthan, Gujarat and western Maharasthra, has now been recommended for general cultivation in Alwar, Sawai Madhopur, Bharatpur and Dholpur of Rajasthan; in view of its shattering resistance and good performance in terms of seed yield in adaptive trials.

Sustained efforts towards improvement of quality traits like '0' (low erucic acid or low glucosinolates) and '00' (low erucic and low glucosinolates) have opened new opportunities to improve status of oil of rapeseed-mustard and to earn valuable foreign exchange through export of oil, meal and value-added products. Promising strains like EC 287711 and PBCM 3590 of *Brassica juncea*, possessing low erucic acid, have been developed. The latter strain has also been found to possess moderately low glucosinolate(40 micromoles/g defatted meal).

**Ahilya 2, a high-yielding soybean**

Ahilya 2 (NRC 12) is a defect rectified induced mutant of Bragg. It matures in 99 days in Central Zone. Its pubescence colour is tawny and flower colour is purple. The variety is resistant to bacterial pustules, *Myrothecium* leaf spot, bacterial blight, yellow mosaic and green mosaic viruses and *Rhizoctonia* aerial blight. Its yield potential is 2.5 to 3.0 tonnes/ha

Two strains of *Brassica napus*, GSL 6016 and HPN 3, possessing double low characters, have been found promising.

Sulphur @ 40 kg S/ha has been most beneficial for realizing increased seed yield.

A total of 179 front-line demonstrations were conducted to highlight impact of improved technologies on seed yield and economics of mustard cultivation. The seed yield which ranged from 250 to 2,200 kg/ha under farmer's practice increased to 420-3,100 kg/ha with improved technology. The increase in seed yield with improved technology over farmer's practice ranged from 0 to 174%.

Variation in flower colour and hairiness in soybean varieties

## SOYBEAN

The high-yielding improved varieties MAUS 1, MAUS 2 have been identified and Ahilya 1, Ahilya 2, Ahilya 3 and PK 1042 have been released. Ahilya 1 is a high-yielding (2.5-3.0 tonnes/ha) mutant of Bragg, maturing in 115 days in Northern Hills Zone and 94-102 days in Malwa plateau. It shows excellent germination even after 7 months of storage under ambient conditions. Ahilya 2 and Ahilya 3 are also high-yielding (3.0-3.5 tonnes/ha), resistant to pod shattering, early-maturing, and are tolerant to defoliating insects and suitable for traditional cropping systems.

The thickness and the length of the bundle cap on the dorsal side of the pod and pod-wall thickness are found negatively correlated with degree of pod shattering. L 129, NRC 123, JS 335, NRC 7, NRC 12, E 264, B 460 and JS 71 05 showed tolerance to major insects. Germplasm line TG X 885-53 D possesses "antixenosis" type of resistance against tobacco caterpillar and accession NRC 27 (EC 251311) has been identified as resistant to major foliar diseases and as superior yielder.

Hilum colour and size variation in soybean varieties

*Bacillus thuringiensis*, neem-based formulations and insecticides Phosphamidon, Phosalone, Chlorpyriphos and Triazophos can be included in formulating an IPM schedule. *Trichoderma viride* as a biocontrol agent not only controlled collar-rot incidence but also increased seedling emergence and reduced rot due to seed-borne infections. Pre-emergence application of Pendimethalin 5G @ 1.0 kg a.i./

ha, Alachlor 10G @ 2.0 kg a.i./ha and Clomozon 50 WP @ 1.5 kg a.i./ha gave effective weed control coupled with higher yield of soybean. Promising lines through interspecific hybrids of soybean with a very high protein content (up to 46 %) in seeds have been identified. EC 14398 and GPC 79 are found tolerant to rust.

Results of 220 front-line demonstrations under farmers' fields conducted at 15 centres all-over the country indicated that adoption of improved production technology for soybean enhanced production by 37 % over farmer's practice. The additional returns from improved technology were Rs 4,020/ha with incremental cost:benefit ratio of 2.95. These trials conducted between 1989-90 and 1995-96 recorded reduction in yield gap from 1,050 kg to 454 kg.

## SESAME

In the initial sesame varietal trials, RS 188, YLM 21 and ORM 17 yielded highest in North-East, Central and South Zones. In advanced varietal trials, RT 274 and TC 473 were promising highest yielders in the North-Eastern Zone and South Zone. Groundnut-sesame (at Vriddhachalam), sesame-blackgram (at Tikamgarh) and pearl millet-sesame (at Amreli) were found profitable intercropping systems.

Seed hardening by 12 hr soaking in water and drying to original moisture level, recorded very high yield (902 kg/ha) in Amreli, which is a low rainfall area. Incidence of *Antigastra* was found positively correlated with temperature and sunshine and negatively with rainfall. Sesame showed reduced incidence of *Antigastra* and gall-fly infestation in intercroppings compared to sole crop.

ABT 6, AKT 64 and TNAU 65 lines have shown resistance to *Macrophomina* stem/root rot in sick plot. AKT 64 was found tolerant to *Phytophthora* blight and bacterial leaf spots in fields. TNAU 65 gave resistant reaction to leaf curl. Seed treatment with *Trichoderma viride* minimized incidence of *Macrophomina* stem/root rot. Solarization of soil for 6 weeks after irrigation and ploughing increased seed germination by 38.4% and decreased *Macrophomina* stem/root rot by 99%.

## NIGER

JNS 2, JNS 1, PNS 6 in the initial varietal trials; JNC 3 (at Raichur and Chhindwara) and SNC 3 (at Raichur, Semiliguda and Bangalore), CHH 3 (at Semiliguda) and JNC 4 (at Chhindwara) in advanced varietal trial-I (early); ONS 150, ONS 126 (at Semiliguda) and JNC 5 (at Chhindwara) in advanced varietal trial-I (late) and UN 4 (at Udaipur and Bangalore), CHH 7 (at Udaipur and Chhindwara) and JNC 1 (at Chhindwara) in advanced varietal trial-II (early) are identified as promising. Two hand-weedings at 30 and 45 days after sowing (DAS) were found to give highest yields, followed by application of Saturan @ 0.75 kg/ha + one hand-weeding at 45 DAS. Niger and kodomillet (*Paspalum scrobiculatum*) in 2:2 (Chhindwara) and niger and horsegram in 4:2 (Igatpuri) ratio were found profitable intercropping systems.

## SAFFLOWER

AKSF 68 safflower with 5-7 days earliness in maturity, gave better yield (1,495 kg/ha) over check A1 among spiny varieties, and JSI 61 gave highest yield (1,185 kg/ha) among non-spiny varieties in the co-ordinated varietal trials. In the initial hybrid trial, MKH 11 (2,052 kg/ha), DSH 130 (2,033 kg/ha) and DSH 129 (1,958 kg/ha) recorded 12-18% yield advantage over A1. Newly developed non-spiny male-sterile system showed high-combining performance with pollinators, with 1.0-1.7 tonnes of hybrid seed/ha. Male sterility of 60% was realized with new MS lines. MS 60 (o), MS 17 (y) and MS 9 (o) are found promising for hybrid-seed production. In a field study on space isolation to assess the influence of male sterile (MSS 17): male fertile (A1) row proportions (3:1, 4:1 and 5:1) on certified hybrid safflower seed production of DSH 130, adoption of 3:1 row proportion provided the maximum seed yield of 199 kg/ha, followed by 5:1 ratio (149 kg/ha).

## LINSEED

Linseed-safflower (6:1) along with recommended fertilizer dose in rainfed areas at Sagar, linseed-mustard (4:2) along with 25% additional fertilizers in irrigated areas at Hoshangabad and linseed : lentil (4:2) along

with 25% additional fertilizer dose at Kanpur proved best intercrops with linseed. Hand-weeding at 20-25 DAS and 40-45 DAS has been found best at Gurdaspur and Kanpur for controlling weeds. Isoproturon @ 1 kg/ha at 35 DAS at Gurdaspur and Isoproturon @ 1kg/ha + 2,4 D @ 0.5 kg/ha at 30-35 DAS at Kanpur are better alternatives for weed control. Two or three sprays of Rovral (0.2%) and Indofil -M 45 (0.25%) controlled *Alternaria* blight significantly. Sowing in border method with lower seed and fertilizer doses reduced disease scores. Addition of gypsum or pyrite as sulphur source and 2,4 D (1 kg a.i./ha) as weedicide reduced incidence of powdery mildew.

## CASTOR

At Hyderabad, 17 pistillate lines of castor with significant differences in initial and final flowering of spikes and seed yield have been identified. New pistillate lines with 100% pistillate character, high oil content, resistance to wilt and earliness have also been identified at Sardar Krushinagar. Application of neem-cake and *Azospirillum* along with recommended dose of fertilizer resulted in highest yields of castor (1,872 kg/ha) at Palem. Groundnut intercropped with castor (2:1) offered highest returns at Tindivanam, with a cost-benefit ratio of 2.41. A row spacing of 90 cm x 60 cm is found ideal for GCHC 4 for obtaining higher yields. At Junagarh and Sardar Krushinagar, no yield losses were observed when only 50% of the recommended fertilizer dose was applied along with FYM and biofertilizers. Irrigation at 1.0 IW/CPE along with 100 kg N/ha substantially increased seed yields of pistillate parents VP 1 and Geeta. High-density sowing of 18,515 plants/ha at 90cm x 60 cm resulted in higher seed yield of 1,969 kg/ha compared to 12,345 plants/ha, which yielded 1,605 kg seed only. Application of nitrogen at 40 kg/ha gave distinct enhancement in seed yield (1,830 kg/ha) over no nitrogen (1,617 kg/ha).

Pistillate lines SKP 108, SKP 4 and SKP 13 were found resistant to wilt. Co 1 is found resistant to seedling blight, root-rot, bacterial leaf blight, wilt and *Botrytis*. Hybrids DSH 113, DCH 129 and DSH 116 showed resistance to *Fusarium* wilt in wilt-sick areas, and DSH 110, DSH 107, DSH 137, DSH 130 and DSH 128 showed less than 20% wilt incidence. All these exhibited high field tolerance to *Alternaria* leaf spot and moderate tolerance to aphids.

RG 1930, a leafminer-free germplasm accession of castor

# Commercial Crops

## COTTON

A total of 23 high-yielding hybrids/varieties have been released and notified for commercial cultivation.

Five genic-male sterile (GMS)-based intra-hirsutum hybrids NGMSH 6, NGMSH 77, NGMSH 107, NGMSH 113 and NGMSH 138 with heterosis ranging from 15 to 75% over the best hybrid checks have been identified. Two CMS based hybrids NCMSH 9 and NCMSH 10 recorded 44.23% and 12.17% superiority over CAHH 468.

By repeated subculturing and incorporation of changes in the media, complete cotton-plants could be obtained from multiple shoots. The protocol for *Agrobacterium*-mediated transformation, utilizing cry I A b synthetic *B.t.* gene into cotton explants, is being standardized. Application of 75% water-soluble phosphate plus 25% rock phosphate along with vesicular arbuscular mycorrhizae (VAM) in medium-P status soil and 100% water-soluble phosphate with VAM in 'P' deficient soils resulted in maximum cotton yield at Coimbatore. For enhancing nutrient-use efficiency, split application of fertilizer-N, half at 15 DAS, one fourth at squaring and one fourth at 60 DAS has been found best. An increase of 73% in seed-cotton yield per plant was observed under elevated levels of $CO_2$ up to 650 ppm.

A new insect pest spiralling white-fly *Alecurodichus dispersus* has been recorded for the first time on cotton at Coimbatore. Insecticide resistance monitoring revealed that with Cypermethrin (0.1 µg), mean resistance was 83% and the suppression of this resistance by synergist Pbo was 34%, indicating importance of oxidative mechanism in resistance. Foliar spray of bioagent *Trichoderma harzianum* for management of grey-mildew and *Pseudomonas fluorescens* against *Alternaria* leaf-spot is found effective. Incidence of leaf-curl virus has shown an increase in Rajasthan. A newly released variety RS 875 of *G. hirsutum* is found resistant to leaf-curl virus.

* Five genic-male sterile based intra-hirsutum cotton hybrids NGMSH 6, NGMSH 77, NGMSH 107, NGMSH 113 and NGMSH 138 with heterosis ranging from 15 to 75% over the best hybrid checks identified
* The protocol for *Agrobacterium*-mediated transformation, utilizing *cry* IA b synthetic *B.t.* gene into cotton explants, is being standardized
* A new insect pest, spiralling white-fly *Alecurodichus dispersus,* recorded for the first time on cotton at Coimbatore
* Jute plants inoculated with rice necrosis mosaic virus (RNMV) grew faster with increased fibre bundles, which finally increased fibre yield significantly
* Drought-tolerant bidi tobacco GT 7 released for rainfed areas of Gujarat
* Incorporation of processed mid-rib in cigarettes resulted in 13.8% reduction in TPM and 15.2% reduction in carbon-monoxide
* Use of entomogenous fungi like *Beauveria bassiana* , *Metarhizium anisopliae* and *Gliocladium* sp. proved useful for biocontrol of insect-pests of jute

**High-yielding hybrids/varieties of cotton for different zones**

| | Varieties | Hybrids |
|---|---|---|
| North Zone | LH 1556<br>HD 107<br>LD 491 | Fateh<br>HHH 81<br>Maruvikas |
| Central Zone | G.Cot.16<br>G.Cot. 17<br>Arogya<br>NH 452<br>PA 183 | G.Cot Hy. 10<br>PKV HY.3<br>Ankur 651<br>NBHB 11<br>Pha 46 |
| South Zone | LK 869<br>L 389<br>JK 276-8-4<br>Surabhi<br>SVPR 2 | TM1312 (Surya)<br>DHB 105 |

## SUGARCANE

Sugarcane Co 86032 has excellent field habits with high yield and better quality potential, and occupies considerable areas in Tamil Nadu and Karnataka.

Application of 4 tonnes/ha pressmud alone and with *Azotobacter* culture (5 kg/ha) saved 25% of the recommended dose of nitrogen at Padegaon (Maharashtra), Thiruvalla (Kerala) and Sehore (Madhya Pradesh). Trash mulching in ratoon crop significantly increased cane yield at Thiruvalla, Padegoan, Kolhapur, Sehore, Lucknow and Jalandhar. Integrated phosphorus management studies conducted at the SBI, Coimbatore, have indicated that phosphobacteria are beneficial to sugarcane. At Lucknow, intercropping 2 rows of biomustard (var. Bio 417) in 90 cm spaced sugarcane (autumn planted) rows yielded 1.75 tonnes of seeds/ha of mustard without affecting sugarcane yield.

ELISA technique has been used at Coimbatore to distinguish red-rot resistance. ELISA value was more in susceptible varieties than in resistant varieties. Infestation of shoot-borer *Chilo infuscatellus* in sugarcane was reduced by 6 rounds of weekly releases of egg parasitoid *Trichogrammotoidea eldanae* in Pravaranagar (Maharashtra).

Ridger-type sugarcane planter has been designed and developed at the IISR, Lucknow. All planting operations are accompanied in a single pass of the machine, and out-put of machine is 1.75 ha/day, and it requires only 4-6 labourers.

## TOBACCO

Mosaic-resistant and high-yielding flue-cured virginia (FCV) varieties Hema and 16/103 for black soils and NLS 4 and NLS 5 for northern light soils of Andhra Pradesh have been identified for release. NLS 4 is also found suitable for light soils of Karnataka. The cultivation of these varieties will increase export potential, resulting in additional foreign exchange earnings.

The drought-tolerant bidi tobacco GT 7 released for rainfed areas of Gujarat can be irrigated twice at 0.4 IW/CPE, when rainfall is

Brown linted cotton. Work on developing varieties/hybrids of cotton with lint of different shades of colours has been initiated under the ICAR Network Programme

**Some of the promising strains of sugarcane**

| Strain | Area of adoption | Remarks |
|---|---|---|
| B.O.120 | North, Central Zones | Early-maturing, high-yielding and moderately tolerant to red-rot and waterlogging |
| CO 88220 | North-Western Zone | Mid-season variety with high sugar content and recovery and shows resistance to red-rot, and is suitable for planting in autumn and spring |
| Co 8011 | Peninsular Zone | Mid-late maturing variety with good ratooning ability, moderately resistant to smut and red-rot disease, is suitable for spring planting |
| Co M 88121 | Peninsular | Mid-late, high-yielding variety with good ratooning ability, tillering profusely. It is moderately resistant to smut disease and is suitable for spring and Adsali planting |

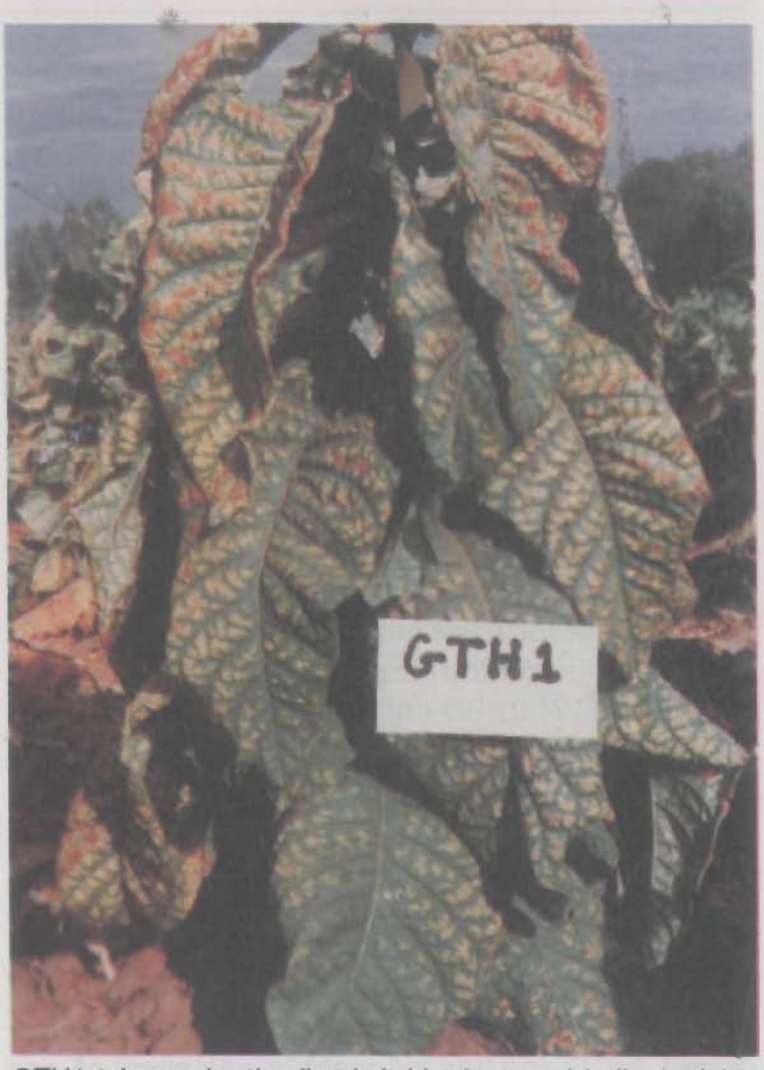
inadequate to sustain yield, without compromising quality. *Kharif*-groundnut and *rabi* FCV tobacco intercropping has been highly remunerative in black soils of Andhra Pradesh, followed by maize-chickpea and cotton. In southern light soils, tobacco is very remunerative in view of its high value and drought tolerance. Mustard among *rabi* crops and chillies in irrigated areas are better alternatives to tobacco in red soils.

Losses due to nematode infestation up to 32% could be avoided in susceptible bidi tobacco Anand 119 and up to 21% in tolerant GT 5 with the application of Sebufos (Rugby 10G) @ 1 kg/ha twice.

Neem formulations, Neem Azal F 1% and 5%, were very effective at 50 ppm azadirachtin concentration in protecting tobacco from *Spodoptera* damage. Pymetrozine 25% WP, a new contact-cum-systematic insecticide, at 200 g and 100 g ai/ha and Acephate 75% S.P. at 750 g ai/ha effectively controlled tobacco aphid *Myzus nicotianae*. Penamiphos (Nemacur 10G) @ 3.0g/$m^2$, and Basamid @ 30 g/$m^2$ gave good control of root-knot nematode.

For Karnataka light soil (KLS), integrated schedule, comprising soil solarization of nursery sites by mulching the prepared beds with 50 gauge WTP sheets for 6 weeks, amendment with neem-cake @ 400 g/sq m before solarization + a foliar spray of Ridomil MZ 0.3% at 30 DAS with an ICBR of 1:6.5, was recommended; Akomin was recommended for control of black-shank disease in FCV-tobacco nurseries.

Incorporation of processed mid-rib in cigarettes has resulted in 13.8% reduction in TPM and 15.2% reduction in carbon-monoxide.




GTH1 tobacco is the first hybrid tobacco of India. It yields 3,644 kg/ha. It has the following special features : (i) tolerant to root-knot nematode, (ii) leaf thickness better than GT5, (iii) synchronous maturity, hence suitable for whole plant harvest, (iv) percentage nicotine content is above 8

## JUTE AND ALLIED FIBRES

Two new jute *capsularis* varieties PBC 6 and PBC 8 and one *olitorius* PBO 6 have been put into front-line demonstrations for their superior yield performance. Short-duration, photo-insensitive *capsularis* cultures D 110 and D 90 are found promising, and gave yields equal to standard varieties which were harvested in 120 days. Axillary buds of sisal leaf are micropropagated in BAP-enriched MS medium in *in vitro* to grow into pseudobulbils.

Integrated nutrient management studies on jute indicated that at Kendrapara (Orissa) and Kathiar (Bihar) $N_{40}P_{20}K_{20}$ kg/ha (recommended dose) + FYM @ 10 tonnes/ha yielded significantly better (2.85 tonnes/ha and 3.33 tonnes/ha respectively) than the recommended dose of NPK alone. Mesta with blackgram in 3:3 ratio has been found promising.

Jute plants inoculated with rice necrosis mosaic virus (RNMV) grew faster with increased fibre bundles in them, which finally increased fibre yield significantly than normal ones, especially in JRO 524, JRO 3690 and JRO 632.

EMS-induced dwarf-branched type of roselle *Hibsicus sabdariffa* produces exceedingly long, deep red and fleshy calyx, which is utilized for production of tasty jam, jelly and sauce.

Use of entomogenous fungi like *Beauveria bassiana*, *Metarhizium anisopliae*, and *Gliocladium* sp. proved beneficial for biocontrol of insect-pests of jute.

Survey and surveillance of jute diseases have showed that in Kendrapara stem-rot is prevalent but its occurrence has not been alarming. Same was the situation in Kathiar for both jute and mesta. In Srikakulam (Andhra Pradesh) foot- and stem-rot ranged from 0.0 to 16.23 and leaf-rot from 0.0 to 15.7% in roselle.

## Seed Production and Technology

A total of about 2,624.6 tonnes of breeder seeds were produced during the year, covering different crops and varieties. The overall availability of quality/certified seed for farmers, after eventual follow-up of seed production chain in the country, at present stands at about 7 million quintals.

Synchrony of flowering in 'A' (IR 58025A) lines of rice could be obtained by staggered sowing. Planting ratios for optimization of hybrid-seed production have been standardized for pearl millet and sunflower hybrids. For pearl millet, an isolation distance of 200 metres for certified and 500 metres for foundation seed has been found adequate, and has been recommended also. In maize, genetic contamination at 600 metres is found negligible. Varietal characterization with the help of electrophoresis has been carried out in 8 AB and R lines of rice, 5 hybrids of castor and their parental lines and 4 hybrids of sorghum and their AB and R lines. Results of electrophoretic analysis have been comparable to field grow-out test (GOT) for testing genetic purity of hybrid-cotton.

For processing greengram (mungbean) seed, a sieve of 2.8 mm (round) has been found most effective and economical than the existing 3.2-mm sieve, which has resulted in 8% higher recovery.

In bulk storage, germination potential of seeds of different crops has been extended by 1-3 months (for MSCS), by using poly-lined gunny bags or poly-lined cloth bags, instead of ordinary gunny/cloth bags. Seed vigour influences crop performance mainly in terms of plant-stand establishment and early vegetative growth. Pre-sowing invigoration treatments have been found effective in improving field emergence, speed of emergence and early vegetative growth of the plant.

Paddy bunt could be controlled fully by spraying Tilt @ 0.1% or Contaf @ 0.2% at boot and panicle exertion stages of growth. Tilt spray on pearl millet hybrid Pusa 23 controlled ergot and smut diseases effectively.

- For pearl millet, an isolation distance recommended for certified seed is 200 metres and for foundation seed, it is 500 metres
- Germination potential of seeds of different crops extended from 1 to 3 months with the use of poly-lined gunny bags or poly-lined cloth bags, instead of ordinary gunny/cloth bags

**Variety Identification and Genetic-purity Testing**

Although genetic-purity test based on morphological characters allows direct observation of gene expression, but it takes several months to obtain information. At present, emphasis is being laid on the development of quick tests for genetic-purity, based on electrophoresis of proteins and isozymes.

Electrophoresis methods have been standardized for variety identification in cotton, pearl millet, wheat, sunflower, maize, castor and rice. Native or SDS-PAGE of soluble proteins and/or storage proteins is employed for discriminating genotypes of cotton, sunflower, castor and maize and isoelectric focussing or electrophoresis of esterase, peroxidase, malate dehydrogenase and GDH isozymes for genotypes of pearl millet and rice. Isozyme patterns have also been found useful in distinguishing sunflower and castor genotypes. Image Analysis system is applied to characterize sunflower and castor hybrids and their parental lines.

# Plant Protection

## BIOLOGICAL CONTROL

### Basic Research

Olfactometer studies on enhancing efficiency of predators with kairomones indicated greater response of *Chrysoperla carnea* larvae to hexane scale-extract of *Helicoverpa armigera*. The extract is amenable for storage up to 7 days at 7°C with no reduction in activity. Another chemical, L-tryptophan has been observed as a good oviposition stimulant for females of *Chrysoperla carnea*. It was possible to rear successfully *Compoletis chlorideae* and *Diadegma argenteopilosa* on laboratory host *Corcyra cephalonica* with good biological characteristics. Three syrphids and one *Leucopis* sp. could be successfully reared on aphid *Aphis craccivora*. Rearing *Cotesia plutellae*, which is a key parasitoid of *Plutella xylostella*, over five generations at the ambient temperature increased cocoon formation but decreased adult emergence. An artificial diet with cabbage-leaf powder as phagostimulant proved good for rearing *Spodoptera litura* as compared to castor-leaf powder. An artificial diet based on *Spodoptera litura* abdomen powder with enrichments has been found promising for rearing *Chrysoperla carnea*, and predator could be reared successfully for nine generations. Fungal antagonists isolated from sunflower and rice ecosystems include species of *Trichoderma*, *Gliocladium*, *Penicillium* and *Aspergillus*. Potato dextrose agar and potato dextrose broth media have proved suitable to support growth of *Trichoderma viride* and *Trichoderma harzianum*.

### Shipments of Natural Enemies / Hosts

Seventy-six shipments of parasitoids comprising different species of *Trichogramma* (53), *Mallada boninensis* (6), *Neochetina eichhorniae*, *Neochetina bruchi* (1), *Chrysoperla carnea* (9), *Cotesia flavipes* (3), *Chilocorus nigrita* (2), *Compoletis chlorideae* (2), *Parascymnus horni* (1), *Chelomenus sexmaculata* (1), *Cryptolaemus montrouzieri* (2), *Telenomus remus* (1), *Copidosoma koehleri* (2), *Chelonus blackburni* (2) and *Curinus coeruleus* (1), and 12 shipments of host-cultures of *Spodoptera litura* (3), *Corcyra cephalonica* (6), *Helicoverpa armigera* (1) and *Maconellicoccus hirsutus* (2) have been sent to co-ordinating centres and other research organizations.

- Quantity of hydroxy-methyl furfural is considered as an index of quality of honey, since it increases on storage at higher temperature or on heating honey
- Difethialone, a new rodenticide, at 0.0025% yielded cent per cent mortality in 1-2 days against *Bandicota bengalensis*, *Rattus rattus*, *Tatera indica*, *Golunda ellioti* and *Mus musculus*
- Methanol extracts (6%) of *Clerodendron* and *Vitex negundo* resulted up to 80% mortality of spidermites
- Recommended Lindane, Quinalphos and Chlorpyriphos for pest control in rice at Velyani, Bhubaneshwar, Jorhat, Kalyani and Coimbatore, as their pesticidal residues were found below the detectable limit
- Sorghum as a screen around maize-field effectively reduced parakeet damage to ripening maize in Punjab
- Two controlled release formulations, Chlorpyriphos 20CS and Quninalphos 70 SC, found effective than conventional EC formulations for groundnut-seed treatment for protecting against whitegrub damage
- Seven entomogenous nematode species belonging to *Heterorhabditis* and *Steinernema* found effective against soil insect pests; cutworms and wireworms, giving up to 80% mortality

### Biological Suppression of Pests

#### *Sugarcane*

*Trichogramma chilonis* released at 10 days interval @ 50,000/ ha, 12 times during cropping season, proved effective in bringing a reduction of more than 50% in damage by sugarcane

Mass-scale production of *Chrysoperla*. **Ist row** : 1 Adult oviposition cage, **2.** Larva feeding on eggs of *Helicoverpa armigera*, **3.** Cocoons collected from louvers. **2nd row** : **4.** Stalked eggs, **5.** Larvae feeding on cotton aphids, **6.** Individual cell in louver. **3rd row: 7.** First stage larval rearing unit, **8.** inside view of the unit, **9.** Louvers stacked in mass production unit

stalk-borer *Chilo auricilius* in trials conducted at 3 locations in Punjab. Detrashing was found a good cultural practice in combination with release of *Trichogramma chilonis*. The indigenous strain of *Cotesia flavipes* proved better than Indonesian strain in reducing incidence of *Chilo auricilius* and Gurdaspur-borer *Acigona steniellus* in Punjab. *Sturmiopsis inferens* was found an active parasitoid of early stage, shoot borer *Chilo infuscatellus*, occurring throughout the year around Coimbatore, while *Cotesia flavipes* was active only during April-June. A negative relationship was seen between parasitization of *Chilo partellus* by *Cotesia flavipes* and a number of larvae per female, but it was positively related to percentage of male parasitoids in parent batch. Granulosis virus of shoot-borer *Chilo infuscatellus* infected 1.80% to 22.45% larvae around Coimbatore. The eggs of the top shoot-borer *Scirpophaga excerptalis* were parasitized by *Telenomus* sp. to an extent of 27.5% and larvae by *Isotima javensis* to an extent of 3.3 to 5.5.% at Lucknow.

### *Rice*

*Trichogramma japonicum* and *Trichogramma chilonis* released @ 50,000/ ha/ week for control of rice stem-borer and rice leaf-folder could bring about effective check of both of these pests in trials in Assam and Tamil Nadu. In Punjab, damage by leaf-folder was reduced by the same treatment. *B.t.* formulations proved effective in suppression of leaf-folders in trials at Kerala and Assam. Biocontrol-based IPM (BIPM) was found best in controlling rice stem-borer and leaf-folder in Coimbatore, and was also found superior to need-based insecticide application.

### *Cotton*

In Punjab, *Trichogramma chilonis* released @ 50,000/ ha proved effective but inferior to PAU spray schedule in control of cotton bollworms. At Hyderabad, BIPM excelled in combination with suitable intercropping in groundnut.

### *Pulses*

In Punjab, Ha NPV @ 625 LE/ ha and Ha NPV @ 312.5 LE + Endosulfan 12.50 ml/ ha gave moderate control of *Helicoverpa armigera* on chickpea. *B.t.* formulation @ 0.5 kg/ ha proved effective in pigeonpea against pod-borer complex. *B.t.* formulations Biobit and BTK II reduced larval population of *Helicoverpa armigera* in pigeonpea, and Dipel and BTK II @ 1 kg/ ha were effective in chickpea in Andhra Pradesh. In Coimbatore, *B.t.* @ 0.5 kg/ha was

found effective against *Helicoverpa armigera* in chickpea.

### *Coconut*

Release of *Goniozus nephantidis* @ 20.5%, *Elasmus nephantidis* @ 49.4% and *Brachymeria nosatoi* @ 31.9% of host population gave significant reduction of coconut caterpillar *Opisina arenosella* at Kayangulam. Mirid predators affected 70-100% mortality of lacewing bug under controlled conditions of field-cages.

### *Fruit Crops*

*Cryptolaemus montrouzieri* was observed feeding on *Rastrococcus invadens*, and pest population was significantly brought down after field release at Bangalore. Safety of different pesticides to citrus-butterfly parasitoid *Apanteles papilionis*, pomegranate whitefly parasitoid *Encarsia azimi* and coccinellid predator *Chilocorus circumdatus* was tested. Cypermethrin remained detrimental even beyond 28 days whereas Phosalone, Dimethoate, Chlorpyriphos and sulphur were safe for *Apanteles papilionis*. Dichlorvos, Fenvalerate and Deltamethrin were toxic to *Chilocorus circumdatus*, and neem-seed kernel extract, neem oil, sulphur, copper oxychloride, Dicofol and Dimethoate were safe. Cypermethrin was toxic to adult of *Encarsia azimi*. An egg parasitoid *Ooencyrtus papilionus*, lycaenid predator *Spalgis epius* and an aphelinid *Pteroptirx koebelei* were found on pomegranate butterfly *Deudorix isocrates*, mango mealybug *Ferrisia virgata* and diaspine scale *Aulacaspis tubercularis* on mango respectively. Parasitoid *Anagyrus dactylopii* and predator *Cacoxenus prespicax* were found on jackfruit mealybug *Ipaecoccus viridis*. Parasitization of San Jose scale by *Aphytis* sp. (proclia group) on apple was common in Solan.

### *Vegetables*

In Bangalore, *Leptomastix nigricoxalis* and *Leptomastix lyciae* were recorded for the first time on brinjal mealybug *Coccidohystrix insolita*. Release of *Trichogramma pretiosum* @ 45,000-90,000/ha was effective against *Helicoverpa armigera* on tomato. *Trichogrammatoidea bactrae* developed well under 30°C. Sporeless mutant B.t. *k.* at 300 g ASP/ha effectively suppressed *Plutella xylostella* larval population on cabbage, with resultant yield increase. In Solan, field release of *Trichogramma pretiosum* provided 45% parasitization of *Helicoverpa armigera*. *B.t.k.* also, was equally effective at 1-1.5 kg/ha.

*Spodoptera litura* on groundnut controlled by *Nomuraea rileyi*, an entomofungal pathogen. Field testing of the efficacy of the fungus was taken up on *rabi* groundnut at Vinauashram, Guntur. A cumulative mortality of 80% of *S.litura* was obtained in soil treatment studies, of which 50% larval mortality was due to a natural coccinellid predator and 30% was due to *N. rileyi*. This demonstrates efficacy of fungus and its compatibility with natural enemies

### Biological Suppression of Weeds

Adults of *Zygogramma bicolorata* (beetle) fed on sunflower were found to have shrunken testes and thin and transparent ovarioles. The beetle can complete development when fed at seedling stage of the plant. Around Bangalore, feeding on sunflower was noticed where a defoliated stand of parthenium was observed in the adjacent field, but not in the sunflower field located away from weed and also during periods of no rainfall. Absence of food increased number of dipausing adults. Adults of *Neochetina eichhorniae* and *Neochetina bruchi* were found established on water-hyacinth in lake Pichola at Udaipur. Successful control of water-hyacinth was achieved in Assam and Gujarat with *Neochetina eichhorniae* and *Neochetina bruchi*.

## HONEY-BEE RESEARCH AND TRAINING

Apple orchards which have low percentage of pollinizer trees (8 to 10%) need 8 colonies of honey-bees/ha for pollination, resulting to an average fruit set of 48% compared to 20% in control. The fruit set was only 25% in orchards with 4 bee-colonies/ha. In orchards having adequate pollinizer proportion (30-35%), fruit set was similar with 2 colonies (34%) or 4 colonies (39%), compared to control (26%). In apple orchards having adequate pollinizer trees recommondation is only for 2 colonies (6-8 frame strength) per hectare for pollination, and orchards with low proportion of pollinizers need 8 colonies/ha for optimum pollination. Data collected on fruit set of Kiwi at Solan revealed that by placing bee-colonies for pollination, the fruit set could be increased by 67-97%.

Apprehensions were expressed that introduction and expansion of *Apis mellifera* may lead to decrease of Indian honey-bee colonies as has happened in Japan and other countries. However, studies conducted at Thiruvananthapuram made it clear that there is resource-partitioning of different *Apis* species. Bowl-shaped flowers with exposed nectar such as Umbellifereae and also many ground flora with small flowers are mainly availed by *Apis florea* and *Apis cerana*, and flora with longer corolla tube are availed by *Apis mellifera* and *Apis dorsata*, which have longer tongue-reach. The two groups of bees may compete by adopting certain foraging strategies, like side-working, nectar robbing etc., and there will always be some sort of overlapping and resource-partitioning. But *Apis cerana* and *Apis florea* may not decrease in number due to competition, but it is obvious that beekeepers will adopt high honey-yielding species.

After successful introduction of *Apis mellifera* in southern states, this bee has been introduced into Assam and Meghalaya also. In Assam, the bee has established itself and its performance is being studied. Beekeeping has been made possible in cotton-growing areas of Punjab after discontinuance of aerial spraying.

Studies at Solan indicated that maximum royal-jelly can be harvested after 72 hours of grafting 12hr-old larvae. The amount of royal-jelly harvested after 24, 36, 48, 60 and 72 hours of grafting was 51.9, 138.5, 167.6, 218.9 and 253.9 mg per cell cup, in 5-frame bee-colonies, and the production was 55.4, 163.6, 200.5, 254.5 and 329.6 mg per cup in case of 10 frames of bee-colonies. The royal-jelly production has been standardized at Ludhiana and it is recommended that royal-jelly should be harvested after 48 to 60 hours, if 48- and 24-hr-old larvae are grafted. Quantity of hydroxy-methyl furfural is considered as an index of quality of honey since it increases on storage at higher temperatures or on heating honey.

## RODENT CONTROL

### Rodent Species Complex

The soft-furred field rat *Millardia meltada*, lesser bandicoot rat *Bandicota bengalensis* and Indian gerbil *Tatera indica* constitute the major pest complex in most of the agroecosystems of the country. Of them, *Bandicota bengalensis* continues to be the most serious rodent pest of the national status. At a time 3-4 generations of this species have been recorded in a burrow system under field conditions. Besides these, field mice *Mus booduga* is also important in rice-wheat cropping system of Madhya Pradesh, in rice in coastal Andhra Pradesh, in irrigated crops of Punjab, Rajasthan, Uttar Pradesh and in fruit orchards of Himachal Pradesh. Brown spiny field mice *Mus platythrix* has been recorded from Northern Zone of Karnataka and fruit orchards of Himachal Pradesh, and common house-rat *Rattus rattus* has been reported to inhabit in irrigated crop fields of Madhya Pradesh, Rajasthan and apple orchards of Himachal Pradesh. Interestingly, Indian bush rat *Golunda ellioti* accounted for more than 15% of rodent-pest fauna in plum and peach orchards of Himachal Pradesh. Indian crested porcupine *Hysterix indica* was also observed infesting vegetable crops in Himachal Pradesh.

### Infestation Patterns of Rodents

Sunflower and maize suffered maximum losses due to *Tatera indica* and *Millardia meltada*

at seedling stage in Karnataka, and soybean and groundnut suffered colossal damages at pod formation and harvest and post-harvest stages. Maximum damage in ragi was caused at earhead formation and maturity stages. In the Kymore plateau and Satpura hills region of Madhya Pradesh, rice-crop harboured maximum rodents at pre-harvest stage. Intensity of rodents was highest on bunds, followed by field and border areas. In apple, plum and pecan-nut orchards of Himachal Pradesh, rodent infestation was significantly more during August-September and at a low level during winter. Trapability of *Bandicota bengalensis* was lower than that of *Millardia meltada* in Madhya Pradesh. During September-October and February-March, high rodent activity was observed, coinciding with maturity of *kharif* and *rabi* crops. Infestation of pomegranate and *Ziziphus* orchards by five-striped squirrel *Funambulus pennanti* began with the onset of fruit-setting, but maximum damage was observed at fruit-ripening stage.

**Extent of Damage**

The rodents damaged 4.7 - 17.7 pods/$m^2$ of chickpea and 0.43 - 15.77 tillers/$m^2$ of wheat in Madhya Pradesh. The areas with two cropping systems experienced more losses than those monocropped. In Himachal Pradesh, cabbage, cauliflower and pea suffered percentage demage of 4.1, 3.4-8.3% and 4.2-5.2%. In another study, porcupine was observed to cause 50% damage to cabbage heads. Among fruit-crops, apple suffered 6.7-21.5% damage at nursery stage, 4.4.% damage during storage, and young plants of pecan-nut recorded 6.5% rodent damage. Hoarding losses due to rodents were of 1.5-24.8 kg/ha in potato and 1.25 kg/burrow in tomato. Summer groundnut was damaged to the extent of 2.5-4.0% in Saurashtra region of Gujarat. Damage by *Bandicota bengalensis* to oyster mushroom *Pleurotus* sp. was recorded for the first time in the North-Eastern Hills region, and the estimated loss was Rs 35-40 per kg. Rodents also inflicted serious damage to honey-combs in apiaries in Meghalaya.

**Technology Assessment and Refinement**

At Jodhpur Centre, it is found that 2 control operations just before sowing of *kharif* and *rabi* crops, if taken up regularly for 3-4 years, drop rodent population down to 5% of original level, but if discontinued, rodents acquired initial levels after 3 crop-seasons again.

**Rodent Management**

Laboratory and field evaluations of some second-generation anticoagulant rodenticides have revealed that Difethialone, a new rodenticide, has a great promise as a single dose anticoagulant. This compound at 0.0025% yielded cent per cent mortality against *Bandicota bengalensis, Rattus rattus, Tatera indica, Golunda ellioti* and *Mus musculus* in 1-2 days in no choice as well as choice tests. It was equally effective in managing both sexes of rodents in laboratory trials. Among subacute rodenticides, Cholecalciferol yielded 100% kill of *Bandicota bengalensis* at Bangalore with delayed death (20.5-39.0 days). Maruteru Centre evolved an action plan for containing rodent menace in rice, coconut and rice-pulse cropping systems. Zinc phosphide (2.5%), followed by aluminum phosphide fumigation resulted 86.0%control in apple orchards. Similar success rate was achieved in plum orchards also by giving one treatment of aluminum phosphide, followed by burrow baiting of zinc phosphide (2.5%). It is generally observed that burrow baiting is superior over surface baiting. In wheat and chickpea, Difethialone, Bromadiolone and zinc phosphide treatments yielded significantly as compared to control in Madhya Pradesh. Shillong Centre reported that maize strains spawn based zinc phosphide bait was preferred by *Bandicota bengalensis* over rice-based bait and Bromadiolone wax-cakes, and this accounted for 100% control in oyster-mushroom houses. Racumin (0.75%) was effective against house-rats, house-mice and bandicoots as tracking powder as well as poison bait. Regular live-trapping as part of the non-toxic management approach was tried in plum orchards in Himachal Pradesh. This method yielded 64.29, 62.5 and 50.0% reduction in *Bandicota bengalensis*, other rats and mice population.

Rodents inflict serious damage to honey-combs

## AGRICULTURAL ACAROLOGY

In a study on seasonal incidence, population of spidermites (*Tetranychus urticae* and *Tetranychus macfarlanei*) infesting brinjal was higher between February and June at Bangalore. At Ludhiana, *Tetranychus cinnabarinus* was severe on brinjal between June and August, and at Agartala, the population of *Tetranychus neocaledonicus* was high during September and October on the crop. On okra, *Tetranychus macfarlanei* was severe in February and June at Navasari, and *Tetranychus cinnabarinus* at Coimbatore in June and July, and at Agartala between July and August. The erineum-mite *Aceria litchi* on litchi was in abundance between August and October in Bihar. The population of *Schizotetranychus cajani* was high during preflowering stages of pigeonpea at Varanasi and that of *Polyphagotarsonemus latus*, which is one of the causal agents of leaf-curling syndrome, during April on chillies at Kalyani, causing losses up to 34% in yield. The field studies at Jobner indicated that severe infestation of *Petrobia latens*, the brown wheat mite, can cause losses up to 12% in yield in wheat and 10% in barley. Boron and zinc reduced attack of *Petrobia latens* in wheat and barley. Sonalika wheat and RD 2052 barley were found tolerant to mite attack. Yield losses caused by common spidermite species like *Tetranychus macfarlanei*, *Tetranychus urticae* and *Tetranychus neocaledonicus* ranged from 4% in Agartala to 31.9% at Bangalore on brinjal and from 11.8% at Hisar to 68% at Agartala on okra.

Early-sown pigeonpea in Bangalore (May-June) and Navasari (September - October) was highly vulnerable to mite *Aceria cajani*, which transmits sterility mosaic disease. The studies confirmed that the mite population is highest when crop is 120-150 days old. Out of many genotypes screened for resistance against mite and disease, GC 11-39, DT 7, ICPL 27, ICPL 87, GPS 7, BP 92-24 have been found tolerant with low mite load and lower disease incidence. Spraying crop with Dicofol (0.05%) or wettable sulphur (0.2%), when crop is 30-45 days old, has been effective in endemic areas. Apart from oils of neem, mahua and pongamia, which have already shown their promise against mite pests, 6% methanol extracts of *Clerodendron* and *Vitex*

*negundo* resulted up to 80% mortality of spidermites.

## PESTICIDE RESIDUES

Multilocational trials on residues of Lindane, Quinalphos and Chlorpyriphos on paddy were conducted at Vellyani, Bhubaneshwar, Jorhat, Kalyani and Coimbatore. Residues of these were below detectable limit and the residues of Lindane present were below the maximum limit on paddy grain, straw, husk and bran. Thus, these pesticides can be recommended for control of pests on paddy. No detectable residues of Chlorpyriphos were present in tobacco leaves at Hyderabad, Anand and Pusa, indicating that Chlorpyriphos can be safely recommended for control of pests on tobacco.

Trials on residues of Fenvalerate and Carbendazim on grapes carried at Bangalore and Rahuri indicated that repeated and excessive spraying of vines is to be avoided and no spraying be given one month prior to harvest. In a multilocational trial conducted at Rahuri, Bangalore, and Coimbatore, recommended and double dose of Lindane, Fenvalerate and Quinalphos were found residue-proof on mangoes by keeping the pre-harvest interval of about 3 weeks before harvest of fruits. Based on a supervised trial conducted at Solan, a waiting period, after the last application, of 15 days for Antracol, 3 days for Carbendazim, 11 days for Chlorpyriphos, 4 days for Endosulfan and 2 days for Malathion was recommended for apple.

Residues of Lindane and Chlorpyriphos were below detectable level in mustard, sunflower and sesamum seeds at harvest. These pesticides can, therefore, be safely recommended for the control of pests on oilseed crops.

Monitoring of pesticide residues in vegetables and fruits was conducted. Out of total 2,500 samples of fruits and vegetables analyzed, about 1,500 were found contaminated with pesticides. Most of the samples had pesticide residues within permissible limits.

## AGRICULTURAL ORNITHOLOGY

Bird damage in Punjab ranged from 0 to 15.7% on maize and 0 to 27% on sunflower. A regression equation developed from pooled data for 2 years expressed need of a minimum of 8.1 hectares contiguous cultivation to lower parakeet damage to sunflower to a negligible level.

**Chlorpyriphos residues on tobacco**

| Place | Variety | Dose (kg a.i./ ha) | Residue at harvest (ppm) |
|---|---|---|---|
| Hyderabad | Burley tobacco | 0.4 | BDL* |
| | | 0.8 | BDL |
| Anand | A 119 | 0.3 | BDL |
| | | 0.6 | BDL |
| Pusa | PT 76 | 0.04 | BDL |
| | | 0.08 | BDL |

* below detectable limit

In a series of experiments conducted to evaluate beneficial role of birds in controlling *Helicoverpa armigera*, at least 14 species of birds were found feeding on larvae of *Helicoverpa armigera* on chickpea. Among these, most important were Cattle Egret, Rosy Pastor, Indian Myna, Bank Myna and Black Drongo. Insectivorous birds were the most important factors regulating population of *Helicoverpa armigera* in nature. It is experimentally proved that if birds are kept away by fixing nylon net over the crop, pest population increased tremendously, resulting in an increased pod damage and remarkable yield loss.

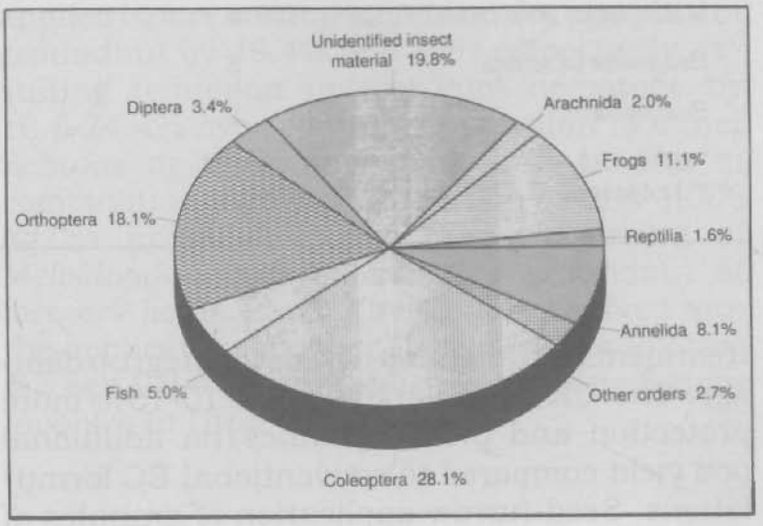
Two sprays of Endosulfan (0.07%) at pod-formation stage coupled with bird activity checked pest population effectively. The prey-searching efficiency of insectivorous birds was much better in chickpea (var. ICCC 4) grown at 60 cm inter-row distance as compared to 45 cm inter-row distance, without affecting yield. In lucerne, at least 7 species of birds were found feeding on insect pests, particularly on *Helicoverpa armigera*. Among predatory birds, Cattle Egret was the most abundant (49.4%), followed by Bank Myna (22.5%), and Indian Myna (8%). The birds fed on insects throughout the growing period of the crop as well as at the time of irrigation.

The cutting practices of lucerne reduced about 50% of *Helicoverpa* larvae population and the remaining 50% was left out on soil or in stubbles. The predatory birds following labourers, engaged in cutting of lucerne, reduced nearly 91.77% *Helicoverpa* larvae. Thereby, a total check on *Helicoverpa* population could be obtained by a combined effect of mechanical removal (50%) and avian predation (45.84%).

Gut-content analysis of 120 green bee-eaters *Merops orientalis* in Ludhiana revealed that Hymenopteran insects (almost exclusively honey-bees) constituted 81% of the total food content. Other insects which constituted diet were Odonata (11.62%), Diptera (2.4%), Lepidoptera (1/8%), Orthoptera (1.27%), Coleoptera 1% and others (0.93%). Honey-bees dominated bee-eaters diet (66.3%- 90%) throughout the year, except in October (31.5%). These studies indicate that bee-eater is a pest on honey-bees and warrants suitable control measures. The analysis of food of Cattle Egret nestlings was carried out by regurgitation method at Anand. The diet constituted 72.95% insects and 27.04% non-insect, animal matter. Among the insects Coleoptera (28.1%) and Orthoptera (18.10%) were the main constituents. Among Coleoptera, grubs of *Holotrichia* species were the main constituent of the diet of the nestlings. Similar studies conducted at Kota (Rajasthan) indicated that Cattle Egrets regulated larval population of saw-fly *Athalia proxima* on mustard to an extent of 60% after irrigation and brought down the population much below the economic threshold level (ETL). The birds were seen picking profusely saw-fly maggots from irrigated plot up to 8 to 10 hours in a day, with a picking success from 48.45 to 65%.

Sorghum as a screen around maize fields was found effective in reducing parakeet damage to ripening maize in Punjab. When screens were classified into *bajra* and sorghum, the data revealed a significant difference among no screen and sorghum screen with respect to parakeet damage and total bird damage, but there was no effect to crows with the presence or absence of screen. The results suggest that sorghum can be cultivated as a lure crop around maize to reduce damage by parakeets, since they prefer sorghum over maize.

Food constituents (in percentage) of Cattle Egret nestlings




The concept of IPM in the bird pest management has been worked out successfully on sorghum and maize using physical method (ribbon) in combination with application of botanical sprays (neem-based) or wrapping method. The trials conducted in farmers' fields in Andhra Pradesh revealed that cumulative effect of wrapping + ribbon on maize showed higher yield (2,667 kg/ha), compared to control (2,065 kg/ha). In *jowar* also, botanical sprays + ribbon-treated plots recorded higher yield (825 kg/ha) compared to control (764 kg/ha). Wrapping of maize-cobs up to one metre on borders+ reflective tape at the inter-distance of 5 metres proved promising in achieving higher yields at Kota. Tobacco leaf decoction (10%) spray at the milky stage of sorghum showed cumulative effect on the reduction of bird damage at Anand.

## WHITEGRUB MANAGEMENT

Two controlled release formulations (CRR), Chlorpyriphos 20 CS and Quinalphos 70 SC were found more effective than respective conventional EC formulations for groundnut-seed

**Bioefficacy of 3 entomopathogenic fungi against the grub of *Holotrichia consanguinea***

| Fungi | Days to cause 100% mortality of grubs under different methods of inoculation | | | |
|---|---|---|---|---|
| | Grub dipping in fungal suspension | | Soil inoculation | |
| | Plates with blotter | Containers with soil | Dry mixing | Drenching |
| *Metarhizium anisopliae* | 4 | 14 | 29 | 30 |
| *Beauveria bassiana* | 5 | 40* | 29 | ** |
| *Beauveria* | 5 | 13 | 39 | ** |

* 60%
** Not tested

treatment for protection against whitegrub damage. The CR formulations gave 10-15% more protection and 0.3-0.8 tonnes/ha additional pod yield compared to conventional EC formulations. Seed-furrow application of granules of controlled release Quinalphos 12 g at 2.4 kg ai/ha at the time of groundnut sowing gave over 85% protection to crop and 1.66 tonnes/ha more pod yield than untreated check.

Further studies on entomopathogenic nematodes revealed that parasitization of whitegrub by *Heterorhabditis bacteriophora* was affected by soil temperature and soil moisture; and maximum grub mortality was recorded when soil moisture was at 100% field capacity and temperature was at 25°C. During studies on optimum conditions required for storage of nematodes for longer period, it was found that *Heterorhabditis* nematodes can be stored for 120 days at 10° C. Seven entomogenous nematode species belonging to *Heterorhabditis* and *Steinernema* were found effective against other soil insect pests like cutworms and wireworms, giving up to 80% mortality. In compatibility test, it was found that fungicides Bavistin and Thiram at recommended doses had no adverse effect on the level of infection caused by entomogenous nematode *Heterorhabditis bacteriophora.*

The most active fraction of pheromone extracted from females of *Holotrichia consanguinea* was found to attract beetles of both sexes, thereby making it useful for mass-trapping.

For sporulation in *Metarhizium enisopliae* and *Beauveria* spp., temperature at 28°C was found optimum . All test fungi could grow at a pH ranging from 4.5 to 8.0. Studies on doses of inoculum and levels of moisture on bioefficacy of fungal pathogens indicated that period of grub mortality decreased with increased levels of inoculum and moisture in lab and pot tests.

The most effective isolates of *Metarhizium anisopliae, Beauveria bassiana* and *Beauveria brongniartii* were selected for a further bioefficacy test. Second and third instar grubs of *Holotrichia consanguinea* inoculated with spore suspension of fungi containing 5 × 10 spores/ml and then kept on moist blotters in petri-plates caused 100% mortality within 4-5 days as compared to soil inoculation methods which took 29-39 days in causing complete mortality. Besides, grubs, beetles also died within 4 days when they were inoculated with spore suspension of *Metarhizium anisopliae* (1 × 10 spores/ml). The most effective isolates of fungi were mass multiplied successfully on molasses yeast broth medium for 20-25 days and then fungal biomass was incorporated in sterilized talcum powder to obtain formulations of desired spore strength.

Two deep ploughings after harvest of summer fodder crop in August exposed whitegrubs to predatory birds and reduced grub population by 70%. Tractor-ploughing in light soils is normally done by disc, which does not expose grubs for bird predation, though a number of birds follow tractor.

## NEMATODE MANAGEMENT

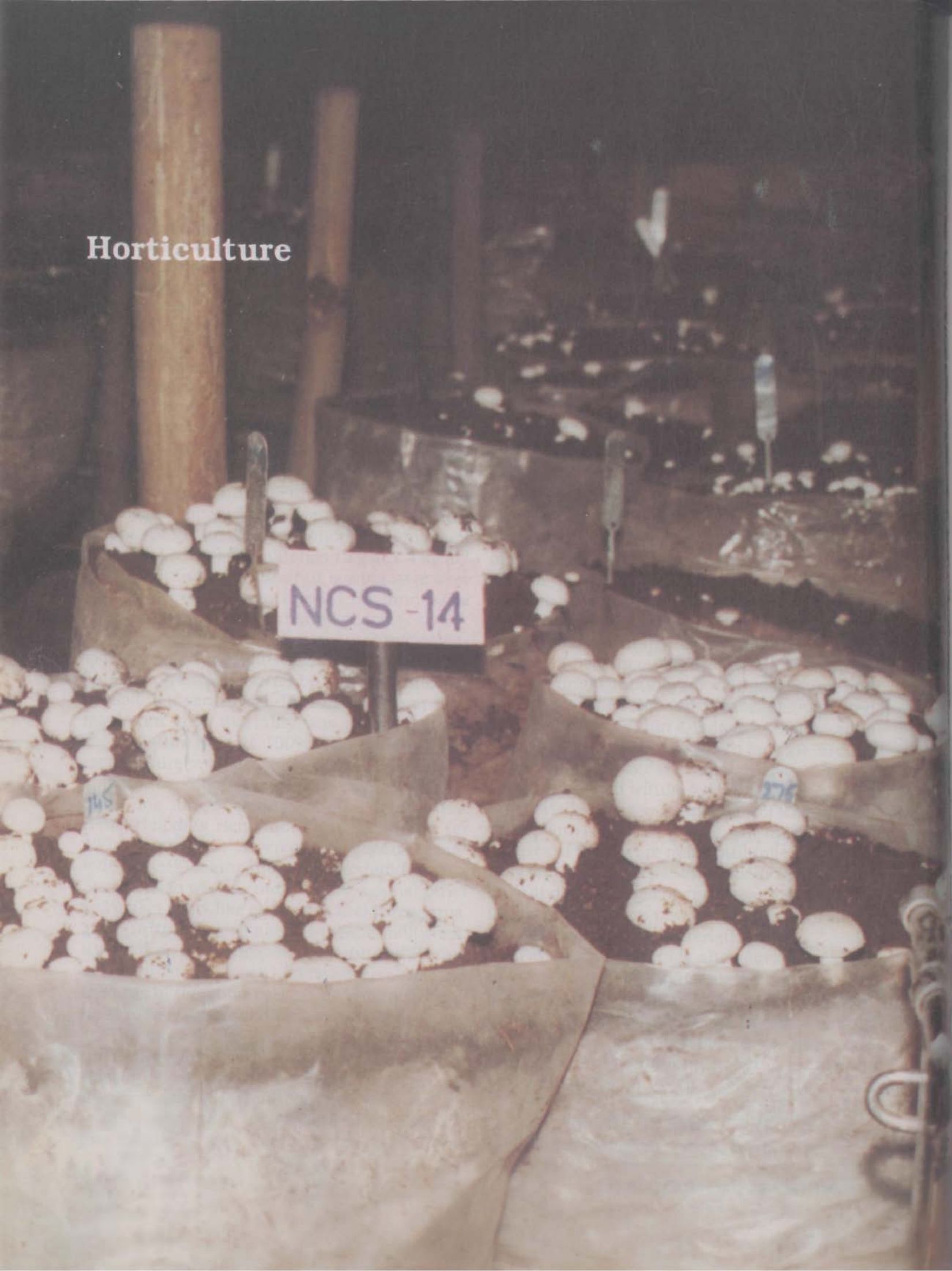
*Tylenchorhynchus vulgaris* has been reported

infesting maize and fennel in Gujarat, and root-knot nematode *Meloidogyne javanica* has been found infesting fennel.

Ecofriendly and economical methods consisting of soil solarization of nursery beds through use of clear LLDPE 100 gauge (polythene sheet) have been demonstrated to farmers for management of root-knot nematodes in fennel in Gujarat. Farmers expressed their willingness to adopt this simple technique of soil solarization. Soil solarization using polythene sheets was also effective for raising nematode-free nurseries of transplanted crops in general. To propagate and popularize this technique, a special training programme was organized at Anand which was attended by scientists of different states and also by the progressive farmers.

Management of root-knot nematodes *Meloidogyne arenaria* and *Meloidogyne javanica* infecting groundnut was demonstrated at farmers' fields in Gujarat. Application of either Carbofuran and Sebufos @ 2 kg a.i./ha coupled with castor and mustard cakes @ 1,000 kg/ha applied before sowing increased dry pod yield of groundnut by 49.4% and 40% respectively, resulting reduction in root-knot nematode by 16.6-24.4% over control. Application of either Sebufos or Phenamiphos @ 1 kg a.i./ha in combination with castor or neem-cake @ 1,000 kg/ha proved effective in management of *Meloidogyne javanica* infecting groundnut at farmers' fields. Similar trend was observed with the application of either Carbofuran or Phorate @ 2 kg a.i./ha in groundnut against *Meloidogyne javanica* in Uttar Pradesh.

# Horticulture



# Horticulture

## Fruit Crops

### MANGO

A number of improved hybrids have been developed for different agroclimatic conditions of the country. 'Arka Neelkiran', a hybrid ('Alphonso' x 'Neelum') performed excellently. It has a lot of export potential. The hybrid is a regular-bearer and late harvesting (July-end to first week of August). Another hybrid 'H 13-1' ('Amrapali' x 'Sensation') was found promising, bearing quality fruits with excellent shelf-life. A clone of mango 'Totapuri' has been selected at Paria, Gujarat. Mango 'Elaichi' has been identified as a new source of resistance to mango malformation. The rootstock 'Vellaikolomban' has been observed as a potential dwarfing rootstock for 'Alphonso'.

High-density planting gave encouraging results at New Delhi, Pantnagar and Sabour. Application of Paclobutrazole @ 5–10 g/adult tree, through soil drenching during July–August (once a year) ensured early and regular cropping in northern India. Soil treated with mycorrhiza *Glomus fasciculatum* at seedling stage increased the availability of Zn, Cu and Mn (3.70, 2.43 and 4.55 ppm) compared to the control (2.86, 1.70 and 2.75 ppm respectively).

Buprofezin (0.0125%), an insect growth regulator, and alcohol and ether extracts of *Alpinia galanga* (3%) were quite effective in controlling

The rich variability in shape and size in mangoes of Goa

hopper *Idioscopus nitidulus* under field conditions. An antagonistic bacterium, *Bacillus coagulans*, has been isolated from the mango phylloplane. It is effective in reducing bacterial canker disease under field conditions. Pre-harvest spraying of Thiphanatemethyl (0.1%) followed by an after-harvest dip and hot-water treatment (50°C) with 1% common salt can effectively reduce post-harvest decay of fruits due to anthracnose.

## BANANA

A collection of 597 germplasm accessions from indigenous and exotic sources has been maintained and evaluated for significant yield characters. Protocols for *in-vitro* multiplication of accessions with different ploidy levels from varying genomic sources have also been developed. Two improved cultivars— 'Karpuravalli' ('Pisang Awak') and 'Monthan'— have been selected for low input conditions. 'Karpuravalli' is high-yielding with tolerance to salt, whereas 'Monthan' is a dwarf selection. In the evaluation trials, 'Karpuravalli' was found suitable for low input conditions. Hybrid 'H 1' developed at Kannara was found highly promising at Kovvur for yield and tolerance to leaf-spot disease. High-yielding selection from 'Dwarf Cavendish' was found promising in Tamil Nadu, Gujarat and Maharashtra, providing consistent bunch weight of 55–60 kg each. Early-maturing clones in 'Dwarf Cavendish' have been identified and are being tested at other locations. Banana 'Grand Naine' was found superior to 'William', 'Zellic' and 'Basrai' for growth and yield. Two promising accessions ('0030' and '0016') performed consistently well.

Planting density of 1.2m × 1.2m × 2m in 'Dwarf Cavendish' was found cost-effective. Planting banana at a spacing of 1.5m × 1.5m gave highest yield in 3-crop cycle in Bihar. Application of 150 g N and 200 g $K_2O$ in vegetative phase and 50 g N and 100 g $K_2O$ in reproductive phase was effective in 'Nendran', 'Rasthali' and 'Basrai'. The application of 25% N in organic form enhanced yield in 'Nendran' and 'Dwarf Cavendish'. Zinc and boron also increased the yields substantially. Irrigation at 40 CPE in 'Nendran', 60 CPE in 'Poovan' and 80 CPE in 'Karpuravalli' was found optimum. During first six months weeds reduced the yield up to 30–60%. Intercropping cowpea significantly suppressed weed growth. Use of polythene mulch is recommended to increase bunch weight and for better economic returns in subtropical regions. Application of framyard manure, neem cake and inorganic nutrients (50%) significantly increased growth attributes under high pH (8.5–9.0).

Scaring beetle can be effectively controlled by the application of 30 ml monocrotophos (0.05%) in heart of the plant. Phosphamidon (0.05%) given twice checked pseudo stem-borer. Double pairing + dip in monocrotophos (0.5%) + sunnhemp intercrop has been found effective for managing nematode. Widespread occurrence of causal agent of banana bract mosaic virus (Konkan disease) has been observed on 'Monthan', 'Nendran', 'Neypoovan', 'Robusta' and 'Poovan' in Tamil Nadu, Kerala, Karnataka, Andhra Pradesh and north eastern region. The yield losses were 46–68 % depending upon the cultivars and growing conditions. Pinkish to dark reddish streaks on pseudo stem, mosaic pattern and dark pinkish spindle-shaped discolouration on bracts are the symptoms. Presence of streak virus disease on 'Poovan' has been recorded in major banana-growing states, resulting in about 48 % yield losses. Bunchy-top virus has been purified and detected by using the PCR technique.

## GRAPE

Twenty-five wild relatives were collected from Konkan (Raigad) district of Maharashtra. 'Flame Seedling', an introduction from California, has been identified for 10-day late-ripening and better fruit quality than 'Perlette' for cultivation in Punjab. Thirteen hybrids have been selected for their fruit quality. They are promising for table purpose, juice and wine-making. Application of ethephon @ 600 ppm as a foliar spray or cluster-dip treatment resulted in increase in berries, TSS and reduction in juice acidity. Pruning 3–4 buds/spur in 'Perlette' and 6–7 buds/cane in 'Thompson Seedless' have been found quite suitable and are recommended for adoption in Punjab. Chemical control measures of downy mildew, powdery mildew and anthracnose in grapes have been worked out.

## CITRUS

'Selection 159' has been identified as suitable for summer cropping in larger areas. At Tirupati, 'Tenali' selection has been found promising. Rough lemon 'Australia' was found highly tolerant to salt. 'Sai Sarbati', a high-yielding, disease tolerant acid lime selection, released earlier, has been supplied to the growers. Application of 200–450g N, 100–200 g P and 100–150 g K/tree with regular plant-protection measures resulted in substantial increase in fruit yield (15.5–19.9 tonnes/ha in Rangpur lime and 12.5–13.6 tonnes/ha in rough lemon rootstocks) at the NRC for Citrus, Nagpur. The yield levels are comparable with the commercially citrus-growing countries Brazil, the USA and Spain. Maximum availability of K should be ensured during fruit setting stage to harness higher K-use efficiency. Application of 1,800 g N, 400 g $P_2O_5$ and 400 g $K_2O$ in mandarin during thirteenth year gave highest yield of 1,700–1,800 fruits/plant at Akola. For acid lime a dose of 600 g N, 300 g $P_2O_5$ and 400 $K_2O$ has been found optimum. Integrated method of weed control was cost-effective in mandarin orchards. Drip irrigation has also been found superior to sprinkler irrigation. Spraying of gramaxone + 0.2% urea gave effective control of weeds in sweet orange orchard at the MPAU, Rahuri.

Monocrotophos + emulsified neem-oil spray at first nymphal stage followed by second spray after a fortnight in each bahar was most effective to control blackfly. Application of fenvalerate (0.05%) followed by monocrotophos (0.05%) is recommended for controlling of leaf-miner. Spraying of chlorpyriphos (0.05%) or carbaryl (0.1%) was found effective to control mealy bug. Spraying of 0.3% Aliette followed by Bordeaux pasting was quite effective in checking the spread of *Phytophthora* root-rot. Pruning followed by spraying of Kavach reduced the incidence of twig blight. Stem-end rot of fruits can be effectively controlled by spraying of Bavistin (0.1%). Hot-water treatment (45°C) followed by dip in tetracycline 200 ppm for 1 hr suppressed greening symptoms.

## APPLE

Application of fungicides Hexaconazole (Contaf 0.03%), Difenoconazole (Score 0.015%), Cyproconazole (Atemi 0.02%), Penconazole (Topas 0.05%) and Flusilazole (Punch 0.01%) has complete inhibitory effect on apple scab pathogen in repeated spray programme, providing 97–100% disease control. Flusilazole (Punch 0.01%), Hexaconazole (Contaf 0.03%), Difenoconazole (Score 0.015%), Bitertanol (Baycor 0.05%) and Fenarimol (Rubigan 0.04%) have shown excellent curative activity.

## GUAVA

'CISH-G1', a high-yielding selection, has been found promising at the Central Institute for Subtropical Horticulture, Lucknow. Its fruits are deep red, uniform in size with attractive shape, fewer soft seeds, high TSS (15 °Brix) and long shelf-life. It has good export potential. Another hybrid of a cross between 'Arka Mirdula' and 'Red Flesh' has been found promising with deep red pulp, soft seeds and TSS (12 °Brix).

Guava 'CISH-G1' is a high-yielding selection. The deep red fruits of uniform size are very attractive and contain fewer soft seeds. The TSS value is high (15° Brix) and the fruits have a long shelf-life

### BER

A high-yielding selection, 'CHES1', has been identified for release at the Central Horticultural Experiment Station, Godhra. It is an early-bearer than ber 'Umran' and 'Gola', thereby escaping from the incidence of fruit-borer, fruit-fly and powdery mildew. The fruits have high keeping quality. Pruning of trees during January–February resulted in maximum fruit yield at Aruppukattai, Tamil Nadu. Spraying of fenvalerate (0.01%) twice at 15-day intervals from pea stage has been quite effective to control fruit-borer at Sardar Krushinagar, Gujarat. There was an increase in the incidence of powdery mildew from October, reaching to its peak in December.

### ANNONA

An improved hybrid, 'Arka Sahan', has been developed for the first time in the country, at the IIHR, Bangalore. It has very less seeds, crisp pulp, high TSS and good keeping quality.

### PINEAPPLE

'H 7', a new hybrid ('Vallera Morande' × 'Kew'), has been found promising with fruits weighing 3–3.4 kg each. Clones '2/82' and '1/82' have excelled over others.

### PAPAYA

'CP 81', a hybrid ('Coorg Honey Dew' × 'CP 85'), has been identified for high yield and quality. A promising hybrid from the cross between 'Co 5' and 'Thailand' has been developed and further purified. Planting during September–November was ideal in Bihar with less incidence of ring-spot virus disease. A spacing of 1.6 m × 1.6 m was found economical for 'Co 6' for higher papain yield. Application of organic nutrients enhanced yield and quality of fruits, latex yield and enzyme activity.

### SAPOTA

During the year, 'PKM 3' from a cross between 'Guthi' and 'Criket Ball' has been released for cultivation. The plants are early with characteristic columner growth, making it suitable for high-density planting. It gives more yield than both the parents with excellent fruit quality. Seed treatment with $KNO_3$ (1%) significantly enhanced seed germination in *Khirnee*. Storage of budstick by wrapping them in newspaper and sealing in polythene is successful for 12 days. Spraying of monocrotophos (0.05%) was effective in reducing the incidence of bud-borer. Application of *Bacillus thuringiensis* (Bt) was also effective in suppressing the bud-borer incidence.

### POMEGRANATE

A selection, 'Mridula', from the hybrid population of 'Ganesh' and 'Gulsha Rose Pink' (Russian cultivar), has been developed at the MPAU, Rahuri. The hybrid combines deep red aril colour of the Russian parent and soft seededness and high TSS of 'Ganesh'. Drip irrigation can replenish evaporation losses up to 60 % in 'Ganesh'. Application of Azadirachtin @ 9 ppm was very effective to control fruit-borer.

## Post-harvest Management

Pre-harvest application of fungicides (Carbendazim, Imidazole) and growth regulators (MH 40, GA 3 and calcium carbide) minimize post-harvest losses and improve keeping quality of mango, onion, ber, pineapple and litchi.

A gap of nine days between the last irrigation and harvesting should be given in litchi to obtain maximum benefit of post-harvest quality of fruits. Fruit harvesters developed have been found suitable and economical for proper harvesting operations in mango and sapota. These resulted in significant reduction of harvest injuries (16–5%) and imparted better post-harvest quality during storage and marketing.

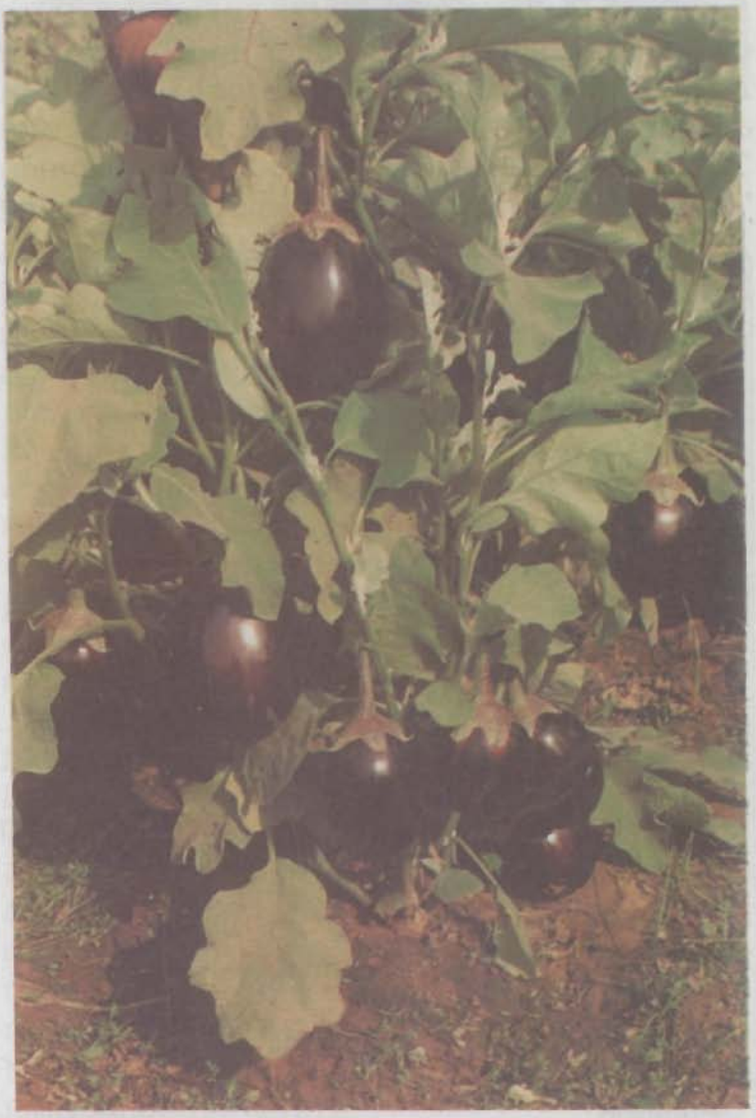
Modified atmosphere packaging (MAP) technology for mango, banana, guava and citrus fruits using various polymeric films and shrink-wrapping have been promising in their keeping quality even up to one month. Hot-water treatment improved the post-storage ripening of shrink-wrapped 'Alphonso' and 'Banganpalli' mangoes held at 15°C for three weeks. Shrink-film wrapping of pomegranate 'Ganesh' and storing them at 6°C extended their shelf-life for 12 weeks. In capsicum, shrink-wrapping ex-

tended their shelf-life to 30 days at 8°C. Pre-cooling of okra at 10°C before MAP extended their shelf-life to 12 days at 10°C. Vase solution containing 1% sucrose, 5 ppm of BA and 300 ppm citric acid increased the vase-life by three days. Rose and chrysanthemums can be stored for three days at 4°C without affecting vase-life.

Grape 'Arkavati' with 24 °Brix and above resulted in good quality raisins. Mango 'Alphonso' and 'Totapuri' were found to be more suitable for osmotic dehydration. Exotic guava collection '7-12 EC-147036' proved best for RTS juice making. Mango 'Kesar', 'Lakhan Bhog', 'Gulabkhas', 'Safder', 'Janardhan Pasand' and 'Swarnarekha' have been identified and evaluated for export market. Corrugated fibre board (CFB) boxes developed from the cotton-stalk wastes have been found suitable for packaging and transportation of mango and citrus fruits.

On-farm storage technology for fruits and vegetables by using evaporative cool-chambers have been standardized at different agroclimatic locations. Post-harvest losses in onion can be successfully reduced from 46 to 30% by storing them in specially designed cool-chambers. Technology for low-cost preservation and processing of fruits and vegetables by addition of food additives (sugar, salt, acetic acid, ascorbic acid, spice extracts and combined preservatives) have been developed.

Several innovative processed fruit and vegetable products (ber candy, ber *churah*, dried aonla shreds, cherry nectar, osmotically dried apple rings, oil-less aonla pickles) have been developed and standardized.



The brinjal 'Pusa Uttam' is a newly-released variety from the IARI, New Delhi. Its medium-sized, oval-round, glossy and purple fruits are ready for picking in 85 days, the yield being 43 tonnes/ha

## Vegetable Crops

During the year, three $F_1$ hybrids and 13 open-pollinated varieties of vegetable crops have been identified for release in different agroclimatic regions of the country (see Table).

In addition, onion hybrid ('Arka Lalima') and six improved varieties (tomato 'Arka Shreshta' and 'Arka Abhijit'; capsicum 'Arka Abir'; cowpea 'Arka Suman'; ridged gourd 'Arka Sujat' and 'Arka Sumit') have been released for cultivation in Karnataka.

A number of improved agro-techniques have been developed and recommended. These include direct seeding of tomato on raised beds during first week of October to get highest net return of Rs 48,221/ha in terai region. Application of NPK in different doses under different crop-growing conditions — @ 120:60:60 kg/ha for 'Pant C 1' and 90:60:60 kg/ha for 'Pusa Jwala' in chilli at Pantnagar and Durgapura respectively; 100:80:60 kg/ha for garlic 'G 1' at Jorhat; NP @ 180:120 kg/ha for tomato hybrid 'ARTH 3' at Sabour; N @ 120 kg/ha for onion 'Agrifound Dark Red' at Durgapura (spacing 45cm x 30 cm); N @ 100 kg/ha for carrot 'Nantes' at Ranichauri and Sabour (spacing 45 cm x 45 cm); N @ 40 kg/ha as basal + 40 kg/ha as topdressing in tomato at Kalyanpur — has been recommended. In addition, application of Metalachlor @ 1.0 kg ai/ha + hand-weeding 45 days after sowing for effective weed control in *kharif* okra has been recommended at Sabour. The crop sequences of paddy–chilli and paddy–tomato are recommended for upland and medium low-land conditions of Jorhat.

A number of plant-protection schedules have been recommended to minimize crop losses.

| Crop | Variety | Hybrid | Recommended for |
|---|---|---|---|
| Brinjal | | 'ABH 2' (small round) | Central region |
| | 'BB 26' (long) | | North-eastern and south-eastern regions |
| | 'AB 1' (round) | | Arid western, central and north-eastern regions |
| | 'PLR 1' (small round) | | Northern plains, arid western and central regions |
| | 'SM 6-6' (resistant to bacterial wilt) | | Northern hills, south, central and western regions |
| | 'BB 44' (resistant to bacterial wilt) | | North-eastern, western and southern regions |
| Tomato | | 'BSS 20' (indeterminate) | Northern plains, arid western and central regions |
| | 'Sel. 32' (determinate) | | Eastern, arid western and central regions |
| | 'DT 10' (indeterminate) | | Northern plains and arid western regions |
| | 'BT 12' (indeterminate) | | Northern hills and plains regions |
| Pumpkin | | 'Pusa Hybrid 1' | Northern plains, arid western and southern regions |
| Chilli | 'JCA 283' | | Northern hills, and western and southern regions |
| | 'Phule C-5' | | Central region |
| Onion | 'Punjab Red Round' | | Central, western and southern regions |
| Bitter gourd | 'MC 84' | | Central, western and southern regions |
| Okra | 'HRB 9-2' (resistant to YVMV) | | Northern plains and arid western regions |

These include soil application of phorate @ 1.25 kg/ha at the time of transplanting + spraying of monocrotophos (0.05%) at 10-day interval for the control of leaf-curl disease in chilli at Junagadh; soil application of carbofuran 3g ai @ 1.0 kg/ha + covering the nursery bed with nylon net followed by three sprays of neem oil (2%) 15 and 35 days after transplanting for integrated management of insect-borne viruses in chilli/ capsicum at Coimbatore; five sprays of Ridomil-MZ combined with streptocycline 100 ppm to control curd-rot complex disease in cauliflower at Katrain; four sprays of mancozeb (0.3%) + monocrotophos (0.05%) at 15-day intervals to control leaf blight in onion.

**COMPUTER IN BREEDING**

A flexible computer package, ***iv CMS version 2.0,*** has been developed at the CPRI, Shimla. It would help in conserving potato crop, by keeping its *in-vitro* gemplasm repository.

# Tuber Crops

### POTATO

A new technique for germplasm distribution has been evolved by nutrient encapsulating *in-vitro* nodal cuttings in sodium alginate to avoid spoilage during transit. The encapsulated beads can be stored in dark up to six weeks and transported in a large number in a small vial without any risk. The encapsulated propagules can be regenerated on incubation under light. For collection, conservation and utilization of germplasm, a flexible computer package (iv CMS version 2.0), has been developed for the first time to manage *in-vitro* germplasm repository.

During the year, 14 improved hybrids have been developed and identified for their significant characters. Five hybrids ('HB 83-39', 'HB 83-185', 'HB 82-36', 'HB 82-372' and 'QB/A/9-120') have been developed for their higher yield and resistance to late blight. Three hybrids ('JW 96', 'JX 90' and 'JK 576') were identified for early maturity and high yield and two hybrids ('MS/ 90-512' and 'MS/90-542') for medium maturity in multilocation trials. Four hybrids ('MP/90-74', 'MP/90-83', 'MP/90-94' and 'MP/91-93') have been identified for superior processing quality. Besides, 'SM 85-50' and 'SM 45' hybrids were superior over other genotypes tested during the first year of trials in hilly region.

A number of potato-based cropping systems and intercropping sequences were evaluated under varying crop-growing conditions to get maximum returns from the limited land resource. In West Bengal, potato-based cropping systems potato–maize–paddy and potato–jute–paddy gave better results, providing net return of Rs 47,000/ha compared to non-potato cropping system wheat–jute–paddy (Rs 30,000/ha). Potato–maize–radish gave maximum net return at Palampur, whereas *kharif* potato–wheat/ safflower/bengal gram–cucumber/coriander has been found economical at Dharwad. Intercropping potato with cotton (2:1 row) with recommended doses of fertilizers was also very economical at Dharwad

Integrated pest and disease management has been given special emphasis by using eco-friendly biocontrol methods. Treating tubers with biocontrol agents *Bacillus* spp. and *Pseudomonas fluorescens* reduced the incidence of bacterial wilt significantly and increased the crop yield. Bio-agent B-68 has been found better than carbofuran for the control of parasitic nematodes. Application of *Bacillus thuringiensis* has been found effective to control potato tuber moth in Maharashtra.

Adoption of improved technology package has been successfully demonstrated in the selected villages of Patna, Bhojpur and Nalanda districts in Bihar under the Operational Research Project (ORP). The benefit-cost analysis indicated that gross return of Rs 24,250/ha is obtained compared to Rs 7,650/ha by the traditional methods. The average yield increase was about 45 tonnes/ha against the state average yield of 10 tonnes/ha. Thus the national average productivity and total production can be increased up to 19 tonnes/ha and 20.5 million tonnes respectively.

## CASSAVA

Of the five improved varieties identified, three are short-duration cultivars ('CI 649', 'CI 731' and 'CI 732') which showed superiority under farmers' field trials. Other two superior varieties ('H 119' and 'H 226') identified for higher tuber yield (35.4 and 31.4 tonnes/ha) performed excellently in farmers' fields at Salem and Peddapuram respectively. A triploid variety, 'Sree Harsha', has been released for general cultivation in Kerala. A high-starch variety 'Sree Harsha' is most suitable for cultivation for industrial purposes. Two short-duration lines — 'CI 649' and 'CI 731' — gave maximum tuber yield with the application of N (75 kg/ha) and K (100 kg/ha) in a rice-based cropping system. Organic manures mushroom-spent compost, saw-dust compost and coir-pith compost can be used as a substitute of farmyard manure. Application of NPK at 100:50:100 kg/ha (P as superphosphate) with full dose of farmyard manure or crop residue gave maximum total dry-matter yield.

Aluminium phosphide has been found as an effective fumigant for disinfesting major pests *Araeocerus fasciculatus*, *Lasioderma serricorne* and *Tribolium castaneum* in cassava chips during their storage. Sun-dried chips are more susceptible to insect infestation compared to oven-dried chips. Chips stored in finely woven gunny bags impregnated with Azadirachtin, malathion or fenvalerate remain uninfested for six months. A motor-driven chipping machine has been fabricated as an improvement over the pedal-operated chipping machine. The output of the machine is 1,091 kg/hr for approximately 10 mm-sized chips.

## SWEET POTATO

During the year, four open-pollinated hybrids have been developed which gave maximum yields in the farmers' fields. Of these, 'KV 4' gave as much as 24.2 tonnes/ha against 15.4 tonnes/ha from the standard variety 'Sree Nandini'. In addition, two short-duration, high-yielding varieties 'Sree Bhadra' ('S 1010') and 'Sree Retna' ('X 108-2') have been released for cultivation in Kerala. They gave a mean yield of

Cassava 'Sree Harsha', a triploid variety, has been released for cultivation in Kerala. Since 'Sree Harsha' is a high-starch variety, it is recommended for industrial uses

### CASSAVA CHIPPING MACHINE DEVELOPED

Casava chipping machine for making cassava chips has been developed at the CTCRI, Thiruvananthapuram. The machine is an improved version of the hitherto popular pedal-operated chipping machine. It makes 1,091 kg chips 10-mm thick in 1 hr.

'Sree Retna' is an improved, short-duration and high-yielding sweet potato. It provides 20–25 tonnes of tubers from one hectare in 105 days

20–25 tonnes/ha with a crop duration of 105 days. 'Sree Bhadra' has also proved superior in the multilocation trials in Maharashtra, Orissa, Bihar and Madhya Pradesh. An application of N @ 37.5 kg/ha along with *Azospirillum* gave maximum tuber yield. The crop sequence of maize–sweet potato–onion gave maximum net return of Rs 43,312/ha at Dholi. Under the IPM technology package use of synthetic sex pheromone against sweet potato weevil resulted in minimizing the tuber damage to 7.6% compared to the the control (48.2%). A combination of biotic agents *Rhaconotus menippus* and *Metarrhizium anisopliae* along with reridging can reduce weevil damage considerably.

## YAMS

Three high-yielding hybrids have been identified and included in the coordinated trials. 'Dah 197', the highest yielding hybrid, having good quality has been recommended for release. Intercropping *Dioscorea alata* and *D. rotundata* with banana 'Robusta' have shown the possibility of reducing fertilizer dose to *Dioscorea* to two-thirds of the recommended dose.

## AROIDS

Three colocasia varieties performed very well under the multilocation trials. Colocasia 'NDC 1' has proved superior at Faizabad and Dholi, whereas 'TVM 293' and 'C 226' have proved promising at Shillong. Colocasia 'Nadia Local', 'Muktakeshi', 'NDC 1' and 'NDC 2' gave good yields with minimum disease infection at Dholi and Faizabad. Three high-yielding hybrids of taro, which are at par with 'Sree Reshmi' and 'Muktakeshi', have been found to be tolerant to leaf blight. In taro, seven hybrids have recorded fairly good yield and showed tolerance to leaf blight in the advance generation trials. The comparative studies on starch-based adhesives of different tubers indicated that colocasia adhesive has good tack- and film-forming ability.

In *Amorphophallus*, a yield potential of 45 tonnes/ha was obtained by the application of lowest dose of NPK (50:60:50 kg/ha) at Kalyani. Of the different methods of fertilizer application, three split doses of N and K, i.e. one-third each as basal, 30 days after planting and 60 days after planting gave maximum corm yield. Seed corm pieces weighing 500 g each is considered as economic optimum set size for Assam.

# Mushroom

A number of fleshy edible and non-edible fungi have been collected, maintained and evaluated for strainal improvement. A new fungi, *Neopaxillus echinospermum*, growing on the upper hills of Himachal Pradesh, has been recorded for the first time from India. On evaluation of high-yielding strains of *Agaricus bitorquis*, NCB 6 and NCB 13 showed superiority of latter for yield, fruit body quality and size of mushroom. In the summer cultivation of temperature tolerant white button mushroom at Solan, mushroom yield at 15% conversion rate was obtained in eight weeks of cropping, using strain NCB 13 on steam-pasteurized semi-synthetic compost prepared from wheat straw and poultry manure. On evaluation of 13 strains of *A. bisporus*, P 1 gave maximum yield at Ludhiana, Solan and Pune, and NCS 5 at Coimbatore, Pantnagar and Faizabad.

Water leaching/washing of decomposed spent compost for 6–8 hr resulted in significant yield increase compared to unleached/leached (for 2–4 hr in water) spent compost as of the casing materials. Water leaching removed salts accumulated in the decomposed spent compost and reduced electrical conductivity, which helped in increased pin head formation and mushroom yield. Coir pith has shown as a promising viable casing medium for button mushroom cultivation. Coir pith after decomposition and mixing with calcium carbonate resulted in more mushroom yield compared to undecomposed coir pith.

Spraying of calcium chloride (6.2% concentration) at pinning stage enhanced whiteness of the fruit body and improved their apparent toughness. The period of composting in Long Method of Composting (LMC) can be reduced to 20–24 days from 28 days of normal schedule at Ludhiana, Pune and Pantnagar. In general, spawned casing (CACing), give early flushes with evenly distributed fruiting and higher yields.

Thirty species of oyster mushroom have been tried for the year-round cultivation and three species of *Pleurotus: P. sapidus, P. florida* and *P. flabellatus* have performed better in terms of mushroom yield. The *P. sajor-caju* gave maximum yield at Ludhiana and Faizabad, *Pleurotus* 503 at Raipur and Udaipur, and *P. salmoneo stramineus* at Coimbatore and *P. florida* at Pune. The *P. florida* was most suitable for winter cultivation at Solan, while *P. membranaceous* for the summer cultivation. A large number of agro/

Mushroom is a protein-rich wonder food. *In picture:* the healthy fruit bodies of *Volvariella* species

agro-industrial wastes have been tested as a substrate for oyster mushroom cultivation. It was observed that *Pleurotus* spp. can be cultivated on a wide variety of substrates. Steam-pasteurization of substrate proved to be the best method of substrate treatment followed by partial composting.

Black-ear mushroom *Auricularia* sp. can be cultivated on steam-pasteurized wheat-straw substrate supplemented with wheat bran. Wheat-straw substrate supplemented with 6% wheat bran resulted in highest biological efficiency (80%) compared to other treatments. Milky mushroom, *Calocybe indica*, can be cultivated on steam-pasteurized wheat-straw substrate supplemented with 4% wheat bran, with 25% biological efficiency.

Substrate supplementation trials for cultivating *Volvariella* sp. conducted at Coimbatore, Ludhiana, Faizabad and Raipur, showed that supplementation with cotton wastes give higher yield at Coimbatore and Ludhiana, while chicken manure supplementation improved the yield marginally at Faizabad. Partial composting of substrates for paddy straw mushroom cultivation has been tried at Coimbatore, Raipur and Faizabad. Soaking in water for 18 hr gave maximum yield at Raipur, while soaking for 48 hr was best at Faizabad.

The National Centre for Mushroom Research and Training, Solan, continued to supply quality spawn of the cultivated edible mushrooms to the small and marginal farmers from all over the country. During the year, a total of 21,205 bottles of spawn was supplied to the growers. At Solan, five training courses including an international training course have been organized. In addition, two off-campus training courses were also organized at Kullu and Karnal/Sonipat.

# Floriculture

## ROSE

Three promising hybrids, 'H 4-86-87' (light pink), 'H 32-86-87' (bright red) for budding and cut flowers and 'H 11-86-87' (pink) for budding and potting, have been identified for release at New Delhi. Hybrid Tea cultivars 'Chambe-de-Kali', 'Jawani', 'Nishada', 'Priyadarshini', 'Pusa Sonora' and 'Rosy Evening' are promising at

Rose hybrid 'First Prize' x 'Sabin' has been released by the IARI, New Delhi. It produces huge flowers of red colour. The flowers have a long vase-life

Bangalore, whereas 'Gladiator', 'Cardinal', 'Eterna' and 'Gold Medal' are suitable for cultivation around Hyderabad. *Rosa multiflora* and *Rosa indica* var. *odorata* are most suitable rootstocks for 'Montezuma' and 'Happiness' at Kalyani and Coimbatore respectively. Application of Bavistin (0.1%) in rose 'Raktagandha' and Bavistin (5%) + linseed oil in rose 'Montezuma' are effective to control black leaf mould and die-back diseases at Ludhiana.

### GLADIOLUS

The hybrid 'Punjab Morning' at Ludhiana, 'Key 88/4' at Kalimpong, and '82-11-90' and '82-18-16' at Vellanikkara have been found promising. Gladiolus 'American Beauty', 'Appllo', 'Friendship', 'Sancere', 'Rose Supreme', 'High Style', 'Wind Song', 'Pricilla' and 'Nova Lux' are promising for export of cut flowers at various coordinating centres. Foliar application of Fe (0.4%) has proved to be best for plant height, days to flower, duration of flowering, spike length and height, and number and size of florets/ spike at Udaipur. The application of Bavistin (0.1%), Benlate (0.2%) and Captaf (0.3%) were best control measures of Fusarium wilt disease at Delhi, Pune and Ludhiana respectively. Gladiolus 'Sel. 1', 'Suchitra', 'Sylvia', 'IARI 74', 'DHN 86-1' and 'Psittacinus' (hybrid) shown resistance to Fusarium wilt. The application of sucrose and 8-Hydroquinoline citrate (HQC) was ideal for increasing the vase-life of cut flowers.

### CHRYSANTHEMUM

Chrysanthemum 'White Charm' was released at Lucknow. Other cultivars 'Indira', 'Red Gold', 'Meera', 'Co 1', 'Vasarvtika', 'IIHR Sel. 5' and 'IIHR Sel. 6' were promising. For export of cut flowers chrysanthemum 'Birbal Sahni' was better than other varieties at Coimbatore. The application of NPK @ 40:40:20 g/m$^2$ significantly increased plant height, plant spread, number of branches, number of flowers/ plant and yield of flowers in chrysanthemum 'Red Gold' at Bangalore.

### CARNATION

Commercial cultivars 'Red Corso', 'Espana', 'Arthur Sim', 'Scarlet' and 'Elegans' were found promising at different AICRP centres.

### ASTER

Two China varieties, 'Kamini' and 'Purnima', were promising at Bangalore

### MARIGOLD

Two varieties, 'Pusa Narangi Gainda' and 'Pusa Basanti Gainda', have been released at New Delhi.

### GERBERA

Two varieties each ('Tropical Panama' and 'Pendora') at Pune and ('Carona' and 'Ludukimari') at Shillong were found promising for commercial cultivation.

## Plantation Crops

### COCONUT

On field evaluation of 62 exotic accessions, coconut 'Philippines Ordinary' has recorded a mean yield of 110 nuts/palm/year with copra yield of 20.8 kg/palm/year, thereby showing an increase of 37.5% and 50.7% over 'West Coast Tall' and 12.2% and 20.9% over 'Chandrakalpa' respectively. Coconut 'Philippines Ordinary' is also relatively tolerant to drought, nematodes and root wilt disease. It has been recommended for the commercial cultivation in the West Coast including Konkan region, East Coast of Andhra Pradesh and West Bengal.

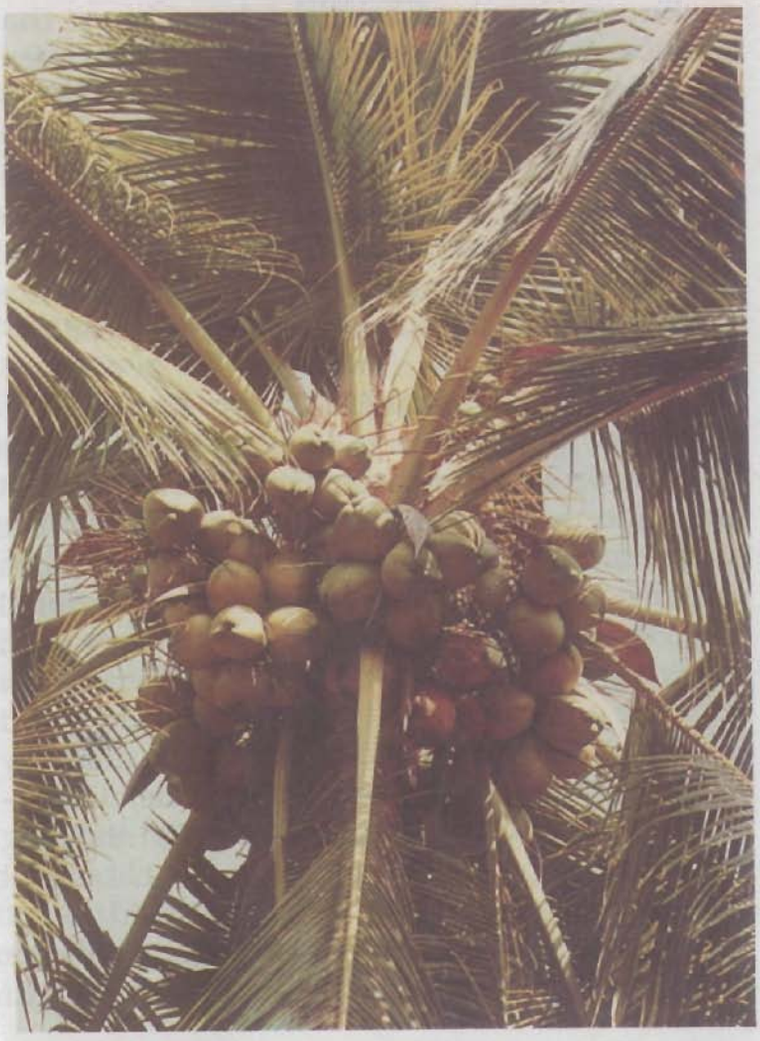
Cultivating coconut with organic fertilizers gave higher nut yield (96.5 nuts/palm/year), followed by cultivating with inorganic manuring (86.9 nuts/palm/year). Coir pith in combination with farmyard manure and soil in the ratio of 2:1:1 was suitable carrier for producing biofertilizer *Beijerinckia indica*, the predominant asymbiotic nitrogen-fixing bacteria in coconut soils.

At Aliyarnagar, maximum cumulative yield for the last four years is 280 nuts/palm for 'Strait Settlement Green', followed by 215 nuts/ palm for 'East Coast Tall'. At Veppankulam, 'West Coast Tall' resulted in the highest annual yield of 159 nuts/palm, followed by 'East Coast Tall' (149). Among dwarfs, 'Malayan Green

Dwarf' yielded the highest annual nut yield of 117 nuts/palm, followed by 'Gangabondam' (106). In NPK nutritional trial on high-yielding varieties at Mondouri, P and K (250:100 g/palm/year) treatment gave maximum copra yield of 20.42 kg/palm, followed by NP (1,000:250 g/palm/year) application giving yield of 17.88 kg/palm. At Ratnagiri, the effects of N and interactions of N and K, and N and P were found significant in nut yield. At Kahikuchi, highest nut yield (111.5/palm/year) has been recorded with NPK (1,000:500:1,000 g/palm/year) treatment.

Enzyme-linked immuno-absorbent assay (ELISA)—a rapid and highly sensitive diagnostic test—has been standardized for the detection of root (wilt) disease in coconut. The technique can be reliably used for large-scale screening of healthy elite palms identified in the hot-spot areas.

At Aliyarnagar, application of 5 kg neem cake/palm along with root feeding of Tridemorph (2%) solution was most effective treatment to control the basal stem-rot (Ganoderma). At Veppankulam, early diagnosis tests EDTA, TTC and electrical conductivity have been developed for the basal stem-rot. In the biological control trial, palms receiving treatment of *T. harzianum* with green leaves + farmyard manure + BM and neem cake minimized the disease intensity.



Coconut 'Philippines Ordinary' with a yield potential of 110 nuts/palm/year and copra yield of 20.8 kg/palm/year, has been recommended for commercial cultivation. It is relatively tolerant to drought, nematode and root-wilt

## OILPALM

Plantlet development from leaf calli has been achieved through both somatic embryogenesis and direct organogenesis in four dura and two tenera seedlings. Tenera hybrids developed at the CPCRI Research Centre, Palode, and planted in the farmers' fields in Andhra Pradesh, recorded highest fresh fruit bunch yield (22–24 tonnes/ha) five years after planting. The results are encouraging and on a par with the material collected from Papua New Guinea and Coasta Rica, indicating stability in yields.

At Mulde, drip irrigation with NPK dose (1,200:600:2,700 g/palm/year) has given maximum fresh fruit bunch yield of 57.8 kg/palm/year. At Gangavathy, number of bunches/palm and fruit weight significantly increased with the application of fertilizers.

Embryo culture is successful in oilpalm. The plantlets developed from the leaf calli in tenera hybrids at the CPCRI, Kasaragod, have been planted in the fields. The fresh fruit bunch yield is 22–24 tonnes/ha five years after planting

Survey on pest incidence has shown that rhinoceros beetle is the major pest. Severe infestation by red palm-weevil and gelechild caterpillar have also been recorded on palm fruits. Incidence of Nettle caterpillar and caseworms has been found in all the palm-growing areas of Krishna, East and West Godavari districts of Andhra Pradesh. Root feeding of monocrotophos has successfully eradicated Nettle caterpillar.

Excission of rotton tissues of stem-wet-rot-affected oilpalm

## CASHEW

A new programme to identify high-yielding trees grown under neglected conditions in forest plantations has been initiated. Under the programme, 24 promising types have been clonally multiplied and added to the National Gene Bank. Some of the accessions have high flowering intensity/unit area, along with high sex ratio and nut weight varying between 6 and 8 g. Twenty-five collections have been made by different AICRP centres which include cluster-bearing types, bold nut types and high-yielding types with short flowering phase. An elite local accession, 'Balli 2', has been identified to get high yield (10.05 kg/tree cumulative yield, the nut and apple weighing 7.2 and 69.8 g each in

Cashew 'Balli 2' has a yield potential of 10.05 kg nuts/tree, with the nut and apple weighing 7.2 and 69.8 g each

Goa. On evaluation, a hybrid ('M 44/3' × 'M 10/4') has been identified for higher yield than the best parent 'M 44/3' in the sixth annual harvest (218%) with cumulative yield (119%).

Multiple shoot induction has been achieved both in MS medium containing thidiazuron alone and in combination with other plant growth regulators BA, NAA and IBA. Rooting can be induced both in *in vitro* and *ex vitro*. The plants have been acclimatized. After hardening they have been transferred to greenhouse in pots. Maximum ground coverage was achieved in a spacing of 5m × 4m by sixth year, giving cumulative yield of 443 kg/ha under pruned conditions and 342 kg/ha under unpruned conditions after three harvests. Pest management trials with plant products showed inhibitory effects of tea mosquito bug with aqueous extracts of *Adhatoda vasica* (5%).

### ARECANUT

'Cal 17', an indigenous variety, has been released for Andaman Islands. It has a yield potential of 18.89 kg fresh nuts/palm/year with a kernel weight of 4.34 kg/palm/year, 22% higher yield than 'Mangala'. 'Sirsi Arecanut Selction 1' ('SAS 1') with a yield potential of 24.03 kg fresh nuts/palm/year, has been recommended for cultivation in Sirsi (hilly area). It is quite popular for its tender nuts.

Field trials have shown complete check on the growth of 20 *Phytophthora* isolates with the application of contact fungicides Captaf and Foltaf. Fungi *Aspergillus* sp. and *Myrothecium verrucaria*, and an actinomycetes have been identified as potential antagonists against *Phytophthora*.

## Spices

The Indian Institute of Spices Research, Calicut, has evolved five new, high-yielding varieties of spices. These are 'IISR Varada' of ginger, 'IISR Prabha' and 'IISR Prathibha' of turmeric, and 'IISR Navashree' and 'IISR Nithyasree' of cinnamon. The varieties of turmeric and cinnamon have been released for commercial cultivation.

### GINGER

'IISR Varada' is a superior selection with an average yield of 22.66 tonnes/ha. It matures in 200 days, with 20.7% dry recovery, 4.5% crude fibre and 1.75% essential oil content.

### TURMERIC

'IISR Prabha' is an open-pollinated selection with an average yield of 37.47 tonnes/ha. It matures in 205 days, with 19.5% dry recovery, 6.52% curcumin, 15% oleoresin and 6.5% essential oil contents, providing 474.39 kg curcumin/ha. 'IISR Prathibha' is also an open-pollinated selection, with an average yield of 39.12 tonnes/ha. It matures in 225 days under rainfed conditions, with 18.5% dry recovery, 6.2% curcumin, 16.2% oleoresin and 6.2% essential oil contents, providing 448.1 kg curcumin/ha.

### CINNAMON

'SL 63' ('IISR Navashree') is a superior open-pollinated selection from Sri Lankan introduction. 'IISR Nithyashree' is another superior, open-pollinated selection from elite tree from Anjarakandy, Cannanore.

**Main features of cinnamon 'IISR Navashree' and 'IISR Nithyashree'**

| Character | 'IISR Navashree' | 'IISR Nithyashree' |
|---|---|---|
| Regeneration capacity (shoots/year) | 6–7 | 4–5 |
| Bark recovery (%) | 40.6 | 30.7 |
| Average yield (kg/ha) | 56 | 54 |
| Quality attributes (%) | | |
| Bark oil | 2.7 | 2.7 |
| Cinnaldehyde content (bark) | 73 | 58 |
| Bark oleoresin | 8 | 10 |
| Leaf oil | 2.8 | 3 |
| Leaf eugenol content | 62 | 78 |

Young flushes of 'IISR Navashree' are purple in colour which turn into green in 7–10 days, while in 'IISR Nithyashree' this occurs in just two days. Both the lines are recommended for all the cinnamon-growing regions of the country.

Micropropagation protocols for rapid clonal multiplication have been standardized for cinnamon, camphor and several herbal spices thyme, spearmint, peppermint, sage, marjoram, oregano, lavender, sweet basil, anise, parsley, fennel, dill, caraway and celery. Plant regeneration from callus cultures of vanilla has been achieved for the first time. Somatic embryogenesis and plant regeneration are obtained from seed culture of cinnamon, anther-derived callus cultures of ginger and callus culture of herbal spices lavender, fennel, anise and sage. Protoplast isolation and regeneration of callus are achieved in *Piper colubrinum*.

Nine cardamom collections containing high volatile oil or high alpha turpenyl acetate, eight ginger accessions with low fibre content and four high quality cinnamon lines have been identified. It is also found that location has significant effect on curcumin content of turmeric.

In black pepper, open-pollinated/hybrid progenies 'Culture 5489' (Cheriyakaniakaddan OP) gave the highest green berry yield (7.14 kg/vine), followed by 'Culture 5403' (Karimunda OP) and 'Culure7156' (Perumkodi OP) with 4.62 kg and 3.89 kg/vine respectively. The promising high-yielding cultivars identified in black pepper are 'Kuthiravally' (3.39 kg/vine), 'Neelamundi' (3.37 kg/vine) and 'Arakkulam Munda' (3.28 kg/vine).

*Verticillium chlamydosporium*, a known nematode biocontrol agent, has been isolated from the rhizosphere of black pepper for the first time. This fungus parasitized root-knot nematode eggs and suppressed their hatching. Agrotechniques for the management of *Phytophthora* foot-rot and nematode diseases of black pepper are being worked out. Treating with biocontrol agents *T. harzianum* and *T. viride* reduced the foot-rot incidence up to 8.3% compared to the control (33.3%). Spraying and drenching with Bordeaux mixture (1%) and Akomin (0.2%)under low and high shade conditions is recommended to control nursery diseases in black pepper.

Coriander 'RCr 20' ('UD 20') has been recommended for release for cultivation under limited moisture and heavy soil conditions in south eastern Rajasthan. Selection 'UD 436' (coriander), 'UC 209' (cumin) and 'UF 101' (fennel) are identified as high-yielding. Two pre-release coriander cultures 'ATP 77' and 'JCo 64' and two fenugreek accessions 'CF 360' and 'CF 464' are in advanced stages of testing at Coimbatore. These lines registered yield records of 683 and 550 kg/ha in coriander and 433 and 390 kg/ha in fenugreek respectively. Fenugreek 'RMt 1' from Rajasthan, having dwarf determinant habit of growth, was identified to use in crossing programmes. Similarly, superior cumin line 'UC 223' was identified in Rajasthan with high grain yield as well as low incidence of wilt. Sowing of coriander 'RCr 41' on 25 October or 4 November at 30-cm row spacing at a seed rate of 14g/ha produced maximum seed yield. A seed rate of 25g/ha with the application of 40g N + 40g $P_2O_5$/ha is recommended for maximum yield for adoption in Rajasthan.

'ECm 109635', an exotic cumin entry, was found to be moderately resistant to root-knot nematode. Fenugreek exotic culture 'EC 257566' and 'Kasuri' were completely free from powdery mildew at Jagudan. An eco-friendly technique of using 5% neem leaf extract as foliar spray (three sprayings) gave an effective control to powdery mildew in coriander. Treating seeds with *Trichoderma viride* @ 4g/kg of seed reduced wilt disease incidence from 36.6 to 6.0%. Application of *T. viride* along with 15 kg of neem cake/ha to manage root-rot in fenugreek has been recommended at Coimbatore.

Pre-sowing fungicide treatment with Captan or a combination of Indofil M-45 and Bavistin along with soil application of Phorate or Anthracol in furrows at planting time reduced the incidence of rhizome-rot in ginger. The fungicides had additive effect with biocontrol agents *Trichoderma harzianum* and *T. haematum* in controlling rhizome-rot and increased the germination and yield of ginger.

**BETELVINE**

The stigma of betelvine flowers is receptive for 6–7 days after anthesis. Highest fruit set (67–68%) was observed in the flowers pollinated one or two days after anthesis. The stigma receptivity can be identified through the change in colour of the inflorescence. Flowers lost their receptivity when the catkins turned to dark brown. The pollen-grains are viable for 5–6 days when stored under ambient conditions (27–28°C). The rate of their germination is highest in 8% sucrose solution without salts.

The experiments conducted at the JNKVV, Jabalpur and MPAU, Sangli, indicated that 100 and 150% of replenishment of evaporation through drip irrigation show better growth and leaf yield respectively. Application of Tricontanol and Mixtalol as bio-regulators revealed that three sprays of Tricontanol (0.05%) give better growth and leaf yield. It was found economical at the RAU, Pusa, with a cost:benefit ratio of 1:11.83.

'Halisahar Sanchi' and 'Awani Pan' were found to be resistant to all major diseases. 'Bangla' and 'Alupatria' were moderately resistant to *Phytophthora*-rot at the OUAT, Bhubaneswar. The application of *Trichoderma* at quarterly intervals controlled foot-rot effectively. At the AAU, Jorhat; BCKVV, Kalyani and TNAU, Coimbatore, application of *Trichoderma* was at par with Bordeaux mixture treatment. At the JNKVV, Jabalpur, application of *Trichoderma* at quarterly interval was found superior to reduce the incidence of *Phytophthora* foot-rot effectively.

Application of oil cakes with carbofuran and three inoculations of *P. lilacinus* showed better control of root-knot nematode compared to other treatments. At the OUAT, Bhubaneswar, application of carbofuran alone and oil cake + carbofuran + three inoculations of *P. lilacinus* were statistically at par in controlling the nematode. At the APAU, Hyderabad, minimum incidence of mites was observed when phosphamidon (0.05%), neem seed-kernel extract (5%) and tobacco decoction (2%) were applied. At the TNAU, Coimbatore, wettable sulpher (0.5%) and Dicofol (0.05%) reduced mite population, followed by neem seed-kernel extract (5%). Spraying of neem seed-kernel extract (5%) and neem oil (2%) reduced the population of stem-borer in *Sesbania*.

# Medicinal and Aromatic Plants

In medicinal plants, 66 accessions from the eastern Uttar Pradesh and 109 accessions from Madhya Pradesh have been collected. In opium poppy, 'NBPGR 2' has given highest yield of 60 kg latex and 10.9 tonnes seed/ha, with over 12% morphine content. Promising selections having high yield and quality parameters have been identified in Ocimum, Aloe, Psoralea, Mucuna, Andrographis and vetiver. Intercropping short-duration legumes (cowpea, blackgram, cluster-bean) in *kharif* and mustard in *rabi* in vetiver plantation gave a net profit of Rs 26,500/ha compared to Rs 15,000/ha in vetiver alone. In palmarosa oil grass, use of *Azotobacter* @ 2 kg/ha was found to cut down the chemical nitrogen dependence by 40 kg/ha without affecting the oil quality.

# Soils, Agronomy and Agroforestry

# Soils, Agronomy and Agroforestry

## Natural Resources Inventories

### Soil Resource Inventories

***Soil Resource Map***

The soil resource map of India on 1:1 m scale (26 sheets) was finalized using categoric and cartographic generalization of 1:250,000 scale maps of different states. The soil maps of Rajasthan, Lakshadweep Islands, Tripura and Nagaland were released during the year.

### Application of Soil Information Through Geographical Information System (GIS) Technology

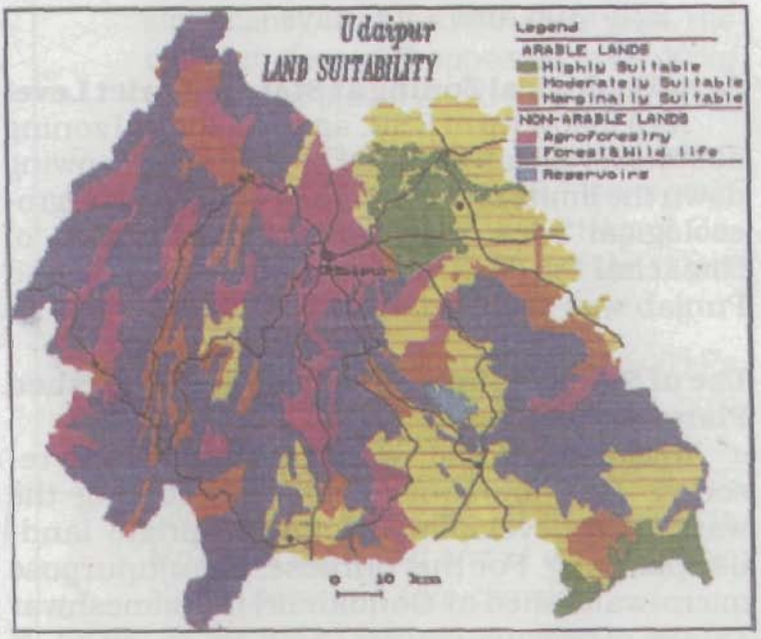
The soil resource maps of Meghalaya, Nagaland, Tripura, Jammu and Kashmir, Andhra Pradesh, Madhya Pradesh, Bihar and Kerala were digitized and various thematic maps on important soil parameters such as soil depth, texture, pH, erosion and drainage were prepared.

Considering the current needs of the data for district level planning, the interpretative maps of the districts of Aurangabad, Ratnagiri, Jamnagar, Udaipur and Bankura were generated.

Based on Geographical Information System (GIS) approach, a consultancy project on "Evaluation of Land Suitablility for Rubber Cultivation in Tripura" was completed.

Collaborative research project with NRSA on"Harmonization of Wasteland/Soil Degradation Database" was undertaken in Salem (TN), Udaipur (Rajasthan), Pune (Maharashtra), Etah (UP), Raipur (MP) and Kohima (Nagaland). The wastelands and soil degradation maps of these

- Soil resource map of six states of India finalized
- District level planning possible through interpretative map of the districts
- Agro-ecological zone map of Himachal Pradesh, J&K and Punjab finalized
- Soil resource Inventory used for water-shed planning
- Soil water conservative treatments in water-shed increased the availability of water for irrigation
- Sunnhemp mulching and green manuring controlled erosion and restored productivity
- Integrated water-shed helped in conserving plant bio-diversity.
- Runoff percentage and soil loss per unit area decreased with slope length.



districts were brought out at a common scale, e.g., in Salem district, 1,506 km² area (17.4%) of the district is under different categories of wastelands. The underutilized degraded forest covers 751 km² area, of which 20% is extreme degree of degradation, 60% has strong degree and 18% moderate degree. The upland with and without scrubs account for 328 km² area of which 21% has extreme, and 39% each of strong and moderate degree of soil degradation.

**Agro-Ecological Zoning**

Twenty agro-ecological region (AER) maps of India were subregionalized based on more finer criteria of parameters and in AER delineation and an agro-ecological subregions (AESR) map on 1:4.4 million scale has been prepared.

*Criteria used at different levels:*

Twenty AER map country level.

Soils-subgroup association; physiography-major division; climate-broad based (six-class); length of growing period (LGP) four-class (<90-150; 150-210 and >210 days).

*Sixty AESR at regional level:*

- Soils-great group association (including soil quality)
- Physiography-subdivision of major climatic types
- Climate -subdivision of major climatic types
- LGP-10 classes (<60;60-90; 90-120; 120-150; 150-180; 180-210; 210-240; 240-270; 270- 300 and >300 days.)

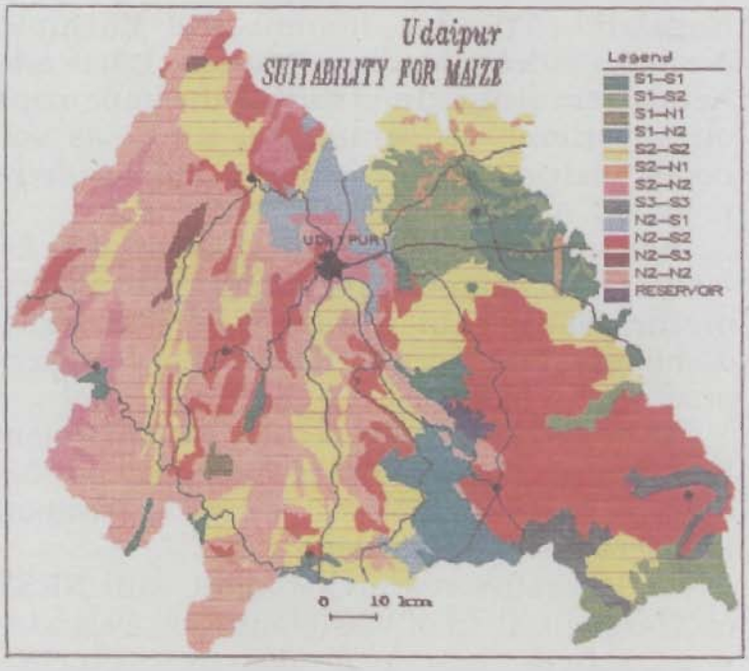
**Agro-Ecological Zoning at State/District Level**

As a follow up of ESR, agro-ecological zoning at state level was initiated by further narrowing down the limits of the parameters used. An agro-ecological zone map of scale 1:100,000 of Himachal Pradesh, Jammu and Kashmir and Punjab was finalized.

**Use of Soil Resource Inventory for Watershed Planning**

Inventory of soil, water and vegetative resource is a prerequisite for undertaking the watershed development for appropriate land-use planning. For this purpose, a multipurpose micro-watershed at Gondkhairi in Kalmeshwar Taluka of Nagpur district (21°8'16" to 2°8'24" N

- Pelleting device developed for establishment of pasture
- Solar PV pump operated drip system
- Intergrated plant nutrient supply system developed for soybean-wheat on black soils
- Farmyard manure improved N-fixation in sobyean
- Mean annual microbial biomass C and N in the soil improved by application of FYM and/or fertilizer N
- Sulphur status and extent of its deficiency in Indian soils studied
- Widespread deficiency of Zn resulting in low crop yield
- Integrated organic manure with 100% recommended NPK fertilizer doses improved the yield sustainability



and 78°54'30" to 78°54'30"E) was adopted for watershed research and development. The detailed soil survey was carried out and water resources (surface and subsurface) and land utilization types were recorded and land assessed for soil-site suitability for major *kharif* (cotton, sorghum, groundnut, pigeonpea and soybean) and *rabi* (gram,mustard and wheat) crops.

Mustard after soybean,wheat/gram after sorghum and summer vegetables after cotton were more profitable.

Variation in soil characteristics under similar management practices affected the crop performance and production potential. The yield of cotton in moderately deep, highly calcareous and excessively drained soil type was poor when compared to slightly calcareous and well drained adjacent soil type.

The soil water conservation treatments in the watershed increased the availability of water for irrigation increasing the area (138%) under double cropping (10.5 to 24.0 ha) within 3 years.

## Resource Management

### Erosion Control and Productivity Restoration Through Sunnhemp Mulching and Green Manuring

Mulching through intercropping of sunnhemp green manuring in maize proved highly efficient in reducing runoff (14-22%) and soil loss (8-25%) on sloppy lands improving crop yields. Through one month-old-sunnhemp 16-18 tonnes green biomass could be recycled as mulch cover on ground. This practice conserved residual soil moisture and fertility after maize harvest.

### Farming System for Erosion Control and Sustained Production in Drylands of the Outer Himalayan Region

Optimal farm plans with improved technologies were developed for small and medium farm groups in outer Himalayas to maximize farm income and minimize soil loss using linear programming technique. Under small farm situation Rs 19,533 can be achieved as the maximum farm income. This income is 114% higher than

### Subsoil Sodicity in Vertisols

- The subsoil sodicity in Vertisols of Purna Valley is mainly due to erratic rainfall and depletion of $Ca^{2+}$ ions.

The inherently low hydraulic conductivity of these soils is due to the dispersion of clay particles caused by high percentage of exchangeable magnesium (in highly smectite soils) and also to slight increase in exchangeable sodium. This adverse physical condition may be prevented by surface application of gypsum before rainy season @ five tonnes/ha. Exchangeable sodium potential of five should be used as lower limit for sodic subgroup of Vertisols rather than15 as adopted in soil taxonomy

- Soils of aridic moisture are rich in potassium reserve
- Soybean (genotype JS-75-46) performed well in shallow shrink-swell soils
- Application of K and Zn in swell-shrink soils significantly increased the wheat yield.The optimum dose of K appeared to be 40 kg $K_2O$/ha and that of Zn 20 kg $Z_nSO_4$/ha
- Overall effect of K and Zn application indicated that production of 0.1 tonne grain yield required 3 kg of K,1.21 kg of Ca, 478 g of Mg, 142 g of Fe, 31 g of Mn,12 g of Zn and 26 g of Cu
- The moisture retention at 33 to 1,500 kPa increases with depth in Vertisols of both subhumid and semi-arid agro-climates. Available water capacity of Vertisols appears to be a function of exchangeable $Mg+^{2}$ in subhumid and of exchangeable Na+ in semi-arid agro-climate

existing income (Rs 9,261) and produces 40% less soil loss. Minimum annual soil loss that can be brought down was 3.51 tonnes/ha with an income of Rs 14,745 which is 59.2% higher than existing level. Similar trend was observed in medium farm group. The trade off between soil loss and farm income with improved technology was Rs 373 and Rs 365 per tonne of soil loss in small and medium farm groups respectively.

**Increased Production Through Watershed Management in Shiwalik Foothills**

Resource conservation vis-a-vis watershed restoration through an appropriate mix of structural and low-cost vegetative measures with a concept of participatory approach, was designed and demonstrated in a 627-ha typical sandy Shiwalik watershed in the village Relmajra of district Ropar, Punjab. A rainwater harvesting dam has produced encouraging results in protecting watershed and improving biological productivity of catchment as well as command areas. Alternative sustainable and resource conserving land-use systems such as horti-pastoral, silvi-pastoral, agroforestry and cultivation of remunerative fodder and industrial grasses were successfully demonstrated on village common lands and private lands as well. The production of fodder has gone up from 7.55 tonnes to 15.64 tonnes per ha and that of agricultural crops from 1.15 to 8.8 tonnes/ha with supplemental irrigation.

Based on the successful results of alternate land-use systems, guava, amla, kinnow and *ber* with *bhabbar* grass as intercrop were recommended for this area.

**Conserving Plant Bio-diversity Through Integrated Watershed Management**

Thirty-two species were recorded in the Nalota nala reclamation site. *Vitex negundo* was the most widely distributed species (IVI 52.05), followed by *Broussnetia papyrifera* (IVI 42.82) which showed a contagious distribution. *V.negundo* was distributed all over the upper catchment of the nala. Grass species like *Eulaliopsis binata* are now confined to only those pockets where there is no overhead canopy

Moderately deep, lightly calcareous and excessively drained black soil

Deep, slightly calcareous and well-drained black soil

of either shrubs or trees. This species had a green biomass of 38.1 g/m$^2$ in the pre-monsoon period.

Further sole forest of *Anogeissus pendula* (IVI 205.9) supported the minimum number of species as associates. This could be attributed to the dense overhead canopy of this species, which is a major obstacle for the appearance and establishment of associated species. A partially disturbed *A. pendula* forest (IVI 74.34) had *Butea monosperma* as a widely associated species (IVI 147.20) along with several others. Moisture availability (although seasonal in the nala course) resulted in the occurrence of a large number of species (12). Species like *Phoenix sylvestris* dominated the ecological niche (IVI 91.40) with a noticeable decrease of strong light demanding species like *A.pendula* and *Holoptelia integrifolia.*

**Effect of Degree and Length of Slope on Vertisol on Runoff and Soil Loss**

The runoff per cent and soil losses were positively and linearly correlated with the steepness of slopes, while the same trend has not been reflected with the length of the slope. In all slope groups, the smallest length produced maximum runoff and soil loss. With increased slope lengths, the runoff percentage and soil loss per unit area decreased considerably and inconsistently.

**Frequency Analysis of Rainfall Crop Planning in Koraput Region**

Rainfall data of 25 years (1968-92) were analysed for computing the weekly, monthly, seasonal and annual rainfall at various probability levels. The results indicated that 70% chance assured rainfall of more than 10 mm from 24th to 38th week. In the *kharif* season, rainfall of 820 mm is received at 70% probability. Duration and quantum of rainfall indicate that *kharif* crops of 11 to 14 weeks duration can be successfully grown in the Koraput region. *Rabi* and summer receive rainfall of 12 mm and 260 mm, respectively, at 70% chance, indicating their inadequacy to sustain any cropping during these periods.

**Evaluation of the Existing Soil Conservation Measures for their Suitability and Adoptability in Chambal Ravines**

Eight low land medium drop structures located in the Chhajawa watershed were evaluated for their suitability and adoptability. The study indicated that three structures silted up to the crest level within eight years of construction while others had scope for further siltation. Silt deposited behind the structure showed a positive relationship with catchment area of the structure and also with area protected by it. The slope of the bed channel ranged from 0.3 to 1.67% indicating a non-erosive/non-silting velocity of flow. This suggests that these structures are well suited for adoption in Chambal ravines.

Graded bunds dwindled in size over a period of three years. However, the reduction in size was not significant, indicating that adopted cross section of graded bund is suitable for the region.

**Assessment of Vegetative Barriers on Slopy Lands for Soil and Water Conservation**

Vegetative barriers of different species were planted (paired row 30 cm apart in staggered fashion) on 2% slope at a horizontal interval of 11 m along with up and down cultivation of pigeonpea, during rainy season.

No barrier (control) plot yielded highest runoff and soil loss (53% and 6.32 tonnes/ha), respectively. Runoff and soil loss under different vegetative barriers ranged between 43% and 47%, and 3.5 and 4.0 tonnes/ha respectively. During the first year of plantation, the magnitude of reduction in runoff and soil loss because of different vegetative barriers as compared to no barrier plot was to the tune of 6.5 to 10.5% and 1.8 to 2.8 tonnes/ha respectively. Among

all grass barriers, *Cenchrus ciliaris* species produced highest fresh and dry biomass (2.06 and 1.07 tonnes/ha) followed by *Dichanthium annulatum* (1.04 and 0.51tonnes/ha) during first year of plantation.

**Parameters of Universal Soil Loss Equation**

Steeper slope caused higher soil erosion. During 1995, there was six times increase in soil loss when steepness of land increased from 2 to 9% ,with total rainfall of 580.5 mm and EI 30 value 336. Fourteen years average (1982 to 1995) indicated that there was maximum soil loss of 85.5 tonnes/ha from 9% slope ,followed by 55.2, 27.4 and 18.4 tonnes/ha from 6, 3 and 2% slopes respectively.

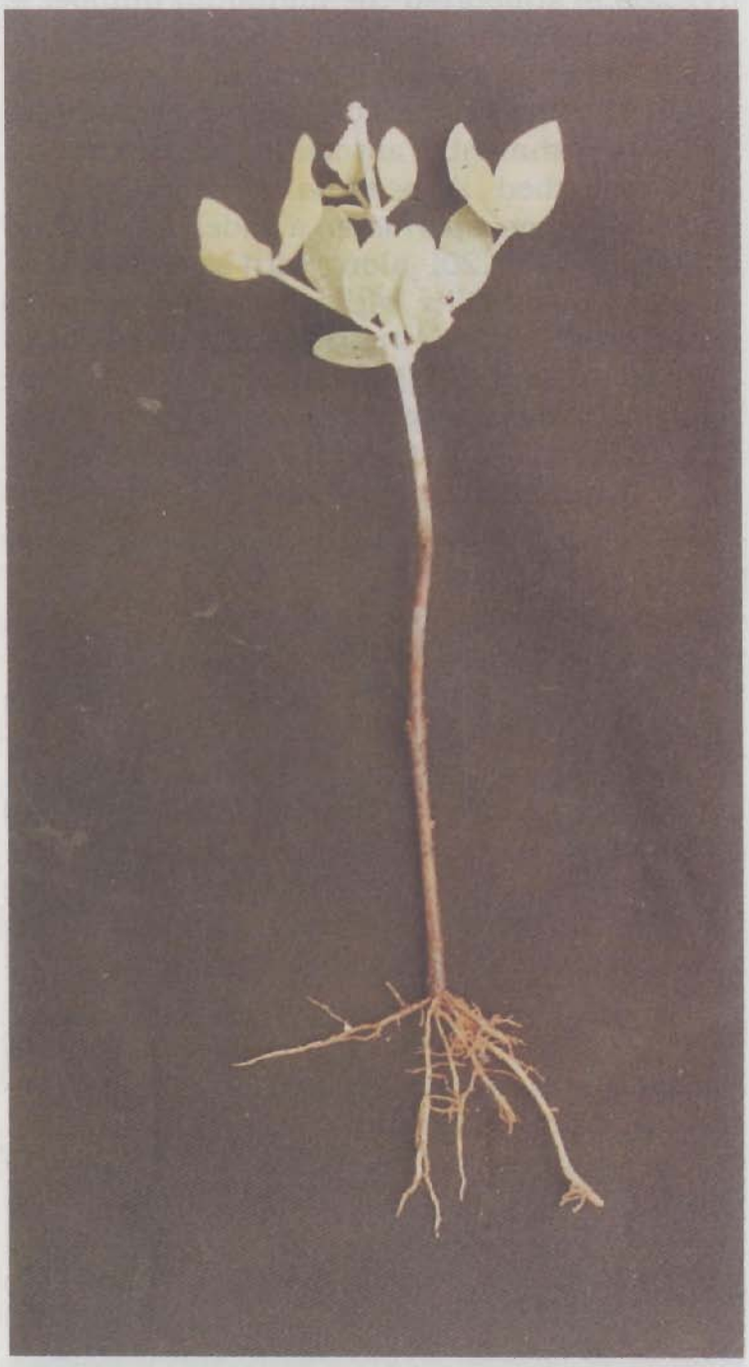
A linear increase in soil loss was recorded as the length of plot increased from 11 to 66 m. During 1995, the highest soil loss of 6.2 tonnes/ha was recorded in 66 m long plot as against 5.1 tonnes/ha in 11 m long plot. Eleven years' average (1985 to 1995) also showed a soil loss of 19.70 tonnes/ha with 66 m length followed by 16.6, 13.5 and 9.8 tonnes/ha with 44, 22 and 11m length of plot respectively.

**Pelleting Device for Establishment of Pastures**

Grass seeds, being very light, pose major problem in sowing. A hand-operated mechanical device was designed. In this machine rejected tractor rear tyre is fitted over iron bar with handle and the unit is fixed on iron angle frame, supported with a ball bearing. Pelleting mixture contains following ingredients: Grass seed 100 g; clay powder 3 kg and 500 g; FYM 500 g; and sand 500 g. Certain quantity of water is added for pelleting. Pellets so prepared are dried in the sun. May-June is the best time for grass seed pelleting. A group of four farmers can prepare 80 kg of pellets per day by this device.

**Vegetative Propagation Technique for Jojoba**

Rooting was successfully induced in stem cuttings of jojoba by treating them with 400 ppm IBA. Treated cuttings were then placed in fully automatic mist chamber. Rooting got initiated in 40% of cuttings in 90-110 days.



Vegetative propagation technique for female plants of Jojoba

**Development of Solar PV Pump Operated Drip System**

A solar pump (CEL make) comprises PV panels (900 Wp) mounted on manually adjustable system for orienting it towards east-south and west for more utilization of solar energy. The time period for orientation of PV panels was standardized. The electricity generated (800 watts power) can deliver 70,000 to 80,000 litres of water per day under clear sky conditions. Suitable OLPC drippers compatible to the variation of solar PV output were identified and used in the system for growing pomegranate plants. Performance studies of these drippers run by solar pump revealed emission uniformity of 92-96% in the pressure range 60-90 kpa with a discharge of 3.2 to 3.6 litres/hr during 10 AM to 4 PM. The system was extended to 1 ha and studies revealed that it is suitable for growing orchard in five ha area.

**Ley Farming for Improved Crop Yields**

Introduction of four year leys, with grasses and legumes in rotation after continuous cropping, restored the crop yields due to improved moisture retention capacity of the soil and organic carbon. Thus, introduction of leys in an integrated farming system could enhance crop production in arid and semi-arid lands.

**Simulation Modelling**

Attempts were made to validate the Rangtek model incorporating data generated on sole pasture system. In sole grass system the *Lasiurus sindicus* gave the highest forage yield (3,771 kg/ha) followed by *Cenchrus ciliaris* (3214 kg/ha) and *Cenchrus setigerus* (2,210 kg/ha ). The differences in the yields of these range grasses were significant. The predicted forage yield, using Rangtek model of *L. sindicus* was 11% lower and in *C. setigerus* 1.2% lower than the actual yield, while in case of *C.ciliaris* the predicted yield was 7.1% higher than the actual yield. Thus the yield predictions were within the reasonable limits of acceptance.

The Spur model was used to simulate the productivity of *L. sindicus* pasture under extreme arid conditions of Chandan. The estimated and observed peak biomass was in close agreement. However, variation in estimated month-end productivity suggested that the model requires further refinement in parameterization.

Cluster bean (Maru) taken at grass pasture of *Cenchrus ciliaris*

The Ceres model was modified using thermal time growth relation stip, including thermal time required for leaf and tiller appearance. The Gumpert's equation was replaced with simple exponential relationship for different growth stages. This modified Ceres millet model performed satisfactorily in simulating grain yield of pearlmillet. The stover yield was, however, overestimated by the model particularly under optimum soil moisture situation.

# Water Management

### Conjunctive Water-use Models

Conjunctive water-use plan for Jamrani Dam Command in Uttar Pradesh (199,650 ha) has been developed for maintenance of a safe hydrological balance. Construction of the dam would supply additional groundwater input (through canal seepage and field application) of 10,008 hectare metre which shall lead to rise in watertable. For pumping of this additional groundwater, 93 deep tubewells in *tarai* and 123 deep tubewells in Gangetic sub-region each having annual capacity of 45 hectare metre to command 100 ha by each well shall be required for construction and operation. Matching cropping plant with irrigation requirements to exploit additional amount of groundwater has also been developed.

### Regional Water Balance Studies

Water balance of Mula Command in Maharashtra showed that precipitation and canal irrigation accounted for 50% and 40% of the total groundwater inflow. Presently, groundwater draft was only 7% of the existing potential which resulted in general rise in watertable during the last five years and has called for enhanced groundwater development. Lining of canals can reduce seepage losses by 87.56% as compared to unlined canals and thus can substantially enhance command area.

### Groundwater Recharge

Artificial recharge of groundwater is one of the promising options to augment depleting groundwater in overexploited regions. Theoretical considerations have shown the possibility of using a large number of cavity wells as irrigation-cum-recharge wells. At Ludhiana, it was possible to recharge aquifer by 1144 m of runoff water in one season through one cavity well. Average recharge rate for filtered and unfiltered water was 0.4 and 5.5 lps (pounds per second) respectively. Continuous efforts are being made to design an efficient filtration mechanism to handle large volumes of runoff water.

### Energy Conservation in Pumping System

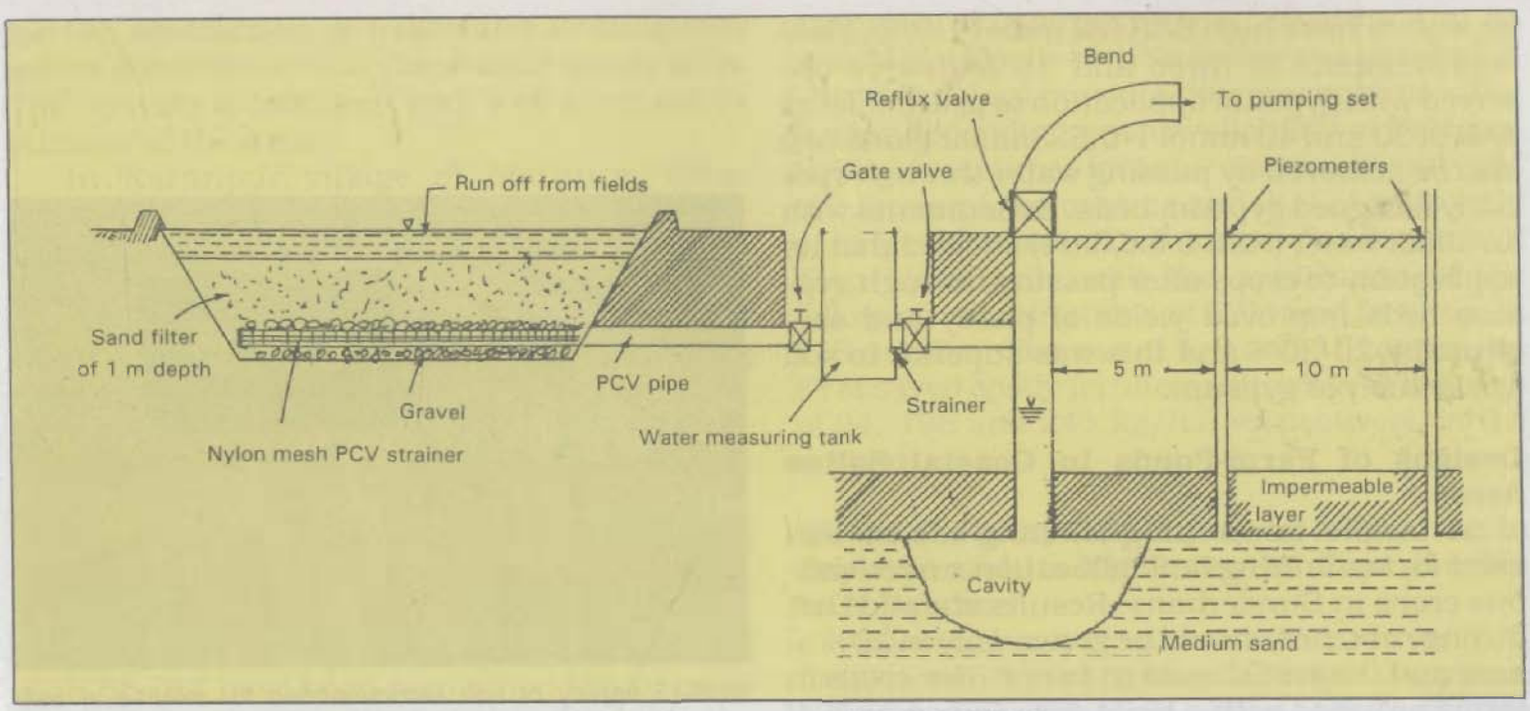
Large number of field studies in Uttar Pradesh *tarai* region showed that combination of stan-

- Conjunctive water-use models developed for Jamrani Dam Command area
- Artificial recharge of groundwater promising option to augment depleting groundwater
- Effluents from agro-industries, excessive use of agrochemicals and heavy extraction of freshwater are causing groundwater pollution in coastal region
- Standard fittings in pumps resulted in 26% higher discharge
- Performance of solar photovoltaic pumping system is being studied
- Hydro-salinity model developed for assissing salinity problem in irrigation, commands
- Gypsum application helped in efficient use of saline or alkaline waters
- Improved *Dorouv* technology developed for use of saline waters
- Improved varieties recommended for saline/alkali/waterlogged soils
- Efficient crop planning serves irrigation waters

### Groundwater Pollution

Major sources of groundwater pollution due to agriculture sector include effluents from agro-industries, excessive use of agrochemicals and heavy extraction of freshwater in coastal region.

Systematic studies initiated to assess groundwater pollution due to excessive use of agrochemicals (133 samples at 6 km x 6 km grid) in Ludhiana district showed that 68% of the samples during premonsoon and 84% of the samples during post-monsoon had nitrate-N concentration higher than 10 mg/litre (WHO critical limit for drinking water).




Experimental set up for artificial ground water recharge through cavity well

dard bends, Pantnagar foot valve and PVC hose pipe on suction side and standard bend on delivery side of the pumps yielded about 26% higher discharge than pumps with local fittings. In Jabalpur, modification of the existing units with change in suction lift, vibration-free setting, replacement of bends, removal of extra fittings and control of leakages resulted in significant improvement of discharge (1 to 5 lps) (pounds per second) and pumping efficiency (4 to 13%).

**Solar Photovoltaic Pumping System**

A collaborative ICAR-MNES Network Project on Performance Evaluation and Optimal Utilization of Water of SPV Pumping System is under operation at ten centres. Optimization studies made for the efficient utilization of water of 960 W SPV pump showed that it was possible to irrigate 0.61 ha of groundnut, 0.55 ha of colocassia and 0.32 ha of chilies at Baptala (Andhra Pradesh).

At Rahuri, it was possible to operate 153 microsprinklers or 673 drippers simultaneously with an SPV pumping system. Such a system was able to irrigate 1.23 and 1.43 ha of cauliflower crop by microsprinklers and drip method.

**Prediction of Salinity Problem in Irrigation Commands**

A hydro-salinity model for assessing water and salt balance in irrigation commands predicted that in Gohana (Haryana) area watertable would fluctuate within two metre depth for most of the times, within one metre in six out of ten years and would touch soil surface during monsoon season. With provision for appropriate drainage measures watertable can be maintained deeper than one metre during monsoon and two metre during dry season.

**Leaching Behaviour of Vertisols**

Information on leaching behaviour is prerequisite for planning drainage in saline-waterlogged soils. Experiments on Vertisols have shown that to leach 80% of the initial salts from upper 90 cm soil depth in clay (Vertic Ustochrept), loam (Typic Ustochrept) and a sandy loam soil (Fluventic Eutrochrept), the amount of water required equals to about 130, 89 and 31 cm respectively.

**Amendment of Sodic/Alkali Waters with Gypsum Application**

Experiments for the efficient use of saline or alkaline waters have shown that farmers will have to go for one to two tonnes/ha of gypsum

for waters have high SAR (20 mmol 1-0.5). Yield improvements of three and 16 fold were observed with gypsum application to pearlmillet at SAR of 30 and 40 mmol 1-0.5. Similar gains can also be achieved by passing water through specially designed gypsum beds. Experiments with an alkali water (RSC 9 me/litre) showed that its application to crops after passing through gypsum beds improved yields of paddy and sorghum by 20-30% and this was superior to soil application of gypsum.

**Designs of Farm-Ponds in Coastal Saline Areas**

A simple linear programming model was used for optimizing land allocation under various crops in Sunderbans. Results showed that during *rabi*, rice should be grown only in 20% of area and the rest should go to non-rice crops in farms provided with a pond covering an area of 20% for rainwater harvesting.

**Operational Research on the Use of Saline Waters**

Improved *Dorouv* technology was developed

CSR-13 variety of rice recommended for release in salt-affected soils

*Dorouv* technology improved to skim freshwater floating over saline water in coastal sandy soils

for the abstraction of freshwater floating over saline groundwaters in the coastal sandy soils. The technique has been very well accepted by farmers of the area.

In Karanpur village of Mathura, Uttar Pradesh, demonstrations on post-sowing irrigation with saline water, use of gypsum/FYM for high-SAR saline water, zinc sprays and conjunctive use modes showed marked improvement in yields (20-30%) of wheat, barley and pearlmillet.

**Improved Varieties for Saline/Alkali/Waterlogged Soils**

Rice CSR 13 having long slender grain with better quality has been recommended for salt-affected soils throughout the country by Variety Identification Committee 1995. CSR 21 and CSR 88-IR1 have been recommended for mini-kit trials by the Rice Workshop.

**Saving of Irrigation Water by Efficient Crop Planning**

There is a growing concern for emerging shortage of water for agricultural use. Saving in use of irrigation water through better agronomic management can be a cheap alternative to physically enhanced water supply. Under the AICRP on Water Management, a considerable saving of irrigation water as well as increase in economic returns were obtained by introducing water-use efficient crops such as oilseeds, pulses and vegetables in traditional cropping systems. For example, at Bhavanisagar (Tamil Nadu) replacing ragi in traditional crop sequence of rice–ragi by either groundnut, sesamum or safflower caused water economy of 15% along with 36 to 56% increase in net monetary returns. Similarly, at Pusa (Bihar), rice–potato–moong crop sequence gave 29% higher economic returns than rice–wheat–moong sequence for comparable application of irrigation water.

# Nutrient Management

**Integrated Plant Nutrient Supply System for Soybean–Wheat on Black Soils**

A technology of integrated plant nutrient supply and management system for sustainable productivity of soybean–wheat, one of the most important cropping systems, covering 4 m ha area of black soils of the country was developed. This technology provides different options to the farmer depending upon availability of FYM and fertilizer resources for achieving a soybean yield of 2.0 tonnes/ha or more and that of grain yield of irrigated wheat of 3.5 tonnes/ha or more in deep black soils with the application of the following combinations of FYM and fertilizer N, P, S and Zn. The use of 4, 8 and 16 tonnes/ha FYM saved costly fertilizer nutrients to the tune of 94, 198 and 241 kg/ha, respectively, in the system.

**Effect of Farmyard Manure on N Fixation in Soybean and its Net Potential Contribution to N Balance**

Effect of farmyard manure (FYM) on yield, $N_2$ fixation and N partitioning in Punjab -I soybean (*Glycine max* (L.) Merr) using 1.5 N-dilution technique and CHS 5 sorghum (*Sorghum bicolor* (L.) Moench) as a non-nodulating reference crop was studied in a field experiment during rainy season on a Typic Haplustert soil. Manuring the soil with FYM @4, 8 and 16 tonnes/ha increased seed yield by 39.6, 69.5 and 85.4% compared with no FYM (1.44 tonnes/ha seed). Out of the total plant N, 75.6-76.1% was translocated to seed irrespective of FYM treatment. Application of four tonnes/ha FYM increased N (%) derived from atmosphere from 54.1 (in no-FYM treatment) to 69.2 and further increase in the level of FYM to 8 to 16 tonnes/ha decreased the N(%) derived from atmosphere to 61.8 and 59.2 respectively. In the no FYM treatment, total quantity of N fixed from atmosphere was 65.8 kg/ha, which increased to 117.4, 126.1 and 131.3 kg/ha, owing to application of 4,8 and 16 tonnes/ha FYM respectively. The potential contribution of $N_2$ fixation to the N balance in soil was negative, being 55.9-90.5 kg N/ha. Calculations showed that such negative balance could be reduced by 11.6-36.4 kg N/ha on returning the whole soybean trash to the soil.

**Contribution of Farmyard Manure and Rhizobium to Soybean and Wheat**

The results of field experiments on Vertisols showed that application of FYM to soybean @4,8 and 16 tonnes/ha contributed to the seed yield of soybean to the extent of 302, 750 and 886 kg/

Various options for IPNS for soybean–wheat system on Vertisols

| Rate of FYM application (tonnes/ha) | Target yield of 2 tonnes/ha or more of soybean seed: Application rate of fertilizer nutrient (kg/ha) | | | | Target yield of 3.5 tonnes/ha or more wheat grain: Application rate of fertilizer nutrient (kg/ha) | | | | Total saving in nutrient with the use of FYM(kg/ha) |
|---|---|---|---|---|---|---|---|---|---|
| | N | P | S | Zn | N | P | S | Zn | |
| 0 | 35 | 39 | 40 | 12* | 135 | 40 | 40 | 0 | |
| 4 | 25 | 24 | 20 | 6 | 120 | 32 | 20 | 0 | 94 |
| 8 | 12.5 | 15.5 | 0 | 3 | 90 | 22 | 0 | 0 | 198 |
| 16 | 0 | 0 | 0 | 0 | 90 | 10 | 0 | 0 | 241 |

* Enough for six crops.

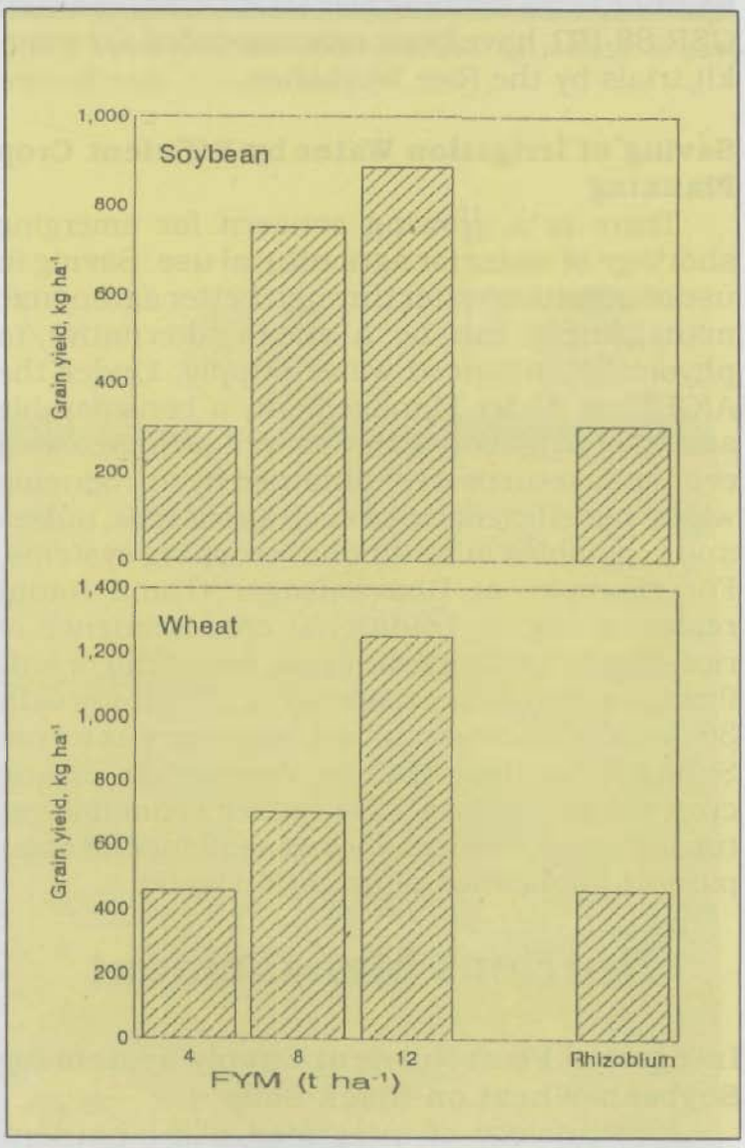
ha and their residual effect equivalent to 458, 698 and 1,250 kg/ha of wheat grain respectively. Inoculation of rhizobium specific to soybean increased the seed yield of soybean by 300 kg/ha and subsequent wheat by nearly 461 kg/ha.

**Phosphorus Recovery by Soybean-Wheat System from Fertilizer-P and/or FYM**

Apparent phosphorus recovery (APR) by soybean-wheat system in response to conjoint use of FYM and fertilizer -P on a Vertisol ranged from 24.9 to 15.1% when fertilizer-P was applied alone (i.e., no FYM), the lower APR being at higher P levels. With FYM applied at 4, 8 and 16 tonnes/ha, without fertilizer-P crops recovered 96.1, 65.6 and 45.5% of the manure-P, respectively. The conjunctive use of FYM and fertilizer-P improved the APR from the fertilizer-P in soybean–wheat system.

**Kinetics of Non-exchangeable K Release by Organic Acids from Mineralogically Different Soils**

A considerable amount of soil K occurs in non-exchangeable form and the release from this source is facilitated by organic acids excreted by plant roots. The kinetics of non-exchangeable K release by organic acids studied in alluvial, red and black (swell-shrink) soils revealed that black soils with smectite dominant clay mineral had higher cumulative K release




Contribution of FYM and rhizobium to seed yield (kg/ha) of soybean and wheat (three years mean)

followed by alluvial (illitic) and red (kaolinitic) soils. Parabolic diffusion equation was the best to describe the rate of K release.

**Microbial Biomass and Release of Microbial Biomass—N in Soil Under Soybean—Wheat Sequence in a Swell—Shrink Soil (Typic Haplustert)**

Application of FYM and/or fertilizer N improved the mean annual microbial biomass, C and N contents in the low fertility upland swell-shrink soil (Typic Haplustert) under soybean-wheat system. But the improvement was much larger with FYM than with fertilizer N application. In absence of any fertilizer N or FYM application, about 24 mg N/kg soil (i.e., 53.8 kg N/ha ) was released per year. But the application of 8-16 tonnes/ha FYM increase the biomass N release to 34 to 41 mg/kg (i.e., 62.7 kg N/ha). The results thus showed that FYM is very important to improve the biological health of the soil.

**Sulphur Status and Extent of its Deficiency in Indian Soils**

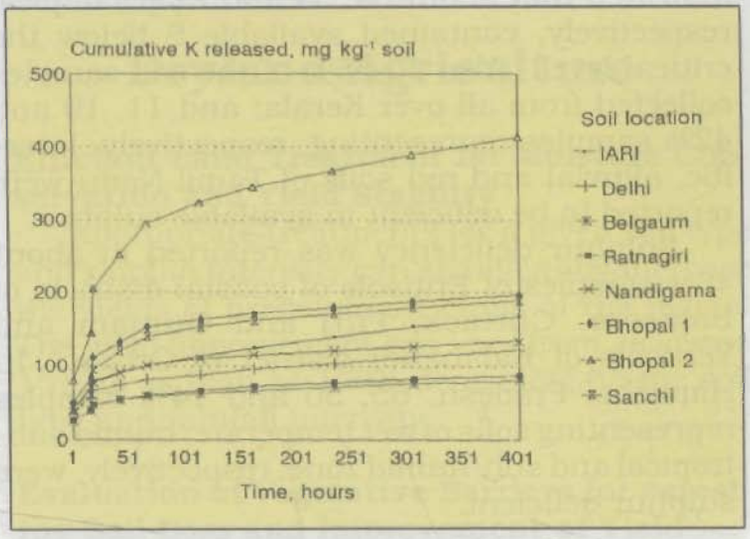
At the centres of AICRP micronutrients, the sulphur status of Indian soils was evaluated by collecting 43,395 surface samples representing soils of 13 states. Available sulphur in soils varied from 0.5 to 793 mg/kg with a mean of 25 mg S/kg soil. The deficiency of sulphur in the states varied from 11 to 64% with an over all mean of 36%. Of the 145 districts surveyed intensively, soils of 22 and 19% districts fell in 20 to 30 and 30 to 40% deficiency category.

Sulphur deficiency in Gujarat was highest (45-55%) in soils of Panchmahal, Bharuch, Mehsana, Ahmedabad and Banaskantha districts followed by 15-26% in saline sandy soils of Kutch and Surendranagar and 19-31% in black clay soils of Rajkot, Jamnagar and Valsad. Overall 37, 13 and 50% soils were categorized as deficient, marginal and sufficient in S respectively.

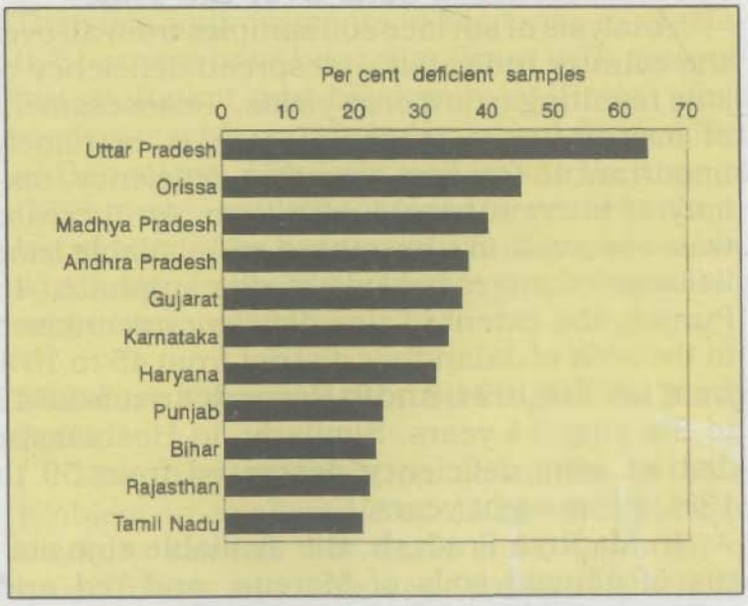
Sulphur deficiency in soils of Bihar ranged from 7 to 58% with an average of 23%. Red and lateritic soils (Ustalfs) of Chotta Nagpur showed 58% sulphur deficiency followed by old alluvium (Calciorthents) soils of North Bihar (20%) and

**Phosphate Adsorption in Soil**

The response of P fertilizers particularly in Vertisols of India is low due to high P fixation. An effort was made to distinguish between the sorbed P and fixed P. Phosphate desorption kinetics revealed that in kaolinite dominant Oxisols and Ultisols there was not much difference between the amount of P sorbed and P fixed. In smectite dominant Vertisols, on the contrary, most of the adsorbed P is held loosely by the soil. In less weathered soils, the amount of specifically sorbed P was correlated positively with free iron oxides and kaolinite and negatively with clay and smectite content.




Cumulative K released in malic acid at different intervals




Extent of sulphur deficiency in soils of different states

the least (15%) in Tal lands (Pellusterts) of Jehanabad and Bhagalpur districts.

In Madhya Pradesh, analysis of 7,048 surface soil samples revealed a wide variation in S deficiency ranging from 9.5% in deep black soils to 91% in shallow black soils. Overall 40% soils were reported to be deficient.

In Punjab 24% and in Haryana about 32% soil samples were deficient in Sirsa, Gurgaon, Bhiwani and Hisar districts.

In Andhra Pradesh, overall 21% of the 232 soil samples, particularly in groundnut and pulse growing areas, were deficient and may need sulphur fertilization.

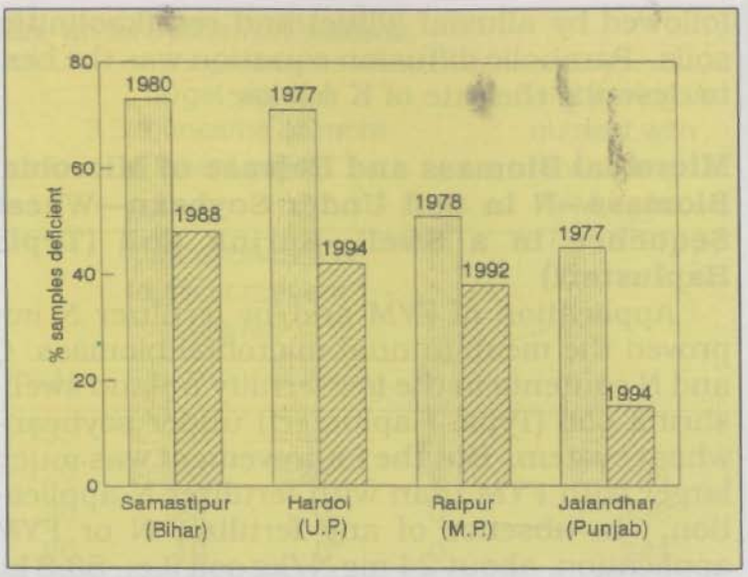
Information compiled for surface soil samples from Uttar Pradesh, Karnataka and Rajasthan indicated that about 64, 34 and 22% samples, respectively, contained available S below the critical level. Also 20-55% of the soil samples collected from all over Kerala; and 11, 19 and 42% samples representing, respectively, lateritic, alluvial and red soils of Tamil Nadu were reported to be deficient in available sulphur.

Sulphur deficiency was reported in about 46% samples of Entisols of coastal districts of Balasore, Cuttack, Puri and Gunjam and Vertisols of Kalahandi district of Orissa. In Himachal Pradesh, 65, 50 and 14% samples representing soils of wet temperate, humid subtropical and sub-humid zone, respectively, were sulphur deficient.

**Changes in the Status and Deficiency of Micronutrients in Soils Over the Time**

Analysis of surface soil samples from all over the country indicated widespread deficiency of zinc resulting in low crop yields. Reassessment of micronutrient status of soils is extremely important to forecast emerging deficiency/toxicity of micronutrients with time. An increase was observed in the status of available zinc because of increased use of zinc sulphate. In Punjab, the extent of zinc deficiency decreased in the soils of Jalandhar district from 45 to 15% from 1977 to 1994, and in Ropar district from 42 to 8% after 14 years. Similarly, in Hoshiarpur district, zinc deficiency decreased from 59 to 13% within eight years.

In Madhya Pradesh, the available zinc status of alluvial soils of Morena, and red and yellow soils of Raipur showed a build up over a




Periodic changes in zinc deficiency in soils

period of time. The deficiency of zinc declined from 96 to 84% in alluvial soils and from 58 to 52% in red and yellow soils as per repeat survey made after 14 to 18 years.

In Uttar Pradesh, reassessment of micronutrient status of the soils after a gap of 12 to 23 years indicated that deficiency of zinc decreased from 70 to 38% in soils of Sitapur, from 71-43% in soils of Hardoi, and from 41 to 30% in Barabanki districts.

The available status of copper, iron and manganese in soils of Madhya Pradesh, Uttar Pradesh and Bihar was adequate even after intensive cropping of 20 to 25 years. However, an increase in the incidence of iron and manganese deficiency from 5 to 10% was recorded in coarse textured soils of Punjab.

**Yield Sustainability**

Integrating organic manure (FYM) at 10-15 tonnes/ha with 100% recommended NPK fertilizer doses sustained higher level of productivity while maintaining soil fertility in most of the cropping system. However, a declining trend in rice productivity was noticed over the years in intensely irrigated rice–rice and rice–wheat systems despite applying recommended doses of NPK fertilizer. It was found to be associated with the overall reduction in soil fertility as a consequence of soil mining of plant nutrients due to their inadequate and imbalanced use in comparison to nutrient uptake by crop plants.

Continuous application of nitrogenous fertilizer alone to soils had a deleterious effect on soil health resulting in yields below those of unmanured plots after 10-15 annual cropping cycles. The grain yield loss has been considerable in the absence of both phophorus and potassium application. It amounted to 96-98% on acidic red loam (Hapludalf) soil at Palampur (Himachal Pradesh), 81-84% on acidic red loam (Haplustalf) at Ranchi (Bihar), 58-79% on medium black (Chromustert) at Jabalpur (MP) land 32-34% on leterite (Haplaquepts) soil at Bhubaneshwar (Orissa) over the years (1971-95).

**Biological Nitrogen Fixation**

Survey, screening and isolation of different efficient rhizobial strains were carried out at various agro-ecological regions of the country. It indicated the yield increase varied from 11.12% to 29.6% for soybean and 19.57% to 30.82% for groundnut over control, respectively, due to rhizobium application.

**Phospho-compost Production Technology**

Phospho-compost was produced using different organic wastes supplemented with small amount of cattle dung, soil and manure compost. The mixture of main raw material and supplementary materials constituted the compost mix which consisted of eight parts of main raw material, one part cattle dung, 0.5 part soil and 0.5 part mature compost at all locations. The compost mix was charged with Mussoorie rock phosphate (MRP). For this charging, required quantity of MRP was made into a slurry with the required quantities of the dung, soil and compost. The slurry was mixed with the main compost material. The material was composted in cemented pits of 1m x 1m size at 70-75% level of moisture. The composting material was turned for aeration at three to four intervals during the composting period of three to four months.

The research conducted on the production and utilization of phospho-compost as a source of P and organic matter at three different agroclimatic conditions (Pune, Delhi and Palampur) with different compostable organic wastes (soybean straw, rice straw, cattle dung and *Lantana camara* foliage) revealed that valuable P-rich compost could be made from organic materials by incorporating 2.5% equivalent of Mussoorie rock phosphate during composting of the material. This compost proved as effective source of P for crops as superphosphate when both sources were compared on equivalent $P_2O_5$ basis as phosphatic fertilizer. About 1.5 metric tonnes of dry phospho-compost of 4-5% $P_2O_5$ equivalent of Mussoorie rock phosphate is required to supply about 60 kg $P_2O_5$/ha, while the quantity of the compost of 2.5% $P_2O_5$ equivalent of the rock phosphate works out to about 2.5 tonnes/ha for the same purpose. This has emerged as general rule for practical utililzation of phospho-compost organo- mineral phosphatic fertilizer.

## Dryland Agriculture

**Efficient Land Treatment for Moisture Conservation and Yield Stability**

Appropriate treatments for a given soil type and rainfall intensity can significantly increase the yields of predominant crops of the region. The yield improvement can vary from as low as 15% to as high as 100% depending on the soil type and rainfall intensity.

**Evaluation of Vegetative Barriers for Arresting Soil Loss and Improvement of Yield**

Most of the vegetative barriers have arrested soil loss and improved the yields significantly. The yield improvements in response to vegetative barriers have been significant with groundnut at Rajkot and blackgram at Rewa, while moderate with cotton at Akola and fingermillet at Bangalore. Similarly, soil loss to the tune of three tonnes could be avoided by contour planting of vegetative barriers at Phulbani in Orissa, which also indirectly helped in obtaining 400 kg additional yield of rice.

**Moisture Conservation Strategies in Black Soils**

Moisture conservation continues to be a problem in shallow Vertisols receiving low to medium rainfall. For such soils a system of broad furrow and ridge was developed which not only conserved moisture but helped in excellent

growth of pigeonpea. The system consists of a broad furrow and a narrow ridge with an amplitude of 1.2 m (mean distance between two furrows).

Pigeonpea (var. S-1) grown on this system yielded significantly more than the conventional method of flat sowing. Two protective irrigations at flowering further improved the beneficial effect of this system.

**Efficient Farm Implements for Drylands**

Central Research Institute for Dryland Agriculture (CRIDA) has designed and developed a 4-row planter using inclined plate mechanism for groundnut which occupies 8.3 million ha area and contributes 40% of the total vegetable oils produced in India. Seeding devices offer scope to economize on groundnut seed cost which constitutes almost 40% of the cost of cultivation. Savings in labour, bullock time and increased productivity could neutralize the cost (Rs 6,000) when the planter was used to sow 10-ha area. It was vigorously tested in 141 ha area covering Krishna, Guntur and Khammam districts by 23 farmers. The planter was found to cover 2.5 to 3.2 ha/day and crop stand varied between 2,80,000 and 3,30,000 plants/ha. The yield advantage observed through maintenance of better plant stand was of the order of 0.08 to 0.12 tonne/ha in addition to reduction in cost of cultivation. The novel feature of the planter is that its cost can be recovered by using it over 8-10 ha area through saving in cost of cultivation and increase in yield. Andhra Pradesh Agro-Industries have started its commercial production and Government of Andhra Pradesh has announced a subsidy of Rs 1,500 per unit.

The ridger seeder, a simple instrument that helps in overcoming crushing problem in sandy soil, was evaluated in detail during 1995-96 at Hisar. The yields of pearlmillet could be increased by 20-25% from 280 to 350 kg/ha when sown with ridger seeder compared to local method of flat sowing.

**Efficient Horti-Pastoral System for Drylands**

Interplanting of guava with cowpea was significantly superior to either leaving the interspaces fallow or growing fodder sorghum or *Cenchrus ciliaris*. However, intercropping with *Stylosanthes hamata* was found on par with cowpea. Similarly the fruit yields were higher with cowpea as intercrop. This combination produced fruit yields on par with leaving the interspace fallow but was significantly superior to all other treatments.

- Rhizobium application improved yield
- Phospho-compost production technology developed
- Moisture conservation improved soil yield
- Vegetation barriers evaluated for arresting soil loss
- Row planters developed for groundnut
- Interplanting of guava with cowpea gave best performance
- Suitable cropping systems suggested for different ecosystems
- Judicious phosphorus supply resulted in high productivity in rice-wheat system

**Cropping System for Different Eco-Systems**

Crop sequences of pearlmillet-wheat-cowpea (fodder) and pearlmillet-potato-onion at Hisar; rice-maize and rice-rice at Siruguppa; pearlmillet-wheat and clusterbean-barley at Durgapura; sorghum-wheat and soybean-wheat at Indore; maize-wheat and soybean-wheat at Rudrur; blackgram-maize-greengram and soybean-maize-greengram at Banswara; sorghum-wheat and sorghum-wheat-cowpea (vegetable) at Akola; rice-rice and maize-ragi-sorghum at Kathalgere; rice-wheat-cowpea (fodder) and rice-wheat-greengram at Varanasi; sorghum-gram and sorghum-wheat at Sehore; rice-gram and rice-tomato at Raipur; rice-wheat-sorghum (fodder) and rice-wheat-greengram at R.S. Pura; rice-wheat-greengram and rice-maize-lady's finger at Chiplima; rice-lentil and soybean-wheat at Kanke; rice-*gobhi-sarson*-greengram and rice-potato-groundnut at Ludhiana were highly promising.

**Effect of land treatments on the yield of crops at different dryland locations**

| Location | Rainfall (mm) | Soil type | Treatment | Crop | Yield (kg/ha) |
|---|---|---|---|---|---|
| Akola | 830 | *Kharif* and *rabi* black soils | Flat sowing<br>Opening furrow after every two rows at 30 DAS | Cotton | 1,096<br>1,284 |
| Rajkot | 625 | *Kharif* black soils | Flat sowing<br>Ridge and furrow sowing | Groundnut | 522<br>573 |
| Rewa | 1,080 | *Kharif* and *rabi* black soils | Normal tillage<br>Ridge and furrow sowing | Soybean | 1,700<br>2,071 |
| Solapur | 722 | *Kharif* and *rabi* black soils | Flat sowing<br>Compartmental bunding | *Rabi* Sorghum | 349<br>397 |
| Arjia | 635 | *Kharif* and *rabi* black soils | Sowing along the the slope<br>Compartmental bunding | Maize | 1,199<br>1,883 |
| Kovilpatti | 730 | *Rabi* black soils | Control<br>Compartmental bunding | Sunflower | 348<br>415 |
| Agra | 710 | Alluvial soils | Conventional tillage<br>Conventional tillage + compartmental bunding | Pearlmillet + greengram | 1,754 + 056<br>2,032 + 066 |
| Anantapur | 570 | Semi-arid red | Conventional tillage<br>Dead furrow | Pearlmillet | 2,023<br>2,210 |
| Hoshiarpur | 1,000 | Sub-montane soils | Conventional tillage<br>Ditch | Maize | 1,913<br>2,746 |

**Sunflower - An Emerging Potential and Profitable Crop for North-West Zone**

Sunflower is gaining ground in Indo-Gangetic plains of Haryana, Punjab and parts of western Uttar Pradesh. At Project Directorate of Cropping Systems Research (PDCSR), Modipuram, the yield of sunflower varied from 2.1 to 2.3 tonnes/ha with the lowest being 2.1 tonnes/ha in pigeonpea-sunflower and highest (2.3 tonnes/ha) in maize-blackgram-sunflower system. The net returns were highest (Rs 31,360/ha) in pigeonpea-blackgram-sunflower.

**Alley Cropping of Rice-Wheat Sequence with *Subabul* for Sustained Productivity**

Raising upland rice in rainy season followed by wheat during winter, in between two hedge row (5.0m apart) of *subabul* (*Leucaena leucocephala*) on the alkali soils for four years revealed that application of 90 kg N/ha in

**Effect of vegetative barriers on the yield of crops at different locations**

| Location | Rainfall (mm) | Soil type | Treatment | Crop | Soil loss | Yield (kg/ha) |
|---|---|---|---|---|---|---|
| Akola | 830 | *Kharif* and *rabi* black soils | Planting across the slope | Cotton | 2.98 | 515 |
| | | | *Leucaena* barrier | | 1.10 | 612 |
| Bijapur | 680 | *Kharif* and *rabi* black soils | Control | Safflower | — | 306 |
| | | | Rubble check | | — | 435 |
| Rajkot | 625 | *Kharif* black soils | No barriers | Groundnut | 0.73 | 289 |
| | | | *Vetiver* barrier | | 0.42 | 446 |
| Rewa | 1,080 | *Kharif* and *rabi* black soils | Control | Blackgram | — | 380 |
| | | | Channel after 6 rows | | — | 621 |
| Bangalore | 890 | Semi-arid red soils | Control | Fingermillet | 0.99 | 2,782 |
| | | | *Vetiver* barrier | | 0.85 | 3,053 |
| Hoshiarpur | 1,000 | Sub-montane soils | Control | Maize | 65.4 | 263 |
| | | | *Kana* grass barrier | | 11.7 | 363 |
| | | | Control | Wheat | 65.0 | 160 |
| | | | *Babbar* grass barrier | | 11.7 | 174 |

combination with *Leucaena* loppings added @ 60 tonnes/annum to soil as green manure before rice and wheat planting was sufficient for maximizing productivity from the system. Association of *Leucaena*, on an average, reduced the grain yield of rice and wheat by 0.4 and 0.2 tonnes/ha, respectively, but it provided six tonnes of green manure/ha/annum for incorporation into soil, which contributed approximately 80 kg organic N/ha/annum and increased the total productivity of the system equivalent to 30 kg N/ha applied through

**Yield of pigeonpea in broad furrow and ridge system with and without protective irrigation**

| Treatment | Piegeonpea yield (kg/ha) |
|---|---|
| Flat sowing without protective irrigation | 1,068 |
| Flat sowing with two protective irrigations at flowering | 1,198 |
| BFR system without protective irrigation | 1,340 |
| BFR system with two protective irrigations | 1,629 |

**Fruit yield of guava in horti-pastoral system (two years after planting)**

| Parameter | Control | Forages as intercrops | | | | |
|---|---|---|---|---|---|---|
| | (No. intercrops) | Cowpea | Sorghum | *Cenchrus* | *Stylo* | Mean |
| Fruit yield (kg/plant) | 5.66 | 6.76 | 4.49 | 4.41 | 4.33 | 5.13 |
| No. of fruits/ plant | 54.6 | 69.0 | 49.1 | 44.4 | 55.9 | 54.6 |
| Mean fruit weight(g/plant) | 115.9 | 100.8 | 99.8 | 108.0 | 82.9 | 101.5 |

chemical fertilizers. Thus, the system saved 25% of the inorganic fertilizer N. Besides, six to seven tonnes of green fodder/ha/annum and four to five tonnes of fuelwood/ha/annum were also harvested resulting in an increase in net profit of about Rs 3 000/ha/annum over normal practice of rice–wheat cropping.

Alley cropping of rice–wheat sequence with *Leucaena leucocephala* is not only economical but also beneficial in improving and sustaining crop and soil productivity on a long–term basis.

**Simultaneous Planting of Wheat and Sugarcane for Sustained Crop Production**

Simultaneous planting of wheat and sugarcane with inter-row spacing of 72 cm and three rows of wheat inbetween two rows of sugarcane with all the recommended package of practices gave sugarcane yield of 73 tonnes/ha (plant crop) and 62.9 tonnes/ha of ratoon crop and 3.3 tonnes/ha of wheat. The cane yields were higher by 79% and 9%, respectively, than that obtained by planting sugarcane after harvest of wheat.

**Judicious Phosphorus Supply System to Ensure High Productivity of Rice–Wheat Sequence**

Field studies conducted for four years on mildly alkaline sandy loam soils at PDCSR, Modipuram, have indicated that application of 60 kg $P_2O_5$/ha to both rice and wheat crops increased the grain yield of rice–wheat system by 2.29 tonnes/ha over no P treatment. Though the response to fertilizer P was higher in wheat (1.23 tonnes/ha) compared with rice (1.06 tonnes/ha), skipping P application to either of the crops resulted in sizeable yield loss of 0.72-0.79 tonne/ha. Results thus established the necessity of P application at 60 kg $P_2O_5$/ha to both the crops. FYM applied at ten tonnes/ha during *kharif* (rainy season) benefited both the crops but failed to meet P requirement of the system in absence of P fertilization. Nevertheless, with FYM application it was possible to skip P application to rice or wheat.

## *Diara* land Improvement

**Yield Gap Analysis**

Based on surveys in Saryu *diara* of Uttar Pradesh variety COS 8118 was most promising, yielding 91 tonnes/ha compared to varieties BO 91 and COS 767 of sugarcane, revealing the average gap of 23 tonnes/ha. In *rabi*, improved varieties of wheat, viz. Sonalika, HD 2285, HUM 234 and UP 2003, with improved management practices yielding 2.9-4.0 tonnes/ha, revealed the yield gap of about 2.0 tonnes/ha. Under rainfed situations, lentil with varieties like PDL-7, T-36, L447 and PL-406 yielded 1.3-1.4 tonnes/ha indicating an evident yield of about 0.8 tonne/ha.

**Nutrient Management**

Application of FYM @ 10 tonnes/ha alone or in combination with chemical fertilizers was observed to be distinctly better than control in buck wheat. FYM alone resulted in 52.6% increase in yield over control and was even better than the application of 20:10:10 kg N: $P_2O_5$: $K_2O$/ha.

*Diara*lands: The rich soil is wasted in general which is the potential food bowl for the country

Judicious utilization of *Diara*land and can contribute considerably to national food basket

# Weed Control Practices

**Weed Management in Ganga *Diara***

In Ganga-*diara* of Bihar, the experiment on weed management in irrigated wheat showed that three hand weeding and hoeing behaved alike but the chemical methods were superior. 2, 4-D and isoproturon efficiently controlled the weed population in which the maximum yield of 3.25 tonnes/ha was obtained when 2,4-D was applied @ 1.5 kg/ha.

**Weed Management in Soybean-Wheat Cropping System**

In soybean, highest grain yield was recorded with the use of following herbicides : fluchloralin (1.25 kg/ha) and fluazifop p-butyl (0.3 kg/ha). Lactofen @ 0.2 kg/ha gave the encouraging result than other herbicides. Combination of lactofen (0.5 kg/ha) and sethoxydim @ 0.5 kg/ha gave significantly higher yield of soybean. Application of alachlor @ 2.0 kg/ha (PE) in granular formulation affected an excellent weed control and gave the highest grain yield of soybean (1,292 kg/ha).

Application of glyphosate @ 1.5 kg/ha, followed by fluazifop-p-butyl @ 0.3 kg/ha post emergia (PE) significantly reduced the number

**Promising Cropping System**

In Brahamputra *diara* of Assam, intercropping rajmash in sweet potato resulted in yield increase of 38.5% over sole of sweet potato and 36.6% over sole crop or rajmash. Intercropping pea with niger in 1:1 and 2:2 row ratio, using 30 cm row distance, resulted into niger yield equivalent to 0.8 and 0.876 tonne/ha respectively.

Raising of hybrid maize alone or intercropping with sawan was significantly better with highest return of Rs 14,488 and 14,382, respectively, when compared with maize local raised alone or intercropped.

* Herbicides improved yield in soybean-wheat and rice-wheat cropping system
* Marigold reduced the height and root length of *Parthenium*

of *Saccharum* shoots/m² and its dry matter and increased grain yield of soybean (1,244.47 kg/ha).

**Weed Management in Rice–Wheat Cropping System**

Application of anilophos @ 0.4 kg/ha coupled with one hand weeding at 30 DAS resulted in significant reduction in weed population in rice crop.

Application of isoproturon @ 1.0 kg/ha in combination with 2,4-D (0.5 kg/ha) applied 30 DAS gave the least weed dry weight and as well as minimum number of weed plants and resulted in highest grain yield of 4,103 kg/ha of wheat.

In wheat, the lowest weed dry matter was recorded in weed-free plot followed by tralkoxydim, isoproturon and 2,4-D. The dominant weed species, viz. *Chenopodium ficifolium*, *Cichorium intybus* and *Phalaris minor*, were best controlled by metalachlor/2,4-D herbicide sequence treatments.

**Biological Weed Management System**

Neem-cake + *Trichoderma viride* could inhibit the germination and seedling vigour of *Phalaris*. Root length was reduced by neem-cake + *T. viride* (600+150 g/m²) with no adverse effect on wheat crop.

*Parthenium* plants could completely be replaced by marigold plant and there was no recovery of *Parthenium*. The marigold, grown in association with *Parthenium*, reduced the height and root length of *Parthenium*.

Studies revealed that Mexican beetle which was released in 1991 at Vindhya Nagar, Sidhi, has spread up to about 20 km. During monthly survey, maximum population of beetle was noted during August. By the end of October, it was reduced drastically, and in March no population was noticed that this beetle completes the life-cycle on *Xanthium*. Larva did not survive on leaves of the sunflower in laboratory. Amidst the high population of *Parthenium*, sunflower was grown in Vindhya Nagar but no attack by the beetle was observed on sunflower. *Zygogramma bicolorata* damaged *Parthenium hysterophorus*.

## Agrometeorology

**Crop Weather Relationship**

At Hisar, reproductive period of mustard crop was shortened under delayed sowing of the crop. Interception of photosynthetically active radiation and exposure to growing degree days were less leading in not only to lesser seed and biological yield but also poorer yield attributing parameters like number of sillique per m², 1,000 seed weight, etc.

The study also revealed that the stage from the beginning of pod formation to ripening is the most critical period and during this stage highest radiation (PAR) and thermal use efficiency is achieved compared to other stages of crop growth.

To predict the grain yield (kg/ha) of fingermillet at Bangalore, a regression model of the form:

$$Y = X/ (-0.0003 X + 0.12)$$

was developed with the help of cumulative Water Requirement Satisfaction Index (WRSI). The model was validated and found to predict the yield perfectly well for normal sown crop.

At Jabalpur, a remarkable reduction in degree-days requirements of soybean crop for each successive delay in planting was noticed over normal planting. It was also observed that the reduction was of higher magnitude (412 - 464 GDD) in the late-maturing genotypes (JS 75-46 and Gurav) than (272 - 292 G) early-maturing genotypes (JS 74-5 and JS 81-335).

The study further revealed that the early-maturing genotypes JS 71-05 produced higher harvest index over other late-maturing under delayed sowing conditions.

In alfisols of Anantapur district, moisture adequacy index of less than 33% during pegging and pod development stages of groundnut was found to reduce the pod yield of groundnut by about half (52%) over mean pod yield.

At Solapur, the grain yield (Y) of pearlmillet was positively related with the radiation-use efficiency (X) of the crop at 60 days of crop growth as follows:

$$Y = -12.07 + 10.4 X \quad R^2 = 0.96$$

**Water Production Functions**

Water production functions of wheat were analysed at Ludhiana through line source sprinkler-based experiments. These studies brought out that highest water-use efficiency (12.8 kg grain/ha/mm) of wheat can be achieved with minimum irrigation (103.4 mm). The crop response was not linear to further application of irrigation (up to 221.3 mm) leading to decreased water-use efficiency (9.7 kg/mm/ha). Similar results were obtained in case of gram and mustard also.

* Regression model developed to predict grain yield (kg/ha)
* Weather positively correlated with egg and larvae population of *Heliothis*
* Agricultural climate of Jalpaiguri, West Bengal characterized

**Weather Pest Interactions**

Studies on 'weather effect on pest and disease incidence' conducted on crops of gram, pigeonpea and mustard at Anand brought out that in gram vapour pressure and relative humidity condition during the afternoon period were positively correlated with the egg and larvae population of *Heliothis*.

In pigeonpea the larval population of *Heliothis* is positively correlated with temperature and vapour pressure under both rainfed and irrigated conditions. GT-100 of determinate type having bunch flowering was found to be more susceptible than BDN-2 of indeterminate type with scattered flowering.

In mustard at Anand, temperature and relative humidity conditions at ground level and mid-level of the canopy during 11 AM to 5 PM, exhibited significantly positive and negative correlation, respectively, with powdery mildew disease. The release of Conodia (*E. crucifermum*) of disease was observed to be highest during 1 PM to 3 PM and least during night. The Progressive Disease Index (PDI) of powdery mildew was regressed with meteorological and biological factors, as follows:

$$PDI = -206.5 + 1.640 x_1 + 4.868 x_2 \quad R^2 = 0.69$$

where $x_1$ = crop age days after sowing (DAS) and $x_2$ = mean temperature of previous ten days.

### Agro-climatic Characterization

Studies on 'characterization of agricultural climate of Jalpaiguri district of West Bengal, brought out that (i) sowing of upland rice and jute can be taken up in 16th meteorological week (3rd week of April) as the available soil moisture will be sufficient for sowing with a moisture availability index of more than 0.5 (AE/PE 50%), (ii) pudding of rice can be taken up in 20th week by which period 200 mm or accumulated rainfall will be normally available (as assessed by forward rainfall analysis) and transplanting of rice can be done around 23rd week by when the chances of getting more than 30 mm rainfall is 75%, and (iii) lengths of growing season, according to the water availability for cropping, are 211, 231, 268 and 304 days in soil types as sandy, sandy loam, loam and sandy clay respectively. In this region, there is, thus, potential for raising double or even triple cropping under rainfed conditions.

At Ranchi, agro-climatic conditions for upland rice revealed that it is not advisable to sow rice beyond second fortnight of July, as the crop sown late will not only experience moisture stress conditions during reproductive stage but also is prone to higher disease intensity.

## Agroforestry

### Diagnostic and Design Exercise

Diagnostic and Design (D&D)) survey conducted by most of the centres under the All-India Co-ordinated Research Project has been synthesized. *Prosopis cineraria* was found to be a priority multipurpose tree (MPT) in agrisilvicultural system for arid and semi-arid regions. During survey, several trees and grasses for salt-affected soils were identified. It was observed that *Avicinia* grown in coastal areas is highly resistant to all types of biotic stresses. *Prosopis juliflora* was found highly successful and economically viable tree for salt-affected areas, and it also reduced soil pH to about 8 from 10.4 within 10 years cultivation. *Prosopis chinensis*, a fast-growing and thornless species of *Prosopis*, was also identified. The survey conducted in Thiruvananthapuram district revealed a very high degree of crop combination

* *Prosopis cineraria* identified as multipurpose tree for arid and semi-arid regions
* *Anjan* is a suitable tree species for agrisilvicultural system in semi-arid zones
* Teak growth improved when grown with five rows of *Stylo* or *Cajanus*
* Trees identified for introduction in red, gravelly soils and medium black soils

### Tree Improvement

At the NRCAF, Jhansi, collection of 38 provenances and 28 plus trees of *Azadirachta indica*, 33 plus trees of *Dalbergia sissoo* and 28 provenances of *Anogeissus pendula* have been made and planted in field for evaluation. Provenances of tamarind were collected from different parts of Karnataka. Among the 40 provenances MTI-19, NTI-14, S-4, NTI-7 and NTI-15 recorded higher pod yield and also performed better. These are also evaluated for tarteric acid content.

Peak performing MPTS identified at various AICRP centres

| Centre | Species | Height (m) | Diameter (cm) |
|---|---|---|---|
| YSPUH&F,Solan | *Melia composita* | 6.7 | 9 3 |
| | *Morus alba* | 6.7 | 9.3 |
| NEH Complex, Manipur | *Eucalyptus citriodora* | 9.0 | 14.6 |
| | *Melia azaderach* | 8.8 | 16.7 |
| RAU, Bikaner(Rajasthan) | *Acacia tortilis* | 3.5 | 6.8 |
| | *Dalbergia sissoo* | 3.4 | 6.8 |
| GAU, Dantiwada | *Albizia lebbeck* | 5.5 | 10 0 |
| | *Acacia tortilis* | 5 50 | 8.7 |
| NDUAT, Faizabad | *Eucalyptus* hybrid | 6 3 | 8.6 |
| | *Sesbania grandiflora* | 4.7 | 13 8 |
| OUAT, Bhubaneshwar | *Acacia mangium* | 6.9 | 32.0 |
| | *Acacia auriculiformis* | 6.7 | 25 |
| KKV, Dapoli | *Acacia auriculiformis* | 5.7 | 28.0 |
| | *Eucalyptus citriodora* | 4.6 | 20.1 |
| UAS, Dharwad | *Casuarina equisetifolia* | 9.9 | 5 8 |
| | *Eucalyptus tereticornis* | 4 3 | 4.7 |

and diversification with an average of 14-15 species and 397 plants per homestead.

**Agri-Silvicultural System**

Studies conducted at the NRCAF, Jhansi, revealed that seed yield of mustard was maximum (1.35 tonnes/ha) at 200 trees/ha and minimum (0.95 tonne/ha) at 800 trees/ha density of *anjan (Hardwickia binata)*. Trees attained maximum collar diameter (12.94 cm) in 200 trees/ha. *Hardwickia binata* has been found a suitable tree species for agrisilvicultural system in semi-arid dry zones as it does not affect growth and yield of intercrops and also offers fodder, fuel, wood and fibre.

**Agri-Silvi-Horticultural Systems**

Studies of eight years conducted at the NRCAF, Jhansi, revealed that interspaces of fruit trees, viz. guava, *ber*, Kinnoo and *anar*, can be exploited without affecting the growth and fruit production potential of fruit trees. Introduction of *subabul* between fruit trees resulted in additional biomass in the form of fodder and fuel wood.

At the KAU , Thrissur, water-harvesting techniques like contour trenches and ring trenches increased the height and number of leaves of *Leucaena* when planted in coconut alleys. In *Casuarina* only ring trenches were effective. The number of leaves in coconut was higher where contour trenches were provided. Bare root nursery techniques of some important tree species were standardized. Rooting media of sand, soil and FYM in the proportion of 0.5 0.34 and 0.16 was found to be the best.

**Agri-Horticultural System**

Four varieties of *ber*, viz. Seo, Gola, Banrasi, Karka and Deshi, with 2 spacings of 12 m x 6 m and 6 m x 6 m and 5 crop sequences, fallow, sesame, blackgram, greengram and pigeonpea in rainfed area revealed that the growth of *ber* plants was not affected by any of the crop sequences. Growth of *ber* in fallow (without crop) was less as compared with crop sequences. *Ber* did not affect growth of intercrops as it did not enter into competition with crops for water, nutrients and light. *Ber* plants were pruned after fruit harvesting every year.

Among varieties Seo produced the maximum fruit yield (6.61 kg/plant). Maximum fuel was obtained from Deshi (16.5 kg/plant). Two fungicides are wettable. Nuphur and Karathane were found effective to control powdery mildew disease of *ber.*

**Silvipastoral System**

At Dapoli, teak growth improved when it was grown with five rows of *Stylo* or *Cajanus,*

At the OUAT, Bhubaneshwar, under silvipastoral system hybrid Napier and guinea grass produced higher green forage 22.6 and 25.5 tonnes/ha in four cuts and *A. auriculiformis* had the highest growth. The yield of ragi was maximum in association with *Leucaena. Cassia siamea* and *Acacia auriculiformis* suppressed yield of fruit crops and ragi.

**Agri-Silvipastoral Systems**

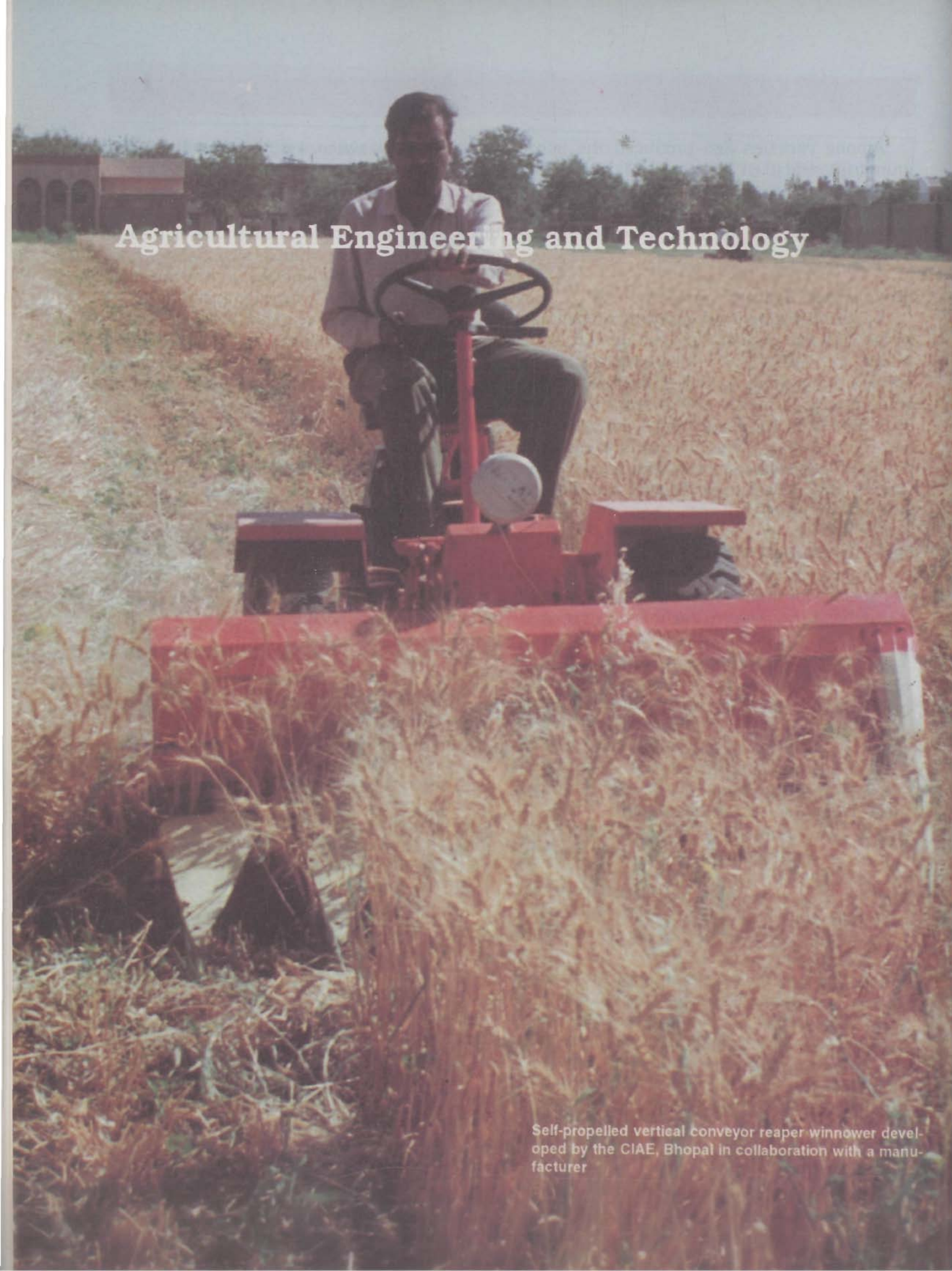
Studies on performance of multipurpose tree species for improvement of rangelands revealed that *Albizia procera, Dichrostachys cinerea* and *Dalbergia sissoo* were most suitable for introduction in red gravely soil while *A. amara, Pongamia pinnata* and *Dichrostachys cinerea* were found suitable for introduction in medium black soils of degraded rangelands for their improvement. At the Jhansi, silvipastoral system produced more biomass in the form of fodder and fuel than natural grassland.

*Acacia auriculiformis* and *Eucalyptus* plantations along with maize, pigeonpea and *Stylosanthes* are being raised by the farmers of West Bengal. *Gmelina arborea* is being grown in the cultivated upland along with rice and elephant foot yam.

**Agrisilvi-Horti-Pastoral System**

At Prabhu Nagar in clayey soil, yield of sapota showed reduction when cropped with teak and sissoo. Similarly yield of soybean reduced when grown with tree species compared to pure crop. Superior clones of cashew (8/46), gooseberry (sebrikolla) and *Jamun* (Krishnagiri) have been identified.

# Agricultural Engineering and Technology



Self-propelled vertical conveyor reaper winnower developed by the CIAE, Bhopal in collaboration with a manufacturer

# Agricultural Engineering and Technology

## Farm Implements and Machinery

A strip till drill operated by 35 hp tractor developed at the PAU, Ludhiana, can directly sow wheat in fields where paddy had been grown earlier. It has a light weight rotary tiller attachment fitted in front of conventional seed-cum-fertilizer drill. The power to the rotary tiller is given by the tractor p.t.o. and it can sow 1.5 to 2.0 ha/day. The Government of Punjab is giving subsidy on this drill. It not only results in timely sowing but also reduces cost of cultivation substantially. The GBPUAT, Pantnagar, has also developed a no-till drill operated by 35 hp tractor for direct drilling of wheat in fields where paddy had been grown earlier. It has a sharp edge tip attached to the furrow openers of conventional seed-cum-fertilizer drill for opening the furrow and placing of seeds. It can sow about 1.5 ha of land/day. Both the above mentioned drills are commercially available.

A power tiller operated 3-row duckfoot cultivator has been developed at the CIAE, Bhopal,

Power-tiller operated three-row duckfoot cultivator developed by the CIAE, Bhopal

* Tractor-operated strip till drill made available for direct sowing of wheat
* Tractor operated no-till drill developed for direct drilling of wheat
* A small weeder having field capacity of 0.6 to 0.8 ha/day developed at IARI
* High capacity multi-crop thresher developed for threshing soybean, sunflower, Bengal gram and wheat
* Groundnut decorticator and portable kinnow grader manufactured at commercial level
* Processes of liquid jaggery and jaggery powder preparation standardized
* Paddy-wheat rotation utilized maximum energy in Punjab
* Energy audit completed for jaggery making, fish farming, fodder production and animal maintenance
* Conveyor belt type animal treadmill developed to study draughtability and fatigue of animals
* A wooden adjustable collar harness for single buffalo developed
* Durable and cheap mild steel hoof shoes developed
* A rice husk-based gasifier coupled with diesel-engine generating set saved 60% of diesel oil
* Continuous lac scrapping machine developed at the CIPHET, Ludhiana
* Indian cottons found suitable for air-jet machines for combed yarn production
* Consumer appeal of jute products improved

for seedbed preparation under rainfed and irrigated farming. It consists of 300 mm sweeps. The capacity of the machine is 0.12 ha/hr.

A six-row manually operated paddy transplanter was popularized in Punjab, Haryana, Uttar Pradesh, Tamil Nadu, Kerala, Karnataka and Andhra Pradesh. A number of manufacturers in Punjab, Tamil Nadu and Andhra Pradesh have taken-up manufacturing of this design.

Animal drawn drill plough was developed at the CRIDA, Hyderabad. It consists of *desi* plough to which frame, hopper box, shaft with rubber agitator, ground drive wheel, metering plates and covering blades have been fixed. It can be used for sowing sorghum, pearl millet, groundnut, pulses etc. It requires one-third labour and covers twice the area as compared to sowing behind *desi* plough. It can sow 0.6 to 0.8 ha/day. It costs Rs 1,000 and is commercially available. The Government of Andhra Pradesh is giving 50% subsidy on this CRIDA plough.

A tractor drawn two-row automatic sugarcane planter operated by 35 hp tractor was developed at the IISR, Lucknow. The average length of the sett is kept 35 cm. In this planter all the operations involved in cane planting, right from cutting whole cane into setts, opening of furrows, dropping of setts, application of fertilizer, fungicidal treatment of the setts and covering of the setts with soil, are accomplished simultaneously in a single pass. The planter has a field capacity of 2 ha/day.

An animal drawn sugarcane interculture implement with earthing and fertilizer application attachments was developed at the GBPUAT, Pantnagar. The field capacity was 0.79 ha/hr and cost of operation Rs 116/ha.

A small weeder using a 1.7 hp engine was developed at the IARI, New Delhi, on the basis of ergonomic considerations. Engine power was transferred to the ground wheels by chain and sprocket mechanism. The powered weeder can be used for weeding row crops with 22.5 to 30.0 cm row spacings. It has a field capacity of 0.6 to 0.8 ha/day.

A four-wheel type self-propelled high clearance sprayer was developed at the PAU, Ludhiana, in collaboration with a manufacturer. The machine consists of 20 hp diesel engine, gear box, 1,000 litre tank, seat for operator, spray pump with boom and 18 nozzles. The sprayer has a ground clearance of 120 cm. This sprayer can be used for spraying in tall crops like cotton and sugarcane. This sprayer was used for spraying in 200 ha of cotton crop and its performance was satisfactory. It has a field capacity of about 1.5 ha/hr and cost is Rs 0.18 million. It is commercially available.

A riding type 10 hp self propelled vertical conveyor reaper windrower was developed by the CIAE, Bhopal, in collaboration with a manufacturer. The field capacity of the machine is 0.23 ha/hr. The cost of the unit is Rs 84,000.

A high capacity multi-crop thresher was developed at the CIAE, Bhopal, for threshing soybean, sunflower, Bengal gram and wheat. It can be operated with 20 hp motor or 35 hp tractor p.t.o. Capacity of the thresher varied from 550 kg/hr for sunflower to 1,200 kg/hr for wheat. The thresher is under multi-location trials.

A 2 hp electric motor operated groundnut pod stripper designed earlier at the CIAE, Bhopal, was modified to reduce thrower losses and improve cleaning efficiency. Threshing efficiency obtained with modified thresher was 100% and thrown pods were less than 0.5%.

**Tractor Operator's Comfort**

The ergonomic studies on tractor operator's comfort indicated that not only the noise levels exceed the permissible value of 90 dB but also the locations of controls (brake pedals, accelerator and clutch) were inappropriate for Indian operators. The oxygen consumption rate of Indian operators was lower (2 litres/min) than that of European operators (3.5 litres/min) and hence the capacity is low.

# Post–Harvest Engineering and Technology

A high capacity (300-350 kg/hr) groundnut decorticator, operated by a 2 hp electric motor has been developed and tested at the CIAE, Bhopal. The improved kinnow harvester (hand-operated scissors type, capacity 800-1,500 pieces/day) and portable kinnow grader (operated by 2 hp electric motor or small tractor, capacity 1-1.3 tonnes/hr) have been undertaken for manufacturing by private agency in Punjab, at cost of Rs 60 and Rs 20,000/piece, respectively.

Packaging studies conducted at the CIAE, Bhopal, on local cultivars of garden fresh seedless grapes under ambient and refrigerated conditions using low density polyethylene (LDPE) film (100-300 gauge) and polypropylene films (100-150 gauge) revealed the reduction in weight loss with increase in gauge thickness of both films used during nine days of storage.

A hand operated garlic bulb breaker (capacity 40-50 kg/hr, with breaking efficiency of 92-93%) and another power operated garlic bulb breaker driven by 0.5 hp electric motor, 100-200 kg/hr capacity was developed, tested and released for manufacturing at Udaipur. The mini *dal* mill of 100 kg/hr capacity with 2 hp electric motor, suitable for pigeonpea and green gram developed at the PKV, Akola, was put under commercial manufacturing. In addition, an auto aspirator aided solar dehydrator was also developed at the PAU, Ludhiana, which dehydrates potato chips from 85% moisture content to 4.5% in 8 hr as against 30 hr required in conventional sun drying.

Soywhey was used as fermentation medium at the CIAE, Bhopal, to produce yeast *Sacchromyces cerevisal* SCP with 31% yield at 6.5% pH, 36°C and with 10% supplementation of sucrose, 0.1% $N_2$ peptone, mineral and vitamin mixture. Soy-based *sattu* (ready to eat mix) was developed using roasted dehusked ingredients. The product containing 20-27% protein was tested organoleptically after 35 days storage in 200 micron polyethylene bags. A *poha* recipe developed at the CIPHET, Ludhiana, using puffed rice with texturized soyprotein (TSP) was standardized. The product has 8.75% protein.

A pilot plant was developed at the PKV, Akola, to process waste Kaghzi lime for production of citric acid granules (2.5% recovery by weight of lime) and gypsum (2.7% recovery). Leather waste (dust) combined with cellulosic and banana pseudostems at the TNAU, Coimbatore, yielded in manufacturing process of blended boards of 70 kg/cm tensile strength.

A laboratory scale rice polisher was developed at the IARI, New Delhi, to assist rice breeders in polishing brown rice samples of 1-10 g size. The machine can polish up to 25 samples at a time and up to 300 samples in 1 hr. Test-tubes containing the rice samples and an abrasive granular material are shaken continuously to achieve the polishing.

Processes for making liquid jaggery and jaggery powder were standardized at the IISR, Lucknow.

Liquid jaggery (*kakvi*)

Studies conducted by the CIAE, Bhopal, at selected pulse milling industries showed high dust concentration in milling and cleaning operations.

## ENERGY IN AGRICULTURE

### Energy Input in Crop Production and Processing

Energy use pattern for cultivation of major crop rotations (paddy-wheat, cotton-wheat and maize-wheat) in Punjab indicated that energy used in various field operations was maximum (28,881 MJ/ha) for paddy-wheat rotation due to continuous flooding of water and it was almost same in other two crop rotations (13,000 MJ/ha). Total energy input was also maximum (49,110 MJ/ha) for paddy-wheat crop rotation and it was minimum (27,450 MJ/ha) for maize-wheat crop rotation. The total yield for paddy-wheat was maximum followed by cotton-wheat and maize-wheat rotations. The energy-ratio (output/input) was 4.94, 6.52 and 5.05 in paddy-wheat, cotton-wheat and maize-wheat, respectively. The specific energy use was minimum (4,660 MJ/ha) in paddy-wheat rotation followed by maize-wheat (6,480 MJ/ha) and cotton-wheat (5,780 MJ/ha).

The energy input pattern for raising orchard crops (kinnow, malta, grape, peach, pear and mango) was determined by the PAU, Ludhiana. The energy to produce 1 kg of kinnow was 1.17 MJ (fertilizer-41.2%; electricity-34.4%; human-14.9%; and chemicals-6.0%) in Abohar, and 2.42 MJ (electricity-55.9%; fertilizer-22.1%; human-10.0% and diesel-6.9%) in Dasuya region. The energy used to produce 1 kg of malta was 2.47 MJ/ha (fertilizer-55.4%; diesel-21.5% and human-14.4%) and 1 kg of grape 1.42 MJ/ha (fertilizer-74%; diesel-31.15% and human-7.7%) in Abohar region. The energy used to produce 1 kg of peach, pear and mango was 3.47, 3.21 and 3.92 MJ/ha, respectively, in Dasuya region. Electricity was major source of energy followed by fertilizer, human and diesel in peach, pear and mango. In Dasuya region, irrigation was the major energy consuming operation (78.4%) due to water lifting from deep tube-wells. Use of machinery in raising of these orchards contributed between 360 and 626 MJ/ha and had a meagre share of 1.8 to 3.6% of the total input energy.

**Low Cost Green House**

Low cost green house of 2.6 m × 5.3m × 3.3 m in size made of slotted angle costing Rs15,000 (with environmental control measures), and green houses made of bamboo and HDPE pipes of size 13 m × 4.5 m × 1.7 m were developed and evaluated at the CIPHET, Ludhiana. The cost of these structures ranges between Rs 3,000 and 5,000.

The studies on the energy input for paddy cultivation at the IARI, New Delhi, indicated that while manual transplanting necessitated an energy expenditure of 1,730 MJ/ha, the use of pre-germinated paddy seeds needed only 31 MJ/ha. Tillage in paddy fields required 594 MJ/ha of energy and weeding required an additional 360 MJ/ha. The harvesting operation required 519 MJ/ha. The results suggest that direct machine seeding of pre-germinated paddy could provide a substantially energy efficient alternative of manual transplanting without affecting the crop yield.

In dairy and poultry production systems, the energy required to maintain different animals depends upon the body weight of the animal and stage of lactation. On an average, manual energy required for chaff cutting, feeding, dung removing and cleaning the shed, milking and other allied work for a 400 kg body weight cow giving 10 kg milk per day is 0.75 MJ/cow. The total energy consumption per lactation period for maintaining Sahiwal cow at Pantnagar was 104.6 GJ/cow whereas crossbred cow required 89.4 GJ/cow. The average benefit-cost ratio for Sahiwal cows was 1.20 whereas it was 1.91 for crossbred cows.

Operational energy required to maintain 1,000 broiler birds varied from 1.2 to 7.8 MJ/day with an average of 5.2 MJ/day, whereas for layer birds, it varied from 1.9 to 8.8 MJ/day with an average of 4 MJ/day. Broiler birds required 30% more operational energy than layer birds for their maintenance. Total energy required for keeping 1,000 birds varied from 294 to 1,810 MJ/day with an average of 1,049 MJ/day for broiler birds, whereas, it varied from 665 to 1,775 MJ/day with an average of 1,158 MJ/day for layer birds. The contribution of feed energy was 85 and 99% of total production energy for farmers at Pantnagar and Coimbatore centres, respectively.

Energy audit for jaggery making at a village in Western Uttar Pradesh was conducted by the GBPUAT, Pantnagar. Handling and crushing of jaggery cane used 88.5% of operational energy for jaggery making. During jaggery making, out of the total energy of 19.2 MJ/q, handling and crushing used 17 MJ/q and evaporation of juice for jaggery making used 1.3 MJ/q of cane. The rest of the operations (transportation of crushed juice to evaporated pan and transportation of finished product) used 0.9 MJ/q of cane. Energy used for fish farming, fodder production and animal maintenance system was also determined.

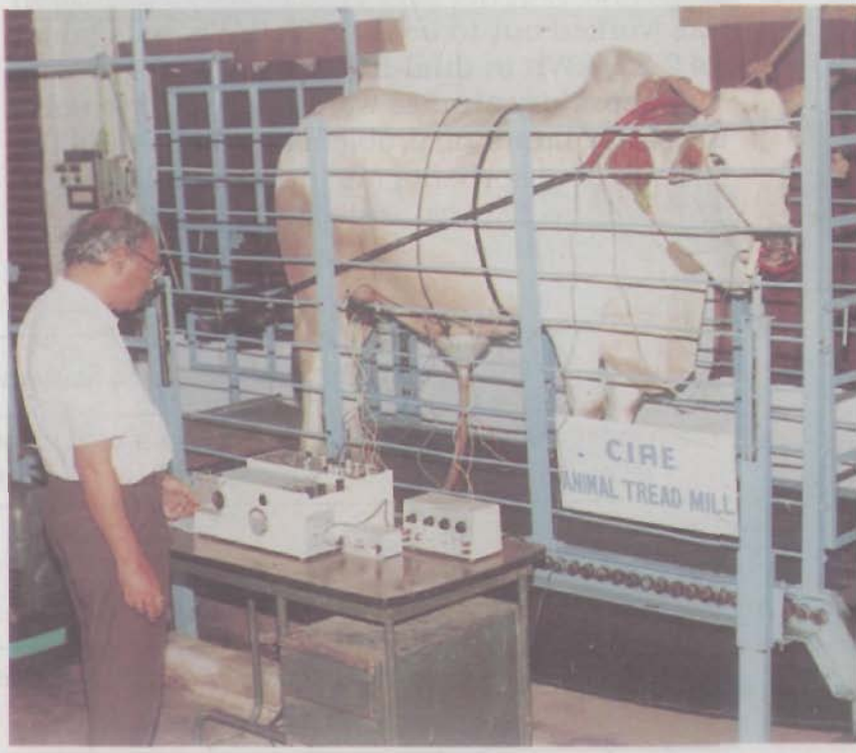
## ANIMAL ENERGY

A conveyor belt type animal treadmill was designed and developed at the CIAE, Bhopal, for laboratory studies on draughtability and fatigue of animals. The treadmill has facilities for loading of animals and for varying speed of walking between 1-3 kmph and inclination 0-10 degree. Its cost is about Rs 100,000. It is a reliable device for draughtability studies. Udaipur centre has developed fatigue score cards for camels and donkeys which are extensively being used in the draughtability studies.

Draughtability studies on bullocks were conducted at the CIAE, Bhopal. On test track animals worked up to draught load equivalent to 12% of body weight. Under field conditions, they worked up to 11% of body weight without getting fatigued, while for puddling operations, they could work up to load equivalent to 6% of body weight only. On treadmill, they worked for 4 hr at a speed of 1.25 kmph up to draught load equivalent to 7.5% of body weight without getting fatigued.

A wooden adjustable collar harness for single buffalo was developed at Pantnagar centre. This collar harness, weighing 5.8 kg was evaluated in comparison to local yoke and Allahabad type single animal harness and was found better giving about 15% more power output than other yokes and harnesses. In the ORP trials for paired animals, the farmers have preferred Nagpuri wooden yoke over local yoke. This improved yoke gives 10-15% more power output due to better contact on the neck of the animals.

Animal tread mill for recording of physiological parameters



In studies conducted at the GBPUAT, Pantnagar, surface coating of mild steel hoof shoes with electrodes improved the life of ordinary hoof shoes by 60%. The cost of operation per 100 hr use for ordinary hoof shoe was Rs 4.80 while it was Rs 2 only in electrode coated hard surface.

**Donkey for Light Field Operations**

Studies conducted at the CAE, Raipur, showed that donkeys could successfully be used for light field operations for ploughing, sowing and weeding for 2-3 hr/day. A pair of donkey could give an output of 0.02 ha/hr in ploughing, 0.27 ha/hr in sowing and 0.29 ha/hr in weeding in wider row crops.

## RENEWABLE SOURCES OF ENERGY

A solar energy based onion flake dehydration plant of 100 kg/batch capacity developed at the SPRERI, Vallabh Vidyanagar, Gujarat, consists of a solar air heater, an electrically operated blower, drying cabinet and a producer gas based thermal back-up for increasing operating hours beyond sunshine hours. It was used to dehydrate onion flakes of Nasik and local varieties in 100 kg batches from an initial moisture content of 85% (wb) to a final moisture content of 8% in 4 to 7 hr depending on solar insolation at Anand (Gujarat).

A 20 kW capacity rice husk based gasifier system for power generation was developed at the SPRERI, Vallabh Vidyanagar, Gujarat. The system produced engine quality gas, consistently at gas flow rate varying from 30 to 50 cu.m/hr. This gasifier coupled to a 20 kW diesel-engine generating set saved 60% of diesel oil and consumed rice husk @ 30 kg/hr. At a rice husk cost of Rs 5/q, the cost of electricity generation was worked out to be Rs 1.83/kWh as against Rs 2.22/kWh in dual-fuel mode.

Laboratory studies were conducted to solve the slurry handling problem by composting the mixture of absorbents (air-dried mango leaves, chopped rice straw and soybean straw) and biodegradable slurry at the CIAE, Bhopal. Known quantity of the absorbent was mixed into the slurry to make the mixture easy to handle. In one set of experiments, the mixtures of slurry and absorbent were kept in perforated sealed polyethylene bags in 5 kg batches for their composting for 20 and 40 days, whereas in the second set of experiments, those inoculated with *Phaneorchaete chrysosporium* @ 10% w/v and kept for 20 days for composting at room temperature. The observed weight losses after 20 days in un-inoculated mixtures ranged from 50 to 56% and in inoculated mixtures, it ranged from 60 to 65%. The study indicated that the inoculation with lignocelluletic fungus improves the composting process and reduces the composting period by about 50%.

## AGRICULTURAL DRAINAGE

A simple and inexpensive activity of maintenance of open surface drains can remove water congestion from the field faster, rendering the land workable sooner to enable timely sowing of crop after presowing irrigation. The following table highlights this in the farmers' fields under wheat in black soils of Tawa Command Area.

Effect of drain maintenance on field workability in black soil of Tawa Command

| Drain maintenance level | No. of days in a year when water table is shallower than 100 cm | No. of days for field to be workable after irrigation or heavy rain |
|---|---|---|
| Good | Nil | 7 |
| Fair | 56 | 14 |
| Poor | 100 | 22 |

Good, Freely flowing drain without any obstruction; Fair, partially blocked drain due to weed growth; Poor, blocked drain due to siltation and weed growth

The most commonly used technique for run off estimation is the Curve Number method which requires information of individual rainfall bursts, which are not available due to paucity of installed recording raingages. A procedure was developed to reliably estimate runoff from daily rainfall data. Using this procedure in 23 agricultural watersheds varying in area from 0.1 ha to 2,793 ha and for 46 rainfall bursts of amounts varying from 2.3 mm to 119 mm, the average absolute deviation between the observed and estimated runoff was found to be 5.6 mm. The procedure can be adopted for surface drainage design purpose.

A major part of tea production comes from north-eastern parts where the annual rainfall is over 2,500 mm. Drainage is essential as the tea leaf production drastically reduces if the root zone remains waterlogged for long duration. The usual practice is to construct open drains, which are not suitable for removing excess water from the root zone and often, such drains collapse under the impact of heavy rain and in light soils, requiring continuous and expensive maintenance. A net work of subsurface clay tile drainage system was adopted in a plantation area and it not only eliminated the maintenance problem, but also increased the tea yield by about 30%.

Methods developed to estimate runoff from daily rainfall data

## LAC TECHNOLOGY

A package of practice for *kusumi* broodlac and sticklac production on *kusum* host was developed providing multi-fold increase in profitability as compared to traditional practices. Technologies for lac production on *Acacia auriculaeformis (akashmani)*, were developed for both the strains of the Indian lac insect in alternation with conventional hosts, *kusum* and *palas*. The technologies offer higher profitability to the lac growers on waste undulated land.

Shellac based air-drying type anti-tracking insulating varnish in conjunction with a synthetic resin was developed possessing high dielectric strength (70-72 kV/mm), increased resistance towards tracking and resistance to transformer oil as per IS:10026-1982. The performance of the varnish is satisfactory on the coils of 3 hp and 5 hp electric motors.

Winter (*Aghani*) lac crop of *kusumi* strain on *Flemingia semialata* at ILRI, Ranchi, Bihar

A continuous lac scrapping machine was developed at the CIPHET, Ludhiana. It is a power operated, self adjusting machine which is capable of scrapping higher volume of lac as compared to the traditional methods in short time from the lac sticks of varying diameters. The machine has two sections, viz. scrapping and cleaning sections. The scrapping section comprises two specially made m.s. scrapping rollers, rotating in opposite directions at a particular speed differential, which scrap the lac from the lac sticks due to combined forces of compression and shear. The scrapped lac and sticks so obtained are guided to two different outlets in the separating sections, so the scrapped lac obtained from the machine is clean. It is expected that the machine will help in mechanization of lac scrapping operation and reduce the cost. The present prototype costs Rs 20,000.

## COTTON TECHNOLOGY

The CIRCOT, Mumbai, conducted air-jet spinning trials for the first time in India on pure Indian cotton varieties for the production of combed yarns, and demonstrated that Indian cottons can be processed satisfactorily on air-jet machines and that fibre strength and elongation are the most important factors of fibre quality for the production of strong and fine yarns.

Research efforts were directed at the CIRCOT to develop a technique for applying lac dye on cotton. Chitosan, a naturally occurring polymer obtainable from chitin which is a by-product of the shell fish processing industry, was used for a pre-treatment of cotton to make it receptive to lac dye. The dye produces a violet shade on cotton fabric when dyed in an acid medium. Wash fastness of dyed material could be improved either by using modrants (alum and ferrous sulphate) or by cross-linking treatments with DMDHEU. The use of mordants can also impart different colours to the fabric.

The CIRCOT, continued its participation this year also as the Co-ordinator for Technology in the AICCIP. Over 1,600 cotton samples from various breeding trials were evaluated for fibre properties and spinning performance and the test reports were presented at the various panel meetings. Promising varieties and hybrids were

### Biogas Technology

The technology of generation of biogas from willow-dust was improved considerably through dry fermentation technique since the installation of a pilot plant at a private textile mill at Mumbai. The improved process is more efficient and economical. The institute is in the process of transferring this technology to intending textile mills. A beginning has been made to transfer the technology with the installation of a biogas plant at a mill at Navasari in Gujarat. When commissioned, this biogas plant, using 30 tonnes of willow dust per annum, would meet the fuel requirement of the canteen of mill.

recommended for release at the appropriate panel sessions.

### JUTE TECHNOLOGY

Efforts are being made to improve the consumer appeal of the particle boards made from jute stick by lamination of the boards on both sides. These boards are waterproof and also have improved screw holding properties. Coloured particle boards were prepared from jute sticks particles dyed with reactive and direct dyes such as reactive green and chlorantine fast orange. The colour does not fade with time.

Biodegradable and environmental friendly jute was used to prepare non-woven geotextiles suitable for soil stabilization and for controlling soil erosion in dry regions and irrigated and rainfed areas. These fabrics can also be utilized for drainage and agricultural mulching in Rajasthan. Sandwitched fabric prepared by needling jute covered by polypropylene on both sides was used for temporary road construction in Himachal Pradesh.

Foam application in bleaching of jute fabric with hydrogen peroxide gives acceptable level of whiteness for dyeing satisfactorily in medium and deep shades. It also reduces the shedding effects of jute fibre and consumes less energy. Uniform dyeing of jute fabric was possible by using direct, acid and basic dyes by foam application technique. By this process, colouration of the jute fabric is possible in shortest possible time using minimum energy and water.

Microbial study indicates that anaerobic bacteria, the most active agents for retting of jute plant, dominates from fourth to thirteenth day of retting. On 13th day, retting is completed and it should not be kept for longer period otherwise over-retted, dazed fibre will result.

**Jute Pulping**

Pulping of jute whole plant by Kraft process and Kraft anthraquinone process was conducted to evaluate suitable conditions of pulping and bleaching to get a homogenous pulp of moderate brightness. It was found that (i) the yield and strength properties of pulp in Kraft anthraquinone process were higher than that in Kraft process, and (ii) ordinary quality wrapping/packaging paper, sack paper etc. of good strength, paper boards for book binding, container boxes, file cover etc. can be made from the pulp, and (iii) the brightness, printing opacity, strength properties of paper made from jute whole plant were acceptable when compared with properties of different newsprint.

# milma

# Instant Natural Banana-Milk Powder Spray Dried

Animal Sciences

Banana shake developed by the NDRI (marketed by MILMA)

# Animal Sciences

## Animal Breeding

### Cattle

The Project to study the genetic aspects of Holstein x Sahiwal crossbreds was started at the Project Directorate on Cattle, Meerut, in collaboration with the Military Farms. Its aim is to evolve a national milch breed of Frieswal capable of producing 4,000 kg milk in a mature lactation of 300 days. This is being done by

Frieswal cow, our national milch breed

Frieswal bull

* The national milch breed Frieswal showed 15 kg/day peak milk yield
* Semen straws of Hariana and Ongole bulls supplied to herds
* CIRB, Hisar, distributed young elite buffalo bulls to developmental agencies and farmers for breeding purposes
* Season of calving influenced lactation length in buffaloes
* Method developed to predict 305-day milk yield from one-day-milk-yield record
* Selected Avikalin rams were better in six-month body weight and greasy fleece yield
* Awassi and Malpura crosses can be developed as sheep for carpet wool and mutton
* CIRG, Makhdoom, distributed Jamunapari goats in adopted village
* Bikaneri camel produced heavier clip followed by Kachchi camels
* Kachchi camels produced higher milk yield compared to Bikaneri camels
* Overall kindling and weaning weight improved in rabbit
* Broiler rabbits being developed for field conditions
* Seven genotypes generated in pigs
* Arunachalees and Nagamees mithuns characterized
* High hatchability recorded in Pb. 1 and Pb.2 poultry populations
* Part period egg mass improved in RIR poultry population

stabilizing Holstein exotic inheritance to around half (5/8) in the available crossbred population at the Military Farms.

The overall least-square means for milk yield in 300 days and less, total yield, lactation length and peak yield of Frieswal in first generation from first to fifth parity, respectively, were 3,168.9± 44.4 kg, 3,479.2±57.9 kg, 340.4±4.0 days and 15.2±0.2 kg. Parity had significant effect on all the above traits except lactation length. Year and season of calving significantly affected all these traits.

At the semen freezing laboratory 119,010 doses of semen from 35 bulls (Frieswal 32 and Sahiwal 3) were frozen and 67,755 doses distributed to various military farms. The laboratory has 207,950 frozen semen doses of 46 Frieswal and 3 Sahiwal bulls.

At the Haryana Unit of CCS HAU, Hisar, 2,575 straws of Hariana bull semen were supplied to the herds. Hariana calves, on an average, weighed 22 kg at birth. The average age at first calving, service period and calving interval were 1,522, 251 and 546 days respectively. The average lactation yield was 1,198 kg in 308 days in third lactation with a peak yield of 6.2 kg.

Under the Field Progeny Testing Project, frozen semen doses of eight, ten and seven crossbred bulls from Frieswal Project were used at the BAIF, Uruli-Kanchan; KAU, Mannuthy; and PAU, Ludhiana. Number of daughters born in first and second batches at the KAU Unit was 956 and 1,603. At the BAIF Unit of this Project 290 daughters were born. At the PAU Unit, 108 progenies of second set and 53 progenies of third set completed their first lactation and daughters (9) of bull No. KF 4249 recorded the best average 305-day milk yield of 2,756.2±180.7 kg.

**Buffalo**

Under Network Project, young bulls (27) from dams yielding more than 2,500 kg were reserved and ten elite bulls were given to developmental agencies and farmers for breeding purpose. During the year 34,983 semen doses were frozen from elite bulls. The wet average increased from 5.66 to 6.44 kg/animal a day at the CIRB, Hisar.

* ILI-80 layer bird topped the Random Sample test, Bhubaneshwar
* ILI-80 showed high margin of profit over feed cost
* Naked Neck gene broiler performed better in all the seasons
* IBI-91 broiler from RBST, Gurgaon, achieved 1,860 g body weight in seven weeks
* Quail crosses excelled pure lines in body weight at four weeks
* Livestock data for the year 1990 and 1992 were added to databank
* Breed survey conducted for Bhadawari buffalo
* Technique standardized for extraction and purification of DNA from blood
* Guineafowl and chicken have similarities in immune function

**Indigenous Breeds Project**

Under the Indigenous Breeds Project, the Germplasm Unit distributed 2,050 straws of Ongole bull semen to the herds. The Ongole male calf weighed 27.5 kg and female calf 25.7 kg. Average age at first calving, service period and calving interval were 41 months, 135 days and 426 days respectively. The overall lactation yield was 842 kg in 231 days with a peak yield of 5.0 kg.

Analysis of first lactation records on Murrah buffaloes from 1971 to 1994, revealed significant effect of periods on all first lactation traits except total milk yield, while season of calving influenced lactation length only. Buffaloes calving in humid season had significantly higher lactation length than that of autumn and winter calvers. Age at first calving significantly influenced total milk yield, 301-day yield and wet average. There were positive and high genetic as well as phenotypic correlations among first lactation traits.

An attempt was made to predict 305-day milk yield from one-day milk yield record of the buffaloes as daily milk recording is not available under field conditions.The regression equation method gave the most accurate predictions.

Selected Murrah bulls distributed for breeding purpose

**Elite and test buffalo herds**

| Name of unit | Adult | Heifers | Total | Elite |
|---|---|---|---|---|
| CIRB, Hisar | 244 | 42 | 286 | 29 |
| PAU, Ludhiana | 190 | 85 | 275 | 39 |
| NDRI, Karnal | 163 | 58 | 221 | 85 |
| CCS HAU, Hisar | 82 | 40 | 122 | 13 |
| CCBF, Alamadi | 153 | 63 | 216 | 4 |
| GLF, Hastinapur | 64 | 45 | 109 | — |
| GLF, Majhra | 134 | 119 | 253 | 5 |
| GLF, Banavasi | 133 | 76 | 209 | — |
| GLF, Mamnoor | 109 | 15 | 124 | 4 |
| Total | 1,272 | 543 | 1,815 | 183 |

**Sheep**

Avikalin sheep produced overall annual greasy fleece weight of 1.88 kg with an average of 2.38 kg in rams and 1.39 kg in ewes. Annual tupping and lambing percentages on ewes available and ewes tupped basis were 94.74, and 76.31 and 82.81% respectively. The overall survivability was 92.57%. Selection index incorporating greasy fleece weight and body weight both at six months of age was used to select the rams. In selection index, total score ranged from 3.06 to 7.19, and rams having total score of 5.80 and above were selected for raising breeding rams. Rams used for breeding were also progeny tested. Average performance of selected rams for 6-month body weight and first 6-month greasy fleece weight were 23.65 kg and 0.985 kg, respectively, as compared to 18.05 kg and 0.786 kg of contemporary males.

Chokla sheep produced overall annual greasy fleece weight of 2.17 kg with average of 2.84 kg in rams and 1.50 kg in ewes. Annual tupping and lambing percentages on ewes available and tupped basis were 89.9, and 75.25 and 84.23% respectively. The overall survivability was 89.28%. Selection index incorporating greasy fleece weight and body weight both at six months of age was used for selection. Progeny tested top four rams were selected. Average performance of progenies of selected rams for body weight and greasy fleece weight at six months of age was 20.27 and 0.934 kg as compared to the population average 17.24 and 0.833 kg respectively.

Bharat Merino flock was improved further through selection and *inter-se* mating. Annual wool yield (2.52 kg) and annual lambing (90.12%) were better than those reported in the previous year. Survivability in younger and adult sheep was well above 95%. The average age of the flock was 1.83 years for rams and 3.33 years for ewes.

Rams (89) were supplied to the developmental agencies.

At Mannavanur, the annual tupping was 81.2%, and lambings on available and tupped basis were 74.5 and 91.7%. The survivability was above 95%. The greasy fleece yield (annual) was 2.51 kg with staple length, diameter and medullation of 7.14 cm, 18.45 μ and 0.12% respectively.

Malpura male lambs were selected on the basis of selection index incorporating greasy fleece weight and body weight both at 6 months of age. In selection index, total score ranged from 12.65 to 29.50. Male lambs having total score of 23.00 and above were identified for raising breeding rams. Rams used for breeding were progeny tested and top four rams were selected. The demand for Malpura rams is increasing; 58 rams were sold to the sheep breeders and developmental agencies. The overall means for preweaning average daily body weight gain (ADG) and post-weaning ADG were 103 and 54 g respectively. Annual tupping and lambing percentages on ewes available and ewes tupped basis were 94.73%, and 90.69 and 95.73% respectively.

Awassi is bred mainly for milk production. The crossbreeding of Malpura with Awassi was started in 1994 for the improvement of mutton and milk yield of native Malpura breed at the CSWRI, Avikanagar. The crossbred lambs exhibited about 16 and 9% improvement over their native counterparts with respect to 6- and 12-month body weight respectively. Simultaneous improvement exhibited in wool yield and quality is an added advantage. It was concluded that Awassi × Malpura crosses can be developed as dual-type sheep for mutton and carpet wool production.

At the CSWRI, Avikanagar, Chokla sheep are being improved for carpet wool production through selection using selection index incorporating 6-month body weight and first 6-month greasy fleece yield (GFY). Selection differential of rams used for breeding for 6-month body weight and GFY was 3.03 kg and 101 g respectively.

At ARC of the CSWRI, Bikaner, Marwari sheep are being improved through selection for carpet wool production. The elite ewes had higher reproductive efficiency, the percentage of tupping and lambing on breed basis were 79.1 and 88.7% for elite as against 75.2 and 81.2%, respectively, for tester. The elite lambs had 32.37 μ fibre diameter, 52.88% pure wool fibre as against 33.83 μ and 54.81%, respectively, for

Crossbred Awassi × Malpura sheep for mutton and carpet wool production

tester flock. The overall survivability was 95.3%. The elite flock showed promising results over the tester flock.

At the MPKV, Rahuri, Deccani sheep are being improved through selection for mutton and wool production. The breeding of Deccani ewes can be carried out throughout the year. The overall age and weight at first successfull service were 544.89±38.78 days and 29.00±0.77 kg respectively. The overall service period and inter-lambing period were 186.52±6.99 and 331.48±7.304 days, respectively. The annual tupping percentage was 99.5, whereas fertility and lambing on the basis of ewes available and tupped were 78 and 85.78%, and 80.39 and 80.39% respectively.

At the RAU, Bikaner, Magra sheep are being improved through selection for carpet wool production. Magra sheep produced greasy fleece of 0.787± 0.0097 kg having 37.5 μ fibre diameter, 4.6 cm staple length and 1.4 crimps/cm.

At the ANGRAU, Palamner, Nellore sheep, and at the TNVASU, Kattupakkam, Madras Red sheep are being improved through selection for mutton production.

**Goat**

Existence of high variability in goat breeds in growth, milk yield and prolificacy provides scope for improvement of goat production through selective breeding. Studies to increase goat production through selective breeding among Jamunapari and Barbari are in progress at the CIRG, Makhdoom.

Highest milk production record of Jamunapari goat is 288.0 kg in 243 days of lactation period. Twinning rate has improved to 53.49%. One kid weighed 5.0 kg at the time of birth. Highest 90-day milk yield of an improved Barbari goat was 192 kg and body weight at 12 months of age was 31.5 kg.

Goat improvement programme in the farmers' flock for Jamunapari in its home tract, is being undertaken. The farmers' participation in the adopted village is highly satisfactory and superior bucks were provided to them for breed improvement programme.

Goat population in village was found to be a highly changing phenomenon. The ratio of sold and purchased among adult females was 74:26

**Muzaffarnagari Sheep**

The Breeding Project on Genetic Improvement of Muzaffarnagari sheep for 6-month body weight and first shearing wool yield showed encouraging results. The study revealed tremendous potential of the breed for mutton production. The 6-month body weight of lambs was 19.71±0.18 kg, and through selective breeding, the body weight could be increased up to 30.19±1.41 kg which is the best growth performance for any of the Indian sheep breed maintained under semi-intensive system of management. Thus, an improvement of 52.9% in 6-month weight within 10 years was achieved. As high as 36.5±0.9 kg body weight at six months with mean feed conversion efficiency (FCE) ranging between 14.01 and 20% was observed during the project. The breed showed more than 95% survivability better than many small ruminant species, during the last six years. Tupping percentage, breeding efficiency, fertility and lambing rate were high. Multiple birth up to 10% was reported for the breed. Ranking of 62 sires for 6-month body weight based on Best Linear Unbiased Prediction of breeding value indicated that some sires could increase the production of their progeny by 1.75 kg. With such an excellent performance achieved through selection the flock is ready for recognition as strain of Muzaffarnagri breed.

for over last 3 years. Besides other factors outflow of adult females from breeding tract is an alarming cause for decreased population trend of this breed in its home tract.

Peak breeding season for Jamunapari is May-June. In field unit, the conception rate, kidding %, kidding rate, twinning and triplet percentage were 73.5%, 65%, 1.5, 53% and 6.1% respectively. The age at first kidding and kidding interval were about 723.0 days and 377 days respectively.

The least-square mean for overall milk yield was 1.15±0.02 litres, whereas milk yields in 30 and 90 days were 34.5 and 104.1 litres respectively. Body weights at birth and 3-month were 2.85±0.03 and 12.79±0.19 kg, respectively.

Jamunapari goats yield 288 litres of milk in 243 days of lactation

**Camel**

The least-square means of birth weight of Bikaneri, Jaisalmeri and Kachchi calves were 38.0±0.63, 36.2±0.84 and 34.5±0.85 kg, respectively. The birth weight of Kachchi and Bikaneri calves indicated improvement in birth weight ranging from 1.7 to 5.0%. Breed, year and sex significantly affected body weights at 6, 18 and 24 months of age. Bikaneri camels weighed heavier as compared to Jaisalmeri and Kachchi camels.

The body length average in Bikaneri, Jaisalmeri and Kachchi calves was 156.4±2.15, 156.6±1.91 and 151.3±3.61 cm respectively. The age effect contributed significantly. The average heart girth in 3 breeds in the same order was 166.5±1.53, 164.3±1.72 and 160.2±2.89 cm respectively. Sex also had significant effect. The average height indicated significant contribution of breed. Jaisalmeri camels were taller as compared to Kachchi and Bikaneri camels.

The correlations estimated among body length, heart girth and height were significant.

The average annual hair production in Bikaneri, Jaisalmeri and Kachchi was 1.252±0.137, 0.768±0.133 and 0.877±0.213 kg respectively. Bikaneri camel produced heavier clip followed by Kachchi and Jaisalmeri camels. The breed and sex affected hair yield significantly. Male camels produced more hair as compared to females. The average hair production was higher in camels of 2-3 years followed by 4.5 and 1 year of age. The heritability of annual hair clip was 6.35±0.29.

The average daily milk production with twice a day milking, at an interval of 8 and 16 hr by machine milking, was 4.04±0.06 and 3.69±0.09 litres/day in Bikaneri and Kachchhi camels. Breed and parity had significant effect on milk yield. Morning milk production during different months of lactation was 14.0 to 45.0% higher than evening production. Milk production indicated increasing trend up to six months of lactation with an average production of 5.22±1.43 litres/day.

The comparison of daily milk production by using different milking techniques indicated higher milk production under stripping of two teats method followed by four teats stripping simultaneously. Kachchi camels produced higher average daily milk over the Bikaneri and Jaisalmeri camels.

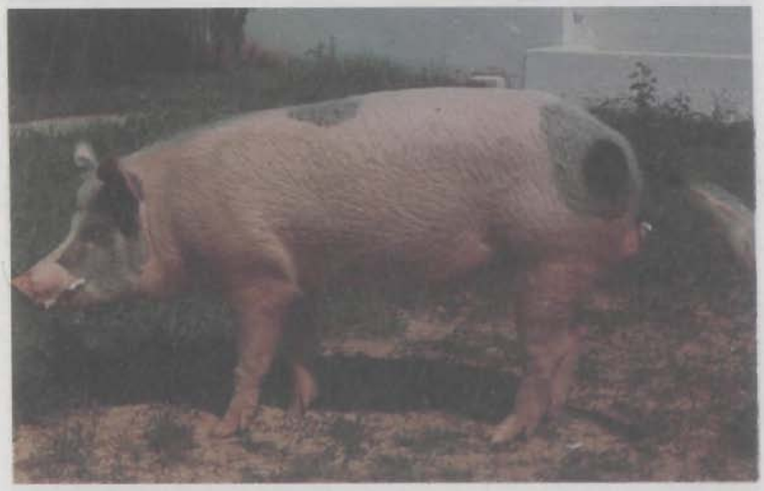
## Pig

Research work under the AICRP on Pigs continued to be conducted at (i) Acharya N G Ranga Agricultural University, Tirupati, (ii) Indian Veterinary Research Institute, Izatnagar, (iii) Assam Agricultural University, Khanapara, Guwahati, (iv) Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (v) Tamil Nadu Veterinary and Animal Sciences University, Kattupakkam, and (vi) Kerala Agricultural University, Mannuthy. The programme is aimed at conducting need-based research on indigenous and crossbred pigs with a view to improve pig production under Indian conditions. Following seven genotypes were generated:

Improved Desi x Hampshire halfbreds, Desi x Landrace halfbreds, Desi x Large White halfbreds, crossbreds carrying 75% Hampshire inheritance, crossbreds carrying 75% Landrace inheritance, and crossbreds carrying 75% Large White inheritance.

At Kattupakkam and Mannuthy centres, work continued to be conducted on indigenous pigs. Average litter size raised to weaning was 5.2 at Kattupakkam and 6.6 at Mannuthy. Litter weights at weaning at these centres were 36.51 and 45.3 kg. At Khanapara, litter size at birth averaged 6.7 and 6.5 in 50% and 75% crossbreds and litter size at weaning averaged 6.1 and 5.6 in two crossbred groups. Litter weights at birth were 6.1 and 7.1 kg and at weaning 51.9 and 55.8 kg, respectively. Similarly body weights at 16, 24 and 32 weeks in the two crossbred groups were 16.0 and 16.3 kg, 23.7 and 24.5 kg and 38.8 and 39.0 kg, respectively. Efficiency of feed utilization was 1:4.45. Body weights at Izatnagar at 16, 24 and 32 weeks were 22.5, 42.0 and 59.0 kg respectively. At Tirupati, litter size was 6.6 and 7.9 at birth and 5.7 and 7.2 at weaning in 50 and 75% LWY crossbred groups. Litter weights at birth averaged 6.3 and 8.2 kg and at weaning 49.3 and 64.1 kg respectively. Body weights at 16, 24 and 32 weeks in the two groups were 22.8 and 32.9 kg; 39.3 and 40.7 kg; and 54.8 and 58.5 kg, respectively. Overall mortality in the herd was 13.3%.

Average dressed carcass weight, head weight and back-fat thickness in indigenous pigs at



A crossbred boar (75% LWY)

A Large White x Desi crossbred sow with her litter

Kattupakkam were 48.2 kg, 5.4 kg and 1.94 cm respectively.

Average slaughter weights were 44.0, 69.2 and 62.0 kg at Khanapara, Izatnagar and Tirupati centres respectively. Carcass length (cm), dressing percentage and back thickness averaged 58, 61.4 and 1.5 cm at Khanapara, 67.1, 73.8 and 3.59 cm at Izatnagar, and 71.5, 77.0 and 2.70 cm at Tirupati.

**Rabbit**

In broiler rabbits the target weight of 2 kg was achieved on *ad lib.* concentrate and green feeding in 85.3 days against 93.1 days under conventional feeding. Average litter size at birth and litter size at weaning were 6.4 and 6.1 respectively. Overall productivity improved by achieving 3.5 kindling/doe a year and 6.1 kg weaning weight/doe in a year under semi-arid condition. Efforts are under way to introduce broiler rabbits under field conditions.

At Garsa station, Angora crosses of German (GA), British (BA), Russian (RA), and their crossbreds GBR and GRA in reproduction flocks produced 524, 390, 392, 257 and 420 g hair in five clips except GBR which was shorn four times. In wool production yield of flock was higher. Males of GA, BA, RA and GRA yielded 546, 430, 381 and 417 g wool, and females 620, 430, 417 and 487 g.

**Poultry**

The IWD and IWF strains were reproduced at the ANGRAU, Hyderabad. The birds were evaluated for their annual egg production. The IWG, IWH, IWI and IWJ lines were reproduced at the CARI, Izatnagar, and housed in cages for evaluating their individual egg production and other traits. At the KAU, Mannuthy, the IWN and IWP populations are being evaluated for egg production in their S.16 generation. The IWN and IWP populations were reproduced at the GAU, Anand. The egg production recording of the parents is being continued.

At the UAS, Bangalore, the S.2 generations of the Pb. 1 and Pb.2 synthetic populations were reproduced. The selected parents are being evaluated for their egg production. The commercial chick supply is being continued. At the OUAT, Bhubaneshwar, the synthetic male and

Broiler rabbits suitable under field conditions

female lines are being maintained. The female line is being evaluated for egg production. The male line birds have just completed 20 weeks of age and will be evaluated for their egg production. At the PAU, Ludhiana, the Pb. 1 and Pb.2 synthetic populations were reproduced. The selected birds are being maintained under restricted feeding. The egg production of Pb. 2 population is being evaluated by housing the birds in individual cages. At the JNKVV, Jabalpur, two dwarfing gene populations designated as DBE and DBG are being evaluated for their egg production. The centre is also maintaining a normal bodied male line for producing commercial broiler chicks. At the CARI, Izatnagar, the synthetic sireline and synthetic damline are being maintained. The hatching programme has been completed and the selected birds are being subjected to feed restriction. The synthetic damline birds were housed in individual cages and their egg production and other traits are being measured.

At the PD on Poultry, a layer randombred control and a broiler randombred control are being maintained. The layer randombred control is being evaluated for egg production and

other traits. The broiler randombred control hatching programme has been completed and three hatches taken. They are being grown under feed restriction. At the germplasm centre, the Pb.1 meat population and IWH, IWI and IWK layer populations are being maintained. The Pb. 2 layer population has been reproduced. Hatchability was 70% on total eggs set and 86.4% on fertile eggs set in the Pb.2 population. The Pb.1 population is being reproduced. Three hatches have been obtained and the remaining hatches are at various stages of incubation.

The layer populations have all been housed in cages and their egg production is being evaluated. The Directorate is also maintaining lines with Naked Neck gene which are being evaluated for egg production. The population carrying dwarfing gene is being expanded. Five hatches have been produced. The dwarf females have been separated and are being subjected to feed restriction.

The hen housed and hen day number of eggs up to 40 weeks of age increased by 12 and 9 eggs for IWG, 11 and 8 eggs for IWH, 14 and 6 eggs for IWI, and 6 and 3 eggs for IWJ respectively. The genetic gains per generation averaged over 21 cycles of selection ranged from 1.3 to 1.96 eggs in different populations. The improvement in egg weight at 40 weeks of age ranged from 1.02 to 2.40 g in different populations. Significant improvement was also achieved in the RIR population under selection for part period egg mass. Response was 81 g higher compared to previous generation. ILI-80 layer developed and released by the Institute topped the Random Sample Test, Bhubaneshwar. The hen housed and hen day egg production was 251.3 and 263.9 eggs respectively. The average feed consumption was 106.6 g/bird/day. The feed consumed per dozen of eggs was 2.247 kg and margin of profit over feed cost was Rs 38.54/bird.

In broilers, the realized genetic gains per generation for 6-week body weight of male and female progenies were, respectively, 56 and 51 g for SML-1, 17 and 19 g for OBNP, 39 and 33 g for SML-2 growth line, and 28 and 21 g for SML-2 index line. The broiler stocks containing Naked Neck gene performed better than the normal broilers irrespective of season. The superiority was more marked in summer compared to winter, although, absolute body weights were higher

Naked neck produces eggs of good quality

Aseel birds are being studied for overall performance

in winter compared to summer in both the stocks. IBI-91 broilers, developed and released by the RSBT, Gurgaon, achieved a body weight of more than 1,500 g with a feed efficiency of 2.1 at 6 weeks of age; and 1,860 g body weight with a feed efficiency of 2.3 at 7 weeks of age. IBI-91 broilers also excelled at the entries participating in the same year with respect to viability which was about 97% up to the end of the test period.

Comparative evaluation of Kadaknath, Naked Neck, Frizzle and Dahlem Red revealed that Dahlem Red although matured late produced more number of eggs (78.67 eggs) up to 52 weeks of age. Least egg production of 57.48 eggs was recorded for Naked Neck stock. Average annual egg production was 111 eggs both for Kadaknath and Frizzle. Egg weight was highest for Dahlem Red and lowest for Kadaknath both at 40 and 52 weeks of age. Naked Neck and Frizzle fowls produced significantly heavier eggs than Kadaknath at both ages of measurement. Pure indigenous stocks excelled their crosses with respect to fertility and hatchability. Fertility improved when Dahlem Red was used as a female parent in the production of crosses. On the other hand, hatchability on fertile eggs was higher when Dahlem Red was used as male parent. Significant differences were observed among the indigenous breeds for body weight at all ages of measurement. Crosses excelled pure strains for growth rate, indicating presence of heterotic effect. Trend remained the same for shank length and keel length. CMI (cell-mediated immune) response and PI (phagocytic index) were higher for Kadaknath compared to Aseel. PI was higher at tenth week than at other ages of measurement. Sex differences were observed for phagocytic activity and CMI response. Males had higher foot index values than females in both Kadaknath and Aseel breeds, but the reverse trend was observed for PI values.

**Quail**

In quails a complete diallel cross involving MTQ, GLQ, SLQ and KLQ lines was undertaken to evaluate the performance of these lines in crosses. The crosses in general excelled the pure lines for body weight at 4 weeks of age, dressed weight percentage and various cut up parts. Cross progeny resulting from GLQ as male line and MTQ as female line performed better compared to other cross combinations studied. Age exerted significant influence on total RNA and protein contents of liver. RNA content of blood and DNA content of liver were also influenced by sex.

Kadaknath males showed high foot index

## Mithun

A survey conducted over 2,000 heads of mithun population, comprising both sexes of all age groups, revealed that mostly two types of mithuns are available in the North-Eastern Hills States. They are easily recognizable on the basis of body conformation, body weight, colour and structure of horns and forehead. The growth and development of horn are quite distinct in both types. Mithun has been classified into 2 breeds viz. Arunachalees and Nagamees, on the basis of habitat and place of existence. Their characteristics have been identified.

| Characteristics | Breed type | |
|---|---|---|
| | Arunachalees | Nagamees |
| Home tract | Boleng, Ying Kiong and Pangin area and other parts of Arunachal Pradesh | Zunheboto in Nagaland and Ukhrul District in Manipur |
| Average adult body and weight | It is smaller in size and lighter in weight, approximately between 350 and 400 kg | It is heavier and weighs approximately between 400 kg and 500 kg; bulls are still heavier |
| General utility | This may be good for dual-purpose (milk and beef) | This may be good for beef |
| Body conformation | It has deep short and compact body | It has long and massive body |
| Average body measurements (cm) | | |
| - Male | | |
| Height | 130±7.2 | 135±8.4 |
| Length | 142±8.31 | 147±10.23 |
| Girth | 190±9.15 | 198±10.24 |
| -Female | | |
| Height | 109±6.05 | 117±7.67 |
| Length | 122±7.23 | 130±8.47 |
| Girth | 176±8.89 | 185±9.53 |
| Forehead | Broad and flat. The upper ridge is quite prominent, particularly in male | Broad and flat. However, the ridge is comparatively less prominent |
| Horn | Horn emerges from the top of the poll and extends on the side. It is stumpy with sharp tapering end. | Horn emerges from the top of the poll and extends on side. It is with thicker, tapering with blunt end |
| Colour | It has white patches on the body; coat cover piebald is quite common | It has black body coat cover with rare piebald |

# Animal Genetic Resources

**Development of Database on Breed Characteristics and Geographical Distribution of Economically Important Domestic Livestock**

(a) Livestock census data of various states and Union Territories for the years 1990 and 1992, were added to the computer databank for all domesticated species.

(b) A databank on animal genetic resources was developed on indigenous breeds of livestock for recording their status, management practices, physical characteristics, performance traits and breeding farms. The available information on all the indigenous breeds of cattle was compiled and estimates obtained for various traits.

Breed survey has been conducted for Bhadawari buffalo in its home tract

A pilot survey on characterization of Kinnauri yak was conducted in Sangla Valley, Himachal Pradesh

**Survey, Characterization and Evaluation**

Breed survey conducted in 56 villages of Agra and Etawah districts of Uttar Pradesh, revealed that 7 villages of the tract were without Bhadawari buffalo. Two villages one each in Bah and Chakarnagar blocks had 20 and 50 Bhadawari buffaloes. The population in the other villages varied from 2 to 5 animals. The estimated population of the breed based on the pilot survey was 37,700. The survey conducted on 216 households revealed that 80% farmers were rearing buffaloes for milk production and 20% for draught purpose. The average fat and SNF were 7.14 and 9.57% respectively.

Morphological investigations and cytogenetic studies revealed that Siri cattle are *Bos indicus*. Observations on socio-economic status of yak farmers, animal husbandry practices, types of yaks, body measurements, production, reproduction performance both under organized farms and farmers' herds, were recorded under pilot survey on yak of Arunachal Pradesh. The average milk fat of yak ranged from 4.40 to 7.00%. Yak butter showed a high percentage of palmitic acid which was the highest among all ruminant species.

**Cytogenetic Characterization of Farm Animals**

Cytogenetic investigation on guineafowl showed mean sister chromatid exchange frequency of 1.71/cell or 0.85/cell a generation. The nucleolar organizers have been located on one pair of microchromosomes.

**Molecular Genetic Characterization of Farm Animals**

Molecular genetic characterization was done at α S1-casein in Sahiwal (62), Tharparkar (25) cattle and Murrah buffaloes (68). ASPCR polymorphism of bovine α S1-casein locus for B and C variants was identified and S1-casein genotypes of these animals were determined at this locus. Gene frequencies of S1-casein B and C alleles among Sahiwal, Tharparkar cattle and Murrah buffaloes were calculated. B allele had lower and C allele higher frequency among the animals screened. These findings are in con-

trast to the gene frequencies of the B and C alleles reported among *taurus* cattle.

**Immunogenetic Characterization of Farm Animals**

Mithun blood group system closely resembled that of cattle indicating that both are closely related.

Yak and cattle erythrocyte antigens/blood group system are also similar. Twenty-nine BoLA (bovine leukocytic antigen) alleles were identified. BoLA alleles are controlled by closely linked genes.

**Goat**

Blood samples of Marwari (50), Kutchi (50) and Ganjam crosses (25) were analyzed for haemoglobin polymorphism on starch-gel electrophoresis. So far blood samples of 9 breeds/genetic groups have been analyzed. Three genotypes Hb-AA, Hb-AB and Hb-BB were observed on starch gels. Allele Hb was at lower frequency ranging from 0.82 to 1.0 in different breeds. Rare allele Hb was at lower frequency (0.04). Faster allele Hb was found in one out of 38 Barbari kids. Frequency of Hb allele was comparatively higher (0.18) in Ganjam crossbreds. Allele Hb was having better adaptive significance.

Samples of Marwari (35) were analyzed for transferrin polymorphism using continuous buffer system in starch-gel electrophoresis. Only two phenotypes, viz. Tf-AA and Tf-BB, were observed on starch gels. Frequency of Tf was higher (0.86) than that of Tf allele (0.14).

Techniques of extraction and purification of DNA from blood were standardized to study the variability at genomic level. Blood was collected using heparin and cells were lysed with lysis buffer (tris/HCl, EDTA, NaCl, SDS and proteinase K). DNA was extracted using phenol/chloroform/isoamyl alcohol and purified according to standard protocol.

**Camel**

*DNA polymorphism*

Blood samples were collected, and camel genomic DNA was isolated and purified. The PCR technique was carried out for random amplification of polymorphic DNA. Eighteen primers were tried, out of which two cattle primers were reactive in camel (1,065 and 1,127).

Guineafowl and chicken have similarities with respect to immune function

**Guineafowl**

Immunogenetic studies in the guineafowl stocks revealed widespread individual variation for immune system parameters like phagocytic index, wing-web index and complement level in serum. Variation between ages was highly significant for haemolytic complement levels. However, difference between sexes and varieties was not significant. Heritability estimates for immuno-function traits ranged from low to moderate. Data suggested distinct similarities between guineafowl and chicken with respect to immune function.

The diploid chromosome number ranged from 70 to 76 in guineafowl. Out of these 8 pairs were macrochromosomes including sex chromosome and rest of the pairs were microchromosomes. The first, second, fourth and fifth chromosomes were paired, whereas third, sixth and seventh chromosomes were acrocentric. The sex chromosome "Z" was metacentric whereas "W" was small and acrocentric. The sister chromatid exchange varied from 0 to 3 metaphase spread. Only 1 pair of microchromosomes has nucleolar organizer region.

can be conducted by using common tap-water of varying pH range and the sticks coated with the reagents can be stored at least for six months at 4°C. Further a microplate-ELISA for the detection of circulating immune complex in equine infectious anaemia (EIA) positive horses was standardized using C1 Q component of human complement.

An immuno-peroxidase assay and immunofluorescence assay were developed using the relevant monoclonal antibodies for detection of rinderpest virus/ BHV-1 in infected cell-cultures.

**Immunoprophylaxis**

A thermostable rinderpest virus (RPV) which grows efficiently at 40° C has been developed by utilizing the vero-cell-adapted tissue-culture rinderpest vaccine (RBOK) strain currently used world over for rinderpest vaccination. This thermostable virus was characterized antigenically by immunoperoxidase test and ELISA utilizing rinderpest hyperimmune serum (HIS) and RPV monoclonal antibodies with and without detergent (SDS,triton × 100) treatment of the virus. Both HIS and monoclonal antibodies reacted with thermostable RPV confirming the multiplication of RPV at 40°C.

The IBD virus isolated from the outbreaks occurring in various parts of the country on characterization was identical to British 52/70 (classic) strain or to European very virulent IBD virus strain. The thermostable IBD vaccine candidate strain developed at the IVRI was safe and potent.

Field trials of polyvalent bentonite-gel adjuvant FMD vaccine conducted at six-month interval in organized dairy farms were highly satisfactory in cattle, sheep and goats. Concentrated polyvalent mineral oil-based FMD vaccine developed for pigs was also supplied to field use. There was no untoward reaction in pregnant animals. All vaccinated animals were protected in face of outbreaks in cattle adjacent to piggeries.

To exploit the immunological method of control for ticks attempts were made to immunize crossbred animals against important tick species. The animals immunized with tick of *Boophilus microplus* were conferrred with significant protection against challenge infestation. Western-blot studies identified two antigenic proteins of 105.4 and 92.2 kDa which are also found in the larval stages of the tick. This larval stage may be exploited as vaccine.

*Babesia bigemina* vaccine was further produced by MASP culture technique. It was used for experimental immunization studies in crossbred calves @ 5 ml equivalent mixed with 3 mg saponin oil A. The dose was repeated after four weeks. These calves are being monitored for immunological responses.

**Basic Research**

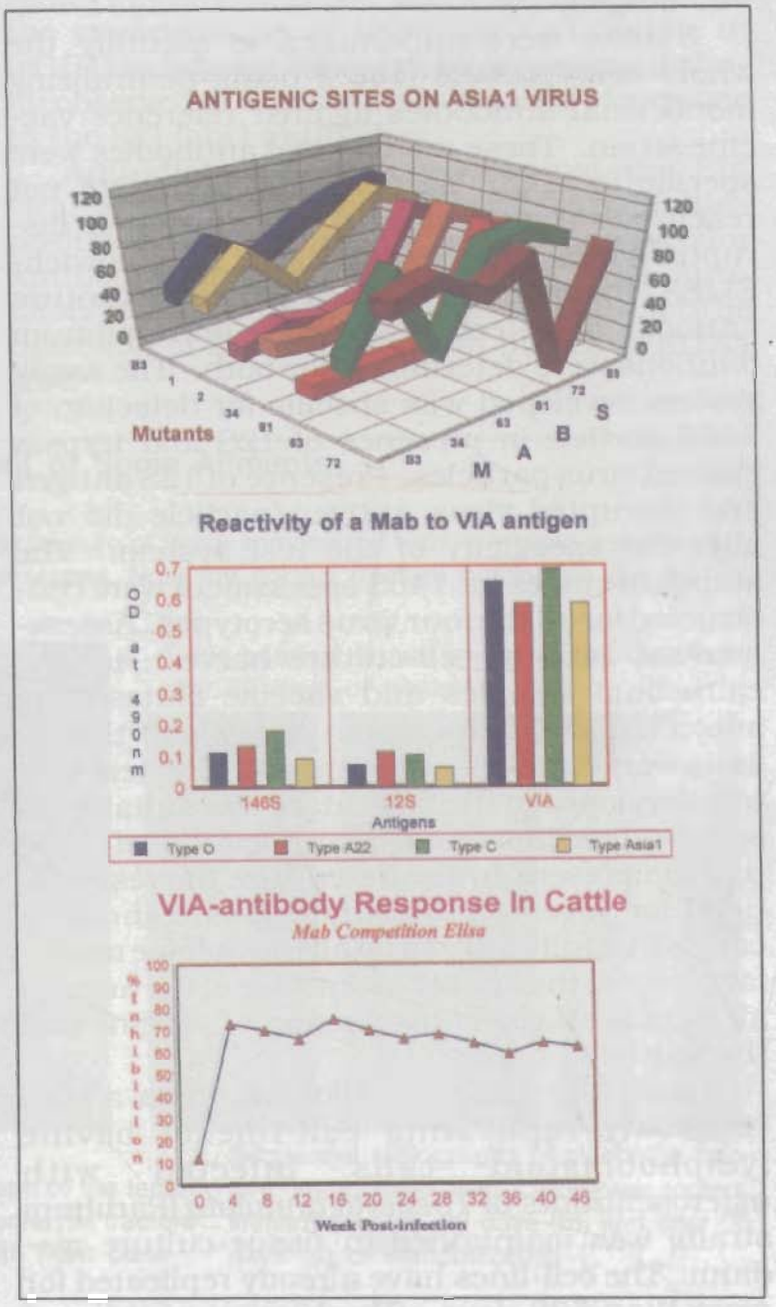
*Characterization of monoclonal antibodies to FMD virus type Asia-I*

Studies on development and characterization of monoclonal antibodies against FMD virus types were continued. Monoclonal antibodies (32) to type Asia-I vaccine strain virus were characterized using enzyme immunoassay and neutralization tests based on various laid down parameters. Using the characterized monoclonal antibodies raised against Asia-I virus, isolation and characterization of monoclonal antibody resistant mutants (MAR) revealed the presence of 4 different neutralizable antigenic sites containing 7 distinct neutralizable epitopes. All the four sites were sensitive to proteolytic cleavage by trypsin and depending on native conformation of the virus. Mab profiling studies of 47 isolates (1986-1995) of type Asia-I showed minor antigenic differences at some of the Mab-binding sites. But all of them were found to be related to vaccine strain in sandwich ELISA using polyclonal serum. Overall, the study revealed antigenic complexity of the virus. This is the first attempt demonstrating of antigenic sites of type Asia-I virus using monoclonal antibody-resistant mutant. This information will elucidate the phenomenon of escape mutants in the field in the actual infection of animals.

Monoclonal antibodies raised against subtype A 22 FMD virus and guineapig serum against synthetic peptide representing 136-151 and 136-157+ 200-213 region of VP1 polypeptide were characterized to understand the anti-

genic make up of the virus. Five neutralizing Mabs were used. Mutants isolated could not be neutralized by respective Mabs used to isolate them. The mutants against antipeptide 136-151 serum could be neutralized by homologous serum only at higher concentration. However, bovine vaccinated serum showed stronger affinity for all the mutants in ELISA and also could neutralize them indicating the presence of other neutralizable site(s) other than those defined by Mab or antipeptide 135-151 guineapig serum on the surface of FMD A 22 virus.

The commonly shared antigen by all the FMD virus types is virus-infection-associated antigen (VIA). The antibody against this antigen develops in the animal in the event of exposure and replication of FMD virus irrespective of the type involved. To use this particular phenomenon and develop a screening test, a panel of five monoclonal antibodies to virus-infection-associated (VIA) antigen were characterized. All the Mabs failed to neutralize the infectivity of the virus of all the four types and also remained non-reactive with 146S and 12S antigens. This showed the specificity of the monoclonal antibodies raised in the laboratory. To develop a screening test, Mab specific to VIA antigen was selected and used in the standardization of indirect competition ELISA using avidin-biotin system incorporating known positive and negative cattle sera as control. Post-infected cattle sera (600) collected from 16 calves experimentally infected with four serotypes were tested to select the cut off value for declaring an unknown sample as positive/negative for the presence of VIA antibody. VIA antibody could be detected as early as first week following infection, reached a peak at fourth week and persisted at a very high level till 51 weeks. Mab-based competition ELISA was subsequently used for screening of random serum samples. A total of 2,175 cattle sera were tested, of which 90.8% were positive as against sheep sera (145) 88.9% and goat (70) 58.6% for antibodies to VIA antigen. Overall, the VIA antibody free status could be identified in 9.2% of the cattle 11.1% sheep (145) and 41.4% goat (70) sera tested. The assay system developed could be used for large-scale screening to know the extent of prevalence of FMD in large

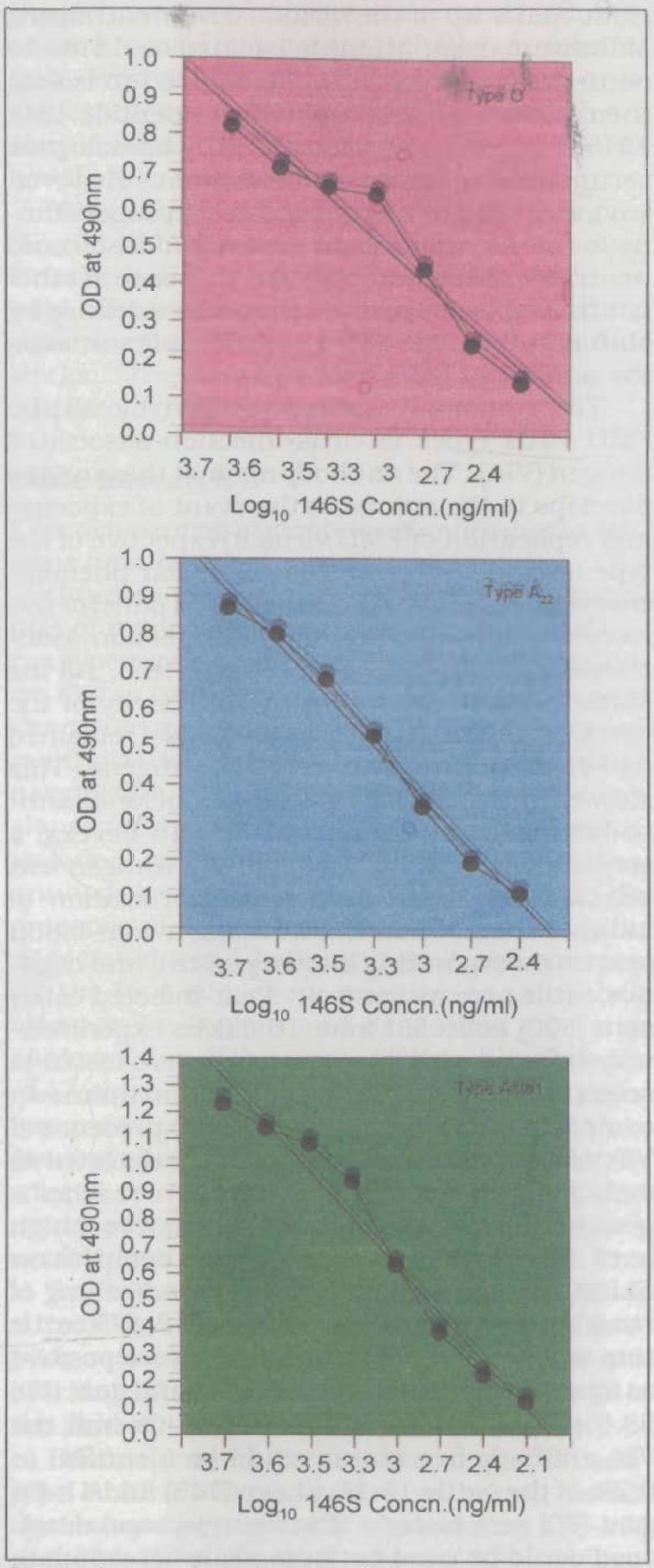


population, vaccination efficacy in the field by monitoring reduction of number of VIA-positive animals, and screening of animals destined for slaughter for export of meat. Further studies are continuing to develop a recombinant product of VIA antigen.

Studies were undertaken to quantify the whole virus particle (146S) using neutralizing monoclonal antibodies against reference vaccine strain. These monoclonal antibodies were specific for 146S particle only and were not reactive to trypsin cleaved 12S antigen or disrupted virus antigen/particles. In sandwich-ELISA, the Mabs were used either as capture antibody or detecting antibody and optimum dilutions were determined for both. The assay system developed was specific for detection of 146S particle in presence of 12S and trypsin cleaved virus particles. Presence of 12S antigen and disrupted virus antigen/particle did not alter the specificity of the test system. The standard curves for 146S assessment were constructed for all the four virus serotypes. Assessment of 146S in cell-culture harvest, tongue epithelium samples and vaccine elutes were subjected to quantification assay and the results were extremely encouraging. The test system developed in the laboratory was suitable for specific detection and quantification of 146S particle present in tissue-culture harvest destined for vaccine production. This technology can be fruitfully utilized by all the vaccine manufacturers in the quality assurance of the antigen at various stages of production of vaccine and the finished product.

Under the AICRP on Blood Protista a continuously replicating cell-line of bovine lymphoblastoid cells infected with macroschizonts of *Theileria annulata* (Parbhani strain) was maintained in tissue-culture medium. The cell-lines have already replicated for more than 500 days. The harvest of infected lymphoblasts was used for antigen preparation and also cryopreserved in liquid nitrogen.

The methodology for harvesting piroplasms of *T. annulata* free from host erythrocytes was standardized. The soluble lysate of purified piroplasms was prepared by sonication. The soluble lysate was fractionated in SDS-PAGE and then transblotted. The polyclonal antisera of cattle immunized with live attenuated




Standard curve for estimation of 146S particle polyclonal serum trapping and Mab tracing

macroschizonts recognized four protein bands at 28.5, 32.5, 42.5 and 47.0 KDa levels. These were not shared by the normal bovine erythrocytes. The peptide bands of normal bovine erythrocyte stroma ranged between 39 and 234 KDa.

The whole cell lysate of bovine lymphoblasts infected with macroschizonts of *T. annulata* was fractionated first into different protein fractions by using various per cent saturation level of ammonium sulphate. These various protein fractions were further subjected to separation into peptides by SDS-PAGE. Four major peptide bands at 32, 50, 66 and 105 KDa levels were obtained in 70% ammonium sulphate fraction.

The results of fractions of purified piroplasm and soluble macroschizont protein indicated that 32.5 KDa protein is a common protein antigen to both piroplasm and schizont.

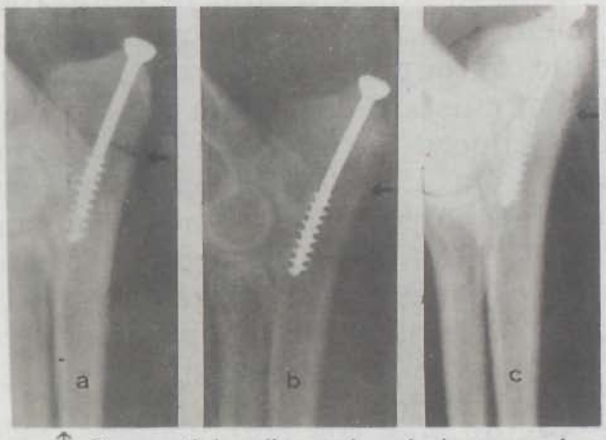
Studies conducted at the NRC on Equines, on the quantification of IgA, IgM, IgG(abc) and IgT isotypes in EIA-positive horses using single radial immunodiffusion test indicated a rise in the concentration of IgG (abc) and decline in IgG(T) levels suggesting that hyper gamma globulin observed in EIA is mainly because of increase in the IgG (abc) antibodies.

Anti-idiotypes developed against the EIA viral antigen inhibited the reactivity of EIA-positive sera and competed with the antigen for antibodies in competitive ELISA. The anti-idiotype 45s could be used successfully for the detection of EIA antibodies in horses in ELISA test.

## Cost-effective Treatment of Some Ailments

← Supracondylar fracture of femur immobilized with horn plate (radiolucent) and stainless screws. Note the normal fracture healing on day 60

← A dog bearing normal weight on fractured limb after 30 days of treatment




↑ Sequential radiographs of olecranon fracture immbolized with calcenous screws, immediately (a), 30 days (b), and after 60 days (c) of immobilization

↑ Gross photograph of the femur showing supracondylar fracture immobilized with horn plate

At the IVRI, Izatnagar, cost-effective techniques were developed for the treatment of ailments of musculoskeletal system, nerves and bone fractures, and these can be used for their management under field conditions also. Internal fixation among different techniques, which were evaluated, trans articular intramedullary pinning, horn plate and stainless-steel bone plating were suitable for the fixation of supracondylar fracture of femur, olecranon fracture of ulna and fracture of oscalsis respectively. Simultaneously pre-emptive use of ketamin given epidurally was useful in the management of post-operative pain and stress in fracture cases.

Another major success was achieved in tendon reconstruction. Different grafts and implants, viz. autogenous tensor fascia lata, autogenous dermis and carbon fibres were successfully used. The carbon fibres, however, proved superior in the repair of tendon defects measuring more than 5 cm.

# Animal Nutrition

**Cattle and Buffalo**

The phytoestrogenic content, a toxin that may affect the animal reproduction efficiency, is highest in berseem (1,079.11 ppm) followed by lucerne (460.55 ppm). Maize, guinea grass, mustard, hybrid maize, oats, *sengi*, cetronella etc. had less than 100 ppm of phytoestrogens. Thus, berseem one of the best leguminous fodders, should not be fed *ad lib.* to the animals.

Mimosine, an amino acid derivative present in *Leucaena leucocephala*, gets broken down to toxic forms, viz. 3,4 or 2,3 dihydroxypyridone (DHP), in rumen. The microbes present in the rumen of Karan Swiss cattle can degrade it to a non-toxic constituent by third week on gradual adaptation. At the NDRI, Karnal, the inoculum technique was developed by which this ability of the microbes can be transferred to other animals. The inoculated animal gets adapted to leucaena leaf-meal within five days of transferring the inoculum.

Formaldehyde treatment @ 1g/100g crude protein (CP) increased the bypass protein (UDP) value of groundnut-cake from 14.37 to 29.08% and of mustard-cake from 8.09 to 16.91%. It also reduced the aflatoxin level of groundnut-cake from 1.92 to 0.6 ppm and marginally reduced the glucosinolate level in mustard-cake from 4.41 to 4.16%. The feeding of treated cakes resulted in significant increase in growth rate of kids over untreated groups, which could be attributed to the synergistic effect of bypass protein and detoxification.

Feeding 20% more protein to crossbred heifers resulted in increased growth rate and improvement in digestibility of nutrients. Puberty occurred at 618.60 days in high-protein fed heifers. Mean LH concentration, frequency of LH pulses/6 hr and LH release after LhRH injection was higher in high-protein fed heifers.

Glucosinolate content in mustard-cake decreases its palatability. Its treatment with 2% $CuSO_4$ solution @ 500 ml/kg cake followed by drying at 60°C decreased its glucosinolate content (127.0 to 79.07 m mol/g) and increased its Cu content. Feeding of treated cake improved its palatability in kids over those on untreated

* Berseem should not be fed *ad lib.* because of its phytoestrogenic content
* Cross species inoculum technique to adopt ruminants on *Leucaena leucocephala* diet, developed
* Formaldehyde treatment of cakes proved doubly beneficial for ruminants
* Heifers on high protein diet showed increased growth rate and early onset of puberty
* Copper sulphate treatment of mustard-cake improved its palatability
* Grainless diet developed for livestock
* Exercise along with bypass protein feeding improved seminal attributes in bulls
* *Khejri* leaves mixed with urea-treated mustard straw formed a scarcity ration for adult sheep
* Sheep manure, 200 g urea and 240 g DAP improved yield of grassland forage
* Perennial grass, lucerne and sweet clover increased forage production in native pasture, under rainfed condition
* Fabrication of oesophageal cannula and surgical technique for fixation in sheep perfected
* Animals meet their protein requirement by selective grazing
* Defaunation of rumen improved performance of goats
* Prepartum supplemental concentrate feeding improved birth weight of kids
* Milk from mustard-cake fed animals safe for human consumption
* Jack fruit in ration reduced the cost of production of pigs
* Pearl millet and sorghum are cheap sources of energy for broilers
* Protein quality and not protein quantity is critical for meat-meal evaluation
* Neem-kernel-meal proved to be a rich protein source for layer birds
* Diet with 2% fat good for quails in summer
* Fungal fermentation of quail droppings improved its nutritional value

cake. However, supplementation of concentrate mixture containing untreated cake with a herbal sweetener did not influence the palatability. Feeding of treated cake did not influence the nutrient utilization and growth performance during a feeding trial of 28 days. However, Cu balance and feed efficiency improved significantly.

To spare cereal grains for human consumption, studies on either low grain or grainless diets with various species of livestock revealed that crossbred calves and milch cows may be fed on diets containing little or no grain with sufficient vegetable protein source and cheaper byproducts like wheat bran alongwith commonly available roughages (wheat straw) in calves and green fodders (berseem/oat/maize) in cows to sustain growth rate of 500-600 g/day in the former and around 10 kg milk production in the later. Methane production did not increase even on high roughage diets. Compressed-feed block preparation was standardized and tested for feeding during scarcity. Feed conversion efficiency was better in the defaunated animals. HPLC procedures were developed for the separation and quantification of lantadenes, the hepatotoxins in lantana plant. The mobile phases developed give baseline separation for most of the lantadenes. In addition, the noxious plant *E. adenophorum* present in the pastures in the region contains toxins that are sequiterpenes in nature. *Ageratum* sp. poses a lot of problem to the grazing animals in the pastures and bunds in the arable land, and contains chromenes as the major noxious/antinutritional factors.

The fungal strain *Aspergillus niger* Van Tiegham was used for more detailed studies of biodegradation of tannins in forages. The enzymatic system responsible for tannin degradation is very tightly bound to the micellial mass. This strain degrades tannin very fast and holds potential for biotransformation of hydrolysable and condensed tannins both of which have a number of harmful effects in ruminants.

A nonconventional concentrate mixture containing urea and molasses up to 4 and 20%, respectively, along with deoiled rice bran supplemented with minerals and salt and sorghum

**Balanced Concentrate Rations for Dairy Cows Using Locally Available Feeds**

At Nadia, Maldah and Murshidabad districts in West Bengal, mustard-cake, rice *kura*, rice grit and pulse *chuni* as byproducts of their main crops are produced in fairly good amount. At the Eastern Regional Station of NDRI, Kalyani, a balanced concentrate ration was formulated using these feed ingredients as follows:

| | |
|---|---|
| Mustard-cake | 38 parts |
| Rice *kura* | 30 parts |
| Rice grit | 15 parts |
| Mung *chuni* | 15 parts |
| Lime powder | 1 part |
| Salt | 1 part |

Calculated values of DCP and TDN of the ration are 16% and 55%, respectively, on dry-matter basis.

A balanced concentrate ration was also formulated using the locally available feeds in Birbhum and West Dinajpur districts of West Bengal. The composition is as follows:

| | |
|---|---|
| Mustard-cake | 38 parts |
| Rice bran | 40 parts |
| Rice grit | 10 parts |
| Gram *chuni* | 10 parts |
| Salt | 1 part |
| Lime powder | 1 part |

Calculated DCP and TDN of the ration on dry-matter basis are 16% and 64% respectively.

On-station feeding trial on crossbred lactating cows revealed that these 2 rations can sustain the milk production of 3 to 8 kg/day without affecting their health. Both the rations have been released for popularization in villages.

**Dry matter intake (g/day) and growth rate (g/day) of faunated (+P) and defaunated (-P) goats**

| Basal ration | DM intake (g/dry) | | Growth rate (g/day) | |
|---|---|---|---|---|
| | +P | -P | +P | -P |
| Green ficus leaves | 130.66 | 158 07 | 33.28 | 47.74 |
| Green *Azadirachta* leaves | 119 45 | 134.85 | 29.95 | 43.80 |
| Barley straw+dry *Leucaena* leaves | 171.74 | 184.35 | 32.82 | 39.15 |
| Pigeon pea straw | 94.39 | 123.83 | 23.64 | 38 22 |

silage offered *ad lib.* reduced the cost per kg gain up to 30%. Morin, a toxin present at a level of 19% in *mahua* seed-cake is not degraded by oxidizing agents thus excluding the possibility of using such agents in the detoxification process.

A survey of existing feeding practices in Hisar district, revealed that buffaloes were in short supply of certain essential minerals like Zn and Mn.

Exercise along with bypass protein feeding in Mehsana bulls, improved sexual behaviour traits and seminal attributes. Quantity of semen was better in monsoon season, whereas the quality was better in winter.

**Sheep**

Adult sheep were reared successfully on grainless diets without any adverse effect on nutritional performance. *Khejri* (*Prosopis cineraria*) leaves mixed with urea-treated mustard straw in a ratio of 25:75 formed a scarcity ration for adult sheep.

Experiments conducted on weaned (Malpura and Awassi x Malpura) lambs under composite feed lot ration or in cafeteria system, indicated that growth performance was significantly better in crossbred compared to native Malpura.

**Goat**

Defaunation in goats increased live-weight gain, digestibility of organic nutrients and nitrogen balance. It also improved the productivity of goats.

Effect of prepartum supplemental concentrate feeding on postpartum performance of crossbred goats showed that animals consumed 2.98% of DM/kg body weight during advanced gestation. The extra feeding of concentrate (around 200g/head/day) over and above the normal practice had positive effect on ensuing milk yield, milk composition and birth weight of kids.

Feeding of mustard-cake to lactating goats did not cause any reduction in FCM yield compared to goats fed groundnut-cake and milk production efficiency also remained unchanged. However, feeding of mustard-cake feeding caused decreased iodine content and increased thiocynate content in milk compared to that on feeding of groundnut-cake.

Weaned rats fed milk from two groups of goats for 90 days, showed similar performance, however, the group fed milk from mustard-cake-fed goats showed mild cellular hyperplasia. Thus, it can be concluded that milk from mustard-cake-fed animals may be safe for human consumption.

**Pig**

Nutritional experiments were conducted to evolve economic ration at different research units. At Tirupati, feeding of chopped green *Amaranthus* @ 890 g/day along with the finisher ration improved average daily gain and nutrient utilization in LWY crossbred pigs. At Izatnagar, pigs fed urea-treated neem seed kernel-cake showed a high feed efficiency. At Mannuthy, inclusion of jack fruit in ration reduced the cost of production of growing and finishing pigs.

**Rabbit**

In broiler rabbits mustard-cake incorporated ration reduced cost of feed /kg gain and increased net profit. Six protein supplements were used in the diet of broiler rabbits. In all groups target weight of 2 kg was achieved at 12 weeks of age. The cost of feed/kg live-weight gain was least (Rs 12.64) in mustard-cake-incorporated ration. The net profit (Rs /100 broilers/month) was highest in the ration containing mustard-cake (1,559) followed by soybean-meal (1,420), clusterbean-meal (1,083), GN-cake, (1,045), cotton seed-cake (1,045) and *gingelly*-cake (990).

**Camel**

Growth and feeding behaviour of camel calves was studied under stall feeding and free grazing. Blood glucose (140.6 mg/dl) and triglycerides (38.9 mg/dl) in stall-fed group were higher than those on sewan pasture (respective values being 127.1 mg/dl glucose and 26.0 mg/dl triglycerides). Blood haemoglobin, total protein, albumin and cholesterol were almost similar in the two groups. Blood urea was higher in stall-fed group (41.8 mg/dl) than that in control group (29.1 mg/dl). The stall-fed group spent 29.8% of 9 hr in feeding as compared to 65.6% spent by grazing group. The water intake period (min) was 2.63±0.20 and 9.64±1.52 in the stall-fed and free-grazing groups respectively.

In camel calves fed green blue panic *(Panicum antidotale)* the absorption of mineral elements, viz. Na, K, Ca, P and Mg, from GI tract was 92.9, 95.2, 45.0, 54.0 and 26.9% respectively. The low % dry-matter intake (0.67 kg) indicated the need of feeding this grass in combination with other feeds.

Nutritional evaluation of dry *pala (Zizyphus nummularia)* leaves was done to check its suitability for adult camels.

**Poultry**

Maize was replaced by pearl millet and sorghum as a source of energy in broiler feeds at the Project Directorate of Poultry, Hyderabad. *Ragi* either as a whole grain or in ground form was not found suitable to replace maize. Supplementation of an enzyme mix marginally improved the energy efficiency of pearl millet, *ragi* and sorghum, but the improvement was not significant. Feeding trials conducted on Naked Neck and normal feathered broilers did not show much difference in performance in winter and summer. Meat-meals as source of animal protein, were evaluated for their protein quality in terms of biological availability. Protein quality of meat-meals rather than the protein content should be considered to evaluate their nutritional value.

At the CARI, Izatnagar, neem kernel-meal, a protein-rich byproduct of neem oil extraction industry, was successfully utilized up to 10% level in the diet of layer hens without any noticeable change in their feed intake, production and reproduction performance, and egg quality traits. No adverse effects were noticed on liver, pancreas, spleen and kidney.

Increasing the dietary level of either calcium and phosphorus tended to decrease retention of phytate phosphorus in chicks irrespective of the breeds. The retention of calcium and phosphorus was higher in Kadaknath compared to that in White Leghorn and Aseel.

**Quail**

Increase in level of dietary ochratoxin A from 0.5 to 5.0 ppm caused a progressive reduction in the hen-day egg production of laying quails. However, reduction in egg production was not appreciable enough up to 1.0 ppm.

Dietary inclusion of 2% fat together with an increase in the nutrient density up to 5% level exerted a beneficial effect in the growing quails and hence recommended as a suitable dietary regime for growing quails during summer.

Fungal fermentation of quail droppings increased its nutritional value. The fungal-fermented droppings can be incorporated up to 25% in the diet of layer quails as against the autoclaved droppings which can be incorporated up to 10% level only in the quail layer mash.

**Grassland Forage and Agronomy**

In nutritive management programme highest crown diameter and dbh of *ardu*, neem and *siris* were recorded with the application of 10 kg sheep manure + 220 g urea + 240 g DAP. Dry

fodder and grain yield of all the tested crops in association with *ardu* and *babool* were comparable with the yield obtained on open space. All the tested crops responded favourably to fertilizer application @ 20 kg N and 40 kg $P_2O_5$ compared to without fertilization. All the crops in *aonla* block gave higher yield in terms of dry fodder and grain yields compared to *ber* block. Dry fodder and grain yield of *Cenchrus*, cowpea, pearl millet and their combination were slightly higher in single-tier system followed by multi-tier and 2-tier systems. Higher grain yield of sole *Cenchrus* and cowpea and their combination in different ratios (1:1, 2:2 and 1:2) was recorded with 100 *ardu* tree densities compared to 75, 50 and 25 tree densities.

In watershed development programme V ditch without and with vegetative barriers proved better soil and moisture conservation measure in terms of total dry fodder and *Cenchrus* yield. Vegetative barrier of *khas* (*Vetirenia* spp) and panipula (*Sosscharum munja*) performed better than others.

Gibberelic acid 10 ppm seed treatment at pH 7.0 gave the highest seed germination of *Cenchrus* than that in rest of the treatments. However, at higher pH beyond 8.0 sulphuric acid seed scurification considerably maintained seed germination than that in other treatments.

At the ARC, CSWRI, Bikaner, the effect of sheep manure application persisted in fourth year also, improving plant growth. Nitrogen application also increased production. Dry sewan forage yield increased by 11, 16 and 19% over control (2.5 tonnes/ha) due to 5, 10 and 15 tonnes/ha of SM and 10, 19 and 25% due to 15, 30 and 45 kg N/ha as urea.

At the NTRS (North Temperate Regional Station), Garsa, apple (A), biul (B), tall fescue (TF) and rye grass (RG) were grown alone and in different combinations. Yields of four cuts of green forages varied from 2.93 (A+B+TF) to 3.5 tonnes/ha (A+B+RG). There was no difference in yield of TF and RG grown alone (30 tonnes/ha). The yield increased up to third cut and reduced in the fourth cut because of climatic variations, i.e. setting up of winter in the fourth cut.

Tall fescue, lucerne (L) and sweet clover (SC) alone and in combinations were grown. The green forage yield in five cuts of TF and four cuts of L and SC resulted in 10.5-18.89 tonnes/ha. Under natural conditions the same forages yielded 9.12 to 14.63 tonnes/ha. Introduction of tall fescue a perennial grass, lucerne and sweet clover as legumes in native pasture under rainfed conditions increased forage production.

Fabrication of oesophageal cannula and surgical technique for fixation in sheep were perfected. The DMI assessment by extrusa using oesophageal cannula was more realistic than that by conventional techniques. Assessment of plane of nutrition in different seasons indicated that animals try to meet their protein requirement by selectively grazing on biomass rich in protein.

**Pasture Improvement Studies**

At the IGFRI, Jhansi, among legume species *Atylosia scarabaeoides* and Stylo were established in all the systems, but *A. scarabaeoides* showed higher establishment except in continuous grazing. *M. atropurpureum* could establish grazing lowest in rotational grazing. Highest biomass production (DM kg/ha) was recorded in deferred rotational system followed by continuous, rotational and cut-and-carry systems. About 90% of total biomass was shared by grass component while that of legume was 6-7% of the total. At Bikaner, silvipastoral system was developed for camel in which trees/shrubs like tortilis, *beri*, *khejri* and *jal* have been planted along with grasses, i.e. *cenchrus* and *Lasiurus* and number of the trees/shrubs species were recorded. Dry matter yield of grasses recorded was about 1.6 tonnes.

**Forage Evaluation and Livestock Production Studies**

At Jhansi highest wool growth was recorded in continuous grazing followed by rotational, deferred rotational and lowest in cut-and-carry system. In goats highest kidding percentage was found in continuous grazing followed by deferred rotational, rotational and lowest in cut-and-carry system. In sheep highest lambing percentage was in cut-and-carry followed by

Animals performed better in silvipastoral system

rotational, continuous and lowest in deferred rotational system. In cattle 50% of heifers conceived in rotational and deferred rotational system and only 25% of heifers conceived in continuous grazing and cut-and-carry system. Blood profile was indicative of better health in rotational and deferred rotational systems.

**Economics Studies**

The cost of pasture production (biomass) was highest in cut-and-carry and was lowest in deferred rotational system. Similarly cost of livestock rearing was highest in cut-and-carry system and it was minimum in continuous grazing system. Highest cost was involved in cut-and-carry system for pasture-livestock integrated production followed by deferred rotational, rotational and continuous grazing systems. The value addition was highest in deferred rotational and lowest in continuous grazing system. At the CIRG, Makhdoom, cost of developing improved pasture was Rs 4,064.26/ha.

## Animal Physiology

**Buffalo**

*Induction of lactation in buffaloes*

A large number of buffaloes of good genetic potential are slaughtered due to infertility and thus a large population of superior germplasm is permanently eliminated. These superior buffaloes can be saved by induction of lactation as it sometimes brings them back into normal reproductive process.

A simplified protocol was developed at the NDRI, Karnal. Estradiol-17 β and progesterone (in the ratio of 1:1) are administered @ 0.1 mg/kg body weight a day for seven days subcutaneously. After a lapse of seven days, udder massage is done daily in the morning and evening till the udder is fully engorged with milk. Milking is done when the udder and teats become turgid. Once the milking starts, it continues till full lactation length. The buffaloes induced into lactation by this technique produced up to 9.0 kg of milk at peak lactation. The milk produced is normal in composition and is fit for human consumption.

*Milk-based extender for buffalo semen*

Addition of 0.1% cystein to the milk-based extender improved the membrane integrity of spermatozoa. Milk-based extenders were suitable for preservation of semen at refrigerator temperature and also for cryopreservation, compared to egg-yolk citrate (EYC), citric acid whey (CAW) and citric acid whey yolk (CAWY) extenders.

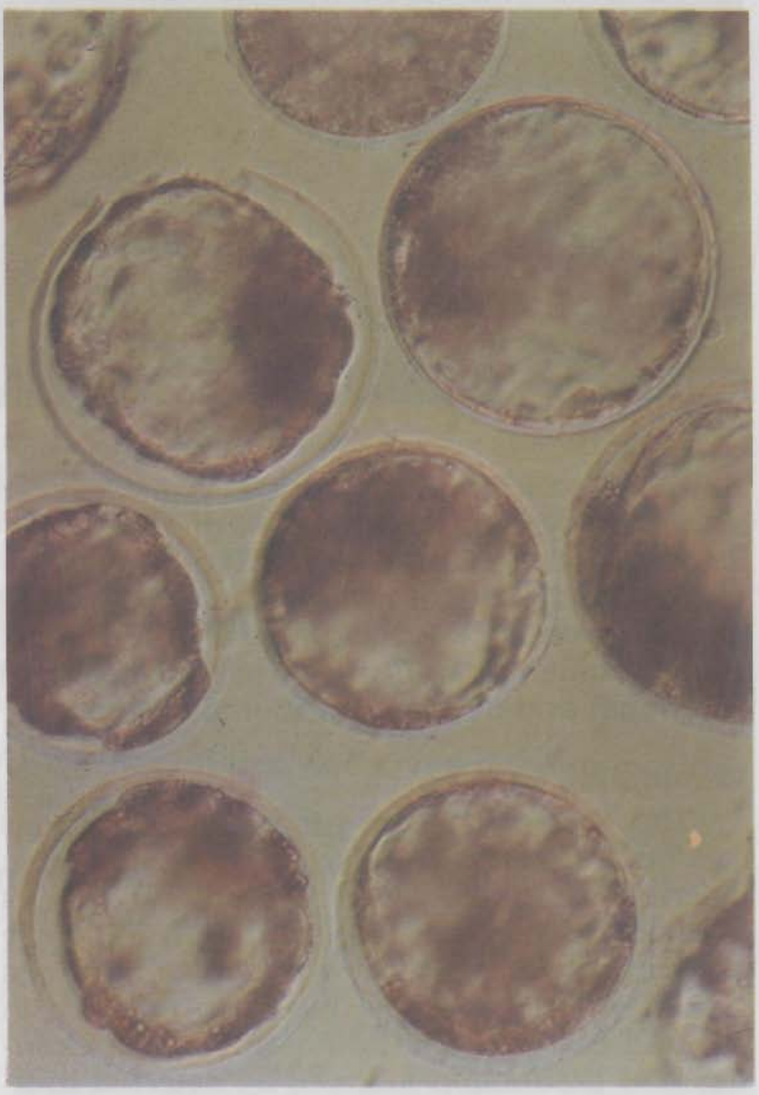
**Embryo Biotechnology**

Emphasis was laid on upstream area of embryo biotechnology like optimization of *in-vitro* fertilization, cryopreservation of oocytes and purification, and utilization of inhibin hormone for enhancing recruitment of follicles. Supplementation of 20 ng/ml epidermal growth factor (EGF) in TCM-199 medium with 10% foetal bovine serum (FBS) increases cumulus expansion and oocyte maturation in buffalo when cultured for 24 hr *in vitro* (IVM). The morula and blastocyst development was significantly increased by the addition of EGF. The cost of *in-vitro* production,of buffalo blastocyst embryos could be reduced by replacement of FBS and FSH in TCM medium with buffalo follicular fluid (BFF) collected from slaughterhouse ovaries. A multiplex PCR-based accurate, specific, sensitive, rapid and reproducible method for sex determination in buffalo was standardized.

At the CIRB, Hisar, 34,983 doses of semen were frozen. Best period for semen freezing was November-December and January-February.

* Laproscope-aided intrauterine insemination technique developed
* Presence of male goat significantly affected the heat synchronization
* Proper shelter management in summer influenced milk yield in goats
* Cyproheptadine at 0.5 ppm increased ready-to-cook weight of broilers
* Age-wise eruption of teeth recorded in camel
* Photoperiodism affected seasonal behaviour of camel

Buffalo embryos produced *in vitro*



The lowest number of doses was produced during the hot summer.

Embryos (78) were recovered from donor buffaloes and 50 were transferred into 47 synchronized recipients. This resulted in the birth of nine calves including a twin.

**Sheep**

At the CSWRI, Avikanagar, freezing protocol was developed for raw semen that gave 70% post-thaw motility consistently in Rambouillet, Awassi, Bharat Merino and Malpura breeds.

A laproscope aided intrauterine insemination technique was developed for conducting AI with frozen ram semen and quick transfer of embryos. It has indigenously-fabricated cradle and other devices, and takes 2-3 min for one insemination without inflating the abdomen. Overall 44% lambing with frozen semen and 49% with embryo transfer were achieved by using this technique.

**Goat**

*Effect of male goat on heat synchronization*

To synchronize the estrous in goats without use of any exogenous hormone, the goats of Marwari, Kutchi and Sirohi breeds were isolated from bucks for about 2 months toward the end of seasonal anestrus. The does started coming in heat 2 days after introduction of bucks and higher percentage of does came in heat in the group that had aproned bucks for a longer period in comparison to those which had them for a shorter period.

*Semen quality*

Evaluation studies were carried out to find out the most suitable months for optimum quality of semen for freezing to improve fertility rate with frozen semen in Barbari, Jamunapari, Kutchi, Marwari, Sirohi and Jhakhrana goats. The total bacterial load in semen collected during different periods of the study was also monitored. The semen quality was better during

ET-born Bharat Merino lamb with Kheri mother

moderate and hot dry periods and of comparatively poor quality during cool and hot humid periods in most of the breeds. Some differences between the breeds were, however, apparent. The total bacterial load was more during cool period than that during moderate period.

*Stress physiology*

Tolerance to thermal, radiation and dehydration stress of Kutchi goats was evaluated. Kutchi bucks were able to maintain normal body temperature during both cool and dry period. The thermoregulatory efforts during hot dry period, when daily maximum temperature was above 40°C, included decrease in metabolic rate and water excretion through urine and faeces and increase in water intake, respiratory rate and sweating rate.

When the bucks were exposed to direct solar radiation the rectal temperature in afternoon increased during both cool and hot dry periods. Increase in respiratory rate, however, increased only during hot dry period. The resting metabolic rate on exposure to direct sun decreased to 76.8 k cal/kg $W^{0.75}$/day during hot dry period and to 83.5 kcal/kg $W^{0.75}$/day in cool period. Magnitude of decrease in metabolic rate in exposed group in comparison to that under shed indicated that bucks exposed to solar radiation utilized some solar energy for thermoregulatory needs during winter.

Bucks lost 20% body weight after 3, 5 and 7 days of complete deprivation of free drinking water during hot dry, moderate and cool periods respectively. The animals, however, recovered their lost body weight on rehydration without suffering any ill effect.

*Shelter management*

Optimum covered and open floor space requirements for kids of different age groups, adult bucks and lactating does were worked out. Provision of optimum covered area in shed and open area in paddocks was very important to attain optimum floor space in kids. Availability of optimum covered floor space is more critical than optimum open area in paddocks for improvement in growth rate. Availability of optimum floor space was found important for milk yield. Availability of floor area lower than optimum during summer adversely affected the daily milk yield in goats.

*Fertility index developed*

A fertility index incorporating motility %, sperm number per ejaculation, live spermatozoa percentage, acrosomal integrity, hyaluronidase and AKP activity in the extracellular fluid and head area gave best accuracy (99.99%) of prediction of conception rate and fertility of bucks at the NDRI, Karnal.

**Poultry**

The physiological significance of the transparent fluid secreted from the cloacal region of cock still remains controversial. Studies revealed that the transparent fluid in semen adversely affected the motility of spermatozoa.

Plasma uric acid level of laying hens exerted significant influence on feed efficiency during summer. Feed efficiency improved in the hens when plasma uric acid level was low. Stability of the protein was higher in the young laying stocks compared to adult broiler stocks. Stability was also more in White Leghorn layers compared to broilers. Higher thermostability of plasma protein, lactic acid dehydrogenase and RBC in males were not influenced by the male sex hormone. On the other hand estrogen in females accounted for their low thermostability. The study also suggested that higher RBC liability due to estrogen in females may account for less amount of haemoglobin in females.

Feeding of cyproheptadine to young broilers did not influence the biweekly body weight gain until the age of four weeks. However, the gain slightly increased during four to six weeks when the chicks were fed cyproheptadine at a concentration of 0.25 ppm. Cyproheptadine did not influence the feed efficiency and the rate of glucose absorption across the intestine, but it increased deposition of abdominal fat. Cyproheptadine at 0.5 ppm increased the ready-to-cook weight of broilers.

## Camel

The riding potential of Indian camels was studied at the NRCC. The significant increase in pulse rate and respiratory frequency, and slight increase in rectal temperature before and after riding in both male and female camels was recorded. The respiratory frequency was higher (1.4 fold) in female than that in male camels during course of riding.

The level of glucose increased during riding in both male and female camels and reached normal within 24 hr. There was slight increase in triglyceride during riding and remained at that level even up to 24 hr. The creatinine kinase activity decreased significantly during riding in both male and female camels while no significant change was observed in glutamyl activity. The activity of lactate dehydrogenase decreased significantly after fourth round in both male and female camels. The lactate dehydrogenase showed significant increase during riding in both male and female camels. The level of cortisol increased significantly in both male and female camels during riding. The increase was higher in male than that in female camels.

Human insulin kit elicited cross reactivity with camel insulin. The same can be used for relative insulin studies in camels. Ascorbic acid tended to rise from 1 to 3 days postpartum in camel milk and subsequently declined to nearly a constant level in mature milk. At the NRCC, Jorbeer, tris extender was found superior than the lactose extender in preserving the camel semen at 5°C. No postpartum ovarian activity could be observed in the ovaries of she camels examined by ultrasound scanner.

Non-seasonal breeding was tried from June to September 1996. No exogenous hormone therapy or special management care was provided to the females for the initiation of follicular activity. The adult male camels showing rutting behaviour were used for mating. The mating was done twice at the interval of 24 hr and injected receptal 10 ml at the time of first mating to synchronize ovulation. Out of eight females four (50%) became pregnant, where two conceived after first service and others after second service. Early pregnancy diagnosis was tried through serum progesterone estimation in cam-

### Age-wise Eruption of Teeth in Camels

The camel became full mouthed at the age of 7-8 years. The age-wise eruption of teeth recorded as under:

| | |
|---|---|
| 0.1 year | 2 [I(0/3) C (0/0) (started eruption after 9 months) PM (3/2)] |
| 1-2 years | 2[I(0/3) C(1/1) (erupted by the age of 18-20 months) PM (3/3)] |
| 2-3 years | 2 [I (0/3) C(1/1) PM (3/3)] |
| 3-4 years | 2 [IC0/3) C (1/1) PM (3/3)] canine started falling for replacement |
| 5-7 years | 2 [I(0/3) C (0/0) (under replace ment) PM(3/2) M (3/3)] |
| 7-8 years | 2 [I(1/3) C (1/1) PM (3/2) M (3/3)] full mouth |

### Yak—The Pack Animal of Difficult Terrains

Yak *(Poephagus grunniens* L.*)* is a time-tested age-old pack in difficult terrains on and above 3,000 m above msl in areas otherwise inaccessible even by horses and mules. A short workout (40 m escalation in 200 m distance in 4 min duration) and a long workout (300 m escalation in 7.5 km distance in 75 min) with load varying from 13 to 28% of the body weight significantly increased body temperature, pulse rate, heart beat and respiration and took 20-24 min to come to the pre-exercise values. Red blood cells, white blood cells, haemoglobin and packed-cell volume also significantly increased with significant lowering of erythrocytes sedimentation rate during the exercise. The stress due to load and walk prompted the changes to cope the biological need of more oxygen demand. Periodical break spanning from 30-60 min depending on the slope and distance is essential to keep the yaks in the best of the condition.

els and it was correctly diagnosed in 86% of the animals because 1 animal suffered from early embryonic mortality.

Off-season breeding was attempted in camels by photoperiodic control. The females were applied with a specially designed face mask for 6 hr to prevent solar light on the eyes for about one month. The photoperiodism played important role in the seasonal behaviour of the camel as all the masked animals exhibited sexual interest, and their ovaries also revealed changes after 25 days of photoperiodic control.

The studies conducted on preovulatory surge of LH in female camels at the NRCC, Jorbeer, revealed that LH is essential for ovulation and subsequent formation of active corpus luteum.

## Animal Products Technology

### Milk

Heavy use of pesticides has resulted in appearance of their residues in milk of livestock. These residual xenobiotics are toxic to these animals and also affect the micro-organisms used for preparation of fermented milk products. Lindane, when added @ 0.01 and 0.1 ppm into boiled milk, inhibited the growth of *Lactococcus lactis* subsp. *lactis* and *Lactobacillus delbrueckii* ssp *bulgaricus* and thus their lactic acid production. Rod-shaped bacteria showed lesser sensitivity than that of the cocci. Heating the milk destroyed the pesticide to a large extent.

Certain species of bacteria secrete bacteriocin(s) which inhibit the growth of undesirable bacteria inhabiting the gastro-intestinal tract. A promising strain of *Lactobacillus* sp. after 16 to 18 hr of growth, showed maximum bacteriocin production when grown in MRS medium using 1% of either lactose or sucrose at 37°C and initial pH of 6.8.

The NDRI, Karnal, developed the technology for the production of direct-vat-set (DVS) cultures for the preparation of dahi and yoghurt. A cryoprotective agent was formulated using buffalo milk, gelatin, sucrose and monosodium-glutamate. The freeze-dried culture powder is packed in aluminium foil pouches and vaccum sealed. These pouches are light weight, convenient to handle and can be sent by post. The culture powder is ready to use for direct inoculation into the vat.

Microwave treatment caused least damage to water-soluble vitamins in milk; similarly fortification of milk with ascorbic acid and removal of dissolved oxygen protected vitamins. Preservation of milk with LP-system was safe towards vitamins. Vitamin D in comparison to vitamins A and E was heat stable in ghee. The antioxidants (BHA and TBHQ) protected all the three vitamins.

Instant Banana Milk Shake Powder was developed at the NDRI. The product is available in a "convenient to use" form and is being test marketed by MILMA.

An indigenously manufactured plastic film successfully replaced the paraffin wax and gave a superior support towards ripening process of cheddar cheese.

- Pesticide residues in milk inhibit growth of starter culture
- Bacteriocin producing *Lactobacillus* isolate identified
- Ghee prepared by microwave technology conformed to legal and nutritional specifications
- Technique developed for direct-vat-set cultures for preparing dahi and yoghurt
- Indigenous plastic film coating developed for ripening of cheddar cheese
- Technique developed for rapid detection of coliforms
- Dairy byproducts available in dry mixes for quick egg-less cakes
- Method available for simple and rapid detection of adulteration of milk and milk products
- Angora-rabbit hair blended with acrylic staples to obtain higher productivity

At the NDRI, Karnal, a rapid method was developed based on PCR technique. The method is useful in assessing the coliforms, *Escherichia coli* strains in milk and milk products within 21 hr. The method was standardized by designing and constructing primer sets specifically targeted for Lac Z Uid A and L T genes.

Buttermilk powder (BMP), skim milk powder (SMP) and whey protein concentrate (WPC) were successfully used as egg substitutes in cakes. These were comparable with the normal egg cake in terms of porosity, cake volume and texture.

A technology was developed at the NDRI, for manufacture of Gouda cheese from low fat milk at the NDRI, without sacrificing the texture or taste of the product.

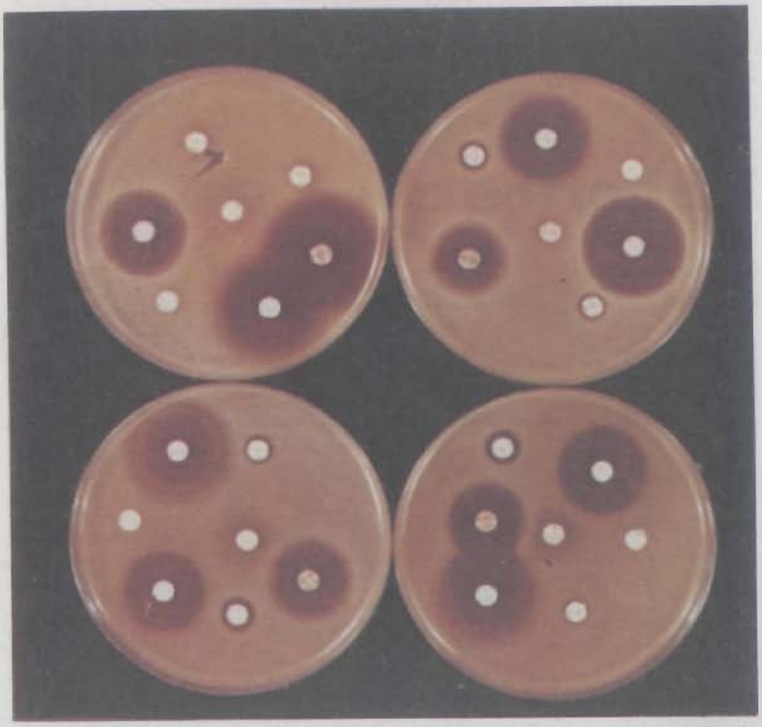
The rotor design of continuous khoa and ghee-making machines was modified and optimized to improve the flow characteristics of the product inside the equipment.

A prototype unit for continuous manufacture of paneer was designed, and is under fabrication.

The temperature distribution curves during manufacture of khoa- and chenna-based products were established. An energy conservation device based on thermo-compression system was designed to improve energy use efficiency of continuous khoa-making machine.

Microwave technology was successfully used for manufacture of ghee from high fat cream/butter. The chemical nature and flavour, colour and textural characteristics of the microwave processed ghee were similar to those of the traditionally prepared ghee. The ghee prepared from accelerated-lipid-oxidation through free radical generation, conformed to the legal specifications with no loss in the nutritional quality.

At the NDRI, simple and rapid methods were standardized for the detection of adulteration of ghee with animal body fats and vegetable oil individually as well as in combination.



Promising strain of *Lactobacillus* sp. which showed maximum production of bacteriocin

**Meat**

Studies carried out at the CARI, Izatnagar, revealed that hot deboned meat could be advantageously utilized in the preparation of comminuted products eliminating chilling and ageing process. Chicken production packaging remains microbiologically safe and organoleptically acceptable up to 3 weeks under refrigeration (-5°C) and up to 3 months under frozen storage (-18°C) condition.

**Wool and Fibre**

At the CSWRI, Avikanagar, to obtain higher productivity the Angora-rabbit hair blends with acrylic staples were processed on Dref-2 friction spinning system @ 100-200 m/min. The yarns were spun with polyester filament core which adds in strength while maintaining the softer and fuller feel. The yarn appearance was quite regular and suitable for the development of shawls and knitwears. The 50:50 and 40:60 Angora rabbit hair: acrylic blended yarns of 10Nm linear densities with filaments core possess about 9.1 and 9.2 g/tex tenacity and 23 and 19.4% elongation, respectively, which are much higher as compared to woollen semi-worsted and other spun yarn.

# Fisheries


QUALITY CARP FEED FROM CIFA

CIFACA

DEVELOPED AFTER
A DECADE OF RESEARCH
IN FISH NUTRITION

TOWARDS BLUE REVOLUTION

- High Fish production
- Efficient feed conversion
- Quality fish flesh
- Good palatability and water stability

# Fisheries

## Capture Fisheries

### Estimation of Marine Fish Landings

The marine fish production in India during 1995 was estimated by the Central Marine Fisheries Research Institute (CMFRI) at 2.26 million tonnes which is 3.9% less than the estimated production of 1994. The north-east region (West Bengal and Orissa) contributed 5.1%, south-east coast (Andhra Pradesh, Tamil Nadu and Pondicherry) 25.8%, south-west coast (Kerala, Karnataka and Goa) 31.4% and north-west region (Maharashtra and Gujarat) 36.2% of the total marine fish landings of India. The contribution of Union Territories of Andamans and Lakshadweep was about 1.5%.

### Remote Sensing and Potential Fishing Zones

Validation of Potential Fishing Zones (PFZ) forecasts received from the National Remote Sensing Agency was carried out from 15 landing centres along the Kerala coast. Comparatively higher catches were obtained from fishing activities carried out within the PFZ by purse seining and gill netting, which suggests that PFZ telecast helps increasing production by these gears. In the case of bottom trawling, however, increased landings were not obtained in the PFZ regions.

### Survey of Resources in Exclusive Economic Zone

During April–October 1996, four cruises of 10–15 days were undertaken onboard FORV Sagar Sampada–three in the south-east Arabian Sea and one in the north-east Arabian Sea–for collection of sea-truth data in relation to

* Pen culture of giant freshwater prawn undertaken successfully in tidal wetland
* Viable hatchery technology of giant freshwater prawn developed and standardized
* Biological treatment complex integrating duckweed and fish culture systems developed
* A balanced feed CIFACA formulated for grow-out carp culture
* A flow-through system specially designed and installed for industrial aquaculture
* Significant progress made in the broodstock development programme of tiger shrimp and finfishes
* Comprehensive survey launched for impact assessment to achieve sustainable shrimp farming
* Awareness programmes launched for prevention of shrimp diseases
* Breakthrough achieved in artificial insemination of female tiger prawn

occurrence/abundance of cephalopod and mesopelagic resources.

**Coldwater Fishery Resources**

To assess the present nutrient status of the Himalayan lake, Bhimtal, detailed investigations on bio-dynamics, food resources, fish and fishery, and production levels were made to exploit the optimum productivity and formulate future management strategies. The lake abounds in golden mahseer as a chief fishery along with other introduced species of exotic carps and Indian major carps. The lake has been stocked with 15,000 seed of golden mahseer produced at Bhimtal centre. A detailed survey of important river systems in Almora district of Kumaon Himalaya was also undertaken to assess their productive potentials for the development of fisheries in this region.

**Pen Culture of Giant Freshwater Prawn in Coastal Areas**

Pen culture of giant freshwater prawn (*Macrobrachium rosenbergii*) was undertaken successfully in tidal wetland (*bheri*). The wetland is connected with the Hooghly estuary through a rainwater discharge channel and receives tidal water during full moon and new moon periods. The 0.3 ha pen, installed in the water body was made of split bamboo screens, supported by an inner lining of nylon cloth. A week after manuring with organic manures @ 500 kg/ha, healthy acclimated prawn juveniles of 5.0 g average weight were stocked in the pen @ 24,000/ha. The prawns were fed twice daily with a commercial feed @ 6–8% of body weight. They attained average weight of 113 g in eight months. Male prawns registered a higher growth (av. 114.5 g) than females (av. 45.0 g). The estimated gross production of prawns was @ 2,720 kg/ha/8 months. This method has become very popular among the local *bheri* owners and has the potential for mass-scale adoption in the coastal West Bengal.

- Method developed for preparing wafers from krill mince
- Partially modified collagen prepared from fish waste for use as artificial skin
- Cryopreservation of male gametes further improved to extend the technology for preservation of early larvae

Pen culture in an estuarine wetland of West Bengal

A rich haul of freshwater prawn from pen culture

# Culture Fisheries

**Freshwater Aquaculture**

***Giant Prawn Complex:*** A viable hatchery technology of the giant freshwater prawn

(*M. rosenbergii*) was developed and standardized. The prawn complex comprising a hatchery, a feed mill and a farm with a number of ponds along with a modern laboratory for monitoring soil and water quality parameters, disease diagnosis etc. has been established. The prawn complex intends to supply quality prawn seed, feed and package of culture practices of this important prawn to the farmers for obtaining sustainable production without degradation of pond ecosystem. A hatchery with a capacity of 10 million post-larvae of giant freshwater prawn per year is established. Trial runs of the hatchery and feed mill have been conducted. The hatchery has been incorporated with latest designs with adequate facilities for production of healthy prawn post-larvae employing semi-closed hatchery system. To develop and produce a quality feed, a feed mill of 250 kg pellets (2–3 mm)/hr capacity has been established. The feed mill follows standard extrusion technology for production of quality pellets. The farm is also useful in conducting training and demonstration of the culture technology of the prawn to the farmers and entrepreneurs.

*Macrobrachium rosenbergii* hatchery at CIFA

***Aquaculture: A Tool for Treatment and Utilization of Domestic Sewage:*** A biological treatment complex comprising duckweed and fish culture system was established. The complex consists of 18 duckweed ponds (25 m × 8 m × 1.5 m), two fish ponds (50 m × 20 m × 2 m) and two depuration ponds-cum-marketing reservoirs (40 m × 20 m × 2 m). The treatment design includes retention of sewage in duckweed ponds for 48 hr, followed by retention of sewage in fish ponds for 72 hr. Duckweeds like *Lemna* spp., *Wolffia* spp., *Spirodela* spp. and *Azolla* spp. were employed for removing nutrients from the sewage water, followed by carps catla, rohu, mrigal, silver carp and grass carp stocked at a density of 10,000/ha/year in ponds. Achieving the desired reduction in the levels of biochemical oxygen demand and other microbiological parameters set for releasing wastewaters into the natural waters, the system is capable of treating 1 million litres of sewage per day. It was evaluated over different seasons. With a fish produc-

Feed mill at CIFA

tion of 4 tonnes/ha/year, the system provided for the recurring costs of management. The technology of the biological wastewater treatment system requiring only 0.56 ha resource recovery is being transferred to the Public Health Engineering Department of different state governments.

***Flow-through System for Industrial Aquaculture:*** A flow-through system consisting of 27 cement tanks each of 10 $m^2$ area with 1 m average depth was specially designed and installed. All these tanks were provided with adequate controllable individual inlet and outlet arrangements for a flow rate up to 20 litres/sec. In a recent fish production experiment, catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) were stocked in ratio of 1:8:1 at a very high stocking density of 500,000/ha, having three different flow rates of 3, 6 and 9 litres/sec in each tank of 10 $m^3$ capacity. After three months of culture, net average productions achieved were 90.0, 94.7 and 100.9 tonnes/ha/year at the flow rates of 3,6 and 9 litres/sec, respectively. The survivability was above 95% in all the cases. The system is highly suitable and economical for places where flow-through arrangement can be achieved by gravity, particularly below the dams and other river valley projects where part of water can be diverted through this system for obtaining high production of Indian major carps.

***Multiple Breeding of Carps:*** Carps like catla, rohu, mrigal, silver carp and grass carp could be bred in advance during pre-monsoon period. Multiple breeding continued during monsoon and post-monsoon months. A total of 17.34 million spawn was produced during the last one year.

**Brackishwater Aquaculture**

***Broodstock Management:*** Significant progress has been made in the broodstock development programme of tiger shrimp (*Penaeus monodon*), finfishes, seabass (*Lates calcarifer*) and grey mullet (*Mugil cephalus*). A technology package has been evolved for the development of

**CIFACA: A Balanced Feed for Indian Major Carps**

A formulated feed comprising groundnut-cake, roasted soybean-meal, rice bran, fish-meal, vitamin-mineral premix and an attractant was formulated for grow-out carp culture. The feed was prepared in pelleted form and contained about 30% crude protein, 9% lipid, 10% crude fibre, 8% ash and 43% nitrogen-free extracts with an energy value of 380 kcal/100 g. The feed was evaluated in terms of fish growth and nutrient digestibility over a period of three years through repeated pilot-scale trials in the laboratory. A gross production of about 17 tonnes in a year could be achieved. This feed was recently released under the brand name CIFACA.

Flow-through system at CIFA

broodstock and maturation of *P. monodon* in captivity. The broodstock of *L. calcarifer* and *M. cephalus* attained maturity up to third stage in captivity.

***Shrimp Feed Formulation:*** Feeds were developed using indigenously available raw materials and field testing experiments conducted in farmers' ponds giving feed conversion ratio of 1.76:1 which was comparable to imported brands of shrimp feed (1.64 : 1). Further improvement of feeds was taken up by incorporating plant protein sources such as soyflour and *Spirulina* as substitute for fish- meal which is scarce animal protein. The small-scale feed processing and production technology developed is being favourably considered for adoption by the industry.

***Environment Impact Assessment Programme:*** A comprehensive survey of Environment Impact Assessment (EIA) due to shrimp farming has been launched. The first phase of the study was carried out on sea-water-based farms in Nellore District in Andhra Pradesh. In the study area the major negative impact noticed were higher levels of chloride values of drinking water from borewells in the adjoining villages, salt intrusion into lands adjoining the farms up to 50 m distance with EC values of 2:1–4.8 mmhos/cm, which gets progressively reduced to less than 1 mmho/cm at 500 m away from the farm. The entrepreneurs are aware of these problems and are taking remedial measures. Several positive socio-economic impacts due to aquaculture were noticed—providing higher levels of employment to the village people (2–15% increase), 6–22% increase in income and 3–20% increase in consumption pattern index. Infrastructure facilities in these distant villages have been vastly improved.

***Shrimp Disease:*** The white spot viral disease was reported from the traditional shrimp farms in West Bengal and Kerala. However, no large-scale mortality was reported as in the case of semi-intensive farms during 1995. Advisory services were rendered to farmers on the use of scientific management practices including low-density stocking of healthy seed and mainte-

*Penaeus monodon* affected with white spot disease virus covering almost entire cuticular surface

nance of good water quality to avoid the occurrence of the disease. General guidelines for prevention of shrimp diseases have been issued to the farmers. A recent survey of some sea-based shrimp farms indicated that the incidence of white spot disease and the virulence of the virus have declined following adoption of proper management measures and only 20–30% of the farms were affected. White spot disease has been experimentally induced under laboratory conditions to study the epidemiology of the virus and develop control measures.

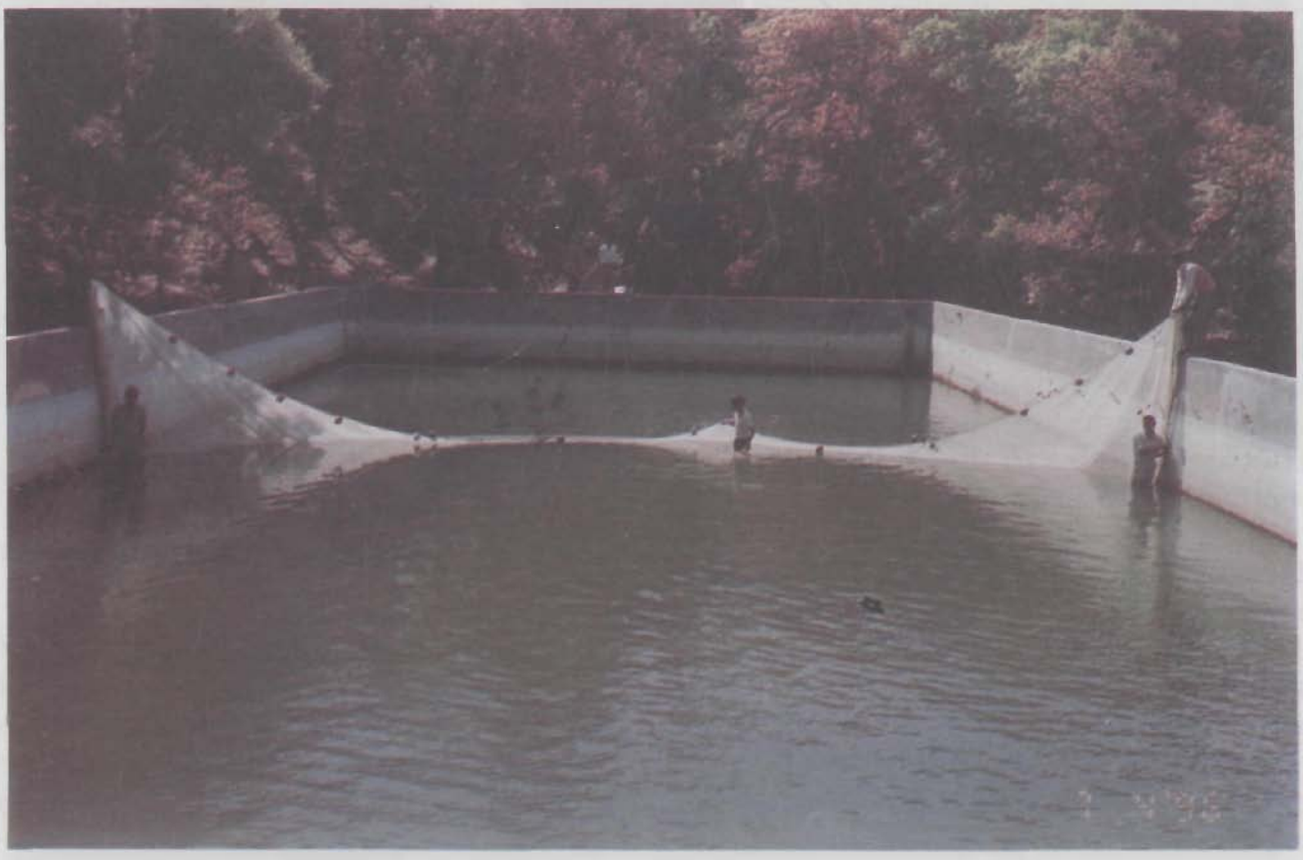
**Coldwater Aquaculture**

***Breeding and Culture of Coldwater Fishes:*** Technologies for intensive production of advance fry of Himalayan mahseer (*Tor putitora*) in flow-through hatchery at Bhimtal have been standardized. About 0.06 million advance fry of mahseer has been produced through artificial fecundation of wild spawners in hatchery. The spawn and advance fry of this species were fed on laboratory-prepared artificial feeds. To augment this depleted fishery, the fish seed was stocked in various lacustrine and riverine waterbodies including farms. Rearing of advance fry to fingerling has also been done on pond environment at the Chirapani Fish Farm.

The rearing of fry and fingerlings of snowtrout (*Schizothorax richardsonii*) on artificial feed is being done under cemented pond environment to build up the broodstock of this species at the Chirapani Fish Farm.

**Mariculture**

***Artificial Insemination of Tiger Prawn:*** Many hatcheries experience the problem of spawning unfertilized eggs due to non-mating and non-deposition of spermatophores. A breakthrough was achieved in transferring artificially the spermatophores from an adult male tiger prawn (*P. monodon*) to a female of the same species which subsequently spawned one million viable eggs; 78% of them hatched into nauplii. The present results go a long way in overcoming the above problem and in producing more seed from less number of spawners.



Culture of exotic carps in cemented ponds with flowing water at Chirapani

***Induced Maturation of Penaeid Prawns:*** Induced maturation of *Penaeus semisulcatus* and *P. indicus* without eyestalk ablation by manipulating the environmental parameters, maintaining the pH of the seawater in the maturation pools, provided with biological filter and recirculation facilities and the intensity of light at 5% lower than the ambient light regime and feeding the spawners with clam meat, squid and polychaetes has been achieved. *P. semisulcatus* spawned 8–11 times within 90 days. The number of eggs per spawning varied from 0.05 to 0.14 million and the percentage of hatching was 90.

***Breeding and Hatchery Production of Marine Crabs:*** Berried specimens of the portunid crab (*Portunus pelagicus*) caught from the wild and maintained in controlled conditions spawned within three to four days, each releasing an average of two million zoeae. These larvae were stocked in different concentrations (10–40 zoeae/litre) in 1 ton FRP tanks. They were provided with *Chlorella* and rotifers as live feed. Advanced zoeae were fed with prawn meat-egg custard. Within 20–21 days, the zoeae metamorphosed into first instar crabs. Some of these crabs were maintained in the same tanks, and clam and fish meat were given as food. In four months, these crabs matured and released eggs, thus completing the life-cycle in captivity. Survival of 8–10% was obtained.

# Fish Processing Technology

### Harvest Technology

A design package of 9.14 m OAL wooden pole and line-fishing vessel was handed over to the Union Territory of Lakshadweep for developing the pole and line fishing in the island. 'V' form steel otter boards were successfully popularized in commercial fishing operations for the first time in Gujarat. Resource-specific gear for squid, quality fishes and prawns were identified for inshore and inner offshore waters.

### Post-harvest Technology

The krill samples brought back from the Antarctic Krill Expedition were tested for the quantitative and qualitative nature of the total microbial population, presence of pathogenic and indicator organisms, spoilage microflora and spoilage pattern. Method was developed for preparation of wafers from krill mince. The product had good swelling property. Chitin and protein extract were also prepared from krill.

A collagen-chitin membrane prepared was found to perform satisfactorily as 'artificial skin' for covering burns and wounds. Method was worked out for preparing partially modified collagen from fish waste.

High-quality battered and breaded fillets were prepared from Kalawa (*Epinephelus* spp.). A recipe was standardized for preparation of soup incorporating protein extracted from crab shell waste.

Laminated and multi-layer films were found better suited for packing IQF samples of head-on and headless shrimp stored at –23°C than single layer films.

### Instrumentation in Fisheries

Design was developed of an improved fuel efficient nozzle-propeller system for vessels of 15–18 m. A hydrometeorological data acquisition system with 16 channels were developed for monitoring measurements associated with agriculture and water management.

# Fish Genetic Resources

### Databank on Fish Germplasm

To strengthen the databank on fish germplasm resources of India, a compendium entitled 'Fish Biodiversity of India' containing information about systematics, habitat and distribution of 2,200 finfishes, has been finalized to serve as a reference inventory for the fishes inhabiting different ecosystems of the Indian subcontinent.

Cryopreservation of male gametes has been further improved and now it is possible to preserve the milt in bulk, i.e. in visitubes (5 ml capacity). Processed milt (3 ml) which is able to fertilize 0.15–0.2 million eggs can be preserved in one such tube. The above success can be exploited to produce carp seed on a mass scale

to get genetically improved stock. Recent progress in cryopreservation of early larval stages of shrimp has opened new avenues.

**Genetic Improvement of Carps through Genome Manipulation**

Fresh production of mitotic gynogens of rohu has been done to study the homozygous level for top-crossing (intra-specific hybridization) to test the heterosis effect. Experiments have also been conducted to induce tetraploidy in common carp for the commercial production of triploids and to test their growth performance. The tetraploid-treated spawn/fry are being reared in the wet lab/field to raise fingerlings for evaluation of their ploidy status.

## Fisheries Education

The Central Institute of Fisheries Education (CIFE) continued to offer doctoral, masters and post-graduate diploma and certificate courses in fisheries through its headquarters at Mumbai and research/education/training centres at Calcutta, Kakinada and Chinhat. A total of 89 students passed out during the year under report—one student obtained Ph.D., 46 candidates passed out in M.Sc. and D.F.Sc. programmes, and 42 candidates completed their one-year PG certificate course. A total of 92 candidates were admitted during the reported year under fresh admissions to these courses.

Under post-graduate programme in Mariculture five students were registered for Ph. D. programmes and five others admitted in the M.Sc. programme. At present 24 students in different courses and batches are continuing their studies under this programme.

## Fisheries Extension

The CMFRI under its technology transfer programme, launched a series of monthly meetings with fishermen, farmers and industries on various subjects related to marine fisheries and mariculture, and assisted the concerned with suitable advice, through its headquarters at Cochin and regional/research centres all along the coast line.

The Trainers' Training Centre (TTC) of the CMFRI conducted five training courses, one each in edible oyster farming, computer-based application of statistics in aquaculture, pearl culture, fish and shellfish disease investigations and live feed culture. A total of 44 participants attended the training programme. Krishi Vigyan Kendra conducted 17 training courses and 367 persons were trained in prawn farming, coconut cultivation, edible oyster culture, poultry production, vegetable cultivation, livestock production, goat farming, and food processing.

**Training Programmes/Seminars/Summer Institutes/Workshops**

Training on coldwater fish culture was imparted to the fisheries agencies concerned in the Himalayan belt. A special short-term training programme was organized for the fisheries personnel of Jammu and Kashmir State Fisheries Department for 15 days on the breeding and culture of Himalayan mahseer.

Ten short-term training programmes were organized on management aspects of aquarium, giant freshwater prawn hatchery, freshwater fish seed farm, brackishwater fish farm, etc. which benefited 208 participants.

The UGC-sponsored 3-day seminar on 'Recent Advances in Industrial Fisheries Research and Development' was organized at Cochin. A total of 22 participants from 14 colleges and 2 universities from different parts of the country attended. One-month training programme for college teachers as vocational course on 'Industrial Fish and Fisheries' was sponsored by the UGC. Ten participants from nine colleges and one university attended the training course.

A six-day Workshop on 'Artificial Reefs and Seafarming Technologies' was conducted in collaboration with the Ministry of Agriculture, Government of India.

A summer Institute on 'Recent Advances in Mariculture of Molluscs' was organized at Tuticorin Research Centre. Participants from Maharashtra, Kerala, Minicoy, Tamil Nadu and Andhra Pradesh attended the course.

Pearl *in-situ*

The prawn feed production units registered as 'All Women Small-Scale Industry' produced and marketed the MAHIMA feed using the low-cost technology. So far six such prawn feed production units came into operation.

## Consultancies

Consultancy assignments of the CIFE during the year included (*i*) project on Environmental Impact Assessment in the oil and gas fields of ONGC in the Bombay high area, (*ii*) verification of data on aquatic biota in general catch, and (*iii*) information on spawning grounds of important finfishes and shellfishes for preparation of Environment Impact Statement (EIS). These specific consultancies were for Institute of Petroleum Safety and Environment Management (IPSEM) of ONGC, Goa and M/s Enron Oil and Gas India Ltd (EOGIL). The CMFRI provided consultancy services and R&D support in various aspects of marine capture and culture fisheries. The Institute also provided consultancy service for the land-based pearl culture to five private entrepreneurs in Tamil Nadu and Andhra Pradesh.

# Agricultural Economics, Statistics and Marketing

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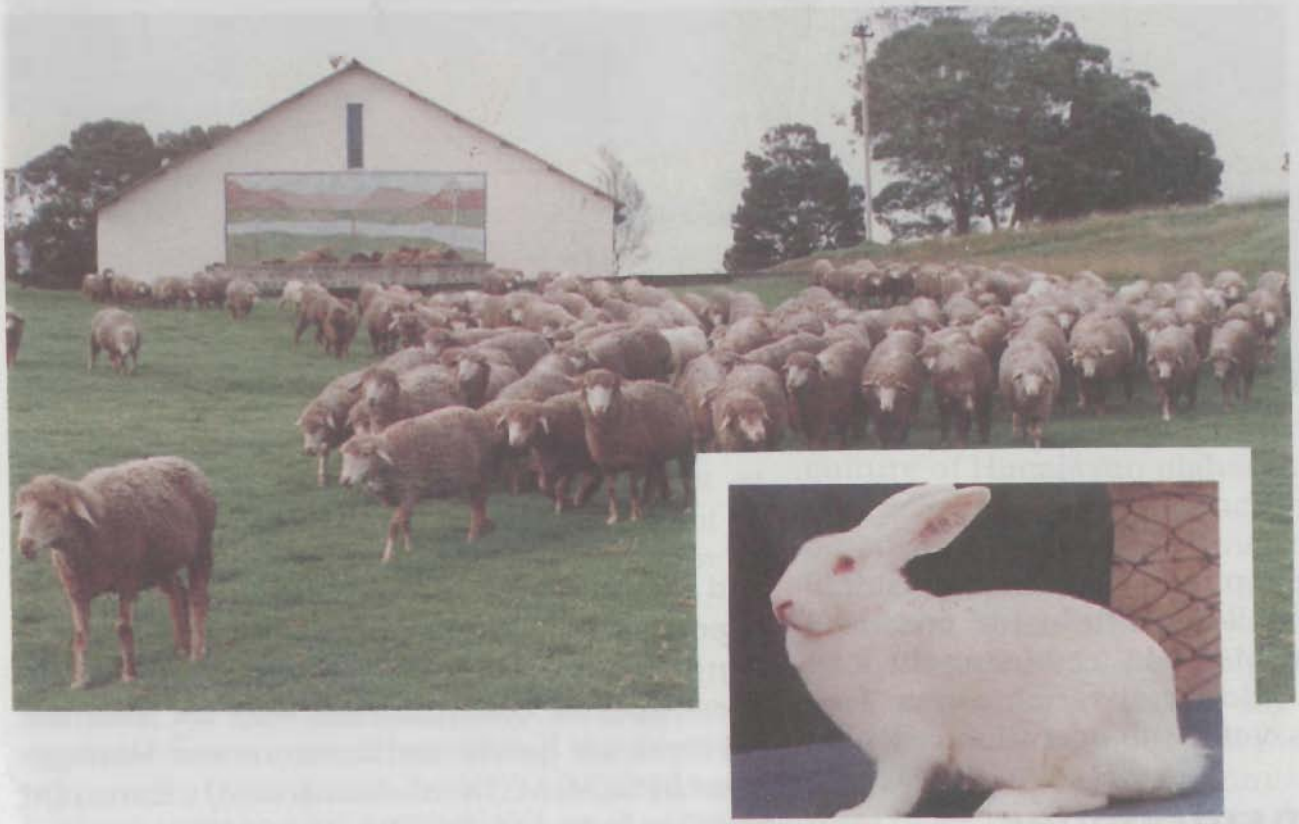


# Agricultural Economics, Statistics and Marketing

## Agricultural Statistics and Computing Science

Constraints to adoption of new crops technology under field conditions were studied in 16 districts covering nine states of the country. The main constraints were, inadequate water, lack of funds to purchase inputs, pest and disease problems and ignorance regarding suitable type dose and method of application of plant protection chemicals.

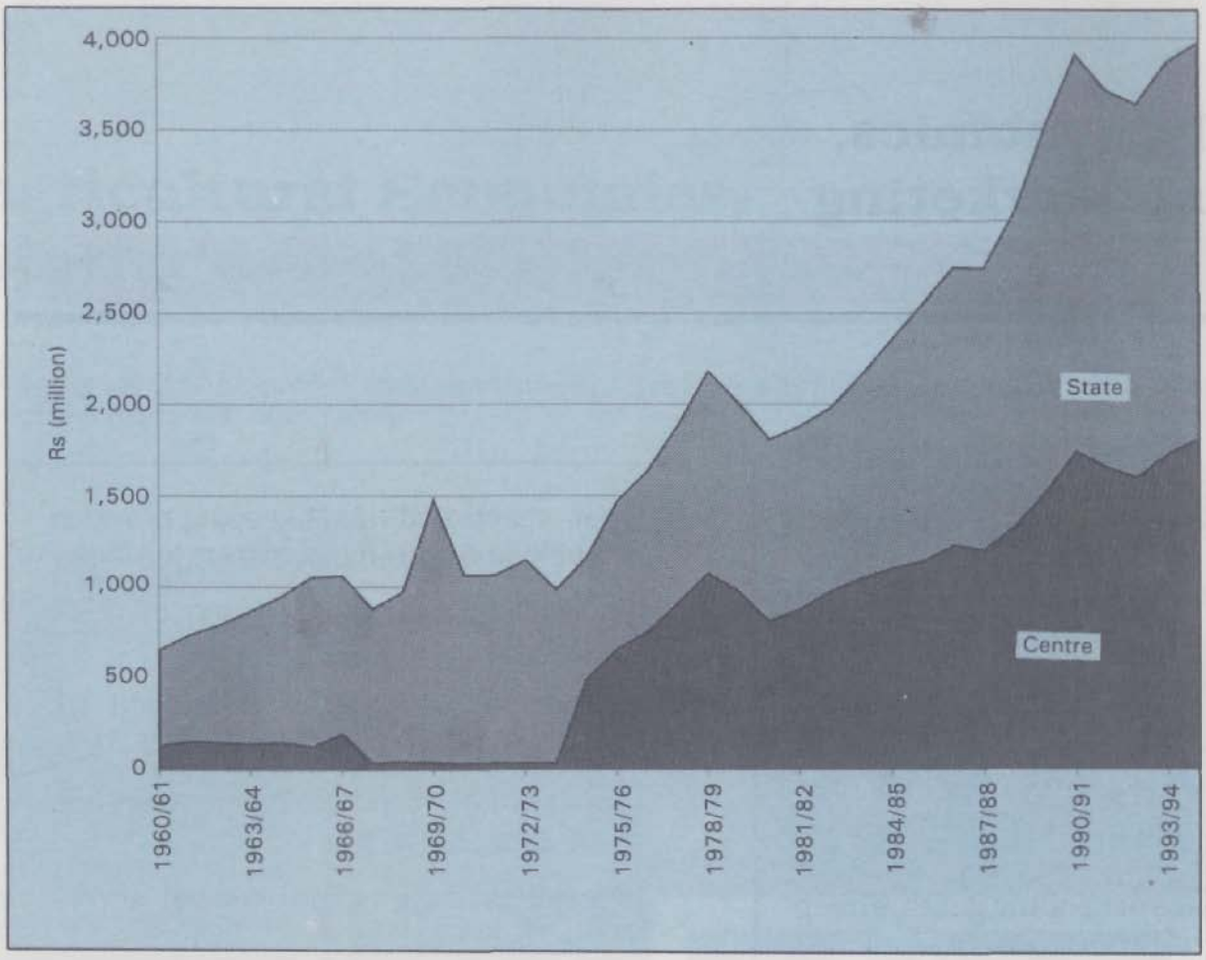
Studies on economics of keeping goats, sheep and rabbits and cost of production of wool and meat were carried out in Mathura (Uttar Pradesh), Tonk (Rajasthan) and Kullu (Himachal Pradesh) respectively. These occupations provide additional source of income to the farmers as well as employment to the family. The study revealed that family labour accounted for highest percentage of cost in almost all these species.

The study undertaken to evaluate the effect of complex survey designs on ordinary Chi-square test has revealed that 40-80% inferences drawn through application of usual Chi-square test in survey data are misleading. The modified Chi-square test will provide direction to the agricultural research workers for application of this test whenever data are collected with the help of complex survey design.

Catalogues of A-optimal and A-efficient block designs with equal and unequal sizes for comparing a set of test treatments to control treatment(s) have been prepared. These catalogues will be of great use to practising statisticians for suggesting suitable designs and even experimenter himself can select a design appropriate for his experimental situation.

- Goat, sheep and rabbit keeping provided more income and employment to the family
- Modified chi-square test using complex survey design developed
- Catalogues of designs developed for statisticians and scientists
- Credit demand found to be interest inelastic on all size farms
- Rice-wheat crop system caused severe strain on groundwater
- Diversification of Punjab agriculture would not jeopardise country's food security

A study to examine the demand for agricultural credit on different sizes of farms and to evaluate the effects of credit on farm income revealed that the long-term co-operative credit




Trends in real expenditure on agricultural research and education in India (at 1981/82 prices)

was distributed more liberally as compared to short and medium-term co-operative credit. The benefits of co-operative agricultural credit could not reach the small and marginal farmers. Commercial banks put more emphasis on infrastructural development of agricultural sector as more credit was disbursed in the form of indirect advances, which are essentially meant for infrastructural development. The demand for credit was found to be interest inelastic on all sizes of farms.

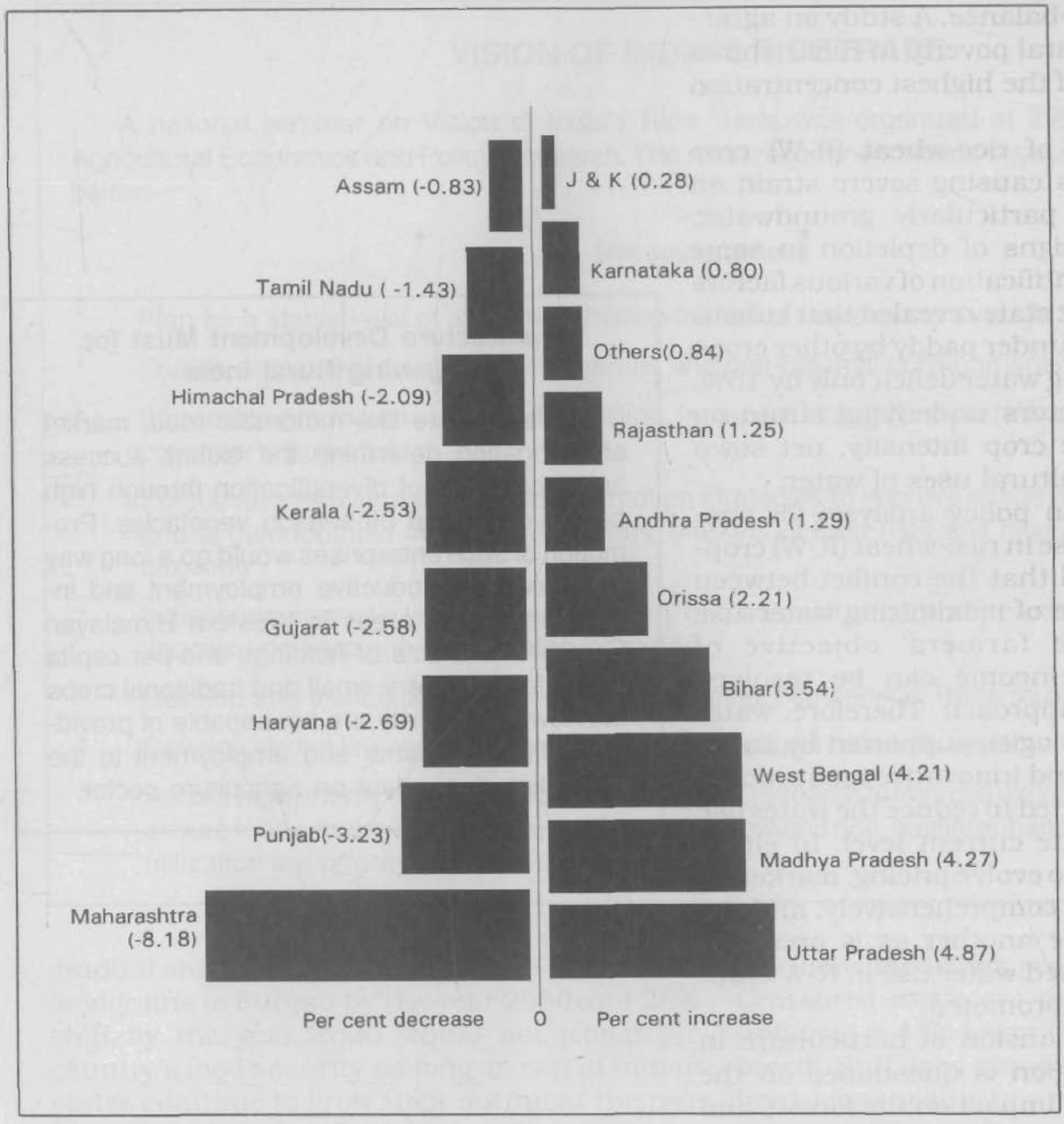
The heritability estimates obtained by parent offspring model, halfsib model and fullsib model revealed that in all the three procedures the distribution of $h_2$ was non-normal and skewed in about 50-90% of cases.

A growth performance index based on multiple traits was developed by maximising the variation 'between genetic groups' relative to 'within genetic groups' for the index based on body weight, pin shoulder length, growth velocity, and growth rate up to one month of age of the animals.

Studies on combining ability indicates that the effects such as purebred, general combining ability and maternal effect are significant for component traits as well as for the composite character. These findings are very useful for deciding the breeding policies of animals and or plants by animal breeders and or plant breeders.

A study was undertaken to develop methodology for pre-harvest forecasting of inland fish production from ponds. Analysis revealed that forecast of fish weight at harvest which is generally 12 months after stocking can be made three months before the harvest.

The IASRI, New Delhi, organized one training course on 'Computer Net-working and Information Processing' and seven short-term courses on 'Use of Computers in Agricultural Research' for research workers of various ICAR Institutes and Agricultural Universities. In all 141 participants attended these courses. Six students were admitted in regular degree courses, viz. two in Ph.D (Ag. Stat.); three in M.Sc. (Ag. Stat.) and one in M.Sc. (CA).




Shifts in regional research allocation

Bio-informatic Centre at this Institute rendered Selective Dissemination Information (SDI) Services to various ICAR Institutes.

## Agricultural Economics and Marketing

Studies made on public expenditure on research and education by centre as well as states suggested that more than 5% per annum growth in real expenditures, driven mainly by about 12% growth in central government expenditures over this period. The pattern of growth has varied over states, ranging from 2.3% per annum in West Bengal to over 13% in Madhya Pradesh during the last 15 years. Further analysis revealed that availability of resources, both within the state and from the centre stimulates state investment in research. ICAR's fund allocation decisions therefore must focus on agriculturally poor states. These data enable an assessment of needed adjustments in regional agricultural research resource allocation. Bihar, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal need a larger share of national research resources. This implies that incremental research resources in the Ninth Plan should be

used to achieve this balance. A study on agrarian structure and rural poverty in Bihar shows that state has one of the highest concentration of poor people.

The dominance of rice-wheat (R-W) crop system in Punjab is causing severe strain on natural resources, particularly groundwater, which is showing signs of depletion in some parts. However, quantification of various factors in water deficit in the state revealed that substitution of entire area under paddy by other crops would reduce existing water deficit only by 15%. The other major factors underlying strain on water resources are crop intensity, net sown area and non-agricultural uses of water.

Another study on policy analysis for sustainable resources use in rice-wheat (R-W) cropping system showed that the conflict between the societal objective of maximizing water-use efficiency and the farmers' objective of maximising stable income can be resolved through a systems approach. Therefore, water management technologies supported by rational pricing policies and innovative institutional mechanisms are needed to reduce the water use beyond 25% from the current level. In either case, it is important to evolve pricing, marketing and subsidy policies comprehensively, and not in isolation from one another as is presently done if efficiency-based water use in R-W cropping system is to be promoted.

The policy of expansion of horticulture in West Himalayan Region is questioned on the ground of its adverse impact on the forests and ecology. The study in Himachal Pradesh demonstrated that diversification through cash crops like fruits and off-season vegetables results in (i) reduction in soil erosion due to reduction in crop intensity, (ii) reduced livestock pressure, (iii) promoting stall feeding practices and reducing grazing incidence and number of grazing animals, and (iv) increase in income, which checks poverty-induced natural resources degradation. The study also brought out that there is complementarity between agroforestry development in adjoining plains and horticultural development in hills.

Another analysis of diversification of Punjab Agriculture and food security suggested that

**Infrastructure Development Must for Improving Rural India**

Infrastructure like motorable road, market and irrigation determine the extent, success and profitability of diversification through high paying crops like off-season vegetables. Promotion of such enterprises would go a long way in generating productive employment and income in the hill areas in Western Himalayan Region where size of holdings and per capita arable land are very small and traditional crops with low productivity are not capable of providing sufficient income and employment to the population dependent on agriculture sector.

## VISION OF INDIA'S RICE TRADE

A national seminar on Vision of India's Rice Trade was organized at the National Centre for Agricultural Economics and Policy Research. The main recommendations of the seminar are indicated below:

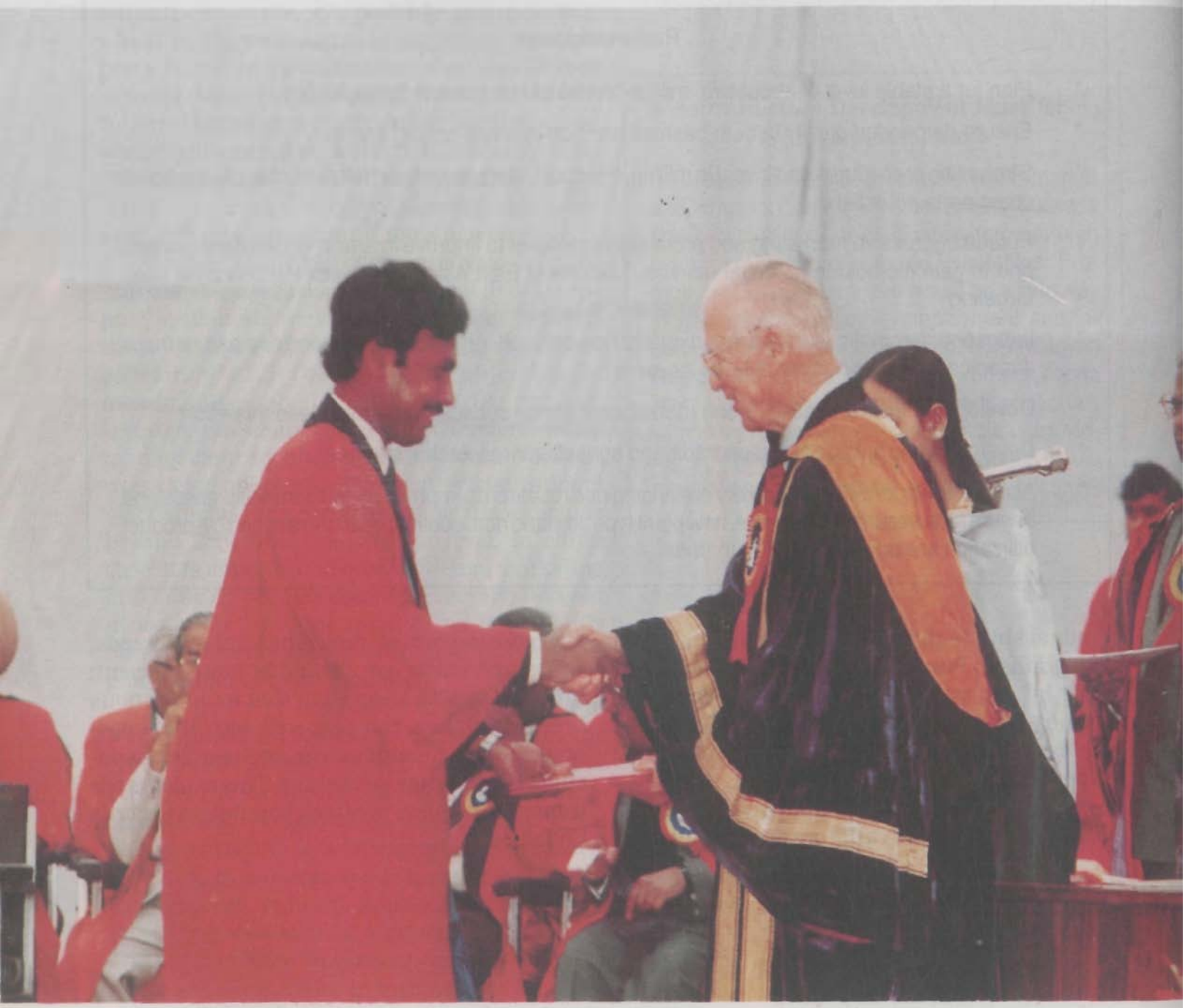
### RECOMMENDATIONS

* Plan for a stable level of about two million tonnes of rice exports through 2001
* Ensure demanded quality in both basmati and non-basmati consignments
* Streamline procedures and invest in milling, transport, storage and port infrastructure. Assess east coast ports potential
* Pursue aggressive marketing and promotion strategies to improve image in established markets and to gain foothold in potential markets. Markets of East Asia and developing countries need targeting
* Indigenous aromatic varieties, good quality non-basmati, organically produced rice and perhaps Japonica rice are good candidates for export
* Develop and institutionalise strong market intelligence service. Trade must lead this effort
* Develop strong linkage between trade and agricultural research system
* Accord high priority to productivity enhancing rice research to improve export competitiveness and ensure food security. Hybrid rice, new plant type, lowland rice, quality enhancement and by-product utilization are priority research themes

gradual shift to the extent of 15% of area under foodgrains in Punjab by the year 2000 and 28% shift by the year 2020 would not jeopardise country's food security as long as rest of Indian states continue to grow their output at the rate experienced during the last decade.

Technical change in milk production was examined. Crossbred cattle are becoming gradually more important, replacing local cow breeds. Crossbred cattle are distinctly more efficient; unit cost is 43% lower than that for indigenous breed. Buffaloes compete well with the crossbred, lower acquisition costs and sturdier disposition confer some advantage. This explains the transition of milch livestock population towards buffaloes.

# Agricultural Education



Dr Norman E. Borlaug as the Chief Guest at the 34th Convocation of the Indian Agricultural Research Institute. The institute is playing an important role in providing trained manpower for agricultural research and teaching

# Agricultural Education

The Education Division has taken up a number of new initiatives during the year, which have a long-term bearing for improving Agricultural Education. The Accreditation Board has been constituted for setting norms and standards of agricultural education.

**DEVELOPMENT AND STRENGTHENING OF AGRICULTURAL EDUCATION**

An All-India Competitive Examination for admission to Undergraduate and Postgraduate level was conducted to reduce inbreeding and promote national integration. Under the developmental grants, support has been provided for improvement of faculty competence, this includes - organizing training programmes for updating skills and knowledge of university teachers, support for strengthening library in respect of textbooks, support for preparation of manuals and other instructional materials and participation of faculty members in national and international symposia and seminars. It was made mandatory for the universities to develop manuals for under-graduate and post-graduate courses. A number of excellent manuals have been prepared.

Computerization and networking is essential for updating knowledge and information retrieval. In all SAUs and ICAR Institutes equipments for networking have been provided. Within a short time all libraries will be networked with the National Agricultural Library at the IARI. By this, students and the scientists would be able to have an access to the latest information from their respective colleges. In addition, support has been provided for strengthening textbook section in library and making latest books available to the faculty for teaching. The West Bengal University of Animal and Fishery Sciences has been accorded recognition. The Accreditation

* Equipment for networking have been provided in all SAUs and ICAR Institutes
* The ICAR is playig a pivotal role in equipping the laboratories and providing audio-visual facilities in the agricultural universities
* Food and nutrition security issues have been taken up under the Centres of Advaced Studies for identifying the regions to meet the domestic and export needs
* Data base on rural women, considering their role in decision-making and time-use pattern in agriculture, animal husbandry and household chores, is being prepared by the Home Science Extension component
* Need-based technologies for each zone have been generated and status report on major farming situations including the farmers' problems prepared under the National Agricultural Research Project
* Taking into account the World Bank and ICAR's official recommendations, guidelines for appointing new consultants and plan of action for the various activities under the AHRD Project have been put forth
* The objective of decentralization of research through zonal stations achieved in all the SAUs through the National Agricultural Resarch Project (NARP), to meet the location-specific research needs of the farmers.

A 100-seat ladies hostel at the College of Fisheries, Kerala Agricultural University, Cochin has been established with 75% assistance from the ICAR. Under the womens' education programme, 14 girls' hostels have been established in different agricultural universities during the Eighth Plan

Team has submitted its report after visiting five colleges. In addition, provision has also been given for the establishment of an Agricultural College at Hassan in Karnataka and a Veterinary College in Andhra Pradesh. The emphasis during the year has been to strengthen the laboratory facilities and provide adequate support for conducting practicals. Support has also been provided for development of audio-visual facilities in various SAUs.

**State Agricultural Universities**

The basic objective of the development was to improve the agricultural education and research standards within each agro-ecological region as three-fourths of India's population has been living in the rural sector, and in their economic development lies the development of the country.

For the strengthening of these universities, the Indian Council of Agricultural Research (ICAR) has been playing a major role in developing infrastructural facilities and providing modern equipment, establishing computer centres, veterinary hospitals, girls' hostels, farmers' hostels and learning through interactions by organizing seminars and symposia. For strenghtening of these areas, the ICAR has provided financial support to the tune of about Rs 23 crores during the year to all the SAUs and other related universities.

**RESIDENTIAL FACILITIES**

Under the womens' education programme, 14 girls' hostels were completed during the year. Earlier, girl students of Assam, Orissa, Kerala, Himachal Pradesh, Faizabad and many backward areas used to either leave the education or stay in rented accommodation. Many a times, these accommodations were also not available. Fourteen states were benefited by this programme. In view of SAUs difficulty in getting support from the States, the Council provided 100% grant as per the recommendations of the Chopra Committee for construction of girls' hostels.

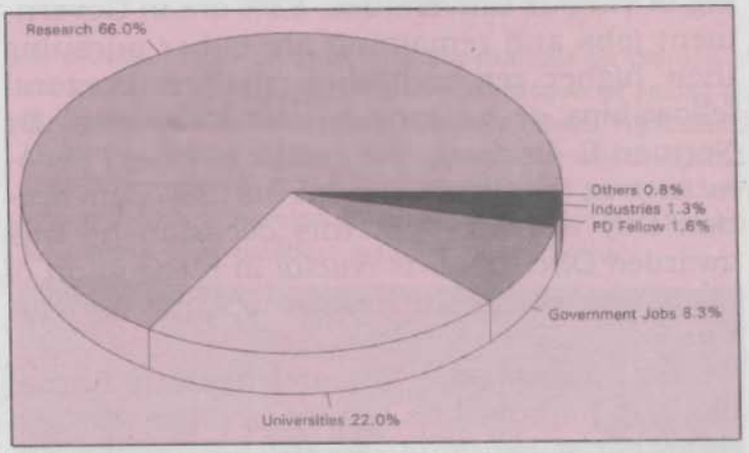
**Deemed Universities of ICAR**

Four of the ICAR Institutes namely IARI, IVRI, NDRI and CIFE are deemed universities offering postgraduate courses. During the year postgraduate education has been strengthened substantially by providing support for modernization and computerization of Post-graduate School Library and renovation of hostels and

library. At IARI, the National Agricultural Library which serves as a resource library for SAUs and ICAR Institutes, networking in the Institute has been established, CD-Rom stations provided and scientists and students are able to retrieve and search information from the division itself. This facility has become a boon to all researchers. It is planned to link all SAUs and ICAR research institutes to the National Agricultural Library. There is upgradation of the library which has a new and modern look with proper designing and lighting.

The major initiative for improving education include, providing grants for conduct of practicals, preparation of laboratory manuals, giving best faculty award in recognition of excellence in teaching, VSAT connectivity for quick retrieval and documentation of information, improvement in lecture halls and teaching aids, hand-outs on training for teachers of SAUs and research institutions, encouragement to faculty members to update their capabilities through long and short term trainings under different programmes.

The Post-graduate School of Indian Agricultural Research Institute is playing an important role in providing trained manpower for agricul-




Placement trend of PhD students from IARI

The KAU Central Library at Thrissur established with the VIII Plan Development assistance of Rs 80 lakhs and balance funding done by Government of Kerala. It is one of the largest multimedia library and information system in India

tural research and teaching in the country. So far the institute has produced nearly 3,000 PhDs and 2,000 MSc students. Out of the students who received PhD degree, 66% are engaged in agricultural research, 22% in teaching in various universities, 83% are in Government jobs and remaining are either pursuing their higher research through Post Doctoral fellowships or working in the industries. Dr Norman E. Borlaug, the Father of Green Revolution was the Chief Guest at the 1996 Convocation Day of IARI. On this occasion he was awarded DSc (*Honoris causa*) in recognition of his outstanding contribution to World Agriculture.

The National Dairy Research Institute, Karnal has also improved its library facilities through computer networking. Evaluation for the entrance examinations conducted by NDRI is by optical mark readers.

**Central Agricultural University**

The Central Agricultural University established at Imphal is playing an important role in generating human resource in agriculture. In the current year, the first batch of 16 successful candidates completed their BSc (Ag) Programme. Ten students have completed PG Programmes in four disciplines.

The CAU issued statutory notification for the establishment of a College of Fisheries at Lembuchera in May 1996. Master Plan of the Fifth College of Veterinary Sciences at Selesih, Mizoram, has been finalized. Selection of site for College of Home Science at Tura(Meghalaya) has been done. The Government of Sikkim has agreed to transfer the land near Majithar and Rangpoh for the College of Engineering and Post-Harvest Technology. During 1997-98, classes will be started in the discipline of Fisheries and Veterinary Sciences.

## MANPOWER DEVELOPMENT

The greatest need for agricultural education is to bring major qualitative improvement through advance training to new generation of scientists, improvement of laboratory facilities, modernization of equipment, teaching aids etc. The scheme for development and strengthening of agricultural universities has items, like participation of teachers in national and international seminars and symposia, starting of new PG programmes in new disciplines, establishment of regional and educational technologies and biotechnology cells, manpower planning cells, students counselling and monitoring cell, and assistance towards conducting practical classes at Undergraduate and Postgraduate level.

Under this programme, 14 SAUs have established computer centres for use by students and faculty. In veterinary sciences, for imparting practical training, veterinary hospitals, ambulatory clinics and eye centres at teaching campuses were strengthened in eight SAUs. Assistance for preparation of teaching manuals and aids like pre-recorded audio-video casettes on educational technology charts, slides and manuals were provided to all SAUs, and more than 100 manuals have been prepared. Under the scheme of 50% travel grant for attending seminar and symposia abroad, 42 teachers were sponsored from 19 SAUs.

During this year, substantial grant from the ICAR has been received for the completion of the following programmes:

**Narendra Deva University of Agriculture and Technology, Faizabad**

- A new college building was constructed with Council's support, for graduate and Masters' programmes.
- Many sophisticated equipment have been funded by the ICAR to cater to the needs of teaching and research in various disciplines, so as to facilitate better academic standard and research quality. The instructional farm developed from ICAR grant offers an effective link between the course work and practicals.
- A prestigious building called Nehru Library has come up with the Council's support to provide library support to the students and research workers. The library has a large number of journals, text books, on different subjects.
- To keep pace with the latest research in the world through networking, and to provide hand-on training to the student community and faculty on the use of computer, a Computer Centre

has been established with financial assistance of the ICAR.

**Rajasthan Agricultural University,Bikaner**

The financial assistance from the ICAR has been instrumental in initiating new programmes in education at the RAU Bikaner. These programmes include:

- Postgraduate teaching in home science at Bikaner and College of Dairy Sciences, Udaipur,
- PhD programme and degree programmes in mechanical, mining and electrical engineering CTAE, Udaipur.
- The computer courses to students and staff at the Computer Centre of CTAE, Students Counselling Centre at all colleges and Academic Staff College-cum-Distance Education Centre at University Headquarters.
- The ICAR provided needed support for the construction of the buildings such as College of Agriculture and Home Sciences at Bikaner, and hostels for the College of Home Science.

**DrY S Parmar University of Horticulture and Forestry, Solan**

- The university library was supported for construction and for equipping it with new and old volume of journals, books for the consultation of students and faculty members.
- The equipment worth several lakhs have been purchased for providing to the Departments of Fruit Breeding, Biotechnology, Floriculture etc. Veterinary Clinical Services have been offered for the welfare of livestock in the area. A Computer Laboratory for effective teaching of computer application and for providing computing skills to the graduates and undergraduate students has been established with the ICAR's grant.
- Under the faculty improvement programme, four scientists were deputed for international conference and many for national conferences and workshops. The faculty was provided with enough funds to develop practical manuals for the students so that they are in a position to improve their practical learning.

To provide hand - on training to the students on the use of computer, ICAR has given financial assistance for setting up a Computer Centre at the Narendra Deva Agricultural University (below). At the Y.S. Parmar University of Agriculture and Forestry, Solan, the faculty was provided with enough funds to develop practical manuals for the students to improve their practical learning (down below).

**Tamil Nadu Veterinary and Animal Sciences University, Chennai**

- This university has strengthened infrastructure from the support of Rs 248 lakhs in this plan period for construction of central laboratory, purchase of equipments, library facilities, instructional farms, fish farm at two campuses—Madras and Namakkal.
- A glasshouse at the Fisheries College and Research Institute at Tuticorin was also established by the grant provided by the ICAR.
- A Communication Centre cum-Museum was also constructed by this grant. Ten excellent teaching manuals were prepared for teaching undergraduate and postgraduate courses in the disciplines of Veterinary Surgery and Radiology, Veterinary Preventive Medicine, Freezing of Bovine Semens, Radioisotope Technology, Animal Biotechnology and Gynaecology and Obstetrics etc..
- The instruments-Roller Culture Apparatus, Elisa Reader and Accessories were used for research and teaching purposes by the postgraduate students.
- The computer centre has been established with 10 terminals and one file server. The centre has trained more than 500 persons of the State and the development departments in use of computer.

**Emeritus Scientist Scheme**

The Emeritus Scientist Scheme has a provision for having a maximum of 50 scientists at any point of time. During the period under report 50 Emeritus Scientists were in position. At present 34 are in position and 16 have completed their term. Schemes involved are:

- Development of environmental friendly organophorus fungicides: Twenty new oaryl, 0 methyl 0-2 chloroethyl phosphates were synthesized and evaluated for fungicidal activity against *Pyricularia oryzae*. In order to find out a broad spectrum of activity, the compounds were also tested against *Helminthosporium oryzae, Rhizoctonia bataticola* and *Pythium aphanidermatum*. The study is in progress.
- Survey, collection, and selection of improved clones of guava of Allahabad District: Most of the guava area falls under Allahabad safeda and seeds of this cultivar have largely been used for multiplication. It has economic benefits in terms of export market for fruits with fewer seeds with long shelf-life and also for industry. Some of the new cultivars identified are M SEL-1 (Maroon guava) which is ideal for desserts, PFS SEL-1, whose exocarp and mesocarp are uniformly pink. It is suitable for canning and dessert, spotted guava, SP SEL-1, ideal for making jelly and dessert.

The survey, collection and selection of improved clones of guava (Allahabad safeda) has shown the economic benefits in terms of export market for fruits with fewer seeds and long shelf-life. Allahabad safeda, Apple colour and pink flesh varieties of guava have been reported to be promising

**National Professors/National Fellows**

The research work and achievements of the National Professors/National Fellows are:

- A field oriented dot immunobinding assay (DIA) has been developed for spot diagnosis by Prof R. Pandey.
- Mechanisms of adaptation to drought and temperature studies by Prof S.K.Sinha.
- The development and use of biological control agents and IPM in cotton, groundnut and soybean by Dr. S. Jayaraj.
- Developing components for production of commercial hybrid *Brassicas* and development of cytoplasmic male sterile lines by Prof V.L.Chopra's group. Cytoplasmic male sterile lines developed from protoplast fusion of *B. juncea* with *Trachystoma balli* and *Moricandia arvensis* have now been fully characterized by them.

Studies made by the National Fellows dealt with (*a*) Monocarpic senescence in relation to sink size and drought (*b*) Biochemical marker for competitive strains of chickpea - rhizobium. (*c*) Study the effect of rising atmospheric CO2 on photosynthesis and productivity of *Brassica* plants under moisture stress condition. (*d*) Development of multiple disease-resistant hybrids and open-pollinated varieties in tomato (*Lycopersicon esculentum Mill.*) through anther culture. (*e*) Chromosome location and designation of new leaf rust resistance genes and their characterization to develop wheat with durable resistance. (*f*) Allelopathic studies in cropping systems, weed control and agroforestry for sustainable agriculture. (*g*) Studies on ecotype development, tritrophic relationship and efficient field management of *Trichogramma* spp. (*h*) Fate of fertilizer nitrogen in cropping systems with particular reference to nitrogen use efficiency and pollution potential. (*i*) Profiles of biogenicamines and volatile fatty acids in buffalo productivity. (*j*) Epidemilogical studies of Bovine Haematuria (Appendix 13).

**Summer Institutes/Refresher Courses**

To improve the quality of education, the ICAR organised 33 Summer Institutes during the period (24 on strategic fields of the crop production, namely genetic, IPM, horticulture, biofertilizer, agriculture extension, agriculture engineering, soil, water management, and 8 in livestock, veterinary and dairy sciences). On an average, 400 participants attended these training courses from various SAUs and ICAR Institutes (Appendix 14).

## CENTRES OF ADVANCED STUDIES

During the Eighth Plan, a new Scheme of Centres of Advanced Studies (CAS) was launched to provide continued support to Centres of Excellence created with the UNDP assistance. Apart from these, the departments in the SAUs and ICAR institutes based divisions on their academic strength were supported to generate skilled human resources in new and emerging areas. Support was provided to 35 Centres of Advanced Studies during the year.

- In all, 60 training programmes were conducted during the year in the areas of Agricultural Extension, Agricultural Economics,

Cytoplasmic male sterile lines developed from protoplast fusion of *Brassica juncea* with *Trachystoma balli* and *Moricandia arvensis* have been fully characterized. Specific probes indicated that chloroplast genome of the CMS has undergone changes. Analysis is further in progress

Agronomy, Plant Physiology, Plant Pathology, Entomology, Horticulture, Plant Breeding and Genetics, Soil Science, Biochemistry, Agricultural Engineering, Home Science, Animal Physiology, Plant and Animal Biotechnology, Clinical Medicine and Therapeutics, Poultry Science, Microbiology, Veterinary Gynaecology and Reproduction and Veterinary Parasitology.

- A total of 850 scientists were trained and provided latest information in their areas of specialization. Through special efforts excellent training manuals for each of the training programmes were brought out. A training programme on hybrid technology for rice, millets, pulses, oilseeds, cotton and forage crops were conducted for a period of three weeks. Nineteen participants were exposed to the recent advances made in hybrid technology in rice and pigeon pea. In other crops, though the hybrid technology has been used for commercial exploitation, the recent advances made were explained to the trainees. In all, 34 topics covering different facets of hybrid technology were covered.

- The Centre of Advanced Studies in Plant Biochemistry has made a study on the low ODAP *Lathyrus sativus* and the somaclones recorded highest yield in the All-India Coordinated trial. Based on the All-India Coordinated trial for maintaining extremely low ODAP somaclones Bio L 212 has been recommended for release by the Rabi Pulse Workshop. The somaclones have a unique feature of producing high biomass bold grains, low ODAP content and high yield potential.

- In the area of Veterinary Sciences excellent training was conducted and manuals and course material were produced. One of the centres on Clinical Medicines and Therapeutics in TNVASU produced a computer-aided training material for use by the students and teachers.

- To strengthen teaching, research and policy analysis capacity of scientists in the country, two short-term training courses were organized under the Centre of Advanced Studies in Agricultural Economics. Two training courses (*i*) Agricultural Research Evaluation and Impact Assessment, and (*ii*) Role of Social Sciences in Agro-biological Research of two weeks duration, were conducted by the faculty of the Division.

- Under the CAS, a research study on Food and Nutrition Security Issues was undertaken. The study provides information on demand for agricultural commodities and suggests the required yield growth in the Ninth and Tenth Five-Year Plans. The study identifies the regions which must be explored to meet the domestic and export needs.

The National Dairy Research Institute has also improved its library facilities through computer networking with several terminals. It has also purchased optical mark readers for evaluating answer books received for entrance examinations conducted and scanners cum printers for printing question papers. Its hostel buildings have been renovated, kitchen modernised and accommodation for girl students increased. Gymnasium of NDRI was also equipped with modern amenities.

## AGRICULTURAL HUMAN RESOURCE DEVELOPMENT PROJECT

The World Bank supported Agricultural Human Resource Development Project (AHRDP) was launched on 14th August, 1995 with a total outlay of Rs 232.76 crores aimed at improvment in quality of agricultural human resource through a series of steps including development of infrastructure, training of scientists and procedural reforms for bringing efficiency and accountability in the system. During the year Accreditation Board has been constituted to oversee norms and standards of agricultural education in the country.

To provide better support for improvement in agricultural education, the education division has been renovated, reorganised and modernised. The guidelines for Sabbatical Leave and visiting scientists scheme have been issued to provide mobility of scientists and to improve capabilities to various departments.

To reduce in-breeding all the SAUs have agreed to recruit scientists at the level of Assistant Professor for those who have qualified the National Eligibility Test (NET) conducted by the Agricultural Scientists Recruitment Board. In

addition, in the Vice Chancellors' Conference it has also been decided to appoint Heads of Departments, Deans and Directors in State Agricultural Universities based on direct selection. This will go a long way in improving educational standards in State Agricultural Universities.

The Mid-Term Review of the implementation of the project was done by the ICAR and the World Bank officials in April 1996. A follow-up action has been taken to fulfil the objectives of the project. These included finalisation of the agency for foreign training of the scientists, review of the progress of the participating States and the Council component. The FAO has been identified as an agency for foreign training. Two consultants Dr. R. Coffman of the University of Florida and Dr. M.W.Menzi from Switzerland have come and visited the participating Universities from July 21 to August 3, 1996 and based on the interaction with the University and ICAR officials, submitted their report which has recommendations about the new consultants that need to be hired and the plan of action for various activities relating to AHRD project.

It is proposed to send the first batch of trainees by January-February, 1997. Prior to this, six trainees from TNVASU were selected to undergo training for 12 months and six months in veterinary subjects. Their placement has been finalised and they are undergoing training. Similarly, senior officers like Deans and Principals from various institutions under APAU visited Universities in USA, Australia and Europe for a short study tour of 30 days.

## PROFESSIONAL RESOURCES UTILIZATION

*University Level Books*

Four books have been completed this year. A Textbook of Dairy Chemistry written in joint collaboration with Dr M.P. Mathur, Dr D. Datta Roy and Dr P. Dinakar of NDRI, Karnal. A Textbook of Veterinary Protozoology was written by Dr B.B.Bhatia, Prof and Head, Department of Parasitology, GBPUA&T, Pantnagar. A Textbook on Temperate Fruits written by Dr T.R.Chadha, Director of Research, of Y.S.Parmar University of Agriculture and Technology, Solan. A book on Fishing Gear and Craft Technology written by Prof Y. Sreekrishna and Mrs.Latha Shenoy of Central Institute of Fisheries Education, Mumbai, in two volumes.

*Internal Competency Scheme*

Under this scheme, agricultural universities/deemed universities, ICAR Agricultural Faculties of Central Universities seek the assistance of the Council for engaging experts/consultants for specific period limited to a maximum of 100 mandays for developing course curriculum plan and establishment of a new programme. Some universities have already initiated this programme. Efforts are being made to revise the postgraduate curriculum, strengthening of research in the area of energy and iron nutrition and for series of lectures on important topics of nutrition. During this period, all AICRP Nutrition Component Faculty, located at nine centres shall be trained for the estimation of mycotoxin in various foods.

*Best Teacher Award Scheme*

For promoting excellence in teaching, Best Teacher Award Scheme has been implemented. The Council has awarded two Best Teacher Awards to M. Thiagarajan, and Dr A. Sundaraj. In addition, Dr Nrusingh Charan Singh, Dr Aratla Trivikrama Rao, Prof S.C.Nayak, Dr P.C.Thomas, Dr Pranati Das, and Dr Prakas Chandra Patro have also been awarded Best Teacher Award by the Council.

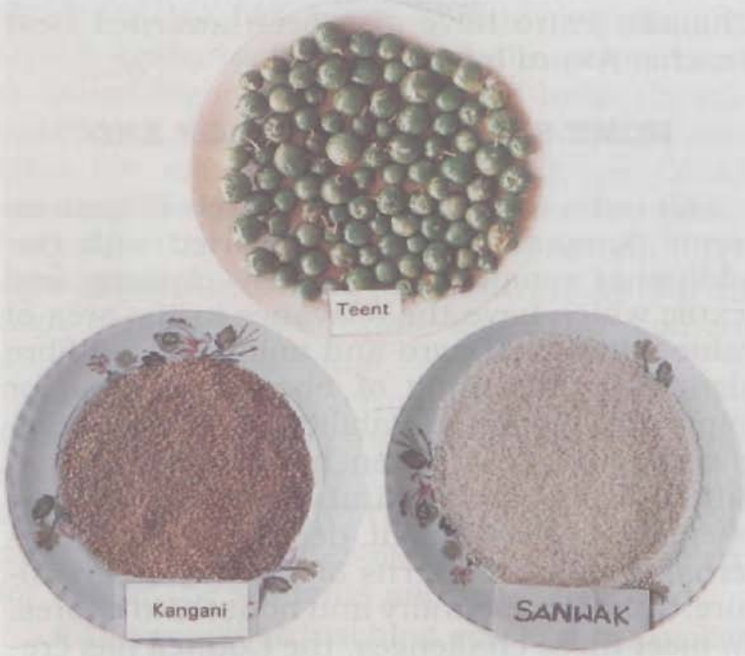
## HOME SCIENCE EDUCATION AND EXTENSION

All-India Coordinated Research Project on Home Science has been supported with two additional components, namely clothing and textile which have the relevance in the area of value addition of agro-and animal-based fibre alongwith processing of fibres and dyes for improving economic viability. The Home Science Extension component has a focus on preparation of data base on rural women with specific reference to involvement, decision-making patterns, time-use patterns of women in agriculture, animal husbandry and household chores. To meet these challenges, the Council has created a Coordination Cell at the Headquarters.

Food and Nutrition component working on the nutritional evaluation of uncoventional/lesser-known foods in terms of calcium, iron and β-carotene and antinutritional factors—phytates, polyphenols, oxalates.

Nutritional evaluation of various unconventional/lesser-known foods, including *pinju, khejri, barbanti, peepalbanti,* wild *ber, lehsora, santhi, bhakri, gullar, sawank* and *teent* was done. Among the fruits studied, *pinju, khejri* contained considerable amount of protein, while *kachri* stood with high amount (13%) of fat. A wide variation was observed in their crude fibre and ash contents. Crude fibre varied from 1% (in *pinju*) to 33% in *peepalbanti* and the ash from 2% in *barbanti*, wild *ber* and *lehsora* to 25% in *santhi*. Total available carbohydrate content of these foods varied from 37% in *kachri* to 33% in wild *ber*. *Gullar* was rich in calcium, iron, and zinc. Leaves of *pinju* had detectable levels of B-carotene. Fruits and leaves in general were good sources of ascorbic acid.

Blends of Red Palm Oil (RPO), and Sunflower Oil (SFO) in the ratios of 30:70 and 50:50 were separately prepared. Forty different food items covering breakfast foods, sweet meats were prepared using RPO and its blends with SFO in the ratios of 50:50 and 30:70. Selected food items




Unconventional foods have been evaluated for their nutritional value in terms of their calcium, iron and ß-carotene contents and antinutritional factors like phytates, polyphenols and oxalates. Crude fibre was 33% in *peepalbanti* and ash 2% in *barbanti*, 25% in *santhi*. Carbohydrate content varied from 37% in *Kachri* to 33% in wild *ber*. *Barbanti, sawank* and *santhi* contain high levels of phytic acid

In winged bean, (*Psophocarpus tetragonolobus*) succulent shoots, flowers, immature pods, dryseeds and tubers are all edible and rich in nutrients. The beans contain high protein upto 33%, next to soybean

## AICRP ON HOME SCIENCE

### Family Resource Management

- Impact of Kitchen Organization. Studies on the existing and improved organized kitchen revealed that organized kitchen saved time (38.8%) of the homemaker in preparing a meal. A good number of respondents strongly liked the improved kitchen.
- Maintaining organized kitchens resulted in time saving(96%), distance travelled (96%), tiredness (88%), easy to work (76%), less postural changes(72%), less mental fatigue(72%) and neat kitchen(64%).
- Clothing and Textiles component with focus on value addition for agro-and animal-based fibres, has been added recently with the focus on identifying agro-based regions in the first phase followed by introducing intervention for improvement in the existing practices of processing fibres and dyes.
- Home Science Extension components database on rural women with work profile, decision-making pattern, drudgery tasks and scientific validation of drudgery reducing technologies shall be explored.

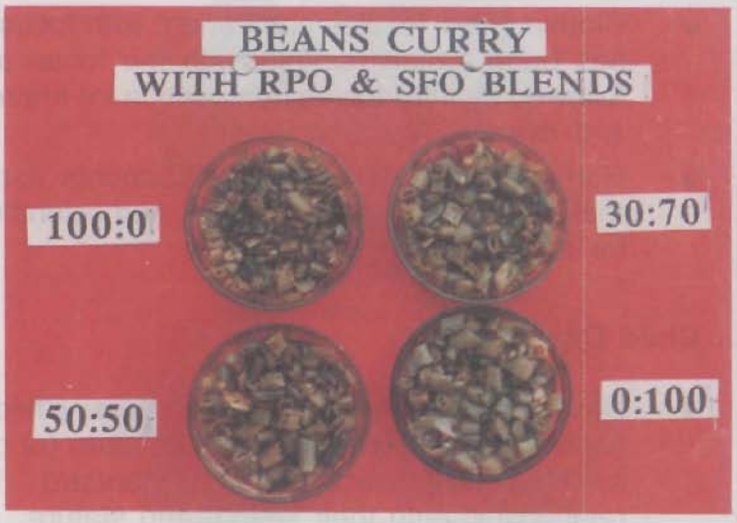
### Child Development

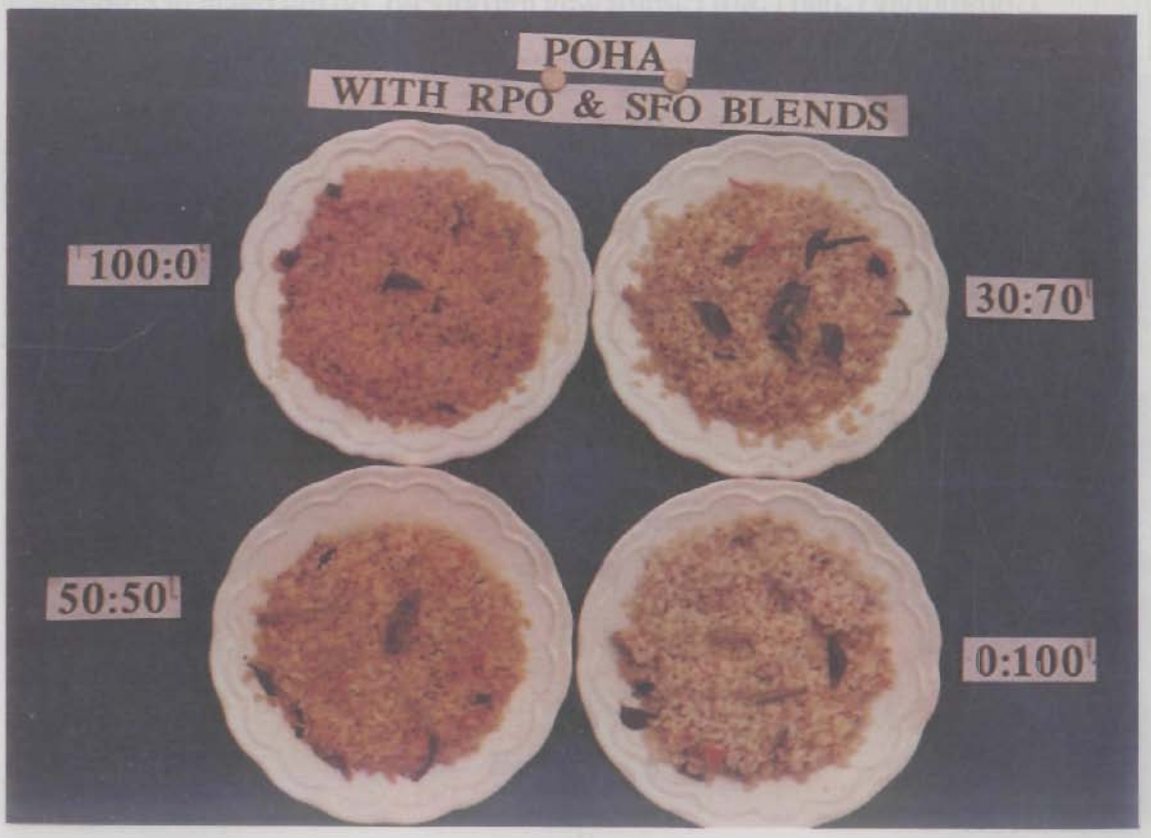
- Developmental Assessment of Rural Children (6-18) in terms of physical and psycho-social assessment showed that rural children (of different age groups) fell short of the National Centre for Health Statistics (NCHS) Standard in weight and stature. The age showed negative relationship with their weight and stature.
- To cater to the needs of infants and pre-school children of subsistence farm families, the Community Child Care Centre was introduced, on the basis of community participatory approach.

The physical and psycho-social assessment of rural children (6-18 yrs) under the AICRP on Home Science has shown that their psycho-social development, retention and concentration is related to class, age, weight and stature
Among the various measures to be taken, the Community Child Care Centres have been introduced to cater to the needs of infants and pre-school children of subsistence farm families

were analysed for total and beta-carotene. Retention of total carotene in different stored products was in the range of 30 to 60% in pickles (stored for 6 months), 78 to 83% in cakes (stored for one week), 71 to 86% in biscuits (stored for one week) and 52 to 81% in sweet meats (stored for three days). βeta-carotene retention was in the range of 38 to 67% in pickles, 35 to 85% in cakes, 61 to 86% in biscuits and 60 to 90% in sweet meats. All foods were also subjected to sensory evaluation by a trained panel of judges. Curry items as well as pickles prepared with RPO: GNO and RPO:SFO blends were well accepted during sensory evaluation. For pickles and baked foods, RPO:SFO blends were found highly suitable. Sweets were moderately accepted when prepared with these oil blends. This being a rich source of vitamin A, it can be easily used as a good supplement of vitamin A, under Rural Community Nutrition Programme.

A study was conducted on 1200 pre-school children of five years of age group from the selected urban slums and rural areas of Andhra Pradesh to understand the differences in nutritional status. The nutrition intake of these




Blends of Red Palm Oil and Sunflower Oil in the ratios 30:70 and 50:50 have been prepared and used for preparation of different food items. This being a rich source of Vitamin A can be used as a good supplement for the vitamin under the Rural Community Nutrition Programme. Photograph above shows bean curry and (below) *Poha* preparation with RPO and SFO blends

children was low when compared with the Recommended Dietary Allowances (RDA), and the diet was grossly deficient in vitamins, especially A and B-Complex.

## NATIONAL AGRICULTURAL RESEARCH PROJECT

The National Agricultural Research Project (NARP) was implemented to strengthen the research capabilities of state agricultural universities (SAUs) for conducting need-based and location-specific research . The project was successfully concluded on 30 June, 1996 and the main objective of decentralization of research through zonal stations located in different agro-ecological regions/subregions has been achieved in all the 26 SAUs to meet the location-specific research needs of the farmers..

Under the project all the agroclimatic-based zonal stations have been provided support for staff, laboratory and residential buildings, equipments, and library facilities, now have their own on-going research programmes. But for NARP activities, research facilities in remote and tribal areas would not have been developed.

The concept of generating need-based technologies for each zone has been accepted by all the States in view of tangible benefits accruing based on the model adopted in NARP. All these zonal stations, after completion of NARP, are continuing with the support of State Government in accordance with the MOU between the State Governments and the ICAR.

Each zonal research station has prepared status report, which includes the identification of major farming situations, farmers' problems and production constraints.

Research and extension linkages have been strengthened, and mechanism developed which permits participation of scientists and development officials in regular monthly and Zonal Research and Extension Advisory Committee (ZREAC) meetings.

Interaction with other development departments, like animal husbandry, forestry, irrigation is now increasing as a result of strengthening and support provided under NARP. There is substantial improvement in the quality of research, and package of practices for various crops and cropping systems are now being recommended on a zonal basis and widely adopted by farmers.

Studies on child development show that rural children fell short of the standard set by the National Centre for Health Statistics in terms of weight and stature

Large areas in the tribal districts, rainfed desert regions, and hill districts etc. in states like Andhra Pradesh, Orissa, Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh etc. which were completely neglected for research now have zonal research stations.

To develop new skills, 16 senior research scientists and managers were deputed to CGIAR institutions for sharpening their skills. This helped in better management of research programs and facilities back home. Another group

of 88 young and talented scientists from SAUs were sponsored for overseas training in their field of specialization and got aquainted with the latest developments in research, experimental techniques, systems and procedures for adaptation in their own research programmes.

To strengthen scientific capability of the regional research centres, 11 training programs of about 20 participants each, were organised in strategic fields for enhancing production in agriculture, horticulture, agroforestry, agricultural implements, improving quality of animal nutrition and post harvest technology of crops and water management. In addition, eight computer training programmes, were organised and 105 staff members trained from different SAUs and ICAR headquarters.

**Basic Research**

(i) Sensitive diagnostic tools employing immunoprobes or nucleic acid probes, have been developed by the Indian Agricultural Research Institute, New Delhi for reliable detection of peanut stripe polyvirus (PSIV) and rice tungro virus(RTV) in plant tissues even when present in small numbers. These tools are of great significance in virus epidemiology.

(ii) Techniques for somatic embryogenesis and organogenesis have been standardised for groundnut, by the National Research Centre for Groundnut, Junagarh with 100% response, and a workable conversion to plantlets.

(iii) The Central Institute of Cotton Research, Nagpur has standardised tissue culture techniques for cotton. With the improved method of shoot tip culture, and with induction of multiple shoots, there is scope for developing transgenic cotton.

(iv) Synthetic diets and *in vitro* rearing of Trichogrammatids and Chrysophids were perfected at Project Directorate on Biological Control, Bangalore. This has significance in integrated pest management (IPM) for control of borers and sucking insects.

(v) At NDRI, Karnal, a set of in-vitro trials with pure chemicals mimosine, 3,4 DPH and 2,3 DPH were carried out and it was observed that mimosine disappeared from the medium after two days in buffalo and goats and 4 days in cattle showing 100% degradation of mimosine.

(vi) Studies were also conducted at IARI, New Delhi on the expression of wsp23 gene in wheat varieties subjected to water deficit of different intensities. The expression of hsps 16.9, 17.3 and 26.4 transcripts in wheat varieties and species differing in thermotolerance under field conditions for yield performance were examined.

## NATIONAL ACADEMY OF AGRICULTURAL RESEARCH MANAGEMENT

The National Academy of Agricultural Research Management (NAARM) conducted some training and course programmers during the year, the highlights of these programmes are:

**Foundation Course for Agricultural Research Service (FOCARS)**

The fifty-four, fifty-five and fifty-sixth courses (of FOCARS) were concluded on June 20, August 2 and December 2, 1996. Forty-five trainee scientists in the 1st and second and 39 trainee scientists in the third course completed their programmes successfully.

**National training-cum-workshop on Agricultural Research Financial Information System (ARFIS)**

A software package "ARFIS" was developed for computerization of monthly accounts of all the ICAR Institutes, with the main objective of bringing uniformity and standardization in accounting procedures. The package was developed under the guidance of the Financial Advisor and Joint Secretary to Government of India, Ministry of Agriculture.

To familiarize the ICAR accounts personnel with the features and operation of the computerized accounting software package, a national training-cum-workshop on Agricultural Research and Financial Information System (ARFIS) was organized by the ICAR at the Academy from April 15 to 23, 1996, in three spells.

Around 300 financial and administrative personnel of the ICAR have been trained with this package. A manual on computerization of accounts entitled "Agricultural Research Financial Information System (ARFIS)" was published by the Academy. Besides offering operational advantages, like speed, reliability and

accuracy, ARFIS would also facilitate easy storage and quick retrieval of financial data.

**Advanced Course on Agricultural Research Project Management**

An advanced course on Agricultural Research Project Management was organized from April 16 to 26, 1996, at the Academy. The main objective of this course was to expose the research project managers of the ICAR Institutes, SAUs and other organizations to the concepts of agricultural research projects and to the scientific management of agricultural research projects. Twenty-five scientists participated in the course.

**Summer Institute on Recent Advances in Agricultural Research Management**

To make the agricultural research establishments responsive and vibrant, the application of basic principles and concepts of management is of paramount importance. In order to sensitize scientists on recent developments in concepts and techniques of various aspects of agricultural research management (ARM), a summer institute on "Recent advances in agricultural research management" was organized at the Academy from June 3 to 22, 1996. The course covered various areas, like ARM concepts, process, and developments; agricultural research project management - principles, techniques, and applications; ARM Information System; manpower planning for effective agricultural research system; technological forecasting and systems approach, etc.

**Course on Management Information System (MIS)**

For planning and managing agricultural research effectively, managers require relevant and timely information on various research resources. A computer-based Management Information System (MIS) becomes useful when the organizations become larger and their research activities multiply. A course on MIS for agricultural research was organized at the Academy from June 11 to 22, 1996. Thirteen senior scientists and teachers working in the ICAR Institutes, SAU's and other research institutes participated in the course.

**Outreach Programme in Educational Technology (OPET)**

The major objective of the OPET programme was to orient the agricultural university teachers to various aspects of higher agricultural education, more specifically to educational methodology and instructional technology. Third and last contact programme in OPET was organized at the Academy from June 18 to 28, 1996.

**FDP in Educational Technology**

Under the Agricultural Human Resources Development (AHRDP) Project, the second teachers' orientation programme was conducted under the joint sponsorship of NAARM and Academic Staff College and Distance Education Centre, Rajasthan Agricultural University, Bikaner from August 5 to 20, 1996 at the Directorate of Extension College of Agriculture, Udaipur.

**Computer Applications in Agricultural Research**

Recognizing the need to bring about the use of computer among the agricultural scientists, a course on "Computer applications in agricultural research", was conducted from July 15 to 22, 1996 at the Academy. Under this hands-on training course, the agricultural scientists, were sensitized to use word processing packages, data storage and retrieval techniques and graphic presentations. Twenty-two scientists from the ICAR institutes and SAUs attended this course.

**Public Relations (PR) - oriented Marketing Communication Strategies of Agricultural Research Programme**

The objectives of the above programme was to expose the participants to the public relations oriented marketing communication concepts and give them a firm grounding in marketing, and 'concept selling' in business and non-profit organizations; to expose the participants to the new and the emerging areas of designing communication plan for advanced packaging and pricing of clientele oriented agricultural research; to improve the PR - oriented marketing communication skills of the participants.

A national workshop on "PR-oriented Marketing Communication Strategies of Agricul-

tural Research" was organized at the Academy from September 2 to 7, 1996.

A course on—Videography in agriculture was organized with an intention to promote communication technologies in the research institutions of ICAR and SAUs from September 3 to 13, 1996.

Seventeen technical personnel engaged in videography and photography in ICAR research institutions, SAUs and also the scientific staff looking after these sections attended the course.

**UNESCO'S CDS/ISIS (ver 3.07) & Associated Packages**

To familiarize the information professionals with CDS/ISIS and the associated packages, the Academy organized a course from September 20 to October 1, 1996 to discuss the concept of databases, DBMS and designing bibliographic databases and to provide a complete hand-on training on the use of CDS/ISIS.

Twenty seven librarians, documentalists, information specialists/analysts, technical personnel handling information services in the ICAR institutes, SAUs and other related organizations, participated in the course.

**Manpower Planning in Agriculture**

To plan and to utilize the existing manpower to the maximum extent efficiently and effectively, a course on "Manpower Planning in Agriculture" was organized at the Academy from September 19 to 27, 1996.

The course covered topics, like principles and practices of manpower planning, manpower efficiency, time management of manpower, manpower requirement for a project..

**SWOT Analysis in National Agricultural Research System**

A course on "Application of SWOT analysis in National Agricultural Research System" was organized from September 23 to 26, 1996 at the Academy. The course covered topics, like concept and an overview on SWOT, applications offered through case studies; application - research and development programmes, etc., with emphasis on practical-orientation.

Twenty-eight participants such as Principal and Senior Scientists and Associate Directors of Research and Professors participated in the course.

**Management of Human Resource for Research**

An advanced course on management of human resources for research was organized from November 18 to 30, 1996 with the main objective to expose managers to the concepts of human behaviour in organizations and to sensitize them to issues important in management. The course helped scientists in this vital area to effectively manage people at work, thereby increasing the productivity of research. Twelve scientists, teachers and administrators of the ICAR Institutes, SAUs and other research development and educational institutes participated in this programme.

**Statistical Softwares for Data Analysis**

A course on statistical softwares for data analysis was organized at the academy from November 19 to 29, 1996 to provide an exposure about the basics of computers and to familiarize the scientists to work on statistical software packages for data analysis, data presentation and interpretation of results from these analysis.

**International Management Development Programme on "Management of Agricultural Research"**

The World Bank sponsored a 2-week International Management Development Programme on "Management of Agricultural Research " for the Directors of Agricultural Research Institutes from Nigeria under the auspices of National Agricultural Research Project. Some of the broad areas covered include NARS in India and Nigeria; research programme planning and management; human resources management; information management; financial and administrative management; agricultural education and extension management and NARP.

## RESEARCH

A research project entitled "Professional (graduate) Women in Agriculture" was

undertaken by the Academy. This project is sponsored by the Department of Science and Technology.

## PUBLICATION

The Indian Council of Agricultural Research (ICAR), had introduced new scientific personnel policy to suit the requirements of scientific personnel and researchers. With a view to keep the scientists and the research managers of the ICAR updated with the personnel policies, a comprehensive handbook incorporating the various changes that have been issued, from time to time, for the original ARS rules, have been compiled and edited. The publication is entitled "Agricultural Scientific Service Rules".

This publication presents various orders, instructions, decisions, clarifications, and rules framed, from time to time, from April 1985 to June 1995.

# Transfer of Technology

# Transfer of Technology

The Division of Agricultural Extension of ICAR plays a centre extension role to facilitate process of assessment, refinement and transfer of technology through which the extension agencies and the farmers can be exposed to the latest agricultural technologies. The major projects functioning are Krishi Vigyan Kendras (KVKs), Trainers' Training Centres (TTCs) and Technology Assessment and Refinement through Institution-Village-Linkage Programme (IVLP). There is also one National Research Centre for Women in Agriculture (NRCWA) functioning at Bhubaneshwar. At present there are 261 KVKs, 8 TTCs and 34 IVLP functioning under the ICAR extension system. These were seven publications brought out by the extension scientists. Five agricultural Scientists were sent abroad for training.

- Farmers' Training courses organized by KVKs
- Long-term Vocational and skill-oriented training courses organized by KVKs
- Extension Activities such as field days, farmers' fairs, kisan gosthies, farm women fair, agricultural exhibitions, clinical camps, campaigns, video and film shows, radio/ TV coverage organized by KVKs
- Increase in yield of redgram, rapeseed and mustard up to 150% achieved through Frontline Demonstrations.
- Training Courses orgazined by TTCs
- Resource of 213 scientists created by Institution-Village-Linkage Programme.
- Workshop-cum-training on *Gender Implications in Farming Systems Approach* organized by NRCWA

### KRISHI VIGYAN KENDRA

The major mandates of the project are : (i) collaborate with the subject-matter specialists of the state agricultural universities/scientists of the regional research stations and the state extension personnel in on-farm testing, refining and documenting technolgies for developing;(ii) organize training to update the extension personnel within the area of operation with emerging advances in agricultural research on regular basis; (iii) organize long-term vocational training courses in agriculture and allied vocations for the rural youths with emphasis on learning by doing for generating self-employment through institutional financing; and (iv) organize frontline demonstrations in various crops to generate production data and feedback information.

The achievements are given below.

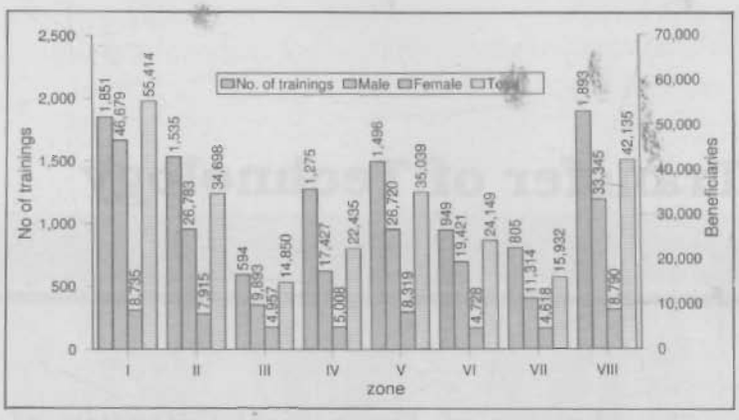
Training on hybrid seed production of sunflower being conducted at KVK, Ferozpur

### Farmers' Training

A total of 10,394 training courses for the

benefit of 2,44,652 farmers and farm women were organized in crop production, plant protection, horticulture, livestock production and management, soil and water management, farm machinery and tools and home science. The project is monitored through 8 zonal coordinating units. The zone I comprises Delhi, Haryana, Punjab, Himachal Pradesh and Jammu and Kashmir. The Zone II comprises Bihar, West Bengal and Andaman and Nicobar Islands. The Zone III and IV comprises Assam and North-Eastern Hill States; Uttar Pradesh respectively. The Zone V and VI include Andhra Pradesh and Maharashtra; Rajasthan and Gujarat respectively. The states of Madhya Pradesh and Orissa are included in Zone VII, whereas Kerala, Karnataka, Tamil Nadu, Goa and Pondicherry are included in Zone VIII.

The impact of various training programmes conducted by KVKs was assessed in adoption and change of income level. The adoption of different technologies/skills was 25–100%. In majority of cases, the level of adoption was more than 50% with proportionate increase in income.




Training courses and beneficiaries in 8 KVK zones during farmers' training in agricultural production

## Vocational Training for Rural Youth

As many as 2,138 long-term vocational and skill-oriented training courses were organized covering 46,869 rural youths. The training courses were in the areas of bee-keeping, poultry, dairying, piggery, fisheries, preservation of fruits & vegetables, maintenance and repairing of farm machineries and tools.

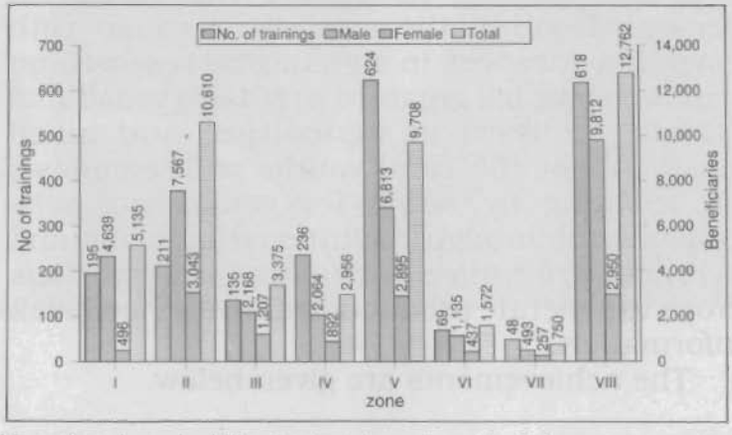
Vocational training for controlling apple scab and other diseases in Pulwama district of Jammu and Kashmir

## Training Programmes for In-service Personnel

The KVKs are given the responsibility of conducting in-service training at grass-root level of extension functionaries working in government and non-government development organizations related directly or indirectly with the development of agriculture. During 1996, 1,047 training programmes were conducted covering 21,489 beneficiaries.

## Other Extension Activities

To speed up the process of transfer of technology extension activities such as field days (928), farmers' fairs (268), kisan gosthies, farm women fair, agricultural exhibitions (354), clinical camps (111), campaigns (238), video and




Vocational and skill-oriented long-term training courses for rural youth in 8 KVK zones

film shows (336), radio/TV coverage (246) were also organized by all the KVKs. Extension literature for its distribution to the farmers were also prepared on various agricultural practices.

**Frontline Demonstations (FLD)**

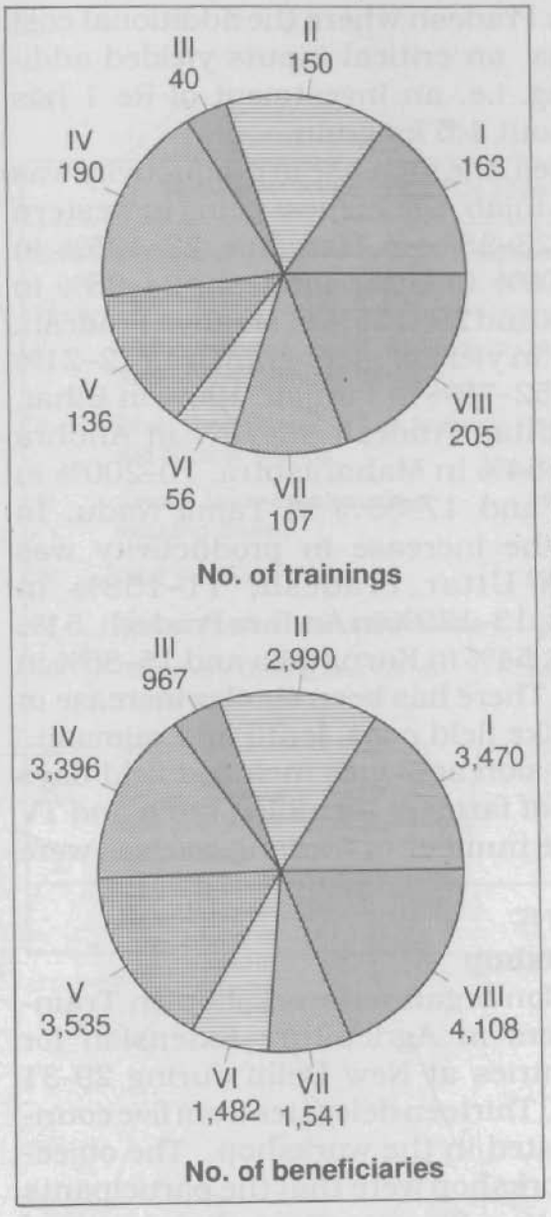
The main objectives of the FLD are: (i) to demonstrate the newly released production technologies at the farmers' fields to exploit their maximum potential in a given farming system; (ii) to prepare technical leadership in the villages by way of imparting desired training; and (iii) to organize the need based training programmes for subject-matter specialists and the farmers after identification of problems.

***Oilseeds:*** During 1995-96, 3,419 ha were covered to demonstrate the potential of technologies in different agro-climatic zones of the country by involving 7,205 farmers.

The yield of different oilseed crops has shown a significant increase in productivity. The increase has also been found to be significant in rainfed demonstration in crops like *kharif* groundnut, *rabi* safflower, soybean and castor. The inclusion of new varieties in rapeseed and mustard has shown an increase in yield of 25-150% over the farmers' practices. The additional yield due to additional cost of critical inputs over the local checks has shown encouraging results in crops like mustard and sesamum. At some of the centres the investment of Re 1 on critical inputs has produced Rs 5–10 in additional yield.

Major feedback from the demonstration is the possibility of increasing yield of oilseed crops in the existing cropping sequences of the farmers. There is need for developing varieties of groundnut suitable for late planting in paddy based cropping system.

***Pulses:*** During the year 1995-96, 5412 demonstrations were conducted on major pulse crops covering 1757 ha in pulse growing districts of 11 states of the country. The production potential was analyzed agro-climatic zone-wise comparing with farmers' practices. The increase in yield of redgram with recommended varieties and improved technologies was 15–150% in different agro-climatic zones in the states. It was most profitable in central plain




In-service training courses for extension functionaries of 8 KVK zones

Frontline demonstration showing superior performance of improved technology in mustard af flowering stage

zone of Uttar Pradesh where the additional cost of Rs 625/ha on critical inputs yielded additional 989 kg, i.e. an investment of Re 1 has produced about 1.5 kg grain.

In chickpea, the increase in productivity was 13–36% in Punjab, the highest being in western plain zone, 23–28% in Haryana, 23–105% in Bihar, 23–109% in Uttar Pradesh, 24–98% in Maharashtra and 29–125% in Madhya Pradesh. The increase in yield of greengram was 12–21% in Haryana, 52–78% in Punjab, 100% in Bihar, 50–94% in Uttar Pradesh 19–78% in Andhra Pradesh, 11–54% in Maharashtra, 70–200% in Rajasthan, and 17–55% in Tamil Nadu. In blackgram, the increase in productivity was 59–154% in Uttar Pradesh, 11–158% in Maharashtra, 13–120% in Andhra Pradesh, 51% in Rajasthan, 54% in Karnataka and 15–86% in Tamil Nadu. There has been similar increase in other crops like field peas, lentil and rajmash.

The extension activities included field days and training of farmers including radio and TV talks. A large number of training courses were organized.

**SAARC Workshop**

The Division organized workshop on Training of Trainers in Agriculture Extension for SAARC Countries at New Delhi during 29-31 August, 1996. Thirteen delegates from five countries participated in the workshop. The objectives of the workshop were that the participants will be able to : (i) appreciate the status of training strategies to reach a million of farmers in SAARC countries; (ii) comprehend the adult learning principles and its application for teaching and training process; (iii) set technical agricultural topics in seven-step design following experimental learning cycle; and (iv) prepare and deliver training sessions on interactive lecturette and interactive demonstration.

Dr R S Paroda, DG, ICAR and Secretary DARE inaugurated this workshop and emphasized the need for using appropriate training methodology which is in the corner stone for the transfer of sustainable agriculture technology. All the participants gave the feedback that the workshop was very effective and has achieved the overall objectives.

Frontline demonstration in groundnut ('Co 2') at farmer's field

Frontline demonstration in chickpea ('Pusa 256') production

**TRAINERS' TRAINING CENTRES**

There are eight TTCs which are specialized institutions to provide technical back up support to the KVKs staff in their areas of specialization as well as latest training methodology. In addition to KVK staff, they also impart training to subject-matter specialists of development departments of various states. During the year under report, 144 courses have been organized which have benefitted 2904 participants.

**TECHNOLOGY ASSESSMENT AND REFINEMENT THROUGH INSTITUTION-VILLAGE LINKAGE PROGRAMME**

The Project was approved by the ICAR in June, 1995 for 42 centres with state agricultural universities and research institutes with a total fund provision of Rs 101.60 million. Two meetings of the senior officers of all the centres were

organized in Delhi. All the centres were appraized of the procedures of site selection, core team constitution, project preparation methodologies and financial management aspects of the project.

To create a resource group of trainers for organizing trainings of core team scientists of different centres, two training programmes were organized for 11 days. In these programmes 64 scientists from different institutions of the country were trained. These scientists were used as resource persons in subsequent training programmes organized in different zones.

Six zonal training programmes each of 13 days duration were conducted for all the centres in the country. In these training programmes 176 scientists from 41 centres were trained. A resource of 213 scientists has been created in the country in the concept, approaches and methodologies to be adopted in planning and execution of participatory technology development approaches envisaged in this project.

Later, the centres were requested to prepare project documents. These documents were discussed in detail in the zonal steering committee meetings organized in November/December, 1995. Till this date, the Project documents of 34 centres covering about 21,000 farm families have been approved by the council and all these centres have started implementing the project since *kharif* 1996.

**Number of KVKs and TTCs zone-wise**

| Zone | States and Union Territories | Number of KVKs | Number of TTCs |
|---|---|---|---|
| I | Punjab, Haryana, Himachal Pradesh Jammu and Kashmir, Delhi | 36 | 01 |
| II | Bihar, West Bengal, UT of Andaman and Nicobar Islands | 26 | — |
| III | Assam, North-Eastern states including Sikkim | 16 | 01 |
| IV | Uttar Pradesh | 29 | — |
| V | Andhra Pradesh and Maharashtra | 41 | 01 |
| VI | Rajasthan, Gujarat and UT of Dadar and Nagar Haveli | 43 | — |
| VII | Orissa and Madhya Pradesh | 32 | 02 |
| VIII | Kerala, Karnataka, Tamil Nadu, Goa and UT of Pondicherry and Lakshadeep | 38 | 03 |
| | Total | 261 | 08 |

## RESEARCH ON WOMEN IN AGRICULTURE

Considering the predominant role of women in agriculture and allied activities the working group on agricultural research and education constituted by the planning commission recommended to establish a National Research Centre for Women in Agriculture (NRCWA) during the Eighth Five-Year Plan. Thus the centre was established and started functioning at Bhubaneshwar in April, 1996 with the following mandates: (i) acting as a repository of information relevant to women in agriculture; (ii) strengthening the use of gender analysis in research and technology development to ensure that women's as well as men's agricultural enterprises and operations are fully considered

A woman farmer showing good seed formation in sunflower hybrid 'Mahyco 8' ('MSFH 8')

for defining research programmes and setting priorities; (iii) collaborating in women's specific research, education and technology assessment and refinement with relevant national and international organizations; (iv) conducting training and developing training modules and manuals for sensitizing gender related issues in research/programme/policy development; (v) development and testing of women-specific extension models and manuals for technology transfer that are to be promoted through regular extension agencies by collaborating SAUs/ICAR institutes; (vi) providing leadership and sponsor training programmes to strengthen the knowledge and skill related to Gender Implications in Farming Systems Approach for the researchers and extension professionals engaged in role of women in agriculture; and (vii) providing consultancy services within and outside the country on women specific research/project/programme.

**Achievements**

In recognition to the increased role played by farm women in agrarian society of developing and under-developed countries, there has been several attempts in understanding the role of women in agriculture. The role played by farm women in economic and social terms, integration of women's concern in the research and development agenda is yet to find an appropriate place. Changes in the organizational, both structural as well as functional dimensions of the programme development and implementation agencies are therefore imperative. Further, such changes are required to be supported by human resource endeavour by strengthening the capabilities of managers at various levels to tackle gender issues in agriculture.

With this background, NRCWA took the earliest opportunity, since its inception on 1 April, 1996, to organize a workshop-cum-training on Gender Implications in Farming Systems Approach during 11-22 May, 1996. Fifteen women scientists from different disciplines representing different state agricultural universities and institutes of the Indian Council of Agricultural Research participated in the programme.

The overall aim of the workshop-cum-training programme was to enhance the capability of the participants to develop research, extension, development and policy agenda for addressing gender issues and other related social concerns in farming systems approach to agriculture. The specific objectives of the workshop were as follows: (i) appreciate the need for incorporating gender concerns in farming system research and extension; (ii) use participatory rural appraisal tools and agro-ecosystem analysis for examining gender issues; and (iii) prepare projects with gender concerns by identifying the problems, prioritization and screening of possible interventions.

The programme was designed on participatory training mode in the framework of experimental learning cycle using the training methods like interactive lecturette, participatory discussion, large group exercise, small group exercise, case study, games, films and field visit to various farming systems.

The whole concept was further operationalized and practiced through a village study to find the applicability of the methodology in understanding the gender perspectives and their applications in reality. While arrangements for adequate reading materials were made in order to provide a strong theoretical back-stopping, it was followed up with individual assignments to provide adequate insights. A training resource book on *Gender Implications in Farming Systems Approach* has also been published.

**Women in Rice Cultivation**

The involvement of women in rice cultivation varies with the production system and socio-economic milieu. Women, landless and poor do 80% work in rice cultivation. They have predominant role in rice production particularly in the seedlings uprooting, transplanting, weeding, harvesting and post-harvest activities. In green revolution production systems women contribute 100% in transplanting, 50% in weeding, 62% in harvesting and threshing, 45% in transporting of harvest from field to threshing yard, and 75% in cleaning, drying and storage of grain. The women in small production system

contribute 20% in uprooting of seedlings, transplanting (100%), weeding (30%) harvesting (80%) transporting (20%) and drying (20%). There is a significant variation in two production systems pertaining to rice cultivation in terms of empowerment, access to and control over resources and preference for various activities in a given farming system.

## MAJOR THRUST IN IX PLAN

Due to the emerging challenges of liberalizations and globalization of economy, it is imperative for the Division to evolve appropriate strategy so that the needs of farmers and farm women are met. Hence, the priority and thrust areas in IX Plan will be as follows: (i) Enrichment of on-going activities of KVKs, TTCs, NRCWA and IVLP programmes; (ii) minimizing regional imbalances in the growth of KVKs particularly in backward, hilly, tribal and rainfed areas; (iii) strengthening Directorate of Extension of SAUs and Division of Agricultural Extension of the ICAR Institute, NRCs, PDs to facilitate effective monitoring and concurrent evaluation and correcting mechanism for KVKs and other extension projects; (iv) initiating mission mode projects in different production system in the country in the areas of livestock based farming in arid and semi-arid eco-system, aquaculture production in coastal eco-system, shifting cultivation in North-Eastern Hill Region, rice-wheat based farming and technology assessment, refinement and transfer in deep water paddy production system in eastern India; (v) human resource development of KVK/TTC staff to orient and revamp their competence and expertize through systematic planning for improving their performance; (vi) strengthening technology assessment, refinement and transfer under IVLP project in 70 centres in order to cover the major agro-climatic zones of the country; (vii) initiating for establishing of additional trainers' training centre in vegetable crops to equip the farmers with the latest production, processing and value addition technology in vegetables; and (viii) initiating village adoption project by SAUs and ICAR institutes. A typical village is proposed to be adopted where the total technology is to be disseminated and transferred with an objective of increasing agricultural productivity and generating self-employment for rural youth with an overriding criteria of sustainability, stability and social equity.

**Major Thrust in IX Plan**

* Enrichment of on-going activities of KVKs/ TTCs
* Minimizing regional imbalances in the growth of KVKs
* Strengthening Directorate of Extension of SAUs
* Initiating mission mode projects in areas of
  * livestock based farming
  * aquaculture production
  * shifting cultivation
  * rice-wheat based farming
* Human resource development of KVKs/ TTCs
* Strengthening technology assessment, refinement and transfer under IVLP
* Establishment of TTC in vegetale crops
* Initiating village adoption project by SAUs and ICAR institutes.

# Research for Tribal and Hill Regions

# 3. Research for Tribal and Hill Regions

## ICAR Research Complex for NEH Region, Barapani

### AGRONOMY

In rainfed upland, maize + groundnut (2:2) and maize + french-bean (2:2) intercropping systems were promising compared with sole cropping. Groundnut intercropping with maize also increased the total productivity per unit area. Maize (sole) produced 38.2 q/ha, while groundnut intercropped with maize in paired

- Rice varieties 'KD 263', 'DR 92', 'IR 317888', 'TRC 10' and 'RCPL 1-87-8' have been found promising for natural farming
- 'ICGS 76' and 'ICGS 44' groundnut gave higher pod yield than 'JL 24' and 'Girnar 1'
- Cob-borer was found the most serious pest of maize
- Pineapple in paired rows with guava and turmeric was found remunerative

The rice varieties grown under natural farming performed well with application of water fern (*Azolla caroliniana*)

rows produced 42.0 q/ha of maize-equivalent yield.

Natural farming under wetland situation has given encouraging results. Some of the rice varieties are found promising with a grain yield of above 30q/ha under natural farming. These rice varieties grown under natural farming without applying any input except release of water fern (*Azolla caroliniana*) @ 335 kg/ha immediately after transplanting performed well. The rice varieties found promising for natural farming are 'KD 263' (40.0 q/ha), 'DR 92' (36.6 q/ha), 'IR 317888' (36.0 q/ha), 'TRC 10' (34.6 q/ha) and 'RCPL 1-87-8' (34.1 q/ha).

'ICGS 76' and 'ICGS 44' gave higher pod yield (25-30 q/ha) than 'JL 24' and 'Girnar 1' (22-25 q/ha). Confectionery bold kernel groundnut varieties, viz. 'ICGV 88385', 'ICGV 88390', 'ICGV 88393', 'ICGV 88375 and 'BAU 13' produced about 35 q/ha of pod yield under mid-hill condition of Meghalaya. Farmyard manure @ 10 tonnes/ha produced as high as 32.0 q/ha of pod yield from 'ICGS 76', which is comparable to NPK @ 20:60:40 kg/ha with similar pod yield (33.0 q/ha).

Farmyard manure @ 10 tonnes/ha enriched with rockphosphate @ 60 kg/ha produced 37.1 q/ha of pod yield in groundnut, while single superphosphate alone @ 60 kg/ha produced 33.2 q/ha of pod yield.

Application of zinc sulphate @ 25 kg/ha in conjunction with NPK (20:60:40 kg/ha) increased yield of groundnut (28.5 q/ha). NPK alone produced 26.6 q/ha of groundnut.

The result of soil-moisture conservation *in situ* showed that 10-15 cm bund height significantly increased the rice grain yield (34-42%) over unbunded crop. Similarly, paddy-straw yield was also highest with 10 cm bund height followed by 15 cm bund height. The interaction of 10-15 cm bund height with rice 'Subhadra' ('DR 92') produced the highest grain (24.58 q/ha) as well as straw yield (69.72 q/ha).

The result of different moisture regimes on potato-tuber yield showed that irrigations at 40 and 80 days after sowing were found superior and produced significantly the highest yield (268 q/ha).

## PEST MANAGEMENT

***Maize.*** Cob-borer *Stenachroia elongella* was observed the most serious pest of maize. Among the six varieties tested, 'Vijay' composite was found the most susceptible, whereas 'RCM 1-2' (pop corn) escaped infestation completely due to early maturity. Neemarc and limanool (Azadirachtin) neem formulations sprayed at silking stage and 15 days after silking @ 3 ml/l resulted in 85% decrease in larval populations.

***Rice.*** Leaf-folder was found the main pest in rice field under lowland conditions. Gundhi bug and rice root aphids were found in large populations on upland rice. A single spray of Monocrotophos 0.02% effectively controlled the pest.

***Groundnut.*** Leaf-folders, *Nacolea vulgalis* and *N. dimmenalis*, were major pests of groundnut. Spraying Monocrotophos 0.02% gave complete control of the pests.

***Sunflower.*** Soil-inhabiting ant (*Darylus orientalis*) and *Spodoptera litura* were found to be the major pests in sunflower.

***Citrus.*** Fruit bugs, *Rhynchochoris humeralis* were found in large numbers (2 nymphs/fruit) to cause premature fruit dropping and uneven growth of the fruits.

***Guava.*** Stem-borer, *Aristobia testuda*, was found the most serious pest of guava in the region, causing 90-100% damage. This is a new pest recorded on guava. Earlier reports revealed it to be a stem-borer of litchi plants in China.

Rodent damage was found very high in the major rice-growing areas of Meghalaya at milk-grain stage. Timely baiting by farmers with zinc phosphide resulted in overcoming the pest population. The new generation anticoagulant, Difethiolone was found highly effective in bringing about mortality under lower dosage compared with conventional anticoagulants like Bromadiolone. Difethiolone wax blocks and loose baits were found to give complete mortality in 4-8 days as compared with other anticoagulants.

## AGROFORESTRY

The agroforestry interventions, viz. silvi-pastoral for hill tops; silvi-horticulture, agri-silviculture, sericulture with fruit plants and grasses for mid hills; agri-horticulture, sericulture with crops for foothills; and agro-aquaculture, paddy-cum-sericulture and paddy-cum-fish culture for valley lands have been perfected.

Pineapple in paired rows with guava and turmeric in alternate terraces was found remu-

nerative under horti-agricultural system with high inputs and intensive management practices. Guava with large cardamom (*Amomum subulatum*) has great potential in mid- and foothill situations, especially where more moisture is available.

### PRODUCTIVITY OF *JHUM* LAND

The productivity of crops under *jhum* lands are quite variable after the land clearing and depends on amount of burning materials, method of its burning, soil depth, slope gradient, manure and fertilizer management and cultural practices adopted. Hence, a comparison has been made between newly cleared forested land and abandoned (one-year old) *jhum* land to ascertain the sustainability of *jhum* land. A drastic reduction in ginger yield was recorded under abandoned *jhum* land in spite of burning of 40 to 120 tonnes of biomass per hectare which failed to restore the productivity of *jhum* land at par with newly cleared forested land which required supplemented nutrients equivalent to 40 tonnes of biomass. The difference in yield was more pronounced with quantity of biomass than method of its burning. In general, closed burning (burn) proved superior and gave 22% and 33.3% higher yield than open burning (*jhum*) in newly cleared forested land and abandoned *jhum* land. Besides, it was 12.8% and 19.8% in between the upper and lower slopes in order. The combined effect of method x biomass was found to be highly significant.

### ANIMAL NUTRITION

Rice polish base feeding system has been formulated and evaulated in pig and poultry. Rice polish can be incorporated up to 70% and 20% level in pig and poultry broiler ration respectively.

Broken rice in place of maize can be used up to 45% level and feed efficiency and protein digestibility can be improved with incorporation of soyaflakes in the poultry ration.

Incorporation of live yeast culture (lactosacc) @ 25 g/100 kg feed improved feed efficiency and digestibility of protein and calcium with reduced feed consumption in poultry broiler.

Nevaro (*Ficus hookerii*) leaves can form a substantial part (40-60%) in complete feed of adult rabbit with satisfactory dry-matter intake and digestibility of nutrients.

### AGRICULTURAL EXTENSION

Thirty demonstrations in the farmers' field were conducted on different crops like tomato, maize and rice to expose these technologies to the tribal farmers and motivate them to adopt modern agricultural innovations.

Four training programmes were organized for officers of the state government as well as enterpreneures.

On-farm trials are being conducted on farmers' field to compare the paddy-cum-fish culture and freshwater-fish culture, specially the net economic return in Meghalaya.

## Central Agricultural Research Institute, Port Blair

### HORTICULTURE

**Pineapple**

The agroclimatic condition of Andaman and Nicobar islands is quite favourable for the growth of pineapple. In off-season fruiting trials, staggering of fruit harvest, almost throughout the

* Intercropping of french-bean and radish gave higher yield compared with sole crops.
* Formulation of vaccine against dropsy disease in fishes
* Development of oil-degrading bacteria for protection of mangrove forests

year, has been obtained by planting suckers of different sizes at different intervals and by treating the suckers with 100 ppm ethrel at 10-12 months after planting (35-40 leaves stage). This has also induced uniform flowering in these plants.

**Vegetable Intercropping**

Intercropping system involving french-bean and radish in 2:2 ratio was found the best with respect to yield (french-bean 58.2 q/ha, radish 118.9 q/ha) and economic returns (Rs 48,356/ha). The combination gave LER of 1.44 compared with sole crop.

**Arecanut**

Sixteen elite palms in arecanut were selected with a yield range of 16.65 to 27.18 kg/palm/year and kernel yield of 3.61 to 6.07 kg/palm/year.

**Fruit Crops**

A study on manipulation of fruiting in mango indicated that 5.0 g cultar was effective for retaining maximum number of fruits at harvest stage.

KMS and sodium benzoate were used for preserving juice extracted from cashew apples.

In minor fruit nursery, the seeds of wild jamun (*Syzygium* sp.) were collected in bulk for further multiplication and fruits of bethphal (*Calamas* sp.) were collected and studied for nutritional value.

## FISHERIES

**Air-breathing Fish Culture**

In polyculture of air-breathing fishes, *C. bactracus* recorded a growth rate of 7.1mm/12.4 g, grass carp 23 mm/235 g and big head carp 45.3 mm/44.6 g per month. *C. bactracus*

An infectious bursal disease resistant chicken has been identified in Andamans

attained the weight of 58.0 g, whereas grass carp and big head carp attained the size of 167.5 mm/120.0 g and 259.0 mm/223.0 g respectively.

**Mullet Culture**

Mullet, *Liza tade*, stocked in brackishwater ponds (0.2 ha) @ 1,500/ha grew from initial size of 39 mm to 135-500 mm and gave a net production rate of 220 kg/ha in 18 months.

**Formulation of Vaccine Against Dropsy Disease in Fishes**

Cultural, biochemical, virulence factors, plasmid and protein profiles of virulent *Aeromonas hydrophila* and attenuated strain passaged up to 75 passages were compared. The cultural, biochemical and protein profiles were found similar, but lack of DNase enzyme (a highly virulent factor) and difference in plasmid profiles was noticed. This is an useful information required for formulating a vaccine against dropsy disease in fishes.

**Pelleted Feed for Aquarium Fishes**

The pelleted feed prepared with shark meat, glyricidia leaf, blood meal and oil cake showed acceptance rate from 85% to 90% for air-breathing fishes. The ammonia level remained low (1.7-2.0 mg/l) in aquarium, after using this feed compared with other feeds.

## ANIMAL SCIENCES

**Infertility in Crossbred Cows**

A survey showed that infertility in crossbred cows increased with increase in number of calvings. About 15% cows showed permanent urino-genital tract deformities in subsequent lactations.

**Poultry**

There was an outbreak of infectious bursal disease in layer chicks having the virulent strain of the virus. Similar outbreaks have been recorded in two other localities in South Andamans. A disease-resistant bird has been identified.

Addition of palm-oil cake, coconut meal at the level of 10% and a combination of these two in broiler ration gave better growth performance up to eight weeks of body weight compared with the control.

**Oil-degrading Bacteria**

A large area in the coastal zone is subjected to oil pollution and thereby affecting the growth of mangrove forests. In an attempt to identify some of the bacteria which can degrade oil, two promising lines were obtained from mangrove forests. It was, however, observed that efficiency of oil-degrading bacteria can be increased by application of fertilizer in water.

**Bacterial Isolates**

Antisera was raised in rabbits against virulent *A. hydrophila*. Laboratory passaged *A. hydrophila* showed very good antibody titer when tested by AGPT (Agar gel precipitation test). Antisera of virulent *A. hydrophila* was found to cross-react with six bacterial isolates, isolated from diseased fishes. While assessing 40 bacterial isolates from mangroves of Andamans for temperature, pH and bio-active compounds, it was found that most of the bacteria were able to grow at 22°C, 37°C and even at 45°C. They were also able to grow at pH 7, few at pH 10 and four cultures at pH 12. Out of 40 bacterial isolates two were xylanolytic (possess xylanolases) and six showed lipase activity (in 25% milk media).

**Bovine Rhino Tracheitis**

Two hundred serum samples collected from cattle in South Andamans were screened for seroprevalence of infectious bovine rhino tracheitis virus infection by enzyme-linked immuno-asorbant assay (ELISA). 96% of cattle showed very high antibody titer in the ELISA and they were reactors (positive) for infectious bovine rhino tracheitis disease.

## AGRICULTURAL EXTENSION

The KVK of the Institute conducted demonstrations, training programmes and field days in effective co-ordination with other departments like Agriculture, Animal Husbandry, Forest, Health and Social Welfare. During the year training programmes on preservation of fruits and vegetables, palm care and management, soil sampling method and package of practices for rice, dairy farming, weed control in rice, use of fertilizers in rice, agroforestry and kitchen gardening were conducted.

# Vivekananda Parvatiya Krishi Anusandhan Shala, Almora

- A rust-resistant variety of wheat 'VL Gehun 738' has been identified for cultivation in the northern-hill zone
- 'VL 6' garden pea has been identified for release

## NEW VARIETIES

A rust-resistant, high-yielding variety of wheat 'VL Gehun 738' has recently been identified for cultivation under rainfed and irrigated conditions of the northern hill zone by the Varietal Identification Committee of the All-India Co-ordinated Wheat Improvement Research Project. This variety has a yield potential of 43-48 q/ha under irrigated and 25-30 q/ha under rainfed condition.

A medium-duration, high-yielding variety of garden pea 'VL 6' has been identified for release in Zones I and II.

## AGRONOMY

Pine-needle mulch @ 6 tonnes/ha lowered soil temperature by 3-5°C, and maintained good soil-moisture regime during the crop growth. This resulted in advancement and enhancement in germination by 4-6 days and 15% respectively, and increase in tuber yield by 73% compared with no-mulch treatment.

In vegetable pea, the pine-needle mulch (6 tonnes/ha) produced the green pod yield (58.95 q/ha) at par with one irrigation at IW:CPE 0.80 (54.84 q/ha).

The mineralization of C and N of wheat straw and soybean trash was measured over a 12-week incubation period under controlled conditions. The rate of decomposition varied considerably and appeared to be controlled by N content of the crop residues ($R^2$=0.98).

Drip irrigation (MTI 40% E-R) in tomato produced maximum marketable fruits (123.24 q/ha) and consumed less irrigation water (104 mm) compared with check basin method (IW:CPE 1.25) which consumed three times more water (320 mm) and produced less yield (117.38 q/ha).

Continuous application of 20 kg N + 80 kg P/ha to soybean followed by wheat cropped on residual fertility showed K-deficiency symptoms in soybean.

Studies on fertilization through microtube-based drip irrigation indicated that about 25% fertilizer can be saved without significant reduction in yield when fertilizers are applied through drips compared with broadcasting in field.

Performance of ginger and turmeric was studied under different trees, viz. *Bauhinia purpurea, Celtis australis, Quercus incana* and *Grewia optiva.* Ginger and turmeric yielded 107 q/ha and 150 q/ha in partial shade and 91.21 q/ha and 127.78 q/ha in open condition respectively.

The dual-purpose wheat ('VL 616') recorded 27% more green forage with two cuts (60 and 90 days after sowing) over one cut at 75 days after sowing. However, the application of two cuts produced less yield of grain (7.2%) and straw (10%) compared with one cut.

The cowpea recorded highest green forage yield (209.49 q/ha) between 50 to 60 days after sowing. The delay in harvesting reduced yield significantly. In horsegram, yield was not reduced up to 80 days after sowing though it was highest at 70 days after sowing.

## CROP PROTECTION

For control of hill-bunt disease of wheat, leaf extracts of *Oxalis latifolia, Melia azedarach* and *Ageratum conyzoides* effectively reduced the disease (98.51 to 99.74%). However, treatment with *A. conyzoides* reduced seed germination considerably (up to 40%).

Effect of methods of sowing, viz. mono-cropping, varietal mixtures, and line, broadcast and cross sowing was studied on yellow-rust incidence in barley. The disease was reduced up

to threshold level (<10%) in the binary mixture of 'Himani' and 'Ratna' (1:1) varieties than in the sole 'Ratna' (13.3-26.6%). In the same combination it was more in broadcast sowing (16.6%) than in the cross or line sowing (10%).

Out of 9,000 rice germplasm screened, 23 test entries, viz. 'INRC 505', 'INRC 507', 'INRC 518', 'INRC 612', 'INRC 624', 'INRC 642', 'INRC 659', 'INRC 660', 'INRC 673', 'INRC 681', 'INRC 724', 'INRC 735', 'INRC 751', 'INRC 753', 'INRC 754', 'INRC 779', 'INRC 1187', 'INRC 1307', 'INRC 1401', 'INRC1579', 'INRC 1584', 'INRC 1586' and 'INRC 2285' were found to possess a high degree of resistance/tolerance to leaf and neck blast.

Rice genotypes 'IRAT 239', 'IRAT 250', 'Milyang 104' and 'Speed 70' have been observed to possess multiple-disease resistance. 'INRC 507', 'INRC 518' and 'INRC 1307' have shown resistance to blast.

In rice, Beam 75 WP was found highly effective in reducing blast incidence and increasing yield significantly compared with the new fungicidal formulations.

# International Co-operation

# 4. International Co-operation

The Indian Council of Agricultural Research and the Department of Agricultural Research and Education are co-operating with foreign governments, institutes and multinational agencies in the field of Agricultural Research and Education through bilateral memoranda of understanding, protocol activities and agreements concluded by the Ministry of Agriculture and the ICAR, along with other ministries of the Government of India also. The ICAR paid contribution to various foreign agencies viz. CGIAR US $ 75 000, CABI US $ 13 418, APAARI US $ 6 000, NACA US $ 30 000, CGPRT US $ 5 000 and ISTA Swish French CHF 2 380, and received invaluable benefits from these foreign agencies through exchange of scientific information, participation of Indian scientists in training or conferences, new scientific developments, germplasm material, for evolving standards commensurate with global standards.

The major thrusts in co-operation with international institutions and under bilateral co-operation terms with agriculturally developed countries are in the areas of (*i*) new emerging technologies, viz. biotechnology, information technology and remote sensing; (*ii*) rainfed agriculture with major emphasis on water-use efficiency and development of draught-resistant varieties; (*iii*) conservation of genetic resources; (*iv*) more efficient inputs, especially integrated nutrient management and integrated pest management; and (*v*) post-harvest technology.

- The First Indo-Tunisian Work Plan signed for exchange of Scientists, scientific information and genetic material.
- Indo-Australian Project on accelerating growth through globalization of Indian agriculture initiated.
- Agricultural Human Resource Development Project renamed as Agricultural Human Resource and Technology Development in second phase.
- Sustainable Rainfed Agricultural Development Project signed with Japan.
- Work Plans signed with Nepal and Mongolia under SAARC Co-operation.
- India signed agreements with IPGRI, Rome; ILRI, Kenya; IIMI, Colombo; and ICLARM for scientific and technical co-operation in Plant Genetic Resources, Livestock Research, Water Resources Management and Aquatic Resources respectively.
- International Centre for Living Aquatic Resource Management agreed for scientific and technical co-operation in Aquatic Resources.

## CO-ORDINATION WITH CGIAR SYSTEM

The Consultative Group on International Agricultural Research is an association of

public, private and institutional donors that supports a network of international agricultural research centres engaged in research, training and information dissemination on various agricultural subjects.

## AGREEMENTS

India signed the following agreements at international level during 1996 :

1. International Plant Genetic Resources Institute, Rome, in July 1996 for scientific and technical collaboration in Plant Genetic Resources.
2. International Livestock Research Institute in Kenya in November 1996 for scientific and technical co-operation in Livestock Research.
3. International Irrigation Management Institute, Colombo, for scientific and technical co-operation in Water Resources Management.

**Indo-UK Collaboration with ODA Assistance**

Under the technical assistance of the Overseas Development Administration the following Indo-UK Collaborative Projects continued their operation in the ICAR institutes and state agricultural universities during1996:

(i) Indo-UK Collaborative Project on Pathology of Oilseeds, at the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar.

(ii) Indo-UK Collaborative Project on Plant Germplasm, at the National Bureau of Plant Genetic Resources, New Delhi.

(iii) Indo-UK Collaborative Project on Salt Tolerance, at the Central Soil Salinity Research Institute, Karnal.

(iv) Indo-UK Collaborative Project on Forage Production, at the Indian Grassland and Fodder Research Institute, Jhansi.

(v) Indo-UK Collaborative Project on Fish Processing (Phase III), at the Central Institute on Fisheries Technology, Cochin.

(vi) Indo-UK Collaborative Project on Transfer of Molecular Biological Technology, at the Indian Veterinary Research Institute, Izatnagar.

Directors-General, Dr R S Paroda (ICAR) and Dr Merryl J. Williams (ICLARM), exchanging a Memorandum of Agreement for scientific and technical co-operation in research on aquatic resources

### Work Plans

Work plans signed between the ICAR and other consultative group centres are :

(1) A work plan was signed between the ICAR and the International Centre for Living Aquatic Resources Management in July 1996 for scientific and technological co-operation in Aquatic Resources.

(2) A work plan was signed between the ICAR and the International Centre for Agricultural Research in Dry Areas in Syria, for 2 years by the respective Directors-General at New Delhi in November 1996.

(3) A work plan was signed in April 1996 between the ICAR and the Centre International de la Popa for 2 years in science and technology co-operation.

(4) A work plan was signed by the Directors-General of the IPGRI and the ICAR for 2 years on 22 November 1996 in science and technology co-operation in Plant Genetic Resources.

(vii) Indo-UK Collaborative Project on Field Research into the Tolerance of Wheat to Salinity Stress, at the Central Soil Salinity Research Institute, Karnal.

Under these Indo-UK collaborative projects, 15 training spots were earmarked for training of Indian scientists in the UK. Besides, visits at the co-ordinators level were exchanged between India and the UK to monitor the implementation of these projects.

## MoUs/WORK PLANS

### Indo-US Collaboration

Ms Catherine Woteki, the acting Under-Secretary of the United States Department of Agriculture (USDA), visited India during 18-19 November 1996 to work out further modalities of implementation of the Agreement (Signed with the USDA in January 1996, during the visit of Mr Dan Glickman, Secretary of State for Agriculture, USA).

### Indo-Australian Co-operation

Umbrella arrangement was signed between India and Australia for co-operation in agricultural research and development. Under this Arrangement, the ICAR signed the Memorandum of Subsidiary Arrangements and the Project Documents in respect of the following ICAR-ACIAR collaborative projects in agricultural research :

(*i*) Accelerating growth through globalization of Indian agriculture was signed on 13 September 1996.

(*ii*) Tools and indicators for planning sustainable soil management on semi-arid farms and watersheds was signed on 30 September 1996.

(*iii*) Overcoming production constraints to cultivate sorghum in rainfed environments in India and Australia was signed on 26 November 1996.

(*iv*) Antigenic competition and vaccine failure in small ruminant vaccines in India : a preliminary investigation was signed on 6 December 1996.

### Indo-Brazilian Co-operation

The ICAR and the Brazilian Agricultural Research Corporation (EMBRARA) signed the first work plan on 1 October 1996 for co-operation in agricultural research.

### Indo-Cuban Co-operation

Under the Indo-Cuban Protocol for Co-operation in Science and Technology, India and Cuba signed work plan for the biennium 1997-1998 on 22 November 1996 for co-operation in agricultural research.

### Indo-Iranian Collaboration

Under the MoU signed between India and Iran for co-operation in agricultural research and education, the following activities were undertaken during 1996 :

(*i*) A delegation from Iran led by Eisa Kalantri, Agriculture Minister, visited the IARI and the NBPGR at New Delhi, ICAR institutes and ICRISAT at Hyderabad.

(*ii*) An Indian scientist visited Iran during 15-20 March 1996 for collection of germplasm of horticultural crops.

(*iii*) An Indian scientist visited Iran during 16-22 June 1996 to collect the germplasm of horticultural crops from Iran under exchange of germplasm.

(*iv*) Two scientists — one each from the Central Inland Capture Fisheries Research Institute, Barrackpore, and the National Research Centre on Cold Water Fisheries, Haldwani—visited Iran for training in Cold Water Fisheries during 31 December 1996 - 20 January 1997.

### Co-operation between ICAR–ICGEB

A Memorandum of Understanding was signed between the ICAR and the International Centre for Genetic Engineering and Biotechnology on 31 July 1996 at New Delhi for co-operation in agricultural research.

### Indo-Tunisian Co-operation

The First Indo–Tunisian Work Plan was signed at New Delhi on 7 October 1996 for the biennium 1996–1997. Both the countries planned exchange of scientists, scientific information and genetic material.

**Indo-French Co-operation**

An Indian delegation went to Paris during 20-25 April 1996 to attend the Working Group meetings under the Indo-French Agreement.

**Co-operation with Lao Peoples' Democratic Republic**

An Indian delegation went to Lao Peoples' Democratic Republic during 28 August–2 September 1996. As a follow-up to the visit of the Indian delegation, ICAR experts in rice, cashew and livestock vaccines will be visiting Laos.

**ICAR–PCARRD Work Plan**

Under the ICAR–PCARRD Work Plan for co-operation in agricultural research, scientists visited India during 15–31 August and 15–22 October 1996 to undertake research on Mango Production and Legume Production and Processing respectively.

**Indo–Japanese Collaboration**

To develop seed storage facilities at the Seed Science Technology Division of the IARI, New Delhi, and its regional station at Karnal, the Japanese grant-aid project worth Yen 662 million was extended up to 31 March 1997 to complete the construction of the building and installation of equipment agreed under the Project.

## BILATERAL AGREEMENTS OF CO-OPERATION

1. An agreement for co-operation in agriculture and related subjects was signed between the ICAR and the Russian Academy of Agricultural Sciences. In pursuance of this agreement, a work plan for 1996–97 was signed on 19 August 1996 at Moscow during the meeting of Sub-Working Group, held during 14–20 August 1996.
2. To promote bilateral co-operation with the Republic of Uzbekistan, two hand-operated rice transplanters were gifted to the Ambassador of Uzbekistan in India on 15 May 1996. Co-operation in agriculture with other CIS countries, viz. Kyrghyzthan, Kazakhsthan and Turkmenistan, is also in progress.

**Indo-Israeli Co-operation**

A draft of work plan between the ICAR and the Hebrew University of Jerusalem was prepared during the visit of the DG, ICAR to Israel. It was followed by a deputation of Indian scientists to Israel for training in international courses at the Hebrew University.

**Training of ICAR Scientists at Hebrew University of Jerusalem**

(i) International training course on Biotechnology was held during 10 September–29 October 1996.
(ii) International course on Crops for Arid and Semi-arid Zones was conducted during 21 October–13 December 1996.
(iii) International course on Horticulture Crop Production in Sub-tropical Climates in Israel was conducted during 5 November 1996–14 January 1997.

**Setting up a Demonstration Farm**

The Government of Israel proposed to set up a Demonstration Farm at New Delhi with the help of Israeli experts in Horticulture, Irrigation and Protected Agriculture. The IARI, New Delhi was considered to be the ideal site for the proposed Demonstration Farm. For its further modalities, Israel decided to depute experts in the areas of Horticulture, Protected Agriculture and Irrigation. In this connection, a Memorandum of intent was signed between India and Israel on 30 December 1996.

## INTERNATIONAL CO-OPERATION PROJECTS

**1. Agricultural Human Resource Development Project, Phase II**

The negotiations for the Phase II of AHRD project have been started. In the meeting of the Core Group, it was decided to incorporate technology as a component of AHRD. The project is proposed to be renamed as Agricultural Human Resource and Technology Development Project.

**2. National Agricultural Technology Project**

National Agricultural Technology Project is contemplated for implementation through credit assistance from the World Bank. The Project will focus attention on the agricultural research and extension. The concept paper of the project has already been prepared by the ICAR. Further modalities for the formulation of the project are being finalized.

**3. Sustainable Rainfed Agricultural Development Project**

Under the Japanese Grant Agreement Yen 81.3 million has been made available to India for undertaking preparatory activities relating to the formulation of the said project. The technical proposals with ICRISAT, IFPRI (International Food Policy Research Institute, USA), and CRIDA (Central Research Institute on Dryland Agriculture, Hyderabad) have been cleared. The contract with ICRISAT and IFPRI has been finalized.

**4. Strengthening of Research and Training in Population and Development Dynamics of Rural Fishing Communities**

A FAO project, total cost US $ 1,82,000, was approved for six countries. This is to be implemented for two years at Central Institute of Fisheries Education (CIFE), Bombay.

**5. Overcoming Production Constraints to Sorghum in Rainfed Environment in India and Australia**

An ACIAR Project was approved at a total outlay of US $ 2,116,237 for three years.

### SAARC CO-OPERATION

1. Among SAARC countries, a work plan for 1997-1998 was signed on 25 November 1996 with Nepal for co-operation in agricultural research. A Memorandum of Understanding is also likely to be signed soon with the International Centre for Integrated Mountain Development, Nepal.
2. A work plan for 1996-1997 was also signed with Mongolia at New Delhi, and it is valid up to 31 December 1997. In pursuance of this work plan, one scientist visited Mongolia during 12-28 May 1996 for study of cultivation of cold-resistant and early-maturing wheat.

**6. Drainage and Water Management for Salinity Control in Canal Commands**

The outlay of the Indo-Netherlands Project is Dfl. 17.060 million for five years and is to be implemented at the CSSRI, Karnal.

**7. Exploitation of Rhizoctonia the toxin-inactivating Genes for Sheath Blight Management in Rice**

Rockefeller Foundation Grant of US $ 61 775 to TNAU, Coimbatore was approved for three years.

Besides above, 60 cases of deputation abroad were approved under various foreign-aided projects. Foreign experts (8) were cleared for consultance assignment under various foreign aided projects.

## PROTOCOL ACTIVITIES

A good number of high dignitaries visited the ICAR headquarters and ICAR institutes during 1996.

1. Visit of a three member high level delegation from Republic of Zaire to IARI and NBPGR, New Delhi on 9 April 1996.
2. Visit of Mr Abdelaziz Arifi and Mr Ahmed Amiri, two members of Morocco delegation, during April 1996–MEA invitees.
3. Visit of Mr Timothy La Salle, President, California Agriculture Leadership Programme.
4. Visit of HE Mr Israel Kibirige Sebunya, Minister of State for Agriculture, Uganda, and Prof Joseph Mukubi, Director-General, NARO, Uganda to India during 2-5 Septempber 1996.
5. Visit of Mr A September, First Secretary, High Commission of the Republic of Namibia, New Delhi to CRIDA, Hyderabad; CSSRI, Karnal; and IARI, New Delhi during 12–18 September 1996.
6. Visit of Dr Shivramiah Shantharam (Chief, Biotechnology Permits, USDA, Washington); Head of 15-member delegation), to ICAR (Hqrs), IARI, and NBPGR, New Delhi on 16 September 1996.
7. Visit of Dr (Ms) Catherine Woteki, acting Under-Secretary, USDA, Washington (USA) to India during 18–19 November 1996.

Minister for Agriculture, Shri Chaturanan Mishra, giving away a plaque to Dr (Ms) Catherine Woteki, acting Under-Secretary, USDA, USA on 19 November 1996 at NBPGR, Delhi, during her visit to India

8. Visit of a French Business delegation to IARI, New Delhi on 12 November 1996.
9. Visit of Mr Ismail Serageldin, Chairman, CGIAR and Vice-President, World Bank, Washington to India during 17–25 November 1996.

## WORKSHOPS/SEMINARS/TRAINING COURSES

The workshops, seminars or training courses organized during 1996 are given below :

1. Workshop on Training of Trainers' in Agricultural Extension for SAARC countries was held at New Delhi during 29-31 August 1996.
2. International Potato Center (CIP) organized a workshop on Potato Storage Systems at CPRS, Modipuram during 10-12 September 1996.
3. International Rice Research Institute (IRRI) organized the Deepwater Rice Research Workshop at Delhi University during 28-31 October 1996.
4. Meeting of International Crop Science Congress was held in New Delhi during 17-23 November 1996.
5. Meeting of Asia Pacific Association of Agricultural Research Institutions was held in New Delhi during 20-26 November 1996.
6. International Plant Genetic Resources Institute (IPGRI) organized a regional training course on Seed Genebank Management at National Bureau of Plant Genetic Resources, New Delhi during 8-22 December 1996.
7. For training, visits, Post-Doctoral Fellowships, scholarships or higher studies leading to the award of Ph.D. 60 visits were approved.

## INDIAN DELEGATIONS TO FOREIGN COUNTRIES

The following major delegations were sent abroad during 1996:

1. Prof V L Chopra, National Professor, NRC on Plant Biotechnology, IARI, New Delhi attended the Meeting of Board of Trustees

### ROLE OF PARLIAMENTARY STANDING COMMITTEES

(i) Parliamentary Standing Committee on Agriculture under the Chairmanship of Shri Santosh Kumar Gangwar visited ICAR Research Complex, Goa on 28 October 1996, and NDRI, Karnal, in connection with study tour on 14 November 1996.

(ii) In session meeting of the Consultative Committee of Ministry of Agriculture, consisting of 31 Members of Parliament from both the Houses, was convened on 16 December 1996 on the subject of Agriculture Education in India.

of IRRI and CIMMYT at Manila during 10-19 April 1996.

2. Dr R P Sharma, PD, NRC on Plant Biotechnology, New Delhi was deputed for participation in the International Conference on Biotechnology and Biodiversity in Kathmandu, Nepal during 16-18 April 1996.
3. Dr M L Madan, DDG (AS), ICAR was deputed for participation in the ACIAR Workshop on Sustainable Parasite Control in Small Ruminants in Bogor, Indonesia during 22-25 April 1996.
4. Dr P Das, DDG (Agricultural Extension), Dr Mruthyunjaya, ADG (ESM), ICAR and Dr D N Jha, Director (NCAP) attended Workshop on Social Science Research and Sustainability of Rice-Wheat Production Systems at Kathmandu during 29 April-2 May 1996.
5. Dr P V Dehadrai, DDG (Fy), ICAR, was deputed for participation in the ODA Fish Genetics Research Programme Workshop at Wales, UK during 2-5 May 1996.
6. Dr M L Madan, DDG (AS), ICAR, was deputed for participation in the 64 Annual General Session of the OIE, held in Paris, France during 20-24 May 1996.
7. Dr Mangala Rai, ADG (P), and Dr S P Tewari, ADG (Seeds), both from ICAR, were deputed for participation in the International Workshop on Reforming Regulatory Frameworks for Small Farmer Seed Supply in London, UK during 29-31 May 1996.
8. Dr Dayanratha Jha, Director, NCAP, New Delhi, visited Bangkok during 3-5 June 1996 to attend International Conference on Impact of Rice Research.
9. Dr K Gopakumar, Director, CIFT, Cochin, was deputed for participation in the FAO Working Party Meeting on Fish Technology and Marketing and STD3 Project Meeting on Utilization of Low Value Fish at Colombo, Sri Lanka during 4-7 June 1996.
10. Dr R N Verma, Director, NCMRT, Solan was deputed for participation in Second International Conference on Mushroom Biology and Mushroom Products at Penn State University, USA during 9-15 June 1996.
11. Dr P S Reddy, PD, DOR, Hyderabad, was deputed for participation in the 14 International Sunflower Conference at Beijing, China during 12-20 June 1996.
12. Dr K C Mathur, Director, Central Rice Research Institute (CRRI), Cuttack, attended Meeting of Steering Committee of Rainfed Lowland Rice Research Consortium at Dhaka during 17-19 June 1996.
13. Dr M Devraj, Director, CMFRI, Cochin, was deputed for participation in Workshop on Fisheries and Oceanography at Cairo, Egypt during 22-27 June 1996.
14. Dr A S Faroda, Director, CAZRI, Jodhpur, was deputed for participation in Expert Meeting on Rehabilitation of Forest Degraded Ecosystems in Lisbon, Portugal during 24-28 June 1996.
15. Dr M L Madan, DDG (AS), ICAR, was deputed for participation in the 13 International Congress on Animal Reproduction in Sydney, Australia during 29 June-5 July 1996.
16. Dr S Ayyappau,, Director, CIFA, Bhubaneshwar, attended Steering Committee Meeting of INGA, Egypt during 8-11 July 1996.
17. Dr (Mrs) Tej Verma, ADG (Home Science), ICAR, was deputed for participation in the 18 IFHE Congress in Bangkok, Thailand during 22-27 July 1996.
18. Dr E A Siddiq, DDG (CS), ICAR and Dr A N Asthana, Director, IIPR, Kanpur, were deputed for participation in the project meeting on improvement of yield and drought resistance of chickpea in Australia during 29 July-2 August 1996.
19. Dr A S Faroda, Director, CAZRI, Jodhpur was deputed for participation in the Fifth International Desert Development Conference in Lubbock, Texas, USA during 12-17 August 1996.
20. Dr J S Samra, Director, CSWCR & TI, Dehra Dun was deputed for participation in the Ninth Conference of ISCO (International Soil Conservation Organization) in Bonn, Germany during 26-30 August, 1996.
21. Dr D G Dhandar, Director, ICAR Research Complex, Goa, was deputed for participa-

tion in the Fifth International Mango Symposium in Tel Aviv, Israel during 1-6 September 1996.

22. Dr N K Tyagi, Director, CSSRI, Karnal, was deputed for participation in the 16 Congress of the ICID and Post-Conference tour in Cairo, Egypt during 15-26 September 1996.
23. Prof V L Chopra, National Professor, NRC on Plant Biotechnology, Indian Agricultural Research Institute (IARI), New Delhi attended Meeting of Board of Trustees of International Rice Research Institute, Manila during 19-20 September 1996 at Manila, Philippines.
24. Dr B S Rana, Director, NRC on Sorghum, Hyderabad attended International Conference on Genetic Improvement on Sorghum and Pearl Millets in Texas, USA during 23-27 September 1996.
25. Dr R B Singh, Director, Indian Agricultural Research Institute (IARI), New Delhi, attended 30 Annual Celebration of Centro International de Meforamiento de Maizy Trigo (CIMMYT) and other delibrations at Mexico during 23-27 September 1996.
26. Dr Mangala Rai, ADG (P), ICAR, was deputed for participation in the Asia Pacific Seed Association Workshop and Asian Seed Conference '96 in Jakarta, Indonesia during 23-27 September 1996.
27. Shri B N Singh, OSD, OAM, was deputed for accompanying the Agriculture Minister as a State Guest to Oman during 3-7 October 1996.
28. Dr M S Kairon, Director, CICR, Nagpur, was deputed for participation in the 55 Plenary Session of the International Cotton Advisory Committee in Tashkent, Uzbekistan during 7-11 October 1996.
29. Dr A S Faroda, Director, CAZRI, Jodhpur, was deputed for participation in the International Conference on Mediterranean Desertification in Crete, Greece during 29 October - 1 November 1996.
30. Dr M L Madan, DDG (AS), ICAR, was deputed for participation in the ICIMOD Regional Workshop on Conservation of Yak Genetic Diversity in Kathmandu, Nepal during 29-31 October 1996.
31. Dr G T Kurup, Director, CTCRI, Trivandrum, attended Fifth Asian Cassava Research Workshop in China during 4-8 November 1996.
32. Dr P Das, DDG (Agricultural Extension), ICAR, was deputed for participation as a resource person, in Training/Seminar on Participatory Analysis, Planning and Institutionalization in Mtwara, Tanzania during 4-27 November 1996.
33. Dr Bhagmal, Director, IGFRI, Jhansi and Dr Panjab Singh, Joint Director (Research), IARI, New Delhi, were deputed for participation in the ICIMOD Regional Expert Meeting on Rangelands and Pastoral Development in the Hindukush Himalaya in Kathmandu, Nepal during 5-7 November 1996.
34. Prof V L Chopra, National Professor, NRC on Plant Biotechnology, IARI, New Delhi, attended Meeting of Excutive Committee of Board of Trustees of International Rice Research Institute at Manila, during 29-30 November 1996.
35. Dr A K Bandyopadhyay, Director, CARI, Port Blair, was deputed for participation in the International Conference on Remediation and Management of Degraded Lands in Hong Kong during 3-6 December 1996.
36. Shri B N Singh, OSD to AM, was deputed for accompanying the Agriculture Minister on his visit to Tehran, Iran during 28-31 October 1996 for attending conference on Problems Relating to Taliban.

Besides above, 84 other officers also visited and scientists were deputed abroad to attend various workshops, conferences, seminars and training courses.

## INDIAN SCIENTISTS ATTENDED FOREIGN CONFERENCES

Our scientists took active interest in scientific activities in foreign countries by participating in various conferences.

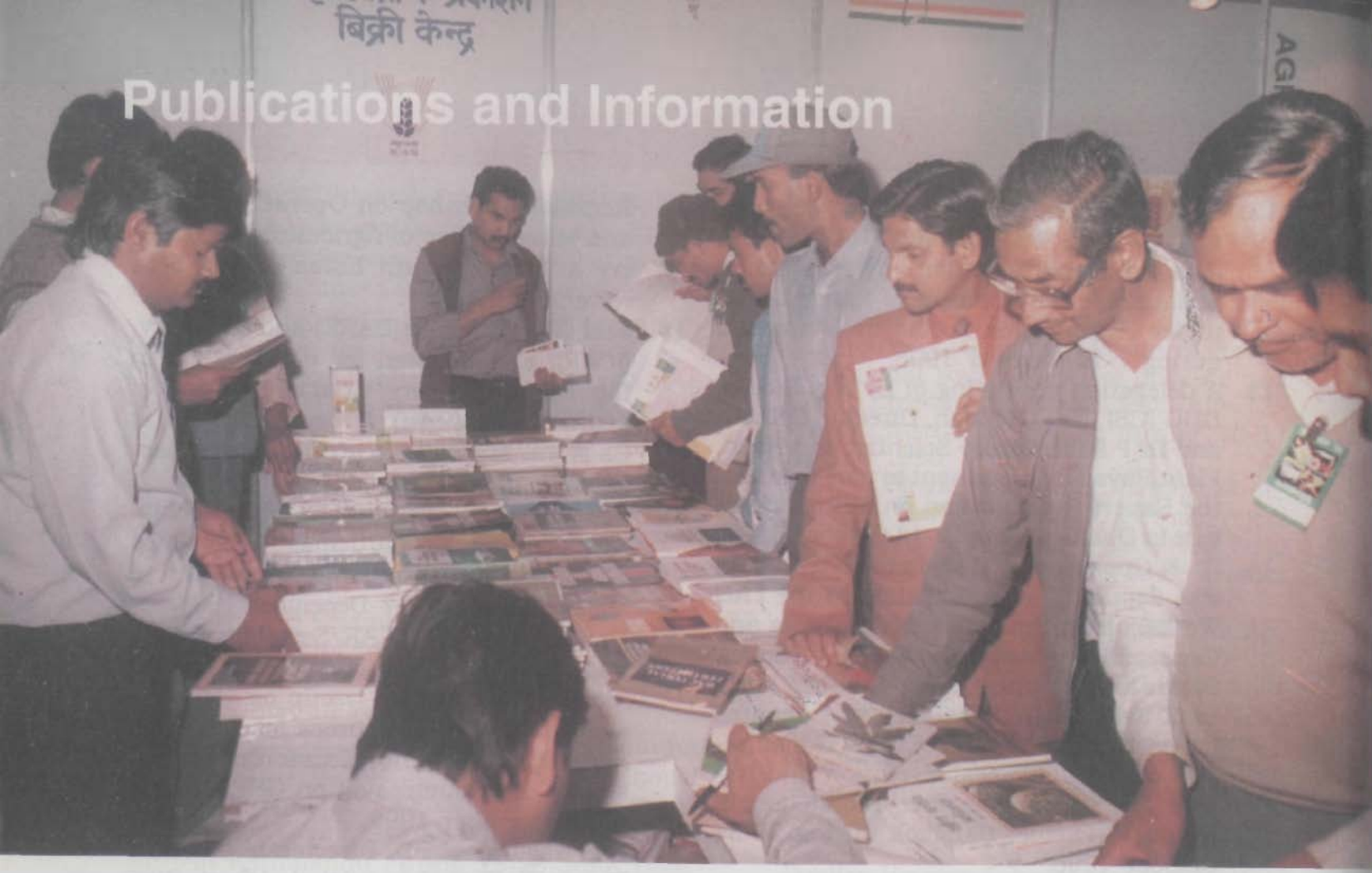
1. Dr Mangala Rai, ADG (P), ICAR, was deputed for participation for the 10 Meeting of the SAIC Governing Board in Dhaka during 9-11 April 1996.

2. Dr K P S Chandel, Director, NBPGR, was deputed for participation in 52 Extra-Ordinary Session of Commission on Genetic Resources for Food and Agriculture, Rome during 22-27 April 1996 as part of delegation from DOA and C.
3. Dr Mangala Rai, ADG (P), ICAR, was deputed for participation in the 15 Meeting of TCA in Thimpu, Bhutan during 11-12 June 1996.
4. Dr R B Singh, Director, (IARI) was deputed for participation in FAO International Technical Conference during 17-23 June 1996.
5. Dr K P S Chandel, Director, NBPGR, was deputed for participation in the FAO International Technicals Conference during 17-23 June 1996.
6. Dr R L Yadav, PD, PDCSR, Modipuram and Dr P N Takkar, Director, IISS Bhopal were deputed for participation in the Seminar on Green Manures under SAARC-TCA in Kathmandu during 25-26 June 1996.
7. Dr Mangala Rai, ADG (P), ICAR, was deputed for participation in the FAO/UNFPA-Expert Consultation on Food Production and Population Growth-Role of Population Factors during 3-5 July 1996 in Rome.
8. Dr D P Singh, Director, and Dr P Palit, Head (Physiology), both from CRIJAF, were deputed to participate as Resource Perons in Regional training course on Jute and Kenaf Breeding at Bangladesh Jute Research Institute, Dhaka during 10-11 August 1996.
9. Dr D P Singh, Director, CRIJAF was deputed for participation in the Final Project Co-ordination Meeting of IJO/FAO Seed Project at Beijing during 16-19 September 1996.
10. Dr R C Maheshwari, ADG (CSC), ICAR, was deputed as Resource Person for Energy Methodology in the Working Seminar Quantifying Sustainability during 20-28 September 1996 at Bogor, Indonesia.
11. A delegation consisting of Dr C Natarajan, Joint Director, IVRI, Regional Station, Bangalore and Dr P S R C Murti, Principal Scientist, ICAR was sent for setting up a Poultry Vaccine Laboratory—Donation of equipment by GOI to Mali Government under ITEC Programme for five days, ie, during 28 September-2 October 1996.

An MoU, signed between the ICAR and the International Centre for Genetic Engineering and Biotechnology, facilitates ICAR scientists to visit at the ICGEB or foreign countries for attending research, conferences, symposia of the same field

12. Dr A S Faroda, Director, CAZRI, Jodhpur and Dr P S Pathak, ADG (AF), ICAR, deputed for participation in workshop on Sustainable Development of Range Lands under Agricultural Sector in Islamabad during 7-10 October 1996.
13. A delegation consisting of Dr E A Siddiq, DDG (CS), Dr D P Singh, Director, CRIJAF and Dr P Palit, Senior Scientist and Head, Plant Physiology was sent to participate in the Expert Consultation on Jute Agriculture in Dhaka during 12-14 October, 1996.
14. Dr K Gopakumar, Director, CIFT, Cochin was deputed for participation in the FAO Workshop on Environmental Aspects and Code of Responsible Fisheries in Seoul, South Korea during 15-18 October 1996.
15. Dr K Krishnaiah, PD (Rice), was deputed for participation in the Expert Consultation on Technological Evolution and Impact for Sustainable Rice Production in Asia and Pacific, Bangkok during 29-31 October 1996.
16. Dr R B Singh, Director, IARI, was deputed for participation as Resource Person in the FAO Expert Consultation on Technoloogy Evolution and Impact for Sustainable Rice Production in Asia and Pacific, Bangkok, Thailand during 29-31 October 1996.
17. Dr G Singh, Director, CIAE, Bhopal, was deputed for participation in ESCAP/RNAM Regional Workshop on Operation, Repair and Maintenance of Agricultural Machinery at Seoul, South Korea during 5-14 November 1996.
18. Shri G S Sahni, JS(DARE) and Secretary, (ICAR), was deputed for participation in the Policy Advisory Council Meeting of ACIAR during 4-6 December 1996 at Canbera, Australia in an Observer capacity from the Government of India.
19. Dr M Devraj, Director, CMFRI, Cochin, was deputed for participation in NACA Workshop on Grouper Aquaculture in Malaysia during 4-7 December 1996.
20. Dr R S Paroda, DG, ICAR/Secretary, DARE, was deputed for participation in the FAO meetings of Working Group on Commission on Genetic Resources for Food and Agriculture, and Third Extraordinary Session of the Commission on GRFA during 5-13 December 1996.
21. Dr S Nagarajan, PD, Directorate of Wheat Research, Karnal was deputed for participation in the Meeting of British Society for Plant Pathology and Systematics Association (BSPP&SA) during 16-19 December 1996 at Canterbery, UK.

Besides above, 15 other scientists were also deputed for participation in various meetings and 12 persons were deputed for short-term consultancy abroad.


बिक्री केन्द्र
Publications and Information

National Seeds Corporation Ltd.

# 5. Publications and Information

The Indian Council of Agricultural Research disseminates information on technological research and developments taking place everyday in the field of agriculture, animal and poultry sciences in the form of publication of books, bulletins, reports, and research and popular journals. The publications brought out by the ICAR cater to the needs of scientists, researchers and the undergraduate and postgraduate students of agricultural colleges and universities in India.

In addition, miscellaneous publications are also brought out from time to time.

## PUBLICATIONS

### English

During the year, nine periodicals were published regularly, six in English and three in Hindi. Besides Annual Report, 21 titles in English and 10 in Hindi were brought out.

Other important publications brought out in English were : ICAR Annual Accounts and Audit Report (1994-95), Report of the Working Group on Agricultural Research and Education for the Formulation of Ninth Five-Year Plan, Updating Status Report of Action taken on the ICAR Review Committee Report, General Guidelines for the A.P. Cess Fund Schemes and Revolving Fund Schemes, Dictionary of Economic Plants in India (revised), Citrus Diseases and their Control (reprint), Home Gardening and Forestry for the People, ICAR - now and ahead. In addition to the above titles, 9 miscellaneous publications were also brought out.

Out of the 6 periodicals brought out by the Directorate of Publications and Information on Agriculture (DPIA) two were research journals, viz. *The Indian Journal of Agricultural Sciences* (monthly), and *The Indian Journal of Animal Sciences* (monthly), two popular journals, viz. *Indian Farming* (Monthly) and *Indian Horticulture* (quarterly); and two newsletters, viz. *ICAR News* (quarterly) and *ICAR Reporter* (quarterly).

Two research journals, viz. *The Indian Journal of Agricultural Engineering* (quarterly) and *The Indian Journal of Fisheries* (quarterly) being brought out earlier were transferred to their respective institutes at Bhopal and Cochin respectively.

During the period, *Indian Farming*, one of the most authoritative magazines of the ICAR, brought out three special issues, i.e. on 'Poultry', for the World Poultry Congress, on the occasion of World Food Day and on 'Crop Productivity and Technologies' for the Second International Crop Science Congress, held during 17-24 November 1996.

*Indian Horticulture*, a magazine containing articles on fruits, vegetables, ornamental crops, plantation crops and gardening, also brought out two special issues, on 'Fruit Crops' and 'Vegetable and Ornamental Crops', in addition to the regular issues.

*ICAR News* publishes news pertaining to research done, new crop varieties evolved and technological innovations made in the ICAR institutes. This newsletter has a wide circulation among the scientific community both in India and abroad. Four issues were brought out during the year.

*ICAR Reporter*, an in-house magazine of the Council, deals with news pertaining to the day-to-day activities of the ICAR both at the headquarters as well as the institutes such as Reforms, Reports, Awards, Personnel, and Visits of Scientists Abroad, etc. Four issues were brought out during the year.

In addition, book reviews and special features were published in various periodicals useful for farmers.

**Hindi**

Three periodicals were brought out in Hindi regularly, i.e. *Kheti* (monthly), *Phal Phool* (quarterly) and *Krishi Chayanika* (quarterly). In *Kheti*, five special issues were brought out during the year, viz. New Vistas in Agriculture, Environment and Agriculture, Fighting Against Hunger and Malnutrition, 50 Years of Crop Science Research in India and Rice Research in India.

*Phal Phool*, a quarterly on horticulture, brought out two accent numbers on Fruits and Vegetables and Flowers.

The notable publications brought out in Hindi during the year were, *Badalte Parivesh me Krishi Anusandhan evam Vikaş ke Naye Aayam*, *Sabji Vigyan*, *Anudan Maang Sameeksha* (1996-97), *Bharat Sarkar Nishpadan Budget* (1996-97), *Phal Vriksh Pravardhan*, etc. In addition, a number of reports and speeches of the President of the ICAR and the DG were also brought out.

**Science Popularization Unit**

The Science Popularization Unit of the ICAR regularly releases features and articles pertaining to agriculture and allied subjects in Kannada and Hindi to various regional newspapers, as well as to the TV and the AIR for the benefit of progressive farmers. There was a good coverage of these features from both the print and electronic media. In Kannada language, about 120 features were released and over 700 newspaper clippings were received.

## ART AND PHOTOGRAPHY

The Art Unit of the Directorate of Publications and Information on Agriculture (DPIA) of the ICAR prepares the artwork for all publications and publicity materials of the ICAR. This includes two scientific journals, two popular journals and two newsletters in English and three semi-technical journals in Hindi, along with books brought out both in English and Hindi. In addition to these primary responsibilities, the Art Unit prepars black-and-white and colour illustrations, charts such as histograms, line graphs, maps, line drawings and slides for

senior officers of the ICAR at headquarters for presentation at national and international seminars, workshops and symposia. The Unit also advises other ICAR institutes and divisions of other organizations in the preparation of illustrations and designs for publication and also evaluates the artwork and designs sent by them for comments. All the designs created by the Art Unit were highly appreciated in the Council and outside. The designs made for the Annual Reports, *ICAR Reporter*, *ICAR News* and the brochure, ICAR-now and ahead improved the publications. A number of ICAR institutes and other organizations have sent the request for designing their reports and other publications by the Art Unit.

Art Unit suggests that a fund may be created where service charges for designing and guiding the publications can be deposited and a new source of earning can be created for the Directorate of Publications and Information on Agriculture (DPIA) in addition to the sale of its publications.

The Photography Unit covered the activities of the Council including visits of dignitaries from other countries, signing of agreements, Press conferences of the Union Minister of Agriculture and State Ministers of Agriculture and the DG, ICAR.

It supplied transparencies, black-and-white as well as colour photographs to various publications brought out by the Council both in English and Hindi.

The Photo library also provided slides and illustrative material to the national and international exhibitions and fairs organized by or involving participation of the ICAR and its institutes, meetings, workshops, seminars, conferences, etc. It has a good collection of photographs and colour transparencies on various subjects.

Directorate of Publications and Information on Agriculture (DPIA) started consultancy services in the year 1996. Highly professional services are available in the field of editing, designing and printing. Initially these services are confined to publications and publicity materials of institutes/universities and national and international organizations in the field of agricultural research, education and information.

## AGRICULTURAL RESEARCH INFORMATION CENTRE

The Agricultural Research Information Centre (ARIC) is the central source of information on all research projects and schemes financed by the ICAR.

It is also the national input centre for the AGRIS and CARIS agricultural databases of the FAO, and the largest information system of its kind in the world. The SDI services are available at the ARIC through AGRIS CD-ROM (1975-1996), CABCD (1984-86), CARIS-CD (1994) and FAO STAT (1994). About 400 scientists or research scholars were benefited from the SDI service.

The ARIC is also the national focal point for the SAIC (SAARC Agricultural Information Centre, Dhaka, Bangladesh) for supply of information on agricultural institutions, agricultural scientists and technologists, improved farm implements, agricultural information systems, agricultural periodicals and research projects.

The Centre continued to bring out the half-yearly publication Directory of Conferences, Seminars, Symposia, Workshops on agriculture.

## ICAR LIBRARY

The ICAR library added 2,500 publications to its collection during this year. About 15,000 readers visited this library and consulted publications for reference and information searches. The library has entered the era of moderniza-

tion, and installed a LAN, using Novell operating system and shifted all its manual activities to computerization like acquisition, processing and dissemination of information. The library provides photocopy, comb binding and reference as well as information services. There is great demand for obtaining its literature on inter-library loan basis.

The Hindi library at the headquarters operated separately from the main library and subscribed to a number of Hindi magazines and books during the year, which were in great demand from the readers.

**PUBLICITY AND PUBLIC RELATIONS UNIT**

The Publicity and Public Relations Unit is the nodal centre to project the activities and achievements of the ICAR to the print and electronic media. During the year, a number of press releases and features were issued to the media, laying special emphasis on rural-based technologies and area-specific information.

A number of Press conferences were arranged during the year and these were addressed by the President, ICAR, Director General, ICAR, and other functionaries to highlight the activities of the Council. These conferences got a good coverage both in the print and electronic media.

Visits of media persons from national and regional newspapers were arranged to the ICAR institutes and projects including CPRI, Shimla, NCMRT, Solan, CRRI, Cuttack, CIFA, Bhubaneshwar, CRIDA, Hyderabad, SBI, Coimbatore, CIBA, Madras, CPCRI, Kasaragod, and IISR, Kozhikode. Based on these visits, several news stories appeared in the national and regional language newspapers.

The ICAR's popular magazines like *Indian Farming, Indian Horticulture, Kheti, Krishi Chayanika, Phal Phool, ICAR News* and *ICAR Reporter*, were regularly supplied to the media persons, and the material published therein was extensively used by them in their news stories.

The Unit also provided regular feedback to the DG, ICAR, Subject-matter Divisions (SMDs) at the headquarters and the institutes regard-

A Press conference was jointly organized by the ICAR and the NAAS on 15 November 1996 on the occasion of the 2nd International Crop Science Congress held from 17-24 November 1996 in New Delhi

ing various stories appearing in newspapers on agricultural research. The PR Unit also provided information assistance to students, researchers, farmers and general public on agriculture and allied subjects.

**Exhibitions (Organized or Participated)**

1. Worldtech 1996, Bangkok, Thailand —January 1996
2. International Food Expo 1996, Bombay —February 1996
3. All-India Industrial and Agricultural Exhibition, Thrissur, Kerala —April-May 1996
4. Industrial Carnival, Cochin —April 1996
5. International Royal Agricultural Show, Warwickshire, London —June-July 1996
6. All-India Agricultural Exhibition, Calcutta —August 1996
7. Agricultural and Industrial Exhibition, 24-Paraganas, West Bengal —September-October 1996
8. International Poultry Exhibition and Congress, New Delhi —September 1996
9. International Crop Science Congress and Exhibition, New Delhi —November 1996
10. India International Trade and Industries Exhibition, New Delhi —November 1996
11. Organized an exhibition on the eve of inauguration of newly constructed building of Gene Bank (NBPGR), New Delhi —November 1996
12. Agrotech 1996, Patna —December 1996

**Video Film**

A U-Matic Highband Video Film on REDEEMING A PLEDGE—ICAR-1996 was also produced in November-December 1996.

**Public Grievances Redressal**

The ICAR has developed a public-guidance redressal system as per the guidelines of the Department of Administrative Reforms and Public Grievances.

The Chief Publicity and Public Relations Officer functions as Staff Grievance Officer (SGO) under the direct supervision of Secretary, ICAR. The SGO also attends to the grievances of the public. Instructions are issued from time to time to all officers for expeditious disposal of grievances. Public grievances appearing in the columns of newspapers are attended to promptly. To cater to the in-house grievances of the employees, the ICAR has an Internal Grievance Committee.

## SALE AND ADVERTISEMENTS

During the year, the Council earned a revenue of approximately Rs 1 million from the sale of its publications and Rs 144,930 from advertisements.

The ICAR participated in exhibitions, book shows, fairs, seminars and conferences for promoting the sale of its publications.

# APPENDICES

## (A) DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION

### APPENDIX 1

**The Government of India (Allocation of Business) Rules**
**The Second Schedule**
**(Rule 3)**

**(A) Distribution of Subjects in the Department (*Vibhag*), Ministry of Agriculture (Krishi Mantralaya)**

**(B) Department of Agricultural Research and Education (Krishi Anusandhan aur Shiksha Vibhag)**

#### PART I

The following subjects which fall within List I of the Seventh Schedule to the Constitution of India.

1. International Co-operation in the field of agricultural research and education including relations with foreign and international agricultural research and educational institutions and organizations, including participation in international conferences, associations and other bodies dealing with agricultural research and education and follow-up of decisions at such international conferences, etc.

2. Fundamental, applied and operational research and higher education including coordination of such research and higher education in agriculture including agroforestry, animal husbandry, dairying and fisheries, including agricultural statistics, economics and marketing.

3. Co-ordination and determination of standards in institutions for higher education or research and scientific and technical institutions insofar as it relates to food and agriculture including animal husbandry, dairying and fisheries.

4. Cesses for financing to the Indian Council of Agricultural Research, and the Commodity Research programmes other than those relating to tea, coffee and rubber.

5. Sugarcane research.

#### PART II

For Union Territories the subjects mentioned in Part I above so far as they exist in regard to these territories and in addition the following subject which falls within List II of the Seventh Schedule of the Constitution of India.

6. Agricultural education and research.

#### PART III

General and consequential:

7. All matters relating to foreign aid received from foreign countries and International Organizations in sofaras agricultural research and education and allied subjects are concerned, including all matters relating to assistance afforded by India to foreign countries in the field of agricultural research and education and allied subjects.

8. Plant introduction and exploration.

9. All-India Soil and Land-Use Survey relating to research, training, correlation, classification, soil mapping and interpretation.

10. Financial assistance to state governments and agricultural universities in respect of agricultural research and educational schemes and programmes

11. National Demonstrations.

12. Indian Council of Agricultural Research and its constituent research institutes, stations, laboratories and centres.

13. Offences against laws with respect to any of the subjects allotted to this Department.

14. Enquiries and statistics for the purpose of any of the subjects allotted to this Department.

15. Fees in respect of any of the subjects allotted to this Department except fees taken in a court.

## APPENDIX 2

### Total Number of Posts and Names of Important Functionaries

| Group | Designation | Scale of pay (in rupees) | Santioned strength |
|---|---|---|---|
| A | Secretary | 8,000 (Fixed) | 1 |
| A | Joint Secretary | 5,900 - 6,700 | 1 |
| A | Financial Adviser and Joint Secretary | 5,900 - 6,700 | 1 |
| A | Director | 4,500 - 5,700 | 1 |
| A | Under Secretary | 3,000 - 4,500 | 5 |
| A | Principal Private Secretary | 3,000 - 4,500 | 1 |
| B | Desk Officer | 2,000 - 3,500 | 2 |
| B | Section Officer | 2,000 - 3,500 | 1 |
| B | Private Secretary | 2,000 - 3,500 | 2 |
| B | Assistant Director (Official Language) | 2,000 - 3,500 | 2 |
| B | Desk Attache | 1,640 - 2,900 | 5 |
| B | Assistant | 1,640 - 2,900 | 1 |
| B | Steno Grade 'C' | 1,640 - 2,900 | 1 |
| C | Junior Hindi Translator | 1,200 - 2,040 | 2 |
| C | UDC-cum-Cashier | 1,200 - 2,040 | 1 |
| C | UDC | 1,200 - 2,040 | 2 |
| C | Steno Grade 'D' | 1,200 - 2,040 | 4 |
| C | LDC | 950 - 1,500 | 3 |
| C | UDC-Hindi Typist | 950 - 1,500 | 1 |
| C | Driver | 950 - 1,500' | 1 |
| C | Daftry | 775 - 1,025 | 1 |
| D | Peon | 750 - 940 | 5 |
| | Total | | 44 |

### Names of the Important Functionaries (As on 31.3.1996)

| S.No. | Name | Designation |
|---|---|---|
| 1. | Dr R S Paroda | Secretary, DARE/DG, ICAR |
| 2. | Mr G S Sahni | Joint Secretary, DARE/Secretary, ICAR |
| 3. | Mr N Parthasarthy | Financial Adviser, DARE/Joint Secretary |
| 4. | Mr M Aslam | Director, DARE |
| 5. | Mr R P Saroj | Under Secretary |
| 6. | Mr A N Murty | Under Secretary |
| 7. | Ms Vandana Sharma | Under Secretary |
| 8. | Mr K K Mittal | Under Secretary |
| 9. | Mr B J Bhattacharya | Under Secretary |
| 10. | Mr R S Bhandari | Principal Private Secretary |

## APPENDIX 3

### Financial Requirements (Grant No. 3)

The Budget estimates (BE) and revised estimates (RE) of DARE and ICAR (Plan, Non-Plan) for 1996-97 is, respectively, Rs 545.07 crore and Rs 529.60 crore and BE for 1997-98 (Plan and Non-Plan) is Rs 528.90. The detailed break-up of these financial figures are given below in Tables 1 and 2.

### Activity Programme Classification

Department of Agicultural Research and Education (DARE): The details in respect of DARE for BE and RE for 1996-97 and BE for 1997-98 are given in Table 1. This excludes the payment to the ICAR.

**Table 1**

**Budget estimates and revised estimates of DARE and ICAR**

(Rupees in lakhs)

| Item | Budget Estimates 1996-97 | | Revised Estimates 1996-97 | | Budget Estimates 1997-98 | |
|---|---|---|---|---|---|---|
| | Plan | Non-Plan | Plan | Non-Plan | Plan | Non-Plan |
| A. Secretariat Economic services | | | | | | |
| Major Head '3451' | | | | | | |
| A-1 Secretariat | | | | | | |
| Major Head '2415' | - | 75 | - | 67 | - | 77 |
| B-7-General | | | | | | |
| B-7 (1)-International operation | | | | | | |
| B-7 (i) (1)-India's membership contribution to Commonwealth Agricultural Bureaus International | - | 61 | - | 61 | - | 61 |
| B-7 (1) (2)-India's Membership contribution to Consultative Group on International Agricultural Research | - | 262 | - | 262 | - | 262 |
| B-7 (1) (3) - APAARI | - | 3 | - | 3 | - | 3 |
| B-7 (1) (4) - Other Programmes | 40 | - | 40 | - | 40 | - |
| B-7 (1 (5) - NACA | - | 7 | - | 7 | - | 7 |
| Total | 40 | 408 | 40 | 400 | 40 | 410 |

**Table 2**

## Details of Financial Outlay

## Demand No. 3. Department of Agricultural Research and Education

(Rupees in crores)

| | | 1995-96 Budget | | | 1995-96 Revised | | | 1996-97 Budget | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Plan | Non-Plan | Total | Plan | Non-Plan | Total | Plan | Non-Plan | Total |
| A. Budget Allocation, net of recoveries | | | | | | | | | | |
| | Revenue | 310.00 | 238.86 | 548.86 | 290.00 | 245.73 | 535.73 | 289.30 | 244.08 | 533.38 |
| | Capital | 0.00 | 0.00 | 0.00 | 0.00 | 0 00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Total | 310.00 | 238.86 | 548.86 | 290.00 | 245.73 | 535 73 | 289 30 | 244.08 | 533.38 |
| | Major | 0.10 | 0.69 | 0.79 | 0.00 | 0.68 | 0.68 | 0.00 | 0.75 | 0.75 |
| 1. Secretariat - Economic Service Agricultural Research and Education Payments to ICAR | Head 3451 | | | | | | | | | |
| 2 Crop Husbandry | | | | | | | | | | |
| 2.01 Payments of net proceeds of cess under Agricultural Produce Cess Act, 1940 | 2415 | — | 14.00 | 14.00 | — | 14.00 | 14.00 | — | 14 00 | 14.00 |
| 2.02 Other Programmes of Crop Husbandry | 2415 | 252.80 | 150.15 | 402.95 | 239.25 | 153.15 | 392.40 | 240.15 | 153.15 | 393.30 |
| Total-Crop Husbandry | | 252.80 | 164 15 | 416.95 | 239.25 | 167.15 | 406.40 | 240.15 | 167.15 | 407.30 |
| 3. Soil ad Water Coservation | 2415 | 3.57 | 4.10 | 7.67 | 3.00 | 4.18 | 7.18 | 2.00 | 4.18 | 6.18 |
| 4. Animal Husbandry | 2415 | 26 28 | 26.25 | 52.53 | 2.82 | 26.78 | 49.60 | 22.40 | 26.78 | 49.18 |
| 5. Dairy Development | 2415 | 4.00 | 13.17 | 17.17 | 3 48 | 13.44 | 16.92 | 3.60 | 13.44 | 17.04 |
| 6. Fisheries | 2415 | 17.10 | 19.75 | 36.85 | 15.84 | 20.15 | 35.99 | 15.50 | 20 15 | 35.65 |
| 7. Forestry | 2415 | 5.75 | 8.15 | 13.90 | 5.21 | 8.30 | 13.51 | 5.25 | 8.30 | 13.55 |
| Total-Payments of ICAR | | 309.50 | 235.57 | 545.07 | 289.60 | 240.00 | 529.60 | 288.90 | 240.00 | 528.90 |
| 8. Other Programmes | 2415 | 0.40 | 2.60 | 3.00 | 0.40 | 5.05 | 5.45 | 0.40 | 3.33 | 3.73 |
| Total-Agricultural Research & Education | | 309.90 | 238.17 | 548.07 | 290.00 | 245.05 | 535.05 | 289.30 | 243.33 | 532.63 |
| Grand Total | | 310 00 | 238 86 | 548.86 | 290.00 | 245.73 | 535.73 | 289.30 | 244.08 | 533.38 |

| B. Plan Outlay | Head of Div. | 1995-96 Budget Budget support | 1995-96 Budget I.E B.R. | 1995-96 Budget Total | 1995-96 Revised Budget support | 1995-96 Revised I.E.B.R. | 1995-96 Revised Total | 1996-97 Budget Budget support | 1996-97 Budget I.E.B.R. | 1996-97 Budget Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Agricultural Research Education | 2415 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| | | 1995-96 Budget | | | 1995-96 Revised | | | 1996-97 Budget | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Plan | Non-Plan | Total | Plan | Non-Plan | Total | Plan | Non-Plan | Total |
| C. Major Head-wise Total | | | | | | | | | | |
| | Total | 310.00 | 238 86 | 548.86 | 290.00 | 245.73 | 535.73 | 289.30 | 244.08 | 533.38 |
| | 2415 | 309.90 | 238.17 | 548.07 | 290.00 | 245.05 | 535.05 | 289.30 | 243.33 | 532.63 |
| | 3451 | 0.10 | 0.69 | 0.79 | 0.0 | 0.68 | 0.68 | 0.00 | 0.75 | 0.75 |

## (B) INDIAN COUNCIL OF AGRICULTURAL RESEARCH

### APPENDIX 1

### INDIAN COUNCIL OF AGRICULTURAL RESEARCH SOCIETY

The Society shall have the following ex-officio members:

(i) *Minister in charge of the porfolio of Agriculture in the Union Cabinet, President of the Society*

1. Mr Chaturanan Mishra
   Minister of Agriculture
   Government of India

(ii) *Minister of State in the Union Ministry of Agriculture, dealing with the ICAR, Vice-President*

2. (Vacant)
   Minster of State for Agriculture and
   Department of Agricultural
   Research and Education
   Government of India
   Krishi Bhavan, New Delhi 110 001

(iii) *Union Ministers holding charge of Finance, Planning, Science and Technology, Education and Commerce (in case the Prime Minister is holding any of these portfolios, the Minister of State in the Ministry/Department concerned)*

3. Mr P Chidambaram
   Minister of Finance
   Government of India
   New Delhi 110 001

4. Dr Yogendra K Alagh
   Minister of State for Planning and
   Programme Implementation
   Government of India
   New Delhi 110 001

5. Mr S R Bommai
   Minister of Human Resources Development
   Government of India
   New Delhi 110 001

6. Mr B Ramaiah
   Minister of Commerce
   Government of India
   New Delhi 110 001

(iv) *Other Ministers in the Union Ministry of Agriculture*

7. Minister of State for
   Agriculture (DAC)
   Government of India
   Krishi Bhavan, New Delhi 110 001

(v) *Ministers in the States/In charge of Agriculture/ Animal Husbandry/Fisheries*

**Andhra Pradesh**

8. Mr S V Subba Reddy
   Minister for Agriculture
   Government of Andhra Pradesh
   Hyderabad (Andhra Pradesh) 500 022

9. Mr B Veera Reddy
   Minister of Animal Husbandry and Fisheries
   Government of Andhra Pradesh
   Hyderabad (Andhra Pradesh) 500 022

**Arunachal Pradesh**

10. Mr Sobeng Tayeng
    Minister for Agriculture
    Government of Arunachal Pradesh
    Itanagar (Arunachal Pradesh) 791 111

11. Mr Mukut Mithi
    Minister for Animal Husbandry
    Government of Arunachal Pradesh
    Itanagar (Arunachal Pradesh) 791 111

12. Mr D Natung
    Minister for Fisheries
    Government of Arunchal Pradesh
    Itanagar (Arunachal Pradesh) 791 111

**Assam**

13. Mrs Syeda Anwara Taimur
    Minister for Agriculture
    Government of Assam
    Janta Bhavan
    Guwahati (Assam) 781 006

14. Mr Jayanth Sinha
Minister for Animal Husbandry
Government of Assam
Janta Bhavan
Guwahati (Assam) 781 006

15. Mr Samral Huda
Minister for Fisheries
Janta Bhavan
Guwahati (Assam) 781 006

**Bihar**

16. Mr Ram Jeevan Singh
Minister for Agriculture
Government of Bihar
Patna (Bihar)

17. Mr Bhola Ram Tugani
Minister for Animal Husbandry
Government of Bihar
Patna (Bihar)

**Delhi**

18. Mr Sahib Singh Verma
Chief Minister and Minister for Agriculture, Animal Husbandry and Fisheries
National Capital Territory of Delhi
Delhi

**Goa**

19. Mr Dayanand Narvekar
Minister for Agriculture
Government of Goa
Panaji (Goa) 403 001

20. Mr Chanderkar Uttam Chandakar
Minister of Animal Husbandry
Government of Goa
Panji 403 001

21. Mr S B Mazakar
Minister for Fisheries
Government of Goa
Panaji (Goa) 403 001

**Gujarat**

22. Mr Buper Singh Chuasma
Minister for Agriculture, Fisheries & Animal Husbandary
Government of Gujarat
Gandhinagar (Gujarat)

**Haryana**

23. Mr Ch. Harpal Singh
Minister for Agriculture
Government of Haryana
Chandigarh (Haryana)

24. Mr Kr Ram Pal Singh
Minister for Animal Husbandry
Government of Haryana
Chandigarh (Haryana)

25. Mr Shakrullah Khan
Minister for Wakf and Fisheries
Government of Haryana
Chandigarh (Haryana)

**Himachal Pradesh**

26. Mr Sujan Singh Pathania
Minister for Agriculture and Fisheries
Government of Himachal Pradesh
Shimla (Himachal Pradesh) 171 002

27. Mr Raghu Raj
Minister of State for Fisheries and Animal Husbandry
Government of Himachal Pradesh
Shimla 171 002 (HP)

**Karnataka**

28. Mr C Baire Gowda
Minister for Agriculture
Government of Karnataka
Bangalore (Karnataka) 560 001

29. Mr B N Bachchea Gowda
Minister for Animal Husbandry
Government of Karnataka
Bangalore (Karnataka) 560 001

30. Mr K Jaiprakash Hedge
Minister for Fisheries
Government of Karnataka
Bangalore (Karnataka) 560 001

**Kerala**

31. Mr B K Rajan
Minister for Agriculture
Government Secretariat
Government of Kerala
Thriuvananthapuram (Kerala) 695 001

32. Mr E Chandrasekharan Nair
Minister of Animal Husbandry
Government Secretariat
Thiruvananthapuram (Kerala) 695 001

33. Mr T K Rama Krishnan
Minister for Fisheries
Government Secretariat
Government of Kerala
Thiruvananthapuram (Kerala) 695 001

**Madhya Pradesh**

34. Mr Hazare Lal Ragubansi
Minister for Agriculture
Ballabh Bhavan
Government of Madhya Pradesh
Bhopal (Madhya Pradesh) 423 006

35. Mr Prem Sai Singh
Minister for Fisheries
Government of Madhya Pradesh
Bhopal (Madhya Pradesh) 423 006

36. Mr Bisahu Lal Singh
Minister of Animal Husbandry
Government of Madhya Pradesh
Ballabh Bhawan
Bhopal (Madhya Pradesh) 423 006 (MP)

**Maharashtra**

37. Mr Harshvardhan Patil
Minister for Agriculture and
Water Conservation
Government of Maharashtra
Mumbai (Maharashtra)

38. Mr Rajbhau Thakre
Minister for Animal Husbandry,
Fisheries and Dairy Development
Government of Maharashtra
Mumbai (Maharashtra)

**Manipur**

39. Mr H Bidur Singh
Minister for Agriculture
Government of Manipur
Imphal (Manipur) 795 001

40. Mr K S H Irabot
Minister for Animal Husbandry
Government of Manipur
Imphal (Manipur) 795 001

41. Mr Mohammad Helaluddin
Minister for Fisheries
Government of Manipur
Imphal (Manipur) 795 001

**Meghalaya**

42. Mr L A Sangma
Minister for Agriculture &
Minor Irrigation and Fisheries
Government of Meghalaya
Shillong (Meghalaya) 793 001

43. Mr Archibold A Sangma
Minister for Animal Husbandry
and Veterinary
Government of Meghalaya
Shillong (Meghalaya) 793 001

**Mizoram**

44. Mr Saikapthianga
Minister for Agriculture and Fisheries
Government of Mizoram
Aizwal (Mizoram) 796 001

45. Mr P Lal Biaka
Minister for Animal Husbandry
Government of Mizoram
Aizwal (Mizoram) 796 001

46. Mr Zakhu Hylchu
Minister for Fisheries
Government of Mizoram
Aizwal (Mizoram) 796 001

**Nagaland**

47. Mr Zachilhu
Minister for Agriculture
Government of Nagaland
Kohima (Nagaland) 797 001

48. Mr Nyamnyei Konyak
Minister for Animal Husbandry
Government of Nagaland
Kohima (Nagaland) 797 001

49. Dr Zimomi
Minister for Fisheries
Government of Nagaland
Kohima (Nagaland) 797 002

**Orissa**

50. Mr Janaki Ballab Patnaik
Chief Minister & Minister
of Agriculture
Government of Orissa
Bhubaneshwar (Orissa)

51. Mr Prakash Chandra Debta
Minister of State for Animal Resources Development
Government of Orissa
Bhubaneswar (Orissa)

52. Mr Ramakanta Mishra
Minister for Agriculture
Government of Orissa
Bhubaneswar (Orissa)

**Pondicherry**

53. Mr V Vaithilingam
Chief Ministr holding the Portfolio of Fisheries
Government of Pondicherry
Pondicherry 605 001

54. Mr N Rangaswamy
Minister for Agriculture and Animal Husbandry
Government of Pondicherry
Pondicherry 605 001

**Punjab**

55. Mr Mahinder Singh Gill
Minister for Agriculture and Forests
Government of Punjab
Chandigarh (Punjab)

56. Mr Harnek Singh Payal
Minister for Animal Husbandry and Fisheries
Government of Punjab
Chandigarh (Punjab)

**Rajasthan**

57. Mr Gyan Singh Chaudhary
Minister for Agriculture
Government of Rajasthan
Jaipur (Rajasthan)

58. Mr Arjun Singh Davara
Minister for Animal Husbandry and Fisheries
Government of Rajasthan
Jaipur (Rajasthan)

**Sikkim**

59. Mr Garjaman Gurung
Minister for Agriculture
Government of Sikkim, Secretariat
Gangtok (Sikkim) 737 101

60. Mr P S Tamang
Minister for Animal Husbandry
Government of Sikkim, Secretariat
Gangtok (Sikkim) 737 001

61. Mr R B Subba
Minister for Fisheries
Government of Sikkim, Secretariat
Gangtok (Sikkim) 737 101

**Tamil Nadu**

62. Mr Veerapadi Arumugam
Minister for Agriculture
Government of Tamil Nadu
Chennai (Tamil Nadu) 600 009

63. Mr Pangalur N Palanisamy
Minister for Animal Husbandry
Government of Tamil Nadu
Chennai (Tamil Nadu) 600 009

64. Mr Jaenefer Chanchran
Minister for Fisheries
Government of Tamil Nadu
Chennai (Tamil Nadu) 600 009

**Tripura**

65. Mr Papan Chakravorty
Minister for Agriculture
Government of Tripura
Agartala (Tripura) 799 001

66. Mr Gopal Das
Minister for Animal Development
Government of Tripura
Agartala (Tripura) 799 001

67. Mr Sukumar Barman
Minister for Fisheries
Government of Tripura
Agartala (Tripura) 799 001

*The UP State is at present under President Rule*

**West Bengal**

68. Mr Kalimuggin Sham
Minister for Agriculture and Horticulture
Government of West Bengal
Writers' Building
Calcutta (West Bengal) 700 001

69. Mr Mehaboob Zahedi
Minister for Animal
Husbandry and Dairy Development
Government of West Bengal
Calcutta (West Bengal) 700 001

70. Mr Kironmoy Nanda
Minister for Fisheries
Government of West Bengal
Calcutta (West Bengal) 700 001

71. Minister for Agriculture
Government of Jammu and Kashmir
Srinagar (Jammu and Kashmir)

72. Minister for Animal Husbandry
Government of Jammu and Kashmir
Srinagar (Jammu and Kashmir)

73. Minister for Fisheries
Government of Jammu and Kashmir
Srinagar (Jammu and Kashmir)

(vi) *Member of Planning Commission, Incharge of Agriculture*

74. Dr Jayant Patil (Up to 9.12.96)
Member of Planning Commission
Incharge of Agriculture
Yojana Bhavan, New Delhi

(vii) *Six members of Parliament (Four elected by Lok Sabha and two elected by Rajya Sabha)*

75. Mr Asim Bala 22.7.99
Member Lok Sabha
Block C, Flat No. 6
Entally Government Housing Estate
CIT Road, Calcutta 700 014 and
24, North Avenue, New Delhi 110 001

76. Mr Oscar Fernandes 22.7.99
Member Lok Sabha
Dorise Rest Haven
Ambalpady, Udupi, Karnataka
B-202 (F2) MP Flats
and
Bhabha Kadak Singh Marg
New Delhi 110 001

77. Mr Raja Rangappa Naik 22.7.99
Member Lok Sabha
Room No. 210
New Karnataka Bhawan
New Delhi 110 001

78. Mr Chandra Bhushan Singh 22.7.99
Member Lok Sabha
Plot No. 85/117
Trilokya Adarsh Kung Patpatgunj
Delhi

79. Mr S S Surjewala Up to 9.12.96
Member Rajya Sabha
AB-89, Shahjahan Road
New Delhi
and
House No. 495, Sector 6
Panchkulla, Distt. Ambala (Haryana)

80. Mr Som Pal Up to 9.12.96
Member Rajya Sabha
Village & P.O. Kakor
Tehsil, Baghpat
Block Chhaprauli
Meerut (Uttar (Pradesh)
and
28, Lodi Estate
New Delhi

(viii) *Director-General, ICAR*

81. Dr R S Paroda
Director-General
ICAR, Krishi Bhavan
New Delhi 110 001

(ix) *All Secretaries in the Ministry of Agriculture*

82. Mr Mohan Kanda
Secretary (Extension)
Ministry of Agriculture
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

83. Mr K Rajan
Secretary (Animal Husbandry and Dairying)
Krishi Bhavan
New Delhi 110 001

(x) *Secretary, Planning Commission*

84. Mr V K Pandit
Secretary
Planning Commission
Yojana Bhavan
New Delhi 110 001

(xi) *Chairman, University Grants Commission*

85. Chairman
University Grants Commission
Bahadur Shah Zafar Marg
New Delhi

(xii) *Chairman, Atomic Energy Commission or Director, Bhabha Atomic Research Centre, if nominated by the Chairman, Atomic Energy Commission*

86. Chairman
Atomic Energy Commission
Chhattarpati Shivaji Maharaj Marg
Mumbai 400 085

(xiii) *Member, Finance (Secretary/Additional Secretary in the Ministry of Finance), Government of India*

87. Mr V K Dhal
Additional Secretary to the
Government of India
Ministry of Finance
Department of Expenditure
New Delhi

(xiv) *Four Vice-Chancellors of the Agricultural Universities nominated by the President*

88. Dr L R Verma — 28.11.98
Vice-Chancellor — (Governing Body
Dr Y S Parmar — member also)
University of Horticulture
and Forestry
Solan (Himachal Pradesh) 173 230

89. Dr K Pradhan — 28.11.98
Vice-Chancellor — (Governing Body
Orissa University of — member)
Agriculture and Technology
Bhubaneshwar (Orissa) 751 008

***(Two Positions Vacant)***

(xv) *Five technical representatives, namely Agricultural Commissioner, Horticultural Commissioner, Animal Husbandry Commissioner, Fisheries Development Commissioner from the Union Ministry of Agriculture and Inspector-General of Forests, Government of India*

90. Mr B K Taimani
Agricultural Secretary
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

91. Dr G L Kaul
Horticultural Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

92. Animal Husbandry Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 11 0001

93. Mr Y S Yadav
Fisheries Development Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

94. Mr A K Mukerjee
Inspector-General of Forests
Governmentof India
Department of Environment and Forests
CGO Complex, Lodi Road
New Delhi

(xvi) *Fifteen scientists from within and outside the Council, including one from the Indian Council of Medical Research nominated by the President*

95. Dr A Appa Rao — 20.7.99
Former Vice-Chancellor
Andhra Pradesh Agricultural University
House No. 22-3 RT High
Vijaynagar Colony
Hyderabad (AP) 500 057

96. Dr A Venkatraman — 20.7.99
Former Vice-Chancellor
Tamil Nadu Agricultural University
No. 16, Vasant Avenue
Kishore Parmal Puram
Chennai (TN) 680 028

97. Mr P N Jha — 20.7.96
Former Vice-Chancellor
Rajendra Agriculture University
Pusa Samastipur (Bihar) 848 125

98. Dr S K Sinha — 26.4.97
Former Director
Indian Agricultural Research Institute
Hill Side Road, Pusa
New Delhi 110 012

99. Dr O S Tomar — 26.4.97
Director
National Dairy Research Institute
Karnal (Haryana) 132 001

100. Dr Shankar Lal 26.4.97
Acting Director
Indian Institute of Pulses Research
Kalyanpur
Kanpur (Uttar Pradesh) 208 024

101. Dr Mangala Rai 26.4.97
Assistant Director-General (P)
Indian Council of Agricultural Research
Krishi Bhavan
New Delhi 110 001

102. Dr S D Tripathi 26.4.97
Director
Central Institute of Fisheries Education
7, Bungalow, Versova
Bombay (Maharashtra) 400 061

103. Dr S C Mudgal 26.4.97
Vice-Chancellor
Govind Ballabh Pant University of
Agriculture and Technology
Pantnagar (Uttar Pradesh) 262 145

104. Dr S Arya 26.4.97
Vice-Chancellor
Ch. Charan Singh Haryana
Agricultural University
Hisar (Haryana) 125 004

105. Dr A S Khera 26.4.97
Vice-Chancellor
Punjab Agricultural University
Ludhiana (Punjab) 141 004

106. Dr R K Patel 26.4.97
Vice-Chancellor
Rajasthan Agricultural University
Bikaner (Rajasthan) 334 001

107. Dr M P Singh 26.4.97
Central Agricultural University
for NEH Region
Imphal (Manipur) 795 001

**Management Expert**

108. Mr Jayant Das 26.4.97
Senior Advocate, AMBIM (Governing Body
M/s Das & Associates member also)
Opp. Orissa High Court
Cuttack (Orissa) 753 001

**Representatives of the ICMR**

109. Dr Aditya Prasad Dash 26.4.97
Director, Incharge of
The Desert Medicine Research Centre
Jodhpur (Rajasthan)

(xvii) *Three representatives of Commerce and Industry, nominated by the President*

110. Mr P K Aggarwal 13.2.98
E.D. Steels
Jalandhar (Punjab)

111. Shri M M Thapar 8.3.98
Joint Managing Director
Ballarpur Industries
Thapar House, Janpath
New Delhi

112. Mr Sudhir Sanghi 8.3.98
Company Director
Sanghi Group of Industries
Hyderabad

(xviii) *One farmer from each region of the country as mentioned in Rule 60 (a) and four representatives of rural interest, nominated by the President*

113. Mr Sher Bahadur Singh 5.2.98
Advocate (Nominated in the Regional
Baradeeh Chauraha Committee No. 1)
Mukhtiar Ganj
Satna (Madhya Pradesh)

114. Mr S Jararam Choudhary 5.2.98
Hotel Mayura (Nominated in the Regional
Tirupati Committee No. II)
(Andhra Pradesh)

115. Mr R S Velan 5.2.98
974, Cross-cut-Road (Nominated inthe
Gandhipuram Regional Committee No. II)
Coimbatore
(Taiml Nadu) 641 012

116. Mr Rameshwar Rajora 5.2.98
Vice-President (Nominated in the Regional
Cong. (I) Sewa Dal, Maur Committee No. IV)
Mandi, District Bhatinda
(Punjab)

117. Mr Bhagwan Sahai Saini 5.2.98
Ward No. 15, Chomu (Nominated in the
Jaipur (Rajasthan) Regional Committee
No. VI)

118. Mr K V Kuppusamy 5.2.98
Chairman and (Nominated in the Regional
Managing Trustee Committee No. VII)
Bhaktvatsalam Memorial Trust,
242 B, Trichy Road
Sulur, Coimbatore (Tamil Nadu)

119. Shatrugan Prasad Singh 2.8.99
24, MLA Quarters, Patel Path
Patna 800 001 (Bihar)

120. Mr Ramindra Kumar 2.8.99
PO Bhurkunda
Distt. Hazaribagh (Bihar)

**Representatives of Rural Development**

121. Ms Suniti Wadhwa 5.2.98
S-468/A, Greater Kailash I (Governing Body
New Delhi member also)

122. Ch Rattal Lal 14.1.99
S/o Ch Jas Ram, Sarpanch
PO Alamgarh
Tehsil Abohar
Ferozepur (Punjab)

123. Mr S.K. Bhargava 5.2.98
56, Darya Mahal-A
Nepeansea Road
Mumbai (Maharashtra) 400 006

124. Mr Abhyanand Jha 2.8.99
Village Kakraul
Distt Madhubani (Bihar)

(xix) *Four Directors of the ICAR Research Institutes, nominated by the President*

125. Dr I S Yadav 7.8.99
Director
Indian Institute of Horticultural Research
P.O Hessargatta
Bangalore (Karnataka) 560 089

126. Dr R P Awasthi 7.8.99
Director
ICAR Research Complex for
North Eastern
Barapani (Maghalaya) 793 103

127. Dr P Rethinam 7.8.99
Director
NRC for Oilpalm
Eluru (Andhra Pradesh) 534 002

128. Dr S A H Abidi 7.8.99
Director
Central Institute of Fisheries Education
Jai Prakash Road
Mumbai (Maharashtra) 400 061

(xx) *Secretary Indian Council of Agricultural Research*

129. Mr G S Sahni
Member-Secretary
Indian Council of Agricultural
Research, Krishi Bhavan
New Delhi 110 001

## APPENDIX 2

## GOVERNING BODY

**Chairman**

1. Dr R S Paroda
   Director-General
   Indian Council of Agricultural Research
   Krishi Bhavan
   New Delhi 110 001

**Ex-officio Members**

2. Mr V K Dhall
   Additional Secretary to the
   Government of India
   Ministry of Finance
   Department of Expenditure
   New Delhi

3. Secretary
   Planning Commission
   Yojna Bhavan
   New Delhi

4. Secretary
   Government of India
   Ministry of Agriculture
   Department of Agriculture
   Krishi Bhavan, New Delhi

5. Chairman
   University Grants Commission
   Bahadur Shah Zafar Marg
   New Delhi

6. Chairman
   Atomic Energy Commission, Trombay
   Mumbai 400 085

**Members**

*Four scientists (including one Management Expert) who are not employees of the ICAR and are nominated by the President*

***Management Expert***

7. Mr Jayant Das — 26.4.97
   Senior Advocate, AMBIM
   M/s Das & Associates
   Opp. Orissa High Court
   Cuttack (Orissa) 753 002
   and
   C/II,30, Talak Lane, New Delhi

***Scientists***

8. Dr A Appa Rao
   Former Vice- Chancellor APAU
   No. 22-3 RT High
   Vijaynagar Colony
   Hyderabad (Himachal Pradesh) 500 057

9. Dr A Venkataraman — 20.7.99
   former Vice-Chancellor, TNAU
   16, Cresent Avenue
   Kishore Parmal Puram
   Madras 680 028

10. Dr P N Jha — 22.7.99
    Former Vice Chancellor
    RAU, Pusa
    Samastipur (Bihar) 848 125

**Three Vice-Chancellors**

11. Dr L R Verma — 28.11.98
    Vice-Chancellor
    Dr YS Parmar University of
    Horticulture and Forestry
    Solan (HP) 173 230

12. Dr K Pradhan — 28.11.98
    Vice-Chancellor
    Orissa University of
    Agriculture and Technology
    Bhubaneshwar (Orissa) 751 008

13. Dr R P S Tyagi — 18.11.96
    Vice-Chancellor
    Himachal Pradesh
    Krishi Vishwa Vidyalaya
    Palampur (Himachal Pradesh) 176 062

**Three Members of Parliament**

14. Shri S S Surjewala — Up to 9.12.96
    Member Rajya Sabha
    H.No. 495, Sector 6,
    Panchkula
    Distt Ambala (Haryana)
    and
    AB 89, Shahjahan Road
    New Delhi

15. Dr Asim Bala — 22.7.99
Member of Parliament
Block C, Flat No. 6
Entally Court Housing Estate
CIT Road, Calcutta 700 014
and
24, North Avenue
New Delhi

16. Mr Oscar Fernandes — 22.7.99
Member of Parliament
Doris Rest Haven,
Ambalpady-Udapi
Karnataka
and
No B-202, (F2) M.P. Flats
Baba Kadak Singh Marg
New Delhi

**Three Farmers**

17. Mr Shatrugan Prasad Singh — 2.8.99
24, MLA Quarters
Patel Path
Patna 800 001

18. Mr Raminder Kumar — 2.8.99
PO Bhurkunda
Distt Hazaribagh (Bihar)

19. Ms Suniti Wadhwa — 5.2.98
S 468-A, Greater Kailash
Part I, New Delhi

**Three Directors**

20. Dr I S Yadav — 7.8.99
Director
Indian Institute of Horticultural Research
P.O. Hessarghatee Lake
Bangalore (Karnataka) 560 089

21. Dr R P Awasthi — 7.8.99
Director
ICAR Research Complex for
North Eastern Hilly Region
Baranani, 793 103 (Meghalaya)

22. Dr P Rethinam
Director
National Research Centre for Oilpalm
Distt West Godavari
Eluru (Andhra Pradesh)

**Member-Secretary**

23. Mr G S Sahni
Secretary
Indian Council of Agricultural Research
Krishi Bhawan, New Delhi

## APPENDIX 3

## STANDING FINANCE COMMITTEE

**Chairman**

1. Director-General
   Indian Council of Agricultural Research
   Krishi Bhavan
   New Delhi 110 001

**Ex-Officio Members**

2. Mr V K Dhall
   Additonal Secretary to the
   Government of India
   Ministry of Finance
   Department of Expediture
   New Delhi 110 001

3. Secretary
   Government of India
   Ministry of Agriculture
   Department of Agriculture
   Krishi Bhavan, New Delhi 110 001

**Members**

*Seven members of the Governing Body of the ICAR Society (viz. one management Expert, two Scientists, one Vice-Chancellor, one Director, one Farmer and one Member of the Parliament elected by the Governing Body in its 162nd meeting on 30.6.94) on the Standing Finance Committee for a fresh period of one year from 30.6.94 to 29.6.95*

**Scientists**

4. Dr A Venkataraman — 16.10.97
   Former Vice-Chancellor
   Tamil Nadu Agricultural University
   16, Cresent Avenue
   Kishor Parmal Puram
   Chennai 680 028

5. Dr P N Jha — 16.10.97
   Former Vice-Chancellor
   Rajendra Agricultural University
   Pusa, Smastipur (Bihar) 848 125

**Director**

6. Dr I S Yadav — 16.10.97
   Director
   Indian Institute of Horticultural
   Research
   PO Hessarghata
   Bangalore 560 089

**Farmer**

7. Mr Shatrugan Prasad Singh — 16.10.97
   24, MLA Quarters
   Patel Path
   Patna 800 001

**Member of Parliament**

8. Dr Asim Bala — 16.10.97
   Member of Parliament
   Block-C, Flat No. 6,
   Entally Government Housing Estate
   CIT Road, Calcutta 700 014

**Management Expert**

9. Dr P Rethinam — 16.10.97
   Director
   NRC for Oilpalm
   Elurce (Andhra Pradesh) 534 002

**Vice-Chancellor**

10. Dr K Pradhan — 16.10.97
    Vice-Chancellor
    Orissa University of Agriculture
    and Technology
    Bhubaneshwar (Orissa) 751 008

**Member-Secretary**

11. Shri G S Sahni
    Secretary
    Indian Council of Agricultural Research
    Krishi Bhavan,
    New Delhi 110 001

## APPENDIX 4

## ACCREDITATION BOARD

| | | | |
|---|---|---|---|
| 1. | Chairman | : | Dr R S Paroda<br>Director-General, ICAR |
| 2. | Vice-Chairman | : | Dr S L Mehta<br>Deputy Director General (Edn), ICAR |
| 3. | Three Vice-Chancellors of State Agricultural Universities | : | i) Dr A M Michael<br>Vice-Chancellor, KAU, Thrissur<br>ii) Dr V K Patil<br>Vice-Chancellor, MAU, Parbhani<br>iii) Dr A S Khera<br>Vice-Chancellor, PAU, Ludhiana |
| 4. | Two eminent Agricultural/Animal Social Scientists | : | i) Dr S S Johl<br>Social Scientist<br>C-21, Gurdev Nagar, Ludhiana<br>ii) Dr B K Soni<br>Animal Scientist<br>2C Lakashore Manor<br>112 Gurgadher Chetty Road<br>Ulsoor Lake<br>Bangalore 560 042 |
| 5. | Two members representing Agriculture/Industry | : | i) Mr Jiwanand Jha<br>CH-14, Road No. 2, S.K. Nagar, Patna-1<br>ii) Dr Md. Shakiluzzaman<br>Nurani Bagh, Alamgunj, Patna-7 |
| 6. | Secretary, UGC | : | Ex-Officio |
| 7. | Secretary, AICTE | : | Ex-officio |
| 8. | Secretary, VCI | : | Ex-officio |
| 9. | One Director from ICAR Deemed University | : | Dr R B Singh, Director, IARI, New Delhi |
| 10. | Secretary (full time) | : | Dr A P Saxena<br>Assistant Director-General |

## APPENDIX 5

## REGIONAL COMMITTEES

**Rule 60(b)**

1. Director-General
   Indian Council of Agricultural Research
   Krishi Bhavan, New Delhi 110 001

**Rule (c) (i)**

*The Members of the Society residing in the region (Ministers of the States)*

2. Minister for Agriculture/Animal Husbandry/Fisheries of the States in the region. Union Ministers holding charge of Finance, Planning, Science and Technology, Education and Commerce
   (For the Regional Committee No. IV)

*Member of Planning Commission, Incharge of Agriculture*

3. Member of Planning Commission
   Incharge of Agriculture
   Yojna Bhavan, New Delhi
   (For the Regional Committee No IV)

*Six Members of Parliament (Four elected by Lok Sabha and two elected by Rajya Sabha)*

4. Mr S S Surjewala — Up to 9.12.96
   Member, Rajya Sabha
   House No. 495, Sector 6
   Panchkula, Distt Ambala (Haryana)
   and
   AB 89, Shahjahan Road
   New Delhi

5. Shri Som Pal — Up to 9.12.96
   Member, Rajya Sabha
   Village and PO Kakor
   Tehsil Bagpat
   Block Chhaprauli
   Distt Meerut (Uttar Pradesh)
   and
   28, Lodi Estate
   New Delhi

6. Dr Asim Bala — Up to 22.7.99
   Member Lok Sabha
   Block C, Flat 6
   Entally Govt., Hubli Estate
   CIT Road, Calcutta 700 014
   and
   24, North Avenue
   New Delhi 110 001

7. Mr Oscar Fernandes — Up to 22.7.99
   Member Lok Sabha
   Dorise Rest Haven,
   Ambalpady, Udupi (Karnataka)
   and
   B 202 (F2), MP Flats
   Baba Kadak Singh Marg
   New Delhi 110 001

8. Mr Raja Rangappa Naik — Up to 22.7.99
   Member Lok Sabha
   Room No. 210,
   New Karnataka Bhavan
   New Delhi

9. Mr Chander Bhushan Singh — Up to 22.7.99
   Member Lok Sabha
   Plot No 85/117
   Trilokya Adarsh Kunj
   Patpatganj, Delhi

*All Secretaries in the Ministry of Agriculture*

10. Secretary (Agriculture and Co-operation)
    Ministry of Agriculture
    Department of Agriculture
    Krishi Bhavan
    New Delhi 110 001

11. Secretary (Animal Husbandry and Dairying)
    Krishi Bhavan
    New Delhi 110 001

*Secretary, Planning Coommission*

12. Secretary
Planning Commission
Yojna Bhavan
New Delhi
(For the Regioonal Committee No. IV)

*Chairman, UGC*

13. Chairman
University Grants Commission
Bahadur Shah Zafar Marg
New Delhi
(For the Regional Committee No. IV)

*Chairman, Atomic Energy Commission, or Director, Bhabha Research Centre, if nominated by the Chairman, Atomic Energy Commission*

14. Chairman
Atomic Energy Commission
Chhatrapati Shivaji Maharaj Marg
Mumbai (Maharashtra)
(For the Regional Committee No. VII)

*Member Finance (Secretary/Additional Secretary in the Ministry of Finance), Government of India*

15. Additional Secretary to the
Government of India
Ministry of Finance
Department of Expenditure
New Delhi
(For the Regional Committee No. IV)

*Four Vice-Chancellors of the Agricultural Universities, nominated by the President*

16. Dr R P S Tyagi — Up to 18.11.96
Vice-Chancellor
Himachal Pradesh Krishi
Vishwa Vidyalaya
Palampur (Himachal Pradesh) 176 062
(For the Regional Committee No. VIII)

17. Dr V Gyanaprakasam — Up to 9.4.96
Vice-Chancellor
Tamil Nadu Veterinary and
Animal Sciences University
Chennai (Tamil Nadu) 600 007

18. Dr A M Michael — Up to 29.12.96
Vice-Chancellor
Kerala Agricultural University
Trichur
(For the Regional Committee No VIII)

19. Dr L R Verma — Up to 28.11.98
Vice-Chancellor
Dr Y.S. Parmar University of
Horticulture & Forestry
Solan 172 230
(For the Regional Committee No. I)

20. Dr K Pradhan — Up to 28.11.98
Vice-Chancellor
Orissa University of
Agriculture & Technology
Bhubaneswar 751 008
(For the Regional Committee No. V)

*Five technical representatives, namely Agricultural Commissioner, Horticultural Commissioner, Animal Husbandry Commissioner, Fisheries Development Commissioner from the Union Ministry of Agriculture and Inspector-General of Forests, Government of India*

21. Agricultural Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

22. Horticultural Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

23. Animal Husbandry Commissioner
Department of Agricultuure
Krishi Bhavan
New Delhi 110 001

24. Fisheries Development Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

25. Inspector-General of Forests
Government of India
Department of Environment and Forests
CGO Complex
Lodi Road
New Delhi 110 003

*Fifteen scientists from within and outside the ICAR, including one from the Indian Council of Medical Research, nominated by the President residing within the region*

26. Dr J C Bakhshi — Up to 21.6.96
House No. 132 D
Kichloo Nagar
Ludhiana (Punjab) 141 001
(For the Regional Committee No. IV)

27. Dr P S Lamba — Up to 21.6.96
51, Defence Colony
Hisar (Haryana) 125 001
(For the Regional Committee No. VI)

28. Dr Sukhdev Singh — Up to 21.6.96
House No. 419, Sector 38 A
Chandigarh (Punjab) 160 014
(For the Regional Committee No. IV & VI)

29. Dr S K Sinha — Up to 26.4.97
Former Director
Indian Agricultural Research Institute
Pusa, New Delhi 110 012
(For the Regional Committee No. IV)

30. Dr O S Tomar — Up to 26.4.97
Director
National Dairy Research Institute
Karnal (Haryana) 132 001
(For the Regional Committee No. VI)

31. Dr Shankar Lal — Up to 26.4.97
Director (Acting)
Indian Institute of Pulses Research
Kalyanpur, Kanpur (Uttar Pradesh) 208 024
(For the Regional Committee No. IV)

32 Dr Mangala Rai — Up to 26.4.97
Assistant Director-General (P)
Indian Council of Agricultural Research
Krishi Bhavan
New Delhi 110 001
(For the Regional Committee No. IV)

33. Dr S D Tripathi — Up to 26.4.97
Director
Central Institute of Fisheries Education
7, Bungalow, Versova
Bumbai (Maharashtra) 400 061
(For the Regional Committee No. VII)

34. Dr S C Mudgal — Up to 26.4.97
Vice-Chancellor
Govind Ballabh Pant University of Agriculture and Technology
Pantnagar (Uttar Pradesh) 263 145
(For the Regional Committee No. I & IV)

35. Dr S Arya — Up to 26.4.97
Vice-Chancellor
Ch. Charan Singh Haryana Agricultural University
Hisar (Haryana) 125 004
(For the Regional Committee No. VI)

36. Dr A S Khera — Up to 26.4.97
Vice-Chancellor
Punjab Agricultural University
Ludhiana (Punjab) 141 004
(For the Regional Committee No. IV)

37. Dr R K Patel — Up to 26.4.97
Vice-Chancellor
Rajasthan Agricultural University
Bikaner (Rajasthan) 334 001
(For the Regional Committee No. VI)

38. Dr M P Singh — Up to 26.4.97
Vice-Chancellor
Central Agricultural University for the NEH Region
Imphal (Manipur) 795 001
(For the Regional Committee No. III)

39. Mr Jayant Das — Up to 26.4.97
Senior Advocate, AMBIM
M/s Das & Associates
Opp. Orissa High Court
Cuttack (Orissa) 753 001
(For the Regional Committee No. V)
and
C-II/30, Tilak Lane
New Delhi

40. Dr Aditya Prasad Das — Up to 26.4.97
Director-Incharge of the
Desert Medicine Research Centre
Jodhpur (Rajasthan)
(For the Regional Committee No. VI)

41. Dr A Appa Rao — Up to 20.7.99
Former Vice-Chancellor
Andhra Pradesh Agricultural University
No. 22-3-RT-HIGH
Vijaynagar Colony
Hyderabad (Andhra Pradesh) 500 057
(For the Regional Committee No. V)

42. Dr A Venkatraman — Up to 20.7.99
Former Vice-Chancellor
16, Cresent Avenue
Kishor Parmal Puram
Chennai (Tamil Nadu) 680 028
(For the Regional Committee No. VIII)

43. Dr P N Jha — Up to 20.7.99
Former Vice-Chancellor
Rajendra Agricultural University
Samastipur (Bihar) 848 125
(For the Regional Committee No. IV)

44. Mr Sher Bahadur Singh — Up to 05.02.98
Advocate
Baradeeh Chauraha
Mukhtiar Ganj
Satna (Madhya Pradesh)
(For the Regional Committee No. V & VII)

45. Mr D S Ananth — Up to 21.6.96
Planter
No. 513, 10th B Main
WCR, III Stage, IVth Block
Bashavshwar Nagar
Behind P.O.
Bangalore (Karnataka) 560 079
(For the Regional Committee No. VIII)

46. Mr Chengal Reddy — Up to 21.6.96
2, Shesh Villa
3-6-293
Hyderguda
Hyderabad (Andhra Pradesh)
(For the Regional Committee No. V)

47. Ms Suniti Wadhwa — Up to 5.2.98
S 468-A
Greater Kailash
Part I
New Delhi
(For the Regional Committee No. IV)

48. Mr S Jayaram Choudhary — Up to 5.2.98
Managing Director
KCP-Mayura, Hotel Mayura
Tirupati (Andhra Pradesh)
(For the Regional Committee No. II)

49 Mr R S Velan — Up to 5.2.98
974, Cross-cut-Road
Gandhipuram
Coimbatore (Tamil Nadu) 641 012
(For the Regional Committee No. III)

50. Mr Rameshwar Rajora — Up to 5.2.98
Vice-President
Cong. (I) Sewa Dal
Maur Mandi
Distt Bhatinda (Punjab)
(For the Regional Committee No. IV)

51. Mr Bhagwan Sahai Saini — Up to 5.2.98
Ward No 15, Chomu
Jaipur (Rajasthan)
(For the Regional Committee No. VI)

52. Mr K V Kuppusamy — Up to 5.2.98
Chairman and Managing Trustee
Bhaktavatsalam Memorial Trust
242 B, Trichy Road
Sulur, Coimbatore (Tamil Nadu)
(For the Regional Committee No. VIII)

53. Mr Shatrugan Prasad Singh — Up to 2.8.99
24, MLA Quarters
Patel Path
Patna (Bihar) 800 001

54. Mr Ramindra Kumar — Up to 2.8.99
P O Bhurkunda
Distt Hazaribagh (Bihar)

55. Shri Prem Nath Vij — Up to 21.6.96
97, Patel Nagar
Abohar
District Ferozepur (Punjab)
(For the Regional Committee No. IV)

56. Mr Ch. Rattan Lal — Up to 14.1.99
S/o Ch. Jas Ram
Sarpanch
Village & PO Alamgarh
Tehsil-Abohar
District Ferozepur (Punjab)
(For the Regional Committee No. I)

57. Mr S K Bharvava — Up to 5.2.98
56, Darya Mahal-A,
Nepeansea Road
Mumbai 400 006
(For the Regional Committee No. VII)

58. Mr Abhyanand Jha — Up to 2.8.99
Village Kakraul
District Madhubani (Bihar)
(For the Regional Committee No. IV)

59. Dr R N Verma — Up to 9.4.96
Director
National Centre for Mushroom Research & Training,
Chambaghat
Solan (Himachal Pradesh) 173 213

60. Dr Harbhajan Singh — Up to 9.4.96
Acting Project Director
National Research Centre on Coldwater Fisheries
Shilwa Hills Nursery, Roop Nagar
PB 28, Distt Nainital
Haldwani (Uttar Pradesh) 263 139

61. Dr A K Bandopadhyay — Up to 9.4.96
Director
Central Agricultural Research Institute
Andaman Nicobar Group of Islands, PB 181,
Port Blair 744 101

62. Dr I S Yadav — Up to 7.8.99
Director
Indian Institute of Horticulture Research
Hassarghatta Lake Post
Bangalore (Karnataka) 560 089

63. Dr R P Awasthi — Up to 7.8.99
Director
ICAR Research Complex for North Eastern Hill Region
Umroi Road
Barapani (Meghalaya) 793 103

64. Dr P Rathinam — Up to 7.8.99
Director
National Research Centre for Oil Palm
Tenali Rama Krishnaiah Street
Ashok Nagar, Eluru
West Godavari (Andhra Pradesh) 534 002

65. Dr S A H Abidi — Up to 7.8.99
Director
Central Institute for Fisheries Education
Jaiprakash Road
Seven Bungalows, Varsova
Mumbai (Maharashtra) 400 006

66. Chairman of the Development Council or Councils of the Department of Agriculture residing in the region

*Directors of the Institutes of the Council in the region*

67. Directors of the Institutes/ National Bureaux/Project Directorates/National Research Centres/Zonal Co-ordinators of the region

68. Secretaries of Agriculture/Animal Husbandry/Fisheries/Rural Development of the States in the region

69. Agricultural Production Commissioners of the States in the region

70. Directors of the Agriculture/Horticulture/ Animal Husbandry and Veterinary/ Fisheries/Rural Development of the States in the region

71. Engineer-in-Chief/Chief Conservator of Forests of the States in the region

**Rule 60 (c) (v)**

*Progressive Farmers (2) to be nominated by the President*

72. Mr Buta Singh Bajwa — Up to 29.12.97
6, Guru Nanak Nagar
Batala (Punjab)
(For the Regional Committee No. I)

73. Mr Prempal Sandhu — Up to 29.12.97
Sandhu Bhavan
Sector 7, Urban Estate
Karnal (Haryana)
(For the Regional Committee No. I)

74. Captain R K Mallik — Up to 29.12.97
AB Mushroom Farm
Solan
(For the Regional Committee No. II)

75. Mr N S Patil — Up to 29.12.97
317, Laxmi Nagar
Nagpur (Maharashtra)
(For the Regional Committee No. II)

76. Mr D V Narkhade — Up to 29.12.97
PO Chinawal
Tal: Raver
Distt Jalgaon (Maharashtra)
(For the Regional Committee No. III)

77. Mr Sunil Beohar — Up to 29.12.97
Sathiya Kua, Anand Bhavan
Jabalpur (Madhya Pradesh)
(For the Regional Committee No. III)

78. Mr Mohinder Singh — Up to 29.12.97
Pakki, Ferozepur (Punjab)
(For the Regional Committee No. IV)

79. Mr Ranveer Singh Chowdhary — Up to 29.12.97
11, Nehru Road
Meerut (Uttar Pradesh)
(For the Regional Committee No. IV)

80. Mr Dhirendra Verma — Up to 29.12.97
Bhairamgarh
Distt Bastar (Madhya Pradesh)
(For the Regional Committee No. V)

81. Smt Uma Bhushan — Up to 29.12.97
C/o Shri P C Jain
Post Office Road
Saharanpur (Uttar Pradesh)
(For the Regional Committee No. V)

82. Mr Ram Saroop Verma — Up to 29.12.97
Mir Gate
PO Kokri
Distt Jaipur (Rajasthan)
(For the Regional Committee No. VI)

83. Mr Nathu Lal Jain — Up to 29.12.97
525, Patwari Building
Govind Rajiya Ka Rasta
Chandpal Bazar
Jaipur (Rajasthan)
(For the Regional Committee No. VI)

84. Ms Jayantiben Shroff — Up to 29.12.97
Near Vegetable Market
PO Palghar
Distt Thane (Maharashtra)
(For the Regional Committee No. VII)

85. Mr Prakash Vyas — Up to 29.12.97
Nutan Nagar Colony
Khargon (Madhya Pradesh)
(For the Regional Committee No. VII)

86. Mr Lingaraj Patil — Up to 29.12.97
5th Cross, IInd Main
Sadashivnagar
Belgaum (Karnataka)
(For the Regional Committee No. VIII)

87. Mr A R Andu Gowde — Up to 29.12.97
PO Ketti Eal, Coonoor
Distt Nilgiris (Tamil Nadu)
(For the Regional Committee No. VIII)

**Rule 60 (c) (vi)**

*Two members from Non-Governmental Organizations engaged in Rural Development in the region, nominated by the President*

88. Mr S K Ahuja — Up to 29.12.97
V&PO Panjkosi
Teh. Abohar
Distt Ferozepur (Punjab)
(For the Regional Committee No. I)

89. Mr Bhagwant Singh — Up to 29.12.97
S/o Shri Harbans Singh
Chhawni Kala
Hoshiarpur (Punjab)
(For the Regional Committee No. I)

90. Prof S S Chakraborty — Up to 29.12.97
Shri R K Missioon Ashram
Narendrapur
24 Parganas (West Bengal)
(For the Regional Committee No. II)

91. Dr A K Butta — Up to 29.12.97
Yug Nirman Yojana
Shanti Kunj
Hardwar (Uttar Pradesh)
(For the Regional Committee No. II)

92. Dr Aparna Hariprasad — Up to 29.12.97
Project Director
Social Work and Research Centre
West Garo Hills
Meghalaya
(For the Regional Committee No. III)

93. Ms Annu Mukherjee — Up to 29.12.97
President
Tripura Adivasi Mahila Samiti
Tripura
(For the Regional Committee No. III)

94. Mr J S Cheema — Up to 29.12.97
S/o Shri Amrik Singh Cheema
President
Farmers' Youth Forum
168, Sector 8
Chandigarh
(For the Regional Committee No. IV)

95. Mr Pramod Agarwal — Up to 29.12.97
B D Educatioonal Foundatioon
2/5, Patel Road
Jalandhar Cantt (Punjab)
(For the Regional Committee No. IV)

96. Mr K V Kuppusamy — Up to 29.12.97
Chairman and Managing Trustee
Bhaktavatsalam Memorial Trust
242 B, Trichy Road
Sulur, Coimbatore (Tamil Nadu) 641 402
(For the Regional Committee No. V)

97. Mr Chengal Reddy — Up to 29.12.97
Peddireddy Thimmareddy
Farm Foundation Trust
No. 2, Shesh Villa, 3-6-293 Hyderguda
Hyderabad (Andhra Pradesh)
(For the Regional Committee No. VI)

98. Mr Mihir Bhatt — Up to 29.12.97
Disaster Mitigation Institute
ASHA 4, Panchsheel Society
Ahmedabad (Gujarat)
(For the Regional Committee No. VI)

99. Mr S R Ola — Up too 29.12.97
Balik Vidyalaya Trust
Ardawata, PO Chairawa
Distt Jhunjhunu (Rajasthan)
(For the Regional Committee No. VI)

100. Mr Sanjay D Patil — Up to 29.12.97
D.Y. Patil Educational Institute
Kohlapur (Maharashtra)
(For the Regional Committee No. VII)

101. Mr S B Nyamagounda — Up to 29.12.97
Krishna Teer Rayat Sangh
Maitri Gali, Jamakhandi
Distt Bijapur (Karnataka) 587 301
(For the Regional Committee No. VII)

102. Mr B V Parmeshwara Rao — Up to 29.12.97
Bhagavatula Charitable Trust
Yellamanchili
Visakha Distt (Andhra Pradesh)
(For the Regional Committee No. VIII)

103. Shri P N Dhawan — Up to 29.12.97
General Secretary, Punjab Association (Regd.)
Lajpatrai Bhavan
PB 416, Peters Road
Royapettah
Chhenai (Tamil Nadu)
(For the Regional Committee No. VIII)

*Member-Secretary*

104. One of the Directors of the ICAR Institutes in the region

**Special Invitee**

*In the respective region*

105. Head of the Regional Office, National Bank for Agricultural and Rural Development, Shimla/Jammu/Chandigarh/Calcutta/Guwahati/Lucknow/New Delhi/Patna/Bhubaneswar/Hyderabad/Jaipur Ahmedabad/Bhopal/Pune/Bangalore/Madras/Thiruvananthapuram/Bombay

**Representatives of WALMIS**

*In the respective region*

106. Director, WALMIS, Tezpur/Lucknow/Patna/Hyderabad/Bhopal/Cuttack/Anand/Kota/Aurangabad/Dharwad/Trichy

**Others**

107. Director-General
U.P. Council of Agricultural Research, A-11, Nirala Nagar
Lucknow (Uttar Pradesh) 226 007
(For the Regional Committee No. IV)

108. Director
National Bureau of Soil Survey and Land-Use Planning
Shankar Nagar
Amaravati Road
Nagpur (Maharashtra) 440 010
(For the Regional Committees)

109. Dean, Home Science
Govind Ballabh Pant University of Agriculture and Technology
Pantnagar (Uttar Pradesh) 263 145
(For the Regional Committee No. I)

110. Associate Dean
Assam Agricultural University
Jorhat (Assam)
(For the Regional Committee No. II)

111. Dean
Chander Shekhar Azad University of Agriculture and Technology
Kanpur (Uttar Pradesh) 208 002
(For the Regional Committee No. III)

112. Dean
Home Science
Punjab Agricultural University
Ludhiana (Punjab) 141 004
(For the Regional Committee No. IV)

113. Dean
Home Science
Andhra Pradesh Agricultural University
Rajendranagar
Hyderabad (Andhra Pradesh) 500 030
(For the Regional Committee No. V)

114. Dean
Home Science
Rajasthan Agricultural University
Udaipur (Rajasthan)
(For the Regional Committee No. VI)

115. Associate Dean
Marathwada Agricultural University
Parbhani (Maharashtra) 431 402
(For the Regional Committee No. VII)

116. College of Home Science
Tamil Nadu Agricultural University
Madurai (Tamil Nadu)
(For the Regional Committee No. VIII)

## Institutes in Eight Regions of India

| | Regions/States | ICAR Institutes |
|---|---|---|
| I. | Himachal Pradesh, Jammu and Kashmir, Hill Region of Uttar Pradesh | CPRI, Shimla; CSWCR&TI, Dehra Dun; CITH, Srinagar, VPKAS, Almora |
| II. | Assam and West Bengal | JTRL, Calcutta; CRIJAF, CICFRI, Barrackpore |
| III. | Sikkim, Mizoram, Arunachal Pradesh Nagaland, Meghalaya, Tripura, Manipur, Andaman and Nicobar Islands | ICAR Research Complex for NEH Region, Shillong; CARI, Port Blair |
| IV. | Bihar, Punjab, Plains of Uttar Pradesh, Union Territory of Delhi | IARI, NBPGR, IASRI, New Delhi; IVRI, CARI, Izatnagar; IFGRI, Jhansi; IISR,CIHNP, CISH, Lucknow; CIPHET, Ludhiana; CIRG, Mukhdoom; ILRI, Ranchi; IIPR, Kanpur |
| V. | Orissa, Andhra Pradesh, eastern Madhya Pradesh | CRRI, Cuttack; CIFA, Bhubaneswar; NAARM, CRIDA, Hyderabad; IISS, CIAE, Bhopal; CTRI, Rajahmundry |
| VI. | Haryana, Rajasthan, Gujarat and Union Territory of Dadra and Nagar, Haveli, Daman and Diu | CAZRI, Jodhpur, CSWRI, Avikanagar; NDRI, NBAGR, NIAG, CSSRI, Karnal; CIRB, Hisar |
| VII. | Maharashtra, Western and Central Madhya Pradesh, Goa | CIRCOT, CTRL, CIFE, Mumbai; ICAR Research Complex for Goa, NBSSLUP, CICR, Nagpur |
| VIII. | Kerala, Karnataka, Tamil Nadu, Union Territory of Pondicherry, Lakshadweep Islands | CIFT, CMFRI, Kochi; NIANP, IIHR, CTCRI, Trivananthapuram; Bangalore; SBI, Coimbatore; CPCRI, Kasaragod; CIBA, Madras; IISR, Calicut; |

## APPENDIX 6

## SENIOR OFFICERS AT THE HEADQUARTERS OF THE ICAR

1. Dr R S Paroda
   Director-General, ICAR, and
   Secretary to the Government of India
   Department of Agricultural Research
   and Education

2. Dr A L Chaudhary
   Chairman
   Agricultural Scientists' Recruitment Board

3. Dr K V Raman
   Member
   Agricultural Scientists' Recruitment Board

4. Dr Kirti Singh
   Member
   Agricultural Scientists' Recruitment Board

5. Shri G S Sahni
   Secretary, ICAR, and Joint Secretary
   to the Government of India
   Department of Agricultural Research
   and Education

**Deputy Directors-General**

6. Dr E A Siddiq (Crop Sciences)

7(a). Dr K L Chadha (Horticulture) Up to 30.11.96

7(b). Dr S P Ghosh (Horticulture)

8. Dr G B Singh (Soils, Agronomy and Agroforestry)

9. Dr M L Madan (Animal Sciences)

10. Dr P V Dehadrai (Fisheries)

11. Dr Gajendra Singh (Agricultural Engineering)

12. Dr S L Mehta (Education)

13. Dr Puranjan Das (Agricultural Extension)

**Directors**

14. Captan Marwaha (Personnel)

15. Smt Vibha Pandey (Finance) w.e.f. 12.6.95

16. Dr R D Sharma
    Acting (DPIA)

17. Mr J S Yadav (Works)

**Assistant Directors-General**

***Crop Sciences***

1. J P Tandon (Food and Forage Crops)
2. A K Raheja (Entomology and Biological-control)
3. N B Singh (Oilseeds and Pulses)
4. S P Tiwari (Seeds)

***Horticulture***

5. S P Ghosh (Horticulture) Up to 30.12.96
6. D P Singh (Vegetable Crops)
7. R N Pal (Officiating) (Plantation Crops)

***Soils, Agronomy and Agroforestry***

8. P C Bhatia (Agronomy)
9. P S Pathak (Agroforestry)
10. R N Prasad (Soils)
11. S Manji (IWM)

***Engineering***

12. R P Kachru (Post-Harvest Technology)
13. A K Bhattacharya (Officiating) (Engineering)

***Animal Sciences***

14. V K Taneja (Animal Production and Breeding)
15. R N Sinha (D&API)
16. Lal Krishna (Animal Health)
17. S C Chopra (Officiating) (ANP)

***Fisheries***

18. M Y Kamal (Inland Fisheries)

***Education***

19. A P Saxena (Accreditation)
20. A K Sinha (Education and HRD II)
21. J L Sehgal (HRD I)

***Extension***

22. B N Choudhury (Lab-to-Land)
23. A N Shukla (Krishi Vigyan Kendras)
24. B S Hansra (Extension)

***Others***

25. R C Maheshwari (Centre-State Co-ordination)
26. Mangala Rai (Policy and Perspective Planning)
27. Tej Verma (Home Science)
28. Mrutyunjaya (Economics, Statistics and Marketing)
29. S M Ilyas (Technical Co-ordination and Intellectual Property Rights)

**Principal Scientists**

***Crop Science***

1. Dr O P Dubey (Entomology)
2. Dr G C Tiwari (Entomology and Biological Control)

***Horticulture***

3. Dr R N Pal (Plantation Crops)
4. Dr P S Bhatnagar (Seeds)

***Soils, Agronomy and Agroforestry***

5. Dr S Manji (Agronomy)
6. Dr R K Gupta (Soils)

***Animal Sciences***

7. Dr S C Chopra (Animal Production and Breeding)
8. Dr P S R C Murti (Livestock and Health)

***Education***

9. Dr Arun Verma (Animal Nutrition)
10. Dr G D Diwakar (Agricultural Economics)
11. Dr Mrs Pran Pyari Bhat (HRD II)

***Extension***

12. Dr S D Rai (Agronomy)
13. Dr S P Singh (Agronomy)
14. Dr G Appa Rao (Extension)
15. Dr Mrs Usha Anand (Social Science)

**Deputy Secretaries**

1. Mr Devinder Singh Malik (Administration and General Administration and Co-ordinatioon)
2. Mr A K Chaturvedi (Animal Sciences)
3. Mr Gaya Prasad (Education and NARP)

**Others**

1. Mr K K Bajpai
   Secretary
   Agricultural Scientists' Recruitment Board
2. 
3. Dr P N Bhat
   Officer on Special Duty (DPIA)
4. Mr G C Sharma
   Officer on Special Duty (Admn.)
5. Dr R D Sharma
   Chief Editor (Hindi)
6. Mr R R Lokeshwar
   Editor (English)
7. Mr R S Gupta
   Editor (English)
8. Mr V K Bharti
   Chief Production Officer
9. Mr J B Mehra
   Production Officer
10. Mr Aravind Chakravarty
    Chief Artist
11. Shri Kuldeep Sharma
    Editor (Hindi)
12. Mr Ratan Prakash
    Chief Publicity and Public Relations Officer

## APPENDIX 7

## ICAR INSTITUTES

### National Institutes

1. Dr R B Singh
   Director
   **Indian Agricultural Research Institute**
   New Delhi-110 012

2. Dr Kiran Singh
   Director
   **Indian Veterinary Research Institute**
   Izatnagar (Uttar Pradesh) 243 122

3. Dr O S Tomar
   Director
   **National Dairy Research Institute**
   Karnal (Haryana) 132 001

4. Dr S A H Abidi
   Director
   **Central Institute of Fisheries Education**
   Jaiprakash Road, Seven Bungalow (Versova)
   Mumbai (Maharashtra) 400 061

### Agricultural Sciences

5. Dr A K Bandopadhyay
   Director
   **Central Agricultural Research Institute**
   Andaman and Nicobar Group of Islands
   P B 181
   Port Blair (Andamans) 744 101

6. Dr A S Faroda
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7. Dr Gyanendra Singh
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8. Dr M S Kairon
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   P B 2255, GPO
   Nagpur (Maharashtra) 440 001

9. Dr Jai Singh
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   **Central Institute of Post-Harvest Engineering and Technology**
   Ludhiana (Punjab) 141 004

10. Dr K R Krishna Iyer
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    **Central Institute for Research on Cotton Technology**
    PB 16640, Adenwala Road, Matunga
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11. Dr S S Negi
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12. Dr A A Sofi
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    **Central Institute for Temperate Horticulture**
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    Srinagar (Jammu & Kashmir) 190 012

13. Dr M K Nair
    Director
    **Central Plantation Crops Research Institute**
    Kasaragod (Kerala) 670 124

14. Dr G S Shekhawat
    Director
    **Central Potato Research Institute**
    Shimla (Himachal Pradesh) 171 001

15. Dr J C Katyal
    Director
    **Central Research Institute for Dryland Agriculture**
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16. Dr D P Singh
    **Central Research Institute for Jute and Allied Fibres**
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    Distt 24 Paraganas (West Bengal) 743 101

17. Dr K C Mathur
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18. Dr N K Tyagi
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**Central Soil Salinity Research Institute**
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19. Dr J S Samra
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Dehra Dun (Uttar Pradesh) 248 195

20. Dr M S Chari
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21. Dr G T Kurup
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22. Dr D G Dhandar
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23. Dr R P Awasthi
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24. Prof Bal B P S Goel
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**Indian Agricultural Statistics Research Institute**
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19. Dr Bhag Mal
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26. Dr I S Yadav
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Bangalore (Karnataka) 560 089

27. Dr A S Asthana
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**Indian Institute of Pulses Research**
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28. Dr P N Takkar
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Bhopal (Madhya Pradesh) 462 011

29. Dr K V Peter
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**Indian Institute of Spices Research**
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Calicut (Kerala) 673 012

30. Dr S R Misra
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31. Dr S C Agarwal
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Ranchi (Bihar) 843 010

32. Dr B C Mitra
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**Jute Technological Research Institute**
12 Reagent Park
Calcutta (West Bengal) 700 040

33. Dr B K Tripathy
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**Sugarcane Breeding Institute**
Coimbatore (Tamil Nadu) 641 007

34. Dr V S Chauhan
Director
**Vivekananda Parvatiya Krishi Anusandhan Shala**
Almora (Uttar Pradesh) 263 601

**Animal Sciences and Fisheries**

35. Dr S C Mahapatra
Director
**Central Avian Research Institute**
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36. Dr M R Sinha
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**Central Inland Capture Fisheries Research Institute**
Barrackpore (West Bengal) 743 122

37. Dr K Alagarswami
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**Central Institute of Brackishwater Aquaculture**
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38. Dr K Gopakumar Panickar
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39. Dr S Ayyappan
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**Central Institute of Freshwater Aquaculture**
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40. Dr M L Punj
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41. Dr Abdur Rekib
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42. Dr M Devaraj
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## APPENDIX 8

## NATIONAL BUREAUX

### Agricultural Sciences

1. Dr K P S Chandel
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   **National Bureau of Plant Genetic Resources**
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   P B 426
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### Animal Sciences

3. Dr A E Nivsarkar
   *Director*
   **National Bureau of Animal**
   **Genetic Resources**
   NDRI Campus
   Karnal (Haryana) 132 001

4. Dr P Das
   Director
   **National Bureau of Fish Genetic Resources**
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   351/28, Dariya Pur
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   Lucknow (Uttar Pradesh) 226 002

## APPENDIX 9

## PROJECT DIRECTORATES

**Agricultural Sciences**

1. Dr R L Yadav
   Project Director
   **Directorate of Cropping Systems Research**
   Modipuram, Meerut
   (Uttar Pradesh) 250 110

2. Dr P S Reddy
   Project Director
   **Directorate of Oilseed Research**
   Rajendranagar
   Hyderabad
   (Andhra Pradesh) 500 030

3. Dr K Krishnaiah
   Project Director
   **Directorate of Rice Research**
   Rajendranagar
   Hyderabad (Andhra Pradesh) 500 030

4. Dr R K Rajput
   Project Director
   **Directorate of Water Management**
   Mahatma Phule Krishi Vidyapeeth Campus
   Rahuri
   Ahmednagar (Maharashtra) 413 722

5. Dr S Nagarajan
   Project Director
   **Directorate of Wheat Research**
   P B 158, Kunjpura Road
   Karnal (Haryana) 132 001

6. Dr S P Singh
   Project Director
   **Project Directorate of Biological Control**
   Bellary Road
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   Bangalore (Karnataka) 560 024

7. Dr N N Singh
   Project Director
   **Project Directorate on Maize**
   Cummings Laboratory
   Indian Agricultural Research Institute
   New Delhi 110 012

8. Dr G Kallu
   Project Director
   **Project Directorate on Vegetables**
   No.1 Gandhinagar
   Sunderpur (Nasic)
   Varanasi
   (Uttar Pradesh) 221 005

**Animal Sciences**

9. Dr V N Tripathi
   Project Director
   **Project Directorate on Cattle**
   PH-7, Pallavpuram
   Phase II, Modipuram
   Meerut (Uttar Pradesh) 250 110

10. Dr V Ayyagiri
    Project Director
    **Project Directorate on Poultry**
    Andhra Pradesh Agricultural
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    Rajendranagar
    Hyderabad (Andhra Pradesh) 500 030

## APPENDIX 10

## NATIONAL RESEARCH CENTRES

### Agricultural Sciences

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   Director
   **National Research Centre for Agroforestry**
   IGFRI Campus
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   Gwalior-Jhansi Road
   Jhansi (Uttar Pradesh) 284 003

2. Dr O P Pareek
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   **National Research Centre for Arid Horticulture**
   C-35, Sadulganj
   Bikaner (Rajasthan) 334 003

3. Dr H P Singh
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   No. 4 Ramalingam Nagar, Veluyur Road
   Tiruchirapalli (Tamil Nadu) 639 103

4. Dr E V V Bhaskar Rao
   **National Research Centre for Cashew**
   Kamminje
   Puttur (Karnataka) 574 202

5. Dr Harcharan Das
   Director
   **National Research Centre for Citrus**
   Seminary Hills
   Nagpur (Maharashtra) 440 006

6. Dr S D Shikamani
   Officer on Special Duty
   **National Research Centre for Grapes**
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7. Dr A Bandyopadhyay
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   **National Research Centre for Groundnut**
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   Junagadh (Gujarat) 362 001

8. Dr S N Puri
   Director
   **National Research Centre for Integrated Pest Management**
   Lal Bahadur Shastri Centre for Biotechnology
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9. Dr K C Dalal
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   **National Research Centre for Medicinal and Aromatic Plants**
   Boriavi Seed Farm
   Boriavi
   Anand (Gujarat) 387 310

10. Dr R N Verma
    Director
    **National Centre for Mushroom**
    Research and Training
    Chambaghat
    Solan (Himachal Pradesh)

11. Dr P Rethinam
    Director
    **National Research Centre for Oilpalm**
    Ashok Nagar
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12. Dr G B Raturi
    Officer-Incharge
    **National Research Centre for Onion and Garlic**
    MF 37, Sundarvan Colony, Near Lekha Nagar
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13. Dr R C Upadhyaya
    Officer-Incharge
    **National Research Centre for Orchids**
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    NEH Region
    Regional Station, Tadong
    Ganagtok (Sikkim) 737 102

14. Dr R P Sharma
    Project Director
    **National Research Centre on Plant Biotechnology**
    Indian Agricultural Research Institute
    New Delhi 110 012

15. Dr P R Kumar
Director
**National Research Centre for Rapeseed and Mustard**
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16. Dr B S Rana
Director
**National Research Centre for Sorghum**
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Hyderabad (Andhra Pradesh) 500 030

17. Dr P S Bhatnagar
Director
**National Research Centre on Soybean**
Bhawerkua Farm, Khandwa Road
Indore (Madhya Pradesh) 452 001

18. Dr S R Singh
Project Director
**National Research Centre for Water Technology**
Eastern Region
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19. Dr V M Bhan
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**Animal Sciences and Fisheries**

20. Dr S M Lal
Joint Director
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21. Director
**National Biotechnology Centre for Animal Health**
Izatnagar (Uttar Pradesh) 243 122

22. Director
**National Embryo Biotechnology Centre for Animal Production**
National Dairy Research Institute
Karnal (Haryana) 132 001

23. Dr N D Khan
Project Director
**National Research Centre on Camel**
Jorbeer PB 07
Bikaner (Rajasthan) 334 001

24. Dr H S Raina
Project Director
**National Research Centre for Coldwater Fishereis**
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Haldwani (Uttar Pradesh) 263 139

25. Dr M P Yadav
Director
**National Research Centre for Equines**
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Hisar (Haryana) 125 001

26. Dr G C Mohanty
Director
**National Research Centre on Meat and Meat Products**
Indian Veterinary Research Institute
Campus
Izatnagar (Uttar Pradesh) 243 122

27. Dr N D Verma
Director
**National Research Centre on Mithun**
ICAR Research Complex
Jharnapani
Distt Kohima (Nagaland) 797 106

28. Dr R N Pal
Director
**National Research Centre on Yak**
West Kemeng
Dirang (Arunachal Pradesh) 797 106

**General**

29. Dr Dayanatha Jha
Director
**National Centre for Agricultural Economics and Policy Research**
IASRI Campus
New Delhi 110 012

30. Dr S K Das
Director
**National Research Centre for Women in Agriculture**
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Bhubaneshwar (Orissa) 751 001

## APPENDIX 11

## ALL INDIA CO-ORDINATED RESEARCH PROJECTS

### Crop Sciences

1. Dr B Mallick
   Acting Project Co-ordinator (**Acarology**)
   University of Agricultural Sciences
   Bangalore (Karnataka) 560 024

2. Dr P Shyam Sunder Rao
   Project Co-ordinator (**Agricultural Ornithology**)
   APAU Veterinary College Campus
   Ranjendranagar
   Hyderabad (Andhra Pradesh) 500 030

3. Dr V K Gupta
   Project Co-ordinator (**Apple Scab**)
   Dr Y.S. Parmar University of Horticulture and Forestry
   Solan (Himachal Pradesh) 173 230

4. Dr B S Dabas
   Project Co-ordinator (**Arid Legumes**)
   NBPGR, Pusa Campus, IARI
   New Delhi 110 012

5. Dr K S Randhawa
   Project Co-ordinator (**Barley**)
   Regional Station (IARI)
   Karnal (Haryana) 132 001

6. Dr C Hanumantha Rao
   Project Co-ordinator (**Castor**)
   Directorate of Oilseed Research
   Hyderabad (Andhra Pradesh) 500 030

7. Dr Masood Ali
   Project Co-ordinator (**Chickpea**)
   Indian Institute of Pulses Research
   Kalyanpur
   Kanpur (Uttar Pradesh) 208 024

8. Dr K Venugopal
   Project Co-ordinator (**Cotton**)
   Regional Research Station (CICR)
   PO Lawley Road
   Coimbatore
   (Tamil Nadu) 641 003

9. Dr C R Hazara
   Project Co-ordinator (**Forage crops**)
   Indian Grassland and Fodder Research Institute
   PO Pahuj Dam, Jhansi-Gwalior Road
   Jhansi (Uttar Pradesh) 284 003

10. Dr M S Basu
    Project Co-ordinator (**Groundnut**)
    C/o NRC on Groundnut
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    Jungarh (Gujarat) 382 001

11. Dr B B Das
    Project Co-ordinator (**Jute and Allied Fibres**)
    Central Research Institute for Jute and Allied Fibres
    PO Barrackpore
    24 Paraganas
    (West Bengal) 743 101

12. Project Co-ordinator (**Linseed**)
    CSA University of Agriculture & Technology
    Kanpur (Uttar Pradesh) 208 002

13. Dr A Seetharam
    Project Co-ordinator (**Minor Millets**)
    University of Agricultural Sciences
    GKVK Campus
    Bangalore (Karnataka) 560 065

14. Dr Vishwa Dhar
    Project Co-ordinator (**Mullarp**)
    Indian Institute of Pulses Research
    Kalyanpur
    Kanpur (Uttar Pradesh) 208 024

15. Dr R K Choudhary
    Project Co-ordinator (**National Seed Project**)
    Division of Seed Science & Technology
    Indian Agricultural Research Institute
    New Delhi 110 012

16. Dr S K Midha
Project Co-ordinator (**Nematodes**)
Division of Nematology
Indian Agricultural Research Institute
New Delhi 110 012

17. Dr S K Bhatnagar
Project Co-ordinator (**Pearl Millet**)
Agricultural Research Station
Mandose
Jodhpur (Rajasthan)

18. Dr S K Handa
Project Co-ordinator (**Pesticide Residues**)
Division of Agricultural Chemicals
Indian Agricultural Research Institute
New Delhi 110 012

19. Dr D P Srivastava
Project Co-ordinator (**Pigeonpea**)
Indian Institute of Pulses Research
Kalyanpur
Kanpur (Uttar Prades) 208 024

20. Dr Bhuri Singh
Project Co-ordinator (**Rape seed and Mustard**)
Sewar Farm
Distt Bharatpur (Rajasthan)

21. Dr B D Rana
Project Co-ordinator (**Rodent Control**)
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22. Dr D M Hedge
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23. Dr M R Siddiqui
Project Co-ordinator (**Seed-borne Diseases**)
Division of Seed Science & Technology
Indian Agricultural Research Institute
New Delhi 110 012

24. Dr S M Sharma
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25. Dr B S Rana
Project Co-ordinator (**Sorghum**)
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26. Dr P S Bhatnagar
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27. Dr H M Srivastava
Project Co-ordinator (**Sugarbeet**)
Indian Institute of Sugarcane Research
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28. Dr S R Mishra
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Lucknow (Uttar Pradesh) 208 002

29. Dr K Virupakashappa
Project Co-ordinator (**Sunflower**)
University of Agricultural Sciences
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Bangalore (Karnataka) 560 065

30. Dr R Lakshminarayana
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Gujarat Agricultural University
Anand (Gujarat)

31. Dr Sudhir Kochar
Project Co-ordinator (**Under-utilized & Under-exploited Plants**)
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32. Dr C P S Yadav
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**Horticulture**

33. Dr O P Pareek
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34. Dr S Maity
Project Co-ordinator (**Betelvine**)
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Bangalore (Karnataka) 560 089

35. Dr E V V Bhaskar Rao
Project Co-ordinator (**Cashew**)
National Research Centre for Cashew
Puttur (Karnataka) 674 202

36. Dr S P S Raghava
Project Co-ordinator (**Floriculture**)
Division of Floriculture and Landscaping
Indian Agricultural Research Institute
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37. Dr R C Mishra
Project Co-ordinator (**Honeybees**)
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38. Dr K C Dalal
Project Co-ordinator (**Medicinal and Aromatic Plants**)
National Research Centre for Medicinal and Aromatic Plants
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39. Dr R N Verma
Project Director and
Project Co-ordinator(**Mushrooms**)
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Solan (Himachal Pradesh) 173 213

40. Dr M K Nair
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Central Plantation Crops Research Institute
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41. S B Maini
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Indian Agricultural Research Institute
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42. Dr S M Paul Khurana
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43. Dr D S Rathore
Project Co-ordinator (**Subtropical Fruits**)
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45. Dr H P Singh
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46. Dr P G Rajendran
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Regional Station of the Central Tuber
Crops Research Institute
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**Soils, Agronomy and Agroforestry**

47. Dr P S Pathak
Assistant Director-General and
Project Co-ordinator (**Agroforestry**)
Indian Council of Agricultural Research
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48. Dr S K Sharma
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Project Directorate for
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49. Dr S L Gulati
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50. Dr B Gangwar
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51. Dr T Vishnumurthy
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52. Dr K K M Nambiar
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Agricultural Chemistry
Indian Agricultural Research Institute
New Delhi-110 012

53. Project Co-ordinator (**Micronutrients**)
Indian Council of Agricultural Research
Krishi Bhavan
New Delhi 110 001

54. Dr K K R Bhardwaj
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Palampur (Himachal Pradesh) 176 062

55. Dr M V Singh
Project Co-ordinator (**Micronutrients and Secondary Nutrients & Pollutant Elements**)
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56. Dr R P Gupta
Project Co-ordinator (**Soil Physical Conditions**)
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Indian Agricultural Research Institute
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57. Dr A Subba Rao
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Indian Institute of Soil Science
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58. Dr D K Das
Project Co-ordinator (**Tillage Management of Indian Soils**)
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Indian Agricultural Research Institute
Pusa, New Delhi 110 012

59. Dr O S Tomar
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Karnal (Haryana) 132 001

60. Dr R K Batra
Project Co-ordinator (**Water Management**)
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61. Dr L P Kauraw
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62. Dr B R Sharma
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**Engineering and Technology**

63. Dr A K Bhattacharya
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Water Technology Centre
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64. Dr Dipankar Dey
Project Co-ordinator (**Energy Requirements in Agricultural Sector**)
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65. Dr M M Pandey
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Bhopal (Madhya Pradesh) 462 038

66. Project Co-ordinator (**Human Engineering and Safety-Studies in Agriculture**)
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Central Institute of Agricultural Engineering
Bhopal (Madhya Pradesh) 462 038

67. Dr O D Wanjari
Project Co-ordinator (**Plastics in Agriculture**)
Central Institute of Post-Harvest
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Ludhiana (Punjab) 141 004

68. Dr B S Bisht
Project Co-ordinator (**Post-Harvest Technology**)
Central Institute of Post-Harvest Technology
Ludhiana (Punjab) 141 004

69. Dr R K Verma
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70. Dr Jaswant Singh
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71. Dr M Shyam
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72. Dr N S L Srivastava
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**Animal Sciences and Fisheries**

73. Project Co-ordinator (**Animal Genetic Resources**)
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74. Dr S N Kaushik
Project Co-ordinator (**Buffaloe Breeding**)
Central Institute for Research on Buffaloes
Hisar (Haryana) 125 001

75. Project Co-ordinator (**Crop Based Animal Production Systems**)
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76. Project Co-ordinator (**Embryo Transfer**)
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Krishi Bhavan
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77. Dr B U Khan
Project Co-ordinator (**Goats**)
Regional Research Centre of CIRG
Alikanagar (Rajasthan) 204 501

78. Dr S S Bhatia
Project Co-ordinator (**Pigs**)
Indian Veterinary Research Institute
Izatnagar (Uttar Pradesh) 243 122

79. Dr S D J Bohra
Project Co-ordinator (**Sheep Breeding**)
Central Sheep and Wool Research Institute
Arid Region Campus
Bikaner (Rajasthan) 334 002

80. Dr A K Mukhopadhyay
Project Co-ordinator (**Foot-and-mouth Disease**)
Division of Epidemiology
Indian Veterinary Research Institute
Izatnagar (Uttar Pradesh) 243 122

81. Dr Y Bhattacharyulu
Project Co-ordinator (**Haemoprotista Disease**)
College of Veterinary Science
Ch. Charan Singh Haryana Agricultural University
Hisar (Haryana) 125 004

82. Project Co-ordinator (**Organic Waste in Aquaculture**)
Indian Council of Agricultural Research
Krishi Bhavan
New Delhi 110 001

83. Dr M Rajshekhar
Project Co-ordinator (**Surveillance of Animal Diseases**)
Institute of Animal Health and Veterinary Biology
Hebbal
Bangalore (Karnataka) 560 004

84. Dr O S Tomar
Project Co-ordinator **(R&D Support for Indegenous Milk Production)**
National Dairy Research Institute
Karnal (Haryana) 132 001

**General**

85. Dr Ramakrishna Rao
Project Co-ordinator **(Agricultural Meteorology)**
CRIDA Campus
Santoshnagar
Hyderabad (Andhra Pradesh) 500 659

86. Dr (Mrs) Tej Verma
Project Co-ordinator-cum-Assistant Director General **(Home Science)**
ICAR, Krishi Anusandhan Bhavan
New Delhi 110 012

# APPENDIX 12

## EXTERNALLY AIDED PROJECTS

(DC in million/Rs in crores)

| S No | Name of Project | Donor | Loan/ credit No | Total project cost (original/ revised) (DC) | Loan grant amount (DC) | Date of opening/ closing | Amount disbursed till 31 3 96 (DC/Rs) | Plan outlay (Rs) | Likely external assistance (Rs) | Expenditure incurred up to 31 6 96 (Rs) I Quarter | Reimbursable component | Expenditure incured up to 30 9 96 (Rs) II Quarter | Reimbursesable component |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | **CENTRAL PROJECTS** | | | | | | | | | | | | |
| 1 | National Agril Res Project (NARP-II) | World Bank | 1631-IN | US$ 110 90 (O) US$77 17 (R) | 77 17 | 25 02 86 to 30 6 1996 | US$71 91 | 19 35 | 16 45 | 7.67 | 6 14 | 16.43 (as on 22 10 96) | 7 09 |
| 2 | Agril Human Resource Development Project | World Bank | 2699-IN | (i)US$ 10 1(O) (ii) US$ 10 01(R) | US$8 2 | 1 July 95 to 30 June 2000 | Rs 1 07 Rs 0 002 | 11 01 | 11 01 | 0 788 | 0 631 | 0 892 | 0.711 |
| 3 | Plant Genetic Resources Project | US Govt | 386-0513 Grant | US$27 95 | US$18 7 | 31 8 1998 to 30 9 1987 | DC 2 755 | 4 00 | 2 00 | 0 08 | 0 05 | 0 11 | 0 07 |
| 4 | Indo-Dutch Network ORP on Drainage & Water Management for Salinity Control in Canal Commands | Nether-land Govt | Grant | (i) dfl 0 98(O) (ii) Rs 14 04 (R) | (i) Dfl 1 9 98 | 1 11 95 to 31 10 2000 | Rs 1 1 | 2 94 | 2 89 | 0 0035 | — | 0.2839 | 0 2762 |
| 5 | Sustainable Rainfed Agril Project | Japan | 29214-IN | US$ 0 750 | US$ 0 750 | 9 Sept 1996 to February 98 | Nil | 0 35 | 2 65 | Nil | Nil | Nil | Nil |
| 6 | Storage research production & storage facility at IARI | Japan Govt. | Grant | DC/6307471 662 million Japan Yen | DC/7178161 662 million Japan Yen | 23 10 95 to 31 3 97 | Nil | 0 15 | 21 50 | Nil | NA | Nil | NA |
| 7 | Indo-UK Wheat salinity stress (Donor Univ of Wales, UK) | UK | | Pound 0 002 | Pound 0 002213 | Nov , 95 to Oct 98 | Pound 0 0004 | 0 0477 | 0.077 | Nil | 0 077 | Nil | 0 077 |
| 8 | Pipeline projects | | | | | | | 2 21 | | | | | |

| S.No | Name of Project | Donor | Loan/ credit No | Total project cost (original/ revised) (DC) | Loan grant amount (DC) | Date of opening/ closing | Amount disbursed till 31 3 96 (DC/Rs) | Plan outlay (Rs) | Likely external assistance (Rs) | Expenditure incurred up to 31 6 96 (Rs) I Quarter | Reimbursable component | Expenditure incured up to 30 9 96 (Rs) II Quarter | Reimbursesable component |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **B** | **TECHNICAL ASSISTANCE** | | | | | | | | | | | | |
| 9 | Transfer of Molecular Biology Technologies | ODA UK | NA | 1 42 | (i) 1.42 (DC) | April, 95 to March, 99 | 0 45 (DC) | 2 62 | NA | NA | NA | NA | NA |
| 10 | Establishment of phytotron facility at IARI (UNDP) | UNDP | — | US$ 2.12 | Equipments | 1991 to July 1997 | NA | 2 25 | 3 25 | 1.91 | 1 34 | 1 93 | 2 50 |
| 11 | Indo-UK collaborative project on Plant Germplasm Conservation & Utilisation of NBPGR | ODA (UK) | — | 0 84 (DC) | Equipments | June 95 to June 1997 | 0 0265 | 0 50 | * | — | * | 0 01 | * |
| 12 | ESCAP Project on Regional Network for Agril Machinery RNAM-V | ESCAP | NA | US$ 0 075 | Nil | Jan 1992 to Dec 1996 | NA | 0 06 | NIL | 0 05 | Nil | 0 05 | Nil |
| 13 | Indo-SAREC project on Stand Alone Fuel Cell Power Plants for Elect | SAREC | NA | Rs 0.28 (GOI) | Nil | April 1993 to March 1997 | Nil | 0 05 | Nil | Nil | Nil | Nil | Nil |
| | | | | | | **Total** | | **45.5377** | | | | | |

(DARE, details of disbursement for externally aided projects)

(i) For project at Sr No 2 the total project cost is US$ 74.2 (in million) out of which the DARE component is US$ 10 1 (in million)
The restof the budget is handled by the participating states viz Andhra Pradesh, Haryana and Tamil Nadu These state governments send their claims directly to CA&A, Govt of India

(ii) ** For Project at Sr No 3 & 9 the ODA assistance is in kind in the form of equipments, softwares & consumables there is no cash in flow from ODA

(iii) * For Project at Sr No 10 the UNDP assistance is for equipment, training and consultancy There is no cash in flow in UNDP

(iv) *** For Project at Sr No 12 is an inter-country project executed by ESCAP with cost being met from contributions of participating countries and donations from Japan, FAO, Australia etc , CIAE, Bhopal is designated Institute for coordinating the RNAM. GOI contribution of US$ 15000 per year There is no cash aid from any foreign agency.

(v) **** There is no cash at SAREC for Project No. 13 Indian Counter part contribution is 28 00 lakhs

(vi) Out of total Plan outlay of 1996-97 is Rs 45 54 crore for EAPs Rs 2 21 crore are for pipeline projects

## APPENDIX 13

## NATIONAL PROFESSORS, NATIONAL FELLOWS AND EMERITUS SCIENTISTS

| Sl. no. | Name |
|---|---|
| | **National Professors** |
| 1. | Dr V L Chopra, IARI, New Delhi |
| 2. | Dr S K Sinha, IARI, New Delhi |
| 3. | Dr S Jayaraj, MSRF, Madras |
| 4. | Dr R Pandey, HAU, Hisar |
| 5. | Dr Rajindra Prasad, IARI, New Delhi |
| 6. | Dr T J Pandian, MKU, Madurai |
| 7. | Dr K L Chadha, DDG (H) |
| 8. | Dr E A Siddiq, DDG (CS) |
| 9. | Dr S D Khepar, PAU, Ludhiana |
| | **National Fellows** |
| 1. | Dr K R Dadarwal, HAU, Hisar |
| 2. | Dr D N Garg, HAU, Hisar |
| 3. | Dr Narendra Singh, HAU Hisar |
| 4. | Dr M K Banerjee, HAU, Hisar |
| 5. | Dr S S Narwal, HAU, Hisar |
| 6. | Dr B S Punia, CIRB, Hisar |
| 7. | Dr V D Sharma, Pantnagar |
| 8. | Dr B D Lakhchaura, Pantnagar |
| 9. | Dr Rajvir Singh, Pantnagar |
| 10. | Dr D C Uprety, IARI, N. Delhi |
| 11. | Dr A V N Paul, IARI, N. Delhi |
| 12. | Dr Y D Gaur, IARI, N. Delhi |
| 13. | Dr M S Sachdev, IARI, N. Delhi |
| 14. | Dr (Mrs) Renu Khanna, IARI, N. Delhi |
| 15. | Dr T Haque, NCAP, N. Delhi |
| 16. | Dr V K Gupta, IASRI, N. Delhi |
| 17. | Dr R G Saini, PAU, Ludhiana |
| 18. | Dr M C Agarwal, JNKVV, Jabalpur |
| 19. | Dr B P Singh, CARI, Izatnagar |
| 20. | Dr R Somvanshi, IVRI, Izatnagar |
| 21. | Dr K R Naskar, CICPRI, Barrackpore |

| Sl. no. | Name |
|---|---|
| | **Emeritus Scientists** |
| 1. | Dr S P Agarwal |
| 2. | Dr T V Moorti |
| 3. | Dr C P C Rao |
| 4. | Dr U B Singh |
| 5. | Dr R L Katra |
| 6. | Dr S B Tiwari |
| 7. | Dr H P Singh |
| 8. | Dr N K Roy |
| 9. | Dr R A Singh |
| 10. | Dr Kirpa Shankar |
| 11. | Dr B B Bhatia |
| 12. | Dr U N Nair |
| 13. | Dr T J Verghese |
| 14. | Dr K K Pannikar |
| 15. | Dr K K Gosh |
| 16. | Dr Sunil Kumar |
| 17. | Dr J N Sachan |
| 18. | Dr S K Verma |
| 19. | Dr Gauri Shankar |
| 20. | Dr O P Meelu |
| 21. | Dr Kamlesh Kumar |
| 22. | Dr K B L Jain |
| 23. | Dr S N Mishra |
| 24. | Dr R P Singh |
| 25. | Dr O P Bhalla |
| 26. | Dr T S Kalda |
| 27. | Dr P C Mehrotra |
| 28. | Dr G C Mohanty |
| 29. | Dr R Ramaiah |
| 30. | Dr R P Gupta |
| 31. | Dr J L Vegad |
| 32. | Dr P P Sharma |
| 33. | DR P Tauro |
| 34. | Dr N M Nair |

## APPENDIX 14

## SUMMER INSTITUTES/SHORT COURSES

| S.No. | Topic of Summer Institute | Director of Summer Institute | Venue | Date |
|---|---|---|---|---|
| 1. | 2. | 3. | 4. | 5. |
| 1. | Recent Advances in Agro-forestry in Salt Affected Soil | Dr Ranbir Chhabra Head | Div. of Soils and Crops Management, CSSRI, Karnal (Haryana) 132001 | 1-21 May 1996 |
| 2. | Biofertilizers and their Production Technology | Dr S T Shenda Professor | Div. of Microbiology, IARI, Pusa, N. Delhi-12 | 6-25 May 1996 |
| 3. | Soil and Water Management for Sustainable Agriculture | Dr B L Baser Prof. & Head | Deptt of Agril. Chem., & Soil Science, R.A.U., Udaipur | 6-25 May 1996 |
| 4. | Recent Advances in Mariculture | Dr K A Narshimham Director-in-Charge | CMFRI, 90, North Beach Road, Toticorin Research Centre, (TN) | 17 May-5 June 1996 |
| 5. | Nutrition and Feeding the Wild Herbivorous Mammals in Captivity | Dr N N Pathak Head, Ani. Nut., Div. | Centre of Advanced Studies in Animal Nutrition, IVRI, Izatnagar (UP) | 20 May-8 June 1996 |
| 6. | Integrated Dryland Technologies for Watershead Management | Dr C J Itnal Prof. & Head | Deptt of Agronomy, UAS, Dharwad-580005 | 20-30 May 1996 |
| 7. | Genetic Conservation, Utilisation, Gene-patenting and Varietal Registration | Mr M Rangaswamy Director | School of Genetics, TNAU, Coimbatore | 20-29 May 1996 |
| 8. | Recent Advances in Genetics Enhancment of Pulse Crops | Dr A N Asthana Director | Div. of Plant Breeding, IIPR, Kanpur | 27 May-5 June 1996 |
| 9. | Recent Advances in Agril. Research Management | Dr S N Saha Prof. & Incharge | National Academy of Agril. Res. Management, Rajendranagar, Hyderabad | 3-22 June 1996 |
| 10. | Training Methodology for the Trainers of KVKs/Training Institutes of Agril. Universities | Dr M Sundarshan Reddy Professor | Extension Education Institute, Rajendranagar, Hyderabad (AP) | 3-22 June 1996 |

| 1. | 2. | 3. | 4 | 5. |
|---|---|---|---|---|
| 11. | Training Course on New Techniques and Approaches for Rational Use of Fungicides in Plant Disease Control | Dr S S Sokhi<br>Senior Plant Pathologist | Deptt of Plant Pathology,<br>PAU, Ludhiana | 3-12 June 1996 |
| 12. | Dietary Manipulation of Rumen Fermentation for Increased Productivity and Reduced Productivity and Reduced Methane Production (a greenhouse gas) in Ruminants | Dr G P Singh<br>Senior Scientist | Dairy Cattle<br>Nutrition Div., NDRI,<br>Karnal | 3-22 June 1996 |
| 13. | Summer Institute in Radio-isotope Technology in Animal Health | Dr K S Palaniswami<br>Prof. & Head | Radio Isotope Laboratory,<br>Madras Veterinary. College,<br>Chennai 600007 | 5-24 June 1996 |
| 14. | Biological Suppression of Agril. Pests including Insects Diseases, Nematodes and Weeds | Dr M Gopalan<br>Director | Central Plantation Crops Protection Studies,<br>TNAU, Coimbatore 641003 | 5-27 June 1996 |
| 15. | Advances in Weed Management in an Agroecological Context | Dr O S Kandasamy<br>Prof. of Agronomy | Deptt of Agronomy,<br>CASA, TNAU,<br>Coimbatore 641002 | 10-19 June 1996 |
| 16. | Composite Fish Culture | Dr G Sanjeevaraj<br>Assoc Prof. & Head<br>College of Research | Deptt. of Fisheries Extension, Fisheries Institute, Tuticorin 628008 (Tamil Nadu) | 10-20 June 1996 |
| 17. | Summer Institute on Tropical Poultry Production | Dr D C Johari<br>Head | Div. of Avian Gen. &<br>Breeding, CARI,<br>Izatnagar (UP) | 10-29 June 1996 |
| 18. | Rice Genetics and Breeding towards 21 Century in India | Dr N Krishnan Nair<br>Assoc. Director Research | KAU, Thrissur | 10-29 June 1996 |
| 19. | Recent Advances in Cheese Technology | Dr K G Upadhyay<br>Prof. & Head | Sheth M.C. College of Dairy Science, GAU, Anand | 10-29 June 1996 |
| 20. | Impact of Environmental Pollution with Special Reference to Industrial Waste and Effluent of Livestock Health | Dr S K Ray<br>Prof. & Head | Deptt of Medicine,<br>CVS & A.H., O.U.A.&T.,<br>Bhubaneswar 751003 | 24 May-12 June 1996 |
| 21. | Monitoring Effects of Environmental Pollutants on Animal Heath | Dr S K Dwivedi<br>Head | Div. of Medicine,<br>IVRI, Izatnagar (UP) | 11-20 June 1996 |
| 22. | Advances in Development and Management of Agro-forestry Systems | Dr V K Mishra,<br>Prof. & Head | Deptt of Silviculture and Agroforestry<br>Dr Y S Parmar Univ. of Hort. & Forestry, Nauni, Solan (HP) | 17 June-6 July 1996 |

| 1. | 2. | 3. | 4. | 5. |
|---|---|---|---|---|
| 23. | Crops and Cropping System Management in High Rainfall Areas for Sustainable Agriculture | Dr A C Thakur, Head | Deptt of Agronomy, Assam Agril. University, Jorhat (Assam) 785013 | 17 June-6 July 1996 |
| 24. | Nutritional Epidemiology and Human Development in Agrarian Ecosystem | Dr Rita Singh Raghuvanshi Sr. Res. Officer | College of Home Science, G.B. Pant Univ. of Agri. & Tech., Pantnagar (UP) | 24 June-14 July 1996 |
| 25. | Advances in Thermal Processing of Fruits and Vegetables | Dr Nirankar Nath Prof. & Head | Deptt of Food Sci. & Tech., G.B. Pant Univ. & Tech., Pantnagar, (UP) | 17 July-5 August 1996 |
| 26. | Ecology, Epidemiology, Surviillance and Control of Parasitic Disease of Livestock | Dr B C Lakhar Prof. & Head | Deptt of Parasitology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati 781022 | 22-31 July 1996 |
| 27. | Modern Technologies in Breeding and Management Practices for Improving Productivity in Goats | Dr Basharat Ullah Khan Principal Scientist | Central Institute for Research on Goats, Makhdoom, Farah, Mathura | 12-31 August 1996 |
| 28. | Nutrient and Pesticide Management in Horticultural Crops for Yield and Quality for Domestic Market and Export | Dr B S Bhargava Head | Div. of Soil Science and Agri. Chemistry, I.I.H.R., Hessarghatta, Bangalore-560 089 | 16 August-4 September 1996 |
| 29. | Application of Cell and Tissue Culture Techniques in Propagation and Improvement of Potato | Dr G S Shekhawat Director | CPRI, Simla | 16-25 September 1996 |
| 30. | Summer Institute on Livestock Economics | Dr Raj Vir Singh Principal Scientist | Div. of Dairy Economics, Statistics & Management, NDRI, Karnal | 26 September-15 October 1996 |
| 31. | Recent Advances in the Integrated Management of Pests and Diseases of Coconut | Dr P K Koshy Head | Central Plantation Crops Res. Institute, Reg. Stn. Krishnapuram, Kayangulam, Kerala | 10-30 October 1996 |
| 32. | Qualitative Methodologies for Planning and Execution of Research in Home Science Extension Education | Dr (Mrs) Sunita Roy Professor | Deptt of Home Science, Education & Extension, College of Home Science, PAU, Ludhiana | 12-23 November 1996 |
| 33. | Computer-aided Designing of Agril. Machinery | Dr B K Garg Senior Scientist | CIAE, Nabibagh, Berasia Road, Bhopal | 27 November-December 1996 |

## APPENDIX 15

## AGRICULTURAL UNIVERSITIES

**State Agricultural Universities**

1. Dr M V Rao
   Vice-Chancellor
   **Andhra Pradesh Agricultural University**
   Rajendranagar
   Hyderabad (Andhra Pradesh) 500 030

2. Dr B Baruah
   Vice-Chancellor
   **Assam Agricultural University**
   Jorhat (Assam) 785 003

4. Dr M G Som
   Vice-Chancellor
   **Bidhan Chandra Krishi Vishwavidyalaya**
   PO Krishi Vishwa Vidyalaya
   Mohanpur (West Bengal) 741 252

4. Mr M A Mohsin
   Vice-Chancellor
   **Birsa Agricultural University**
   Ranchi (Bihar) 834 006

5. Dr Indra Pal Singh Yadav
   Vice-Chancellor
   **Chandra Shekhar Azad University of Agriculture and Technology**
   Kanpur (Uttar Pradesh) 208 002

6. Dr J B Chowdhary
   Vice-Chancellor
   **Chaudhary Charan Singh Haryana Agricultural University**
   Hisar (Haryana) 125 004

7. Dr S C Modgal
   Vice-Chancellor
   **Govind Ballabh Pant University of Agriculture and Technology**
   Pantnagar (Uttar Pradesh) 263 145

8. Dr V M Mehta
   Vice-Chancellor
   **Gujarat Agricultural University**
   Sardar Krushinagar
   Dist. Banaskantha (Gujarat) 385 506

9. Dr R P S Tyagi
   Vice-Chancellor
   **Himachal Pradesh Krishi Vishwavidyalaya**
   Palampur (Himachal Pradesh) 176 062

10. Dr A Alam
    Vice-Chancellor
    **Indira Gandhi Krishi Vishwavidyalaya**
    Raipur (Madhya Pradesh) 492 012

11. Dr K S Johar
    Vice-Chancellor
    **Jawaharlal Nehru Krishi Vishwavidyalaya**
    Jabalpur (Madhya Pradesh) 482 004

12. Dr A M Michael
    Vice-Chancellor
    **The Kerala Agricultural University**
    Vellanikkara
    Distt Thrissur (Kerala) 680 654

13. Dr A G Sawant
    Vice-Chancellor
    **Konkan Agricultural University**
    Dapoli (Maharashtra) 431 712

14. Dr Y S Nirkar
    Vice-Chancellor
    **Mahatma Phule Krishi Vidyapeeth**
    Rahuri (Maharashtra) 431 722

15. Dr V K Patil
    Vice-Chancellor
    **Marathwada Agricultural University**
    Parbhani (Maharashtra) 431 402

16. Dr B R Tripathi
    Vice-Chancellor
    **Narendra Deva University of Agriculture and Technology**
    Faizabad (Uttar Pradesh) 224 001

17. Dr K Pradhan
    Vice-Chancellor
    **Orissa University of Agriculture and Technology**
    Bhubaneshwar (Orissa) 141 004

18. Dr A S Khera
    Vice-Chancellor
    **Punjab Agriculture University**
    Ludhiana (Punjab) 141 004

19. Prof B G Bathkal
Vice-Chancellor
**Punjabrao Deshmukh Krishi Vidyapeeth**
Akola (Mahrashtra) 444 104

20. Dr R K Patel
Vice-Chancellor
**Rajasthan Agriculture University**
Bikaner (Rajasthan) 334 002

21. Dr K S Chauhan
Vice-Chancellor
**Rajendra Agricultural University**
Pusa
Distt Samastipur (Bihar) 848 125

22. Dr H A Dar
Vice-Chancellor
**Sher-e-Kashmir Univerisity of Agricultural Sciences and Technology**
*In summer* (May-October)
Srinagar (Jammu & Kashmir) 190 001
*In winter* (November-April)
Jammu Tawi (Jammu & Kashmir) 180 004

23. Dr Abdul Karem
Vice-Chancellor
**Tamil Nadu Agricultural University**
Coimbatore (Tamil Nadu) 641 003

24. Dr S Shanmugasundaram
Vice-Chancellor
**Tamil Nadu Veterinary and Animal Sciences University**
Chennai (Tamil Nadu) 600 007

25. Dr G K Veeresh
Vice-Chancellor
**University of Agricultural Sciences**
Bangalore (Karnataka) 560 065

26. Dr M Mahadevappa
Vice-Chancellor
**University of Agricultural Sciences**
Dharwad (Karnataka)

27. Dr B B Mullik
Vice-Chancellor
**West Bengal University of Animal and Fishery Sciences**
Belgachia
Calcutta (West Bengal)

28. Dr L R Verma
Vice-Chancellor
**Dr Yashwant Singh Parmar University of Horticulture and Forestry**
Nauni
Distt Solan (Himachal Pradesh) 173 230

**Central University**

29. Dr M P Singh
Vice-Chancellor
**Central Agricultural University**
Imphal (Manipur) 795 001

**Deemed Universities**

1. Dr R B Singh
Director
**Indian Agricultural Research Institute**
Pusa, New Delhi-110 012

2. Dr Kiran Singh
Director
**Indian Veterinary Research Institute**
Izatnagar (Uttar Pradesh) 243 122

3. Dr O S Tomar
Director
**National Dairy Research Institute**
Karnal (Haryana) 132 001

4. Dr S S Abidi
Director
**Central Institute of Fisheries Education**
Jaiprakash Road, Seven Bungalow
Mumbai (Maharashtra) 400 061

## APPENDIX 16

### KRISHI VIGYAN KENDRAs AND TRAINER'S TRAINING CENTRES

**Krishi Vigyan Kendras**

| S.No. | Designation & Address of the KVK | Name of the Host Institute | Year of Sanction |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| **Andaman & Nicobar** | | | |
| 1. | Training Organiser,<br>Krishi Vigyan Kendra, CARI,<br>Port Blair 744 101 | The Director,<br>Central Agril. Research Institute,<br>Port Blair (A&N) 744101 | 1992 |
| **Andhra Pradesh** | | | |
| 2. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Vishakapatnam 531005 | Bhagaya Tula Charitable<br>Trust, Yellamanchily,<br>Vishakapatnam 531005 | 1995 |
| 3. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Opp. Rama Krishnan Temple<br>UNDI, Rayalam Bhimavaram<br>West Godavari 534208 | Vice-Chancellor,<br>Andhra Pradesh Agriculture<br>Univ., Rajendranagar,<br>Hyderabad 500030 (AP) | 1995 |
| 4. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Warrangal 506101 | -do- | 1996 |
| 5. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Malyal Farm,<br>Village Malyal,<br>Distt Warangal 506 101 | -do- | 1984 |
| 6. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Agril. Research Station,<br>Amadalavalsa,<br>Distt Srikakulam-532523 | -do- | 1984 |
| 7. | Training Organiser,<br>Krishi Vigyan Kendra,<br>DCMS Building, Kamlanagar<br>Distt Anantpur | -do- | 1983 |
| 8. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Rastakuntabai,<br>Distt Vizianagaram-535523 | -do- | 1984 |
| 9. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Nandyal, M.C. Farm P.O.<br>Distt Kurnool 518503 | Vice-Chancellor<br>Andhra Pradesh Agricultural<br>University, Rajendranagar<br>Hyderabad (AP) 500 030 | 1992 |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 10. | Training Organiser,<br>Krishi Vigyan Kendra,<br>P.O. Baraganapalli,<br>Yagantipalle-513 524,<br>Distt Kurnool | Secretary,<br>Shri Hanumantharaya<br>Educational & Charitable Soc.,<br>Rendakanti Public School,<br>Olliri, Kothapeta (AP) | 1989 |
| 11. | Training Organiser,<br>Krishi Vigyan Kendra,<br>P.O. Box No. 214, Zaheerabad,<br>Distt Medak 502 220 | Chairman,<br>Decan Development Society,<br>A-5, Meera Apartment,<br>Basheerbagh, Hyderabad (AP) | 1992 |
| 12. | Training Organiser,<br>Krishi Vigyan Kendra,<br>RASS Vansathli,<br>Village Karakanbadi,<br>Distt Chittoor 517501 | Chairman,<br>Rayalseema Seva Samithi,<br>9, Old Hazur Office Building,<br>Tiripati (AP) | 1992 |
| 13. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Gaddipalli 508201<br>Distt Nalgonda | Secretary,<br>Sri Aurobindo Institute of Rural<br>Development,<br>Gaddipalli (AP) 508201 | 1983 |
| 14. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Jammikunta,<br>Distt Karimnagar-505122 | Director,<br>Gram Nava Nirman Samithi,<br>H.No. 1-9-639/1,<br>Vidyanagar, Hyderabad (AP) | 1992 |
| 15. | Training Organiser,<br>N.G. Ranga Krishi Vigyan Kendra,<br>Vinayshram, Kavur,<br>Distt Guntur | Chairman,<br>Vinayashram, Kavur,<br>Distt Guntur (AP) | 1992 |
| 16. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Behind M.R.O. Office,<br>Kotha, Madanpur,<br>Distt Mahaboobnagar | The Executive Director,<br>Youth for Action,<br>1-8-702/26/1, Padma Colony,<br>Hyderabad (AP) 500044 | 1992 |
| 17. | Training Organiser,<br>Krishi Vigyan Kendra,<br>CRIDA, Hayatnagar,<br>Distt Rangareddy | Director,<br>CRIDA Complex,<br>PO Saidabad, Santoshnagar<br>Hyderabad (AP) | 1976 |
| 18. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kalvacherla,<br>Rajahumundry-533105 | Director,<br>CTRI,<br>Rajahmundry (AP) 500 659 | 1983 |
| **Arunachal Pradesh** | | | |
| 19. | Training Organiser,<br>Krishi Vigyan Kendra,<br>ICAR Complex for NEH Region,<br>Basar 791 101,<br>Distt West Siang | Director,<br>ICAR Complex for NEH Region,<br>Umroi Road,<br>Barapani-79310<br>(Meghalaya) | 1979 |

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| **Assam** | | | |
| 20. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Assam Agricultural University,<br>Khuontail, Golaghat 785601 | Vice-Chancellor<br>Assam Agril. University<br>Jorhat (Assam) 785013 | 1993 |
| 21. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Assam Agricultural University,<br>Arunachal Silchar 788025<br>Cachar Assam | Vice-Chancellor<br>Assam Agril. University<br>Jorhat (Assam) 785013 | 1994 |
| 22. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Tinsukhia | -do- | 1996 |
| 23. | Training Organiser,<br>Krishi Vigyan Kendra<br>Assam Agricultural University<br>Napam, Sonitpur, Tezpur 25,<br>c/o P.B. 51,<br>Tezpur Main Post Office,<br>(Assam) | Vice-Chancellor<br>Assam Agricultural University<br>Jorhat (Assam) 785 013 | 1979 |
| 24. | Training Organiser,<br>Krishi Vigyan Kendra<br>Assam Agricultural University,<br>Trlipara, Gossaigaon 783 360<br>Distt Kokarajhar (Assam) | Vice-Chancellor<br>Assam Agricultural University<br>Jorhat (Assam) 785 013 | 1985 |
| **Bihar** | | | |
| 25. | Training Organiser,<br>Krishi Vigyan Kendra<br>SCARDA, P.O. Aara,<br>Bhojpur 802301 | Chairman,<br>SCADA, Patna (Bihar) | 1993 |
| 26. | Training Organiser,<br>Krishi Vigyan Kendra<br>Sinri, Dhanbad 828122 | Chairman,<br>Hindustan Fertiliser Corporation<br>New Delhi | 1994 |
| 27. | Training Organiser,<br>Krishi Vigyan Kendra<br>Sharma Bharti Khadigram,<br>PO Jamui 811 313 | Chariman,<br>Khadi Gramodyog Sangh<br>Khadigram, Jamui-811313<br>(Bihar) | 1994 |
| 28. | Training Organiser,<br>Krishi Vigyan Kendra<br>VPO Basaith, Chandpura,<br>Madhubani 847 102 | Chairman,<br>S.K. Chowdhry Educational<br>Trust, New Delhi | 1994 |

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| 29. | Training Organiser,<br>Krishi Vigyan Kendra<br>Darbhanga | Vice-Chancellor<br>Rajendra Agricultural University,<br>Samastipur 848125 (Bihar) | 1996 |
| 30. | Training Organiser,<br>Krishi Vigyan Kendra<br>Supaul | -do- | 1996 |
| 31. | Training Organiser,<br>Krishi Vigyan Kendra<br>Agwanpur, Distt Seharsa 859901 | -do- | 1979 |
| 32. | Chief Training Organiser,<br>Krishi Vigyan Kendra<br>Munger, PO Sankaspur,<br>Distt Munger 811201 | Vice-Chancellor,<br>Rajendra Agricultural University,<br>Samastipur 848125 (Bihar) | 1979 |
| 33. | Chief Training Organiser,<br>Krishi Vigyan Kendra<br>PO Vijay Nagar,<br>Banka 813101 | Vice-Chancellor,<br>Rajendra Agricultural University,<br>Samastipur 848125 (Bihar) | 1983 |
| 34. | Training Organiser,<br>Krishi Vigyan Kendra<br>PO Meghaul, Khodawanpur,<br>Distt Begusarai | -do- | 1992 |
| 35. | Chief Training Organiser,<br>Krishi Vigyan Kendra<br>Barh,<br>Distt. Patna | -do- | 1992 |
| 36. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Harnaut,<br>Distt Nalanda 848125 | -do- | 1992 |
| 37. | Chief Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Jagannathpur,<br>Distt West Singhbhum 833203 | Vice-Chancellor,<br>Birsa Agricultural University,<br>Kanke, Ranchi (Bihar) 834 006 | 1983 |
| 38. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Ramkrishna Mission Ashram,<br>PO Morabadi, Ranchi 834008 | Secretary,<br>Ramakrishna Mission Ashram<br>Morabadi, Ranchi 834008<br>(Bihar) | 1977 |
| 39. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sujani, PO Ghorlash,<br>Distt. Deoghar 814152 | General Secretary,<br>Santhal Paharia Seva Mandal,<br>Deoghar 714152<br>(Bihar) | 1985 |

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| 40. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Holycross V.T.I.,<br>Hazaribagh 825301 | Director<br>Holycross V.T.I.,<br>Hazaribagh 825301<br>(Bihar) | 1984 |
| 41. | Training Organiser,<br>Krishi Vigyan Kendra,<br>P.O. Sokhodeora,<br>Distt. Nawada 805106 | General Secretary,<br>*Gram Nirman Mandal* Ashram<br>Sokhodeora 805106<br>Distt Nawada (Bihar) | 1979 |
| 42. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Banvasi Seva Kendra,<br>PO Adhaura, Kaimur Plateau,<br>Bhabhua 821116 | President,<br>Banvasi Seva Kendra,<br>Adhaura, Kaimur Plateau<br>Distt Bhabhua 821116 (Bihar) | 1992 |
| 43. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Shekhpura | Vice-Chancellor,<br>*Rajendra Agricultural University*,<br>Samastipur (Bihar) 848 125 | 1996 |
| **Delhi** | | | |
| 44. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Ujwa, New Delhi 110073 | Chairman,<br>NAFED/NHRDF,<br>New Delhi | 1995 |
| **Goa** | | | |
| 45. | Training Organiser,<br>Krishi Vigyan Kendra,<br>ICAR Complex, Ela,<br>Old Goa 403202 | Officer on Special Duty<br>*ICAR Research Complex*,<br>Ela, Old Goa 403202 | 1984 |
| **Gujarat** | | | |
| 46. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Bharauch | Chairman,<br>Bhartiya Agro-Industries<br>Foundation, Pune (Maharashtra) | 1994 |
| 47. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Mangal Bharti Golagamadi,<br>Bahadurpur, Baroda 391125 | Chairman,<br>Mangal Bharti,<br>Golag Mandi,<br>Vadodara | 1994 |
| 48. | Training Organiser,<br>Krishi Vigyan Kendra, Deesa,<br>Distt Banaskantha 385535 | Vice-Chancellor,<br>Gujarat Agril. Univ.,<br>Govt. Bunglow, No. 6,<br>Shahibagh, Ahmedabad (Gujarat) | 1976 |
| 49. | Training Organiser,<br>Krishi Vigyan Kendra,<br>*Regional Hill Millet*<br>Research Station Waghai<br>Distt Dangs | -do- | 1985 |

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| 50. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Devgarh baria,<br>Distt panchmahals-383630 | -do- | 1976 |
| 51. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Devtaj (Sojitra),<br>Distt Kheda 387240 | Vice-Chancellor,<br>Gujarat Agril. University,<br>Govt. Bunglow, No. 6,<br>Shahibagh, Ahmedabad (Gujarat) | 1985 |
| 52. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Vill. Randhja,<br>Distt Gandhinagar 383630 | Vice-Chancellor,<br>Gujarat Agril. University,<br>Govt. Bunglow, No. 6, Shahibagh,<br>Ahmedabad (Gujarat) | 1977 |
| 53. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Ambheti Ashram,<br>Via Vapi, Distt Valsad 396191 | -do- | 1992 |
| 54. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Samoda, Ganwada, Taluka,<br>Sidhpur, Distt Mehsana 384130 | Director,<br>Saraswati Gram Vidyapeeth,<br>Samoda, Distt Mehsana,<br>(Gujarat) | 1992 |
| 55. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Mundra,<br>Distt Kutch 370421 | Chairman,<br>Rural Agro. Research &<br>Development Society,<br>Gandhigram Road, Juhu, Mumbai | 1992 |
| **Haryana** | | | |
| 56. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Seema Theater Commercial<br>Complex, Court Road,<br>Panipat 132103 | Vice-Chancellor,<br>CCS Haryana Agril. University,<br>Hissar (Haryana) | 1993 |
| 57. | Training Organiser,<br>Krishi Vigyan Kendra,<br>No. 2 Rajendra Park,<br>Mahesh Nagar, Ambala Cantt,<br>Ambala | President,<br>Society for Creation of Heaven<br>on Earth, Chanakyapuri,<br>New Delhi | 1993 |
| 58. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Plot No. 82, Auto Market,<br>Sadalpur, Hisar 125052 | Vice-Chancellor,<br>CCS Haryana Agril. University<br>Hisar (Haryana) 125004 | 1989 |
| 59. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Peoda,<br>Kaithal 132027 | Vice-Chancellor,<br>CCS Haryana Agril. University,<br>Hisar (Haryana) 125004 | 1992 |

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| 60. | Training Organiser,<br>Krishi Vigyan Kendra,<br>House No. 2131, Urban Estate,<br>Jind 126102 | -do- | 1992 |
| 61. | Training Organiser,<br>Krishi Vigyan Kendra,<br>430/13, Urban Estate,<br>Kurukshetra 132118 | -do- | 1992 |
| 62. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sector-14, House No. 449,<br>Sonipat 131001 | -do- | 1992 |
| 63. | Training Organiser,<br>Krishi Vigyan Kendra,<br>House No. 604, Sector-16A,<br>Faridabad 121001 | -do- | 1992 |
| 64. | Training Organiser,<br>Krishi Vigyan Kendra,<br>House No. 269-4,<br>Model Town,<br>Yamunanagar 135001 | -do- | 1992 |
| 65. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sri B.B. Ashram, Rampura,<br>Rewari 123401 | Secretary,<br>Bhagwat Bhakti Ashram,<br>Rampura,<br>Distt Rewari (Haryana) | 1983 |
| 66. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Shikohpur, Gurgoan 122001 | Director,<br>Indian Agricultural Research Institute<br>New Delhi 110012 | 1983 |
| 67. | Training Organiser,<br>Krishi Vigyan Kendra,<br>National Dairy Research Institute,<br>Karnal 132004 | Director,<br>National Dairy Research Institute,<br>Karnal 132001<br>(Haryana) | 1976 |
| **Himachal Pradesh** | | | |
| 68. | Training Organiser,<br>Krishi Vigyan Kendra,<br>HPKV, Una 174303 | Vice-Chancellor,<br>Himachal Pradesh Krishi<br>Vigyan Vishwavidylaya,<br>Palampur (HP) | 1993 |
| 69. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Mandi | -do- | 1993 |

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| 70. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Vill. Kudowada, PO Channer<br>Indara, Distt Kangra 176401 | Chairman,<br>Foundation for Organisational<br>Research & Education,<br>New Delhi | 1993 |
| 71. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sharbo at Rekong Peo<br>Kinnaur 171107 | Vice-Chancellor,<br>YSPHU&F, Solan | 1995 |
| 72. | Training Organiser,<br>Krishi Vigyan Kendra,<br>YSPUHF, Near Petrol Pump,<br>Rohru, Shimla 171207 | -do- | 1995 |
| 73. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Reg. Res. Stn., Dhaula Kuan,<br>Distt Sirmur 173001 | Vice-Chancellor,<br>Himachal Pradesh Krishi<br>Vishwa Vidyalaya,<br>Palampur 176062 (HP) | 1982 |
| 74. | Training Organiser,<br>Krishi Vigyan Kendra, HPKVV,<br>Agril. Research Station,<br>Bajaura, Kullu 175125 | -do- | 1985 |
| 75. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Bara,<br>Distt Hamirpur 177004 | -do- | 1989 |
| 76. | Training Organiser,<br>Krishi Vigyan Kendra,<br>P.O. Sultanpur, Baloo,<br>Distt Chamba 176314 | -do- | 1991 |
| **Jammu & Kashmir** | | | |
| 77. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Leh | Vice-Chancellor,<br>S.K. University of Agricultural<br>Sciences & Technology, Srinagar | 1993 |
| 78. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kalibari, Kathua 184104 | Secretary,<br>Shiv Gramodyog Mandal,<br>Kathua (J&K) | 1993 |
| 79. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Malangpura,<br>Distt Anantnag | Vice-Chancellor,<br>Shere-e-Kashmir Univ. of Agril.<br>Sci. & Tech., Dalgate,<br>Srinagar (J&K) | 1983 |

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| 80. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Agrol. Res. Stn., R.S. Pura,<br>Distt Jammu 181102 | -do- | 1992 |
| **Karnataka** | | | |
| 81. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Suttur, Mysore | President,<br>JSS Rural Development<br>Foundation, Mysore | 1994 |
| 82. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Chikkaballapur, Kolar | President,<br>Karnataka Welfare Society,<br>Chikaballapur (Kular) | 1994 |
| 83. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Hegari, Bellary | Vice-Chancellor<br>University of Agril. Sciences,<br>Dharwad | 1994 |
| 84. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Tukanatti Gohak,<br>Belgaum 591319 | President,<br>Belgaum Integrated Rural<br>Development Society, Belgaum | 1994 |
| 85. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Reg. Res. Stn., Raichur | Vice-Chancellor,<br>University of Agril. Sciences,<br>Dharwad | 1994 |
| 86. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Hunumanmatti 581135<br>Distt Dharwad | -do- | 1977 |
| 87. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Agril. Research Station,<br>Janawada, Bidar | Vice-Chancellor,<br>University of Agril. Sciences,<br>Dharwad | 1985 |
| 88. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Regional Research Station,<br>Mudigere-5787132<br>Chikkamagalur | Vice-Chancellor<br>University of Agril. Science,<br>Bangalore<br>(Karnataka) | 1985 |
| 89. | Training Organiser,<br>Krishi Vigyan Kendra,<br>(UAS), Kandali,<br>Distt Hassan | -do- | 1992 |
| 90. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Gonikoppal 571213,<br>Distt Kodagu | Director,<br>IIHR, 255 Upper Palace,<br>Orchards, Bangalore-560079<br>(Karnataka) | 1976 |

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| 91. | Training Organiser,<br>Krishi Vigyan Kendra,<br>K.H. Patil Agril. Science<br>Foundation,<br>Hulkoti 582205<br>Gadag Taluk,<br>Distt Dharwad | Chairman<br>Agricultural Sciences Foundation,<br>Hulkoti 582205<br>Distt Dharwad<br>(Karnataka) | 1985 |
| **Kerala** | | | |
| 92. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Pathenamthitta | Chairman<br>Christian Agency for Rural<br>Development, Thiruvalla,<br>Pethennamthitta (Kerala) | 1994 |
| 93. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sadanandapuram,<br>Quillon | Vice-Chancellor,<br>Kerala Agril. University<br>Mannuthy 680651<br>Thrissur (Kerala) | 1994 |
| 94. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Chakkupallam,<br>Idukki | President,<br>Bapooji Sewak Samaj,<br>Chakkupallam, Idukki (Kerala) | 1994 |
| 95. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Regional Research Station,<br>Pattambi 679306,<br>Distt Palghat | Vice-Chancellor<br>Kerala Agril. Univ.,<br>Mannuthy 680651<br>Thrissur (Kerala) | 1979 |
| 96. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Regional Research Station,<br>Ambalavayal 673593,<br>Distt Wynad | -do- | 1984 |
| 97. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Central Marine Fisheries<br>Res. Stn., Narakkal 682505,<br>Ernakulam | Director<br>Central Marine Fisheries<br>Research Institute,<br>Distt Cochin (Kerala) | 1976 |
| 98. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Mitraniketan,<br>Vellanad 696543<br>Distt Thiruvananthapuram | President<br>Mitraniketan,<br>Vellanad,<br>Distt Tiruvananthapuram 696 543<br>(Kerala) | 1979 |
| 99. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Central Plantation Crops<br>Research Institute,<br>Kasargod 671124 | Director<br>Central Plantation Crops<br>Research Institute,<br>Kasargod 671124<br>(Kerala) | 1991 |

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| 100. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Peeruvannamuzhi,<br>Calicut 673012<br>Kozhikode | Director<br>Indian Species Research Instt.,<br>Calicut (Kerala) | 1992 |
| **Madhya Pradesh** | | | |
| 101. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Block Office Compound,<br>Seoni | Vice-Chancellor,<br>Jawaharlal Nehru Krishi Vishwa<br>Vidyalaya, Jabalpur (MP) | 1994 |
| 102. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Near Lalitpur Naka,<br>Tikangarh-472001 | -do- | 1994 |
| 103. | Training Organiser,<br>Krishi Vigyan Kendra,<br>College of Agril, Warwadi Farm,<br>East Nimar (Khandwa) | Vice-Chancellor,<br>Jawaharlal Nehru Krishi Vishwa<br>Vidyalaya, Jabalpur (MP) | 1994 |
| 104. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kathi Bagh, Rajgarh | -do- | 1994 |
| 105. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Post-Aaraon, Guna | -do- | 1994 |
| 106. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sarguja | Vice-Chancellor,<br>Indira Gandhi Krishi Vishwa<br>Vidyalaya, Raipur (MP) | 1994 |
| 107. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Joara, Kalukeda,<br>Distt Ratlam 457340 | President,<br>Kalukheda Shikshat Samiti<br>Ratlam | 1994 |
| 108. | Training Organiser,<br>Krishi Vigyan Kendra, IGKVV,<br>Research Station, Sarkanda<br>Farm, Bilaspur 495001 | Vice-Chancellor,<br>Indira Gandhi Krishi Vishva<br>Vidhalaya, Raipur (MP) | 1984 |
| 109. | Training Organiser,<br>Rana Hanuman Singh<br>Krishi Vigyan Kendra<br>Bydgaon Block - Kirnapur,<br>PO Pala Balaghat 481115 | -do- | 1992 |

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| 110. | Training Organiser,<br>Krishi Vigyan Kendra,<br>College of Veterinary and<br>Animal Husbandry Science,<br>Gokulan, G.E. Road,<br>Anjora, Durg 491001 | -do- | 1992 |
| 111. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Regional Agril. Research<br>Station, Chandangaon,<br>Chhindwara 480001 | Vice-Chancellor,<br>JNKVV, Jabalpur (MP) | 1983 |
| 112. | Training Organiser,<br>Krishi Vigyan Kendra,<br>JNKVV Farm,<br>Jhabua 457661 | Vice-Chancellor,<br>JNKVV, Jabalpur (MP) | 1984 |
| 113. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Goviana Site, PB 7,<br>Sidhi, Distt Sidhi 486661 | Vice-Chancellor,<br>JNKVV, Jabalpur<br>(MP) | 1992 |
| 114. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Birhulia Farm,<br>Shahdol | -do- | 1992 |
| 115. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Central Institute of Agriculture<br>Engineering (ICAR),<br>Nabibagh, Berasia Road,<br>Bhopal 462018 | Director,<br>CIAE, Nabibagh,<br>Barasia Road,<br>Bhopal 462018 (MP) | 1979 |
| 116. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Mata Rukmini Seva Sansthan,<br>Via. Dimrapal,<br>PO Jagdalpur,<br>Distt Bastar 494001 | Secretary,<br>Mata Rukmini Seva Sansthan,<br>Via. Dimrapal,<br>P.O. Jagdalpur,<br>Distt Bastar (MP) 494001 | 1992 |
| 117. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Malwa Mahila Vikas Samiti,<br>PO Sironj,<br>Distt Vidisha 464228 | President,<br>Shri Malwa Mahila Vikas Samiti,<br>32, Niyamatpura, Shajahanabad<br>Bhopal (MP) | 1992 |
| 118. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kasturba Gandhi National<br>Memorial Trust,<br>Kasturbagram, Indore 420020 | Secretary,<br>Kasturba Gandhi National Memorial<br>Trust, Kasturbagram<br>Indore (MP) 450020 | 1976 |

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| 119. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Deendayal Research Institute,<br>Majhgawan, Satna 485331 | Chairman,<br>Deen Dayal Research Institute<br>7-E, Swami Ram Tirth Nagar,<br>Rani Jhansi Road, New Delhi | 1992 |
| **Maharashtra** | | | |
| 120. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Y.C. Maharashtra Open Univ.<br>Nasik 422005 | Vice-Chancellor<br>Yashwantrao Chavan<br>Maharashtra Open University,<br>Nasik (Maharashtra) | 1994 |
| 121. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Bhagyanagar,<br>Parbhani 431401 | President,<br>Jeevan Jyoti Charitable<br>Trust, Parbhani (Maharashtra) | 1994 |
| 122. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Talasadi,<br>Kolhapur 416012 | D.Y. Patil Education Society,<br>Talashande, Kolhapur (Maharashtra) | 1994 |
| 123. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Jalgaon, Jamod,<br>Buldana 443402 | Chairman,<br>Satpuda Education Society<br>Jalgoan-Jamod,<br>Buldana (Maharashtra) | 1994 |
| 124. | Training Organiser,<br>Krishi Vigyan Kendra,<br>CICR PB 225,<br>Nagpur 440001 | Director,<br>Central Instt. of Cotton<br>Research, Nagpur (Maharashtra) | 1994 |
| 125. | Training Organiser,<br>Krishi Vigyan Kendra,<br>57, Congress Nagar,<br>Amravati 444602 | President,<br>Shram Sadhna Trust,<br>57, Congress Nagar,<br>Amravati 444602 (Maharashtra) | 1995 |
| 126. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Madhubani Colony Camp,<br>Amravati 444602 | President,<br>Shram Sadhna Foudation<br>Madhoban Colony Camp,<br>Amravati 444602 (Maharashtra) | 1995 |
| 127. | Training Organiser,<br>Krishi Vigyan Kendra,<br>HIG Colony, Near IIT,<br>Nanded | Chairman,<br>Jawaharlal Nehru Institute of<br>Education, Science & Tech. Res.,<br>Nanded (Maharashtra) | 1994 |
| 128. | Training Organiser,<br>Krishi Vigyan Kendra,<br>51, Railway Lines,<br>Solapur 413001 | President,<br>Shabari Krishi Pratishtan,<br>Solapur (Maharashtra) | 1994 |

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| 129. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Risod, Akola 444106 | President,<br>SUVIDE Foundation, Risod,<br>Akola (Maharashtra) | 1994 |
| 130. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Poip Adarsh Krishi,<br>Sindhudurg 416622 | President,<br>Poip Falaotpadan Sahakar Samithi<br>Sindhudurg (Maharasthra) | 1995 |
| 131. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Selsura,<br>Distt Wardha | Vice-Chancellor,<br>Punjabrao Krishi Vidyapeeth,<br>Krishinagar,<br>Akola (Maharashtra) | 1976 |
| 132. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Paithan Road,<br>Aurangabad 431005 | Vice-Chancellor,<br>Marathwada Agril. University,<br>Parbhan (MS) 415712 | 1983 |
| 133. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Shirgaon,<br>Distt Ratnagiri | Vice-Chancellor<br>Konkan Krishi Vidyalaya<br>Dapoli,<br>Ratnagiri (Maharashtra) 415712 | 1983 |
| 134. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Agril. Research Station,<br>Dhule, Distt Dhule 424004 | Vice-Chancellor<br>Mahatma Phule Krishi Vidyapeeth<br>Rahuri 413712<br>(MS) | 1983 |
| 135. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Gokhale Education Society,<br>Kosbad Hill 401703<br>Distt. Thane | Secretary,<br>Gokhale Education Society,<br>BYK College of Commerce<br>Nasik (MS) | 1976 |
| 136. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Satpura Vikas Mandal, Pal,<br>Taluka : Raver,<br>Distt Jalgaon 425508 | Secretary,<br>Satpura Vikas Mandal Pal,<br>Taluka : Raver,<br>Distt Jalgaon (MS) | 1984 |
| 137. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Adarsh Colony,<br>Village - Ambajogai,<br>Distt Beed 431517 | Chairman,<br>Deen Dayal Research Institute<br>&-E, Swami Ram Tirath Nagar,<br>Rani-Jhansi Road, New Delhi | 1992 |
| 138. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kalavade, Karad,<br>Distt Satara 415110 | Chairman,<br>Kalyani Gorakshan Trust,<br>A/2, Priyadarshan Apartment,<br>Koregaon Road, Pune (MS) | 1992 |

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| 139. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sharda Nagar,<br>Baramati 413115,<br>Distt Pune | Chairman,<br>Agril. Development Trust,<br>Sharda Nagar,<br>Baramati, Distt Pune | 1992 |
| 140. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Babhleshwar, Shrirampur Tal,<br>Distt Ahmednagar 413736 | Chairman,<br>Pravara Instt. of Res. & Edu.<br>in Natural & Soc. Sci., Parvaranagar,<br>Distt Ahmednagar (MS) | 1992 |
| 141. | Training Organiser,<br>Krishi Vigyan Kendra<br>C-413, Vasant Dada Sakar<br>Sahakari Karkhan,<br>Distt Sangli 416416 | President,<br>Vasant Prakash Vikas<br>Pratishthan, Opp. Sahkari,<br>Sakhar Karkhana Ltd.,<br>Sangli 416416 (MS) | 1992 |
| 142. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PB 45., S.P. Road,<br>Distt Jalna 431203 | Secretary,<br>Marathwada Sheti Sahayya<br>Mandal, PB 45,<br>Sardar Patel Road,<br>Jalna 431203 (MS) | 1992 |
| **Manipur** | | | |
| 143. | Training Organiser,<br>Krishi Vigyan Kendra,<br>ICAR Complex for NEH Region,<br>Lamphelpet, Imphal 795004<br>Manipur | Director,<br>ICAR Complex for NEG Region,<br>Umroi Road,<br>Barapani 793103<br>(Meghalaya) | 1979 |
| **Meghalaya** | | | |
| 144. | Training Organiser,<br>Krishi Vigyan Kendra,<br>ICAR Complex for NEH Region,<br>Sansan Girri, Bobasipara,<br>Tura 794005<br>West Garo Hills, Meghalaya | Director<br>ICAR Complex for NEH Region,<br>Umroi Road,<br>Barapani 793103<br>(Meghalaya) | 1979 |
| **Mizoram** | | | |
| 145. | Training Organiser,<br>Krishi Vigyan Kendra,<br>State Deptt. of Agril.<br>Hnahthial Lunelei, Mizoram | Director of Agriculture<br>Govt. of Mizoram<br>Aizawal (Mizoram) | 1995 |
| 146. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Farm Science Centre,<br>Deptt. of Agril.,<br>Govt. of Mizoram,<br>Kolasib 796081,<br>Mizoram | Director of Agriculture,<br>Govt. of Mizoram<br>Aizawal (Mizoram) | 1979 |

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| **Nagaland** | | | |
| 147. | Training Organiser,<br>Krishi Vigyan Kendra,<br>ICAR Complex for NEH Region,<br>Jharanpani,<br>Shillong (Meghalaya) 793103<br>Medziphema 797106<br>Nagaland | Director,<br>ICAR Complex for NEH Region,<br>Umroi Road, Barapani,<br>Shillong (Meghalaya) 793103 | 1977 |
| **Orissa** | | | |
| 148. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Dhenkanal (Orissa) | Director,<br>Central Rice Research<br>Institute, Cuttack (Orissa) | 1994 |
| 149. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Angul,<br>(Orissa) | -do- | 1994 |
| 150. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kendrpada<br>(Orissa) | Vice-Chancellor,<br>Orissa University of Agril. &<br>Technology, Bhubaneshwar | 1994 |
| 151. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Regional Research Station,<br>Semiliguda, PB 10,<br>Sunabeda-763002 Distt. Karaput | -do- | 1982 |
| 152. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Regional Research Station,<br>PO Judia Farm,<br>Distt Keonjhar,<br>Keonjhar 758002 | -do- | 1982 |
| 153. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Deevog via Singila,<br>Baliapal, Distt Balasore 756026 | -do- | 1983 |
| 154. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Bhanjanagar, At : Benakunda,<br>PO Dihapadhal, Via Bhanjanagar,<br>Distt Ganjam 761126 | -do- | 1985 |
| 155. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Gambharipalli, PO Larambha,<br>Distt Sambalpur 768102 | Vice-Chancellor<br>Orissa University of Agril. &<br>Technology, Bhubaneshwar<br>(Orissa) | 1992 |

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| 156. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Udyagiri,<br>Distt Phulbani 762110 | Vice-Chancellor,<br>Orissa University of Agril. &<br>Technology, Bhubaneshwar<br>(Orissa) | 1982 |
| 157. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Reg. Res. Stn., NARP Campus,<br>Bhawani Patna,<br>Distt Kalahandi (Orissa) | Vice-Chancellor,<br>Orissa University of Agril. &<br>Technology, Bhubaneshwar<br>(Orissa) | 1992 |
| 158. | Training Organiser,<br>Krishi Vigyan Kendra,<br>CIFA, Kausalyaganga,<br>Dhauli, Bhubaneswar 751002 | Director<br>CIFA, Kausalyaganga Dhauli,<br>Bhubaneshwar 751002<br>(Orissa) | 1976 |
| 159. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Santhpur, Cuttack 753006 | Director<br>CRRI, Cuttack<br>(Orissa) | 1992 |
| **Pondicherry** | | | |
| 160. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Madur, Karaikal 609607 | Chief Secretary,<br>Govt. of Pondicherry<br>Chief Secretariate Bldg.,<br>Pondicherry 605009 | 1994 |
| 161. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kusumbapet,<br>Pondicherry 605009 | -do- | 1974 |
| **Punjab** | | | |
| 162. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kheri, Distt Sangrur | Vice-Chancellor,<br>Punjab Agril. University,<br>Ludhiana 141004 (Punjab) | 1993 |
| 163. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Reg. Res. Stn.,<br>Faridkot 151203 | -do- | 1994 |
| 164. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Langroya,<br>Distt Jallundhar | -do- | 1994 |
| 165. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Hardochani Road, Old Gurunanak<br>College Building, Gurudaspur,<br>Distt Gurudaspur 143521 | Vice-Chancellor,<br>Punjab Agricultural University<br>Ludhiana (Punjab) 140 004 | 1982 |

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| 166. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Malwal Farm, G.T. Road, Ferozpur,<br>Distt. Ferozpur 152 001 | Vice-Chancellor,<br>PAU,<br>Ludhiana | 1988 |
| 167. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Near Kheti Bhavan,<br>Dabawali Road,<br>Bhatinda 151 001 | -do- | 1989 |
| 168. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Bahowal,<br>Distt Hoshiarpur 146 105 | -do- | 1989 |
| 169. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PB 22,<br>Village : Rauni,<br>Distt Patiala 147 001 | -do- | 1989 |
| 170. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sultanpur Road,<br>Near New Grain Market,<br>Kapurthala,<br>Distt Kapurthala 144 601 | -do- | 1989 |
| 171. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Abohor,<br>Distt Abohar | Director<br>Central Institute of Post Harvest<br>Engineering & Technology,<br>Ludhiana (Punjab) | 1992 |
| **Rajasthan** | | | |
| 172. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Dhoinda,<br>Rajsamand 313 342 | Vice-Chancellor,<br>Rajasthan Agril. University<br>Bikaner 334 001 (Rajasthan) | 1994 |
| 173. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Station Road, Anta,<br>Baran 325 202 | -do- | 1994 |
| 174. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Teachers Colony,<br>Gupteshwar Road,<br>Dausa 303 303 | -do- | 1994 |

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| 175. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Surajgarh, Jhunjhunu | -do- | 1995 |
| 176. | Training Organiser,<br>Krishi Vigyan Kendra,<br>B-33, Man Nagar,<br>Distt Jhunjhunu (Rajasthan) | -do- | 1989 |
| 177. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Borwat Agril. Research Station,<br>Distt Banaswara 327 001 | Vice-Chancellor,<br>RAU,<br>Bikaner | 1983 |
| 178. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Fatehpur Sekhawati,<br>Distt Sikar 332 301 | -do- | 1976 |
| 179. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Fodder Farm,<br>Village - Beechwal,<br>Distt Bikaner 334 002 | -do- | 1983 |
| 180. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Keshwana,<br>Distt Jalore 342 001 | Vice-Chancellor<br>Rajasthan Agril. University,<br>Bikaner 334 001 (Rajasthan) | 1985 |
| 181. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kisan Vidyapeeth,<br>Near Sarag Guest House,<br>Kumber,<br>Distt Bharatpur 321 001 | -do- | 1980 |
| 182. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kolar Farm, Ambasweiji Gate,<br>PO Palri,<br>Distt Sirohi 307 001 | -do- | 1989 |
| 183. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Gonera, Deepak Bhavan,<br>Dabla Road,<br>Kotputli 303 108,<br>Distt Jaipur | -do- | 1989 |
| 184. | Training Organiser,<br>Krishi Vigyan Kendra,<br>V.P. Tankarda, Chomu, Jaipur | Secretary<br>Pragati Trust,<br>Chomu, Jaipur (Raj.) | 1992 |

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| 185. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Chittorgarh 312 001 | Vice Chancellor<br>RAU<br>Bikaner | 1992 |
| 186. | Training Organiser,<br>Krishi Vigyan Kendra,<br>30, M.P. Colony,<br>Distt Swaimabadhopur 322 001 | -do- | 1992 |
| 187. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Borkhera Farm,<br>Kota 324 001 | -do- | 1992 |
| 188. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PB 46,<br>Jaisalmer 345 001 | Vice-Chancellor,<br>Rajasthan Agril. University,<br>Bikaner 334 001 (Rajasthan) | 1992 |
| 189. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Villa, Navgaon,<br>Distt Alwar | -do- | 1992 |
| 190. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Agril. Research Station,<br>Amajia Farm, Gandhi Nagar,<br>Distt Bhilwara 311 001 | -do- | 1992 |
| 191. | Training Organiser<br>Krishi Vigyan Kendra<br>Chattarapura Road<br>Distt Bundi | -do- | 1992 |
| 192. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Regional Research Station,<br>Tabiji Farm, NH 08,<br>Distt Ajmer 305 001 | -do- | 1992 |
| 193. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Old City, Distt Dhaulpur | -do- | 1992 |
| 194. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Near Badat Mat,<br>Shastri Colony,<br>Dungarpur 314 001 | -do- | 1992 |

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| 195. | Training Organiser,<br>Krishi Vigyan Kendra,<br>9-A, Godam Ki Talai, PB 16,<br>Distt Jhalawar 326 001 | -do- | 1992 |
| 196. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sanjay Colony,<br>Distt Nagaur | Vice-Chancellor,<br>Rajasthan Agril. University,<br>Bikaner 334 001 (Rajasthan) | 1992 |
| 197. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Banasthali Vidhya Pith,<br>Distt Tonk 304 022 | Secretary<br>Banasthali Vidyapeeth,<br>Banasthali,<br>Distt Tonk (Raj.) | 1983 |
| 198. | Training Organiser,<br>Krishi Vigyan Kendra,<br>CAZRI,<br>Jodhpur 342 003 | Director<br>CAZRI,<br>Jodhpur 342 003 | 1983 |
| 199. | Training Organiser,<br>Krishi Vigyan Kendra,<br>RRS, CAZRI,<br>Pali-Marwar 306 401 | Director<br>CAZRI,<br>Jodhpur 342 003<br>(Rajasthan) | 1992 |
| 200. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Vidya Bhawan, Badgaon,<br>Udaipur 313 001 | President<br>Vidya Bhawan Society<br>Udaipur 313 001<br>(Rajasthan) | 1983 |
| 201. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Gandhi Vidya Mandir,<br>Sardar Shahar,<br>Distt Churu 311 401 | The Registrar,<br>Gandhi Vidya Mandir,<br>Sardar Shahar<br>Distt Churu (Raj.) | 1992 |
| 202. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Gayatri Shant Peeth,<br>Distt Barmer 344 001 | The Secretary<br>Society to Uplift Rural Economy,<br>Barmer (Rajasthan) | 1992 |
| 203. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sangaria,<br>Distt Sri Ganganagar | President,<br>Keshyanand Memorial Trust,<br>Sangaria,<br>Sri Ganganagar (Raj.) | 1989 |
| **Sikkim** | | | |
| 204. | Training Organiser,<br>Krishi Vigyan Kendra,<br>ICAR Complex for NEH Region,<br>Saramsa, Ranipool 737 135,<br>East Sikkim, Sikkim | Director,<br>ICAR Complex for NEH Region,<br>Umroi Road,<br>Barapani 793 103<br>Meghalaya | 1982 |

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| **Tamil Nadu** | | | |
| 205. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Dharmapuri | President,<br>Tamil Nadu Board of Rural<br>Development, T. Nagar,<br>Chennai 500 012 (Tamil Nadu) | 1994 |
| 206. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Salem | Vice-Chancellor,<br>Tamil Nadu Agricultural<br>University, Coimbatore 641 003 (TN) | 1994 |
| 207. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Tenkosi,<br>Nellai, Kattabomman 627 852 | Chairman,<br>Ratnavel Subramanium<br>Kattabomman Educational Trust,<br>Dindigul (Tamil Nadu) | 1994 |
| 208. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Katchipuram via,<br>Theni, Madurai 626 520 | Chairman,<br>Centre for Development and<br>Communication Trust, Theni,<br>Madurai 626 520 (Tamil Nadu) | 1994 |
| 209. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Allikulam, Mundradaipu,<br>PO Kariaptti,<br>Kamarajar 626 102 | Chairman,<br>Meyer's Trust, Madurai<br>(Tamil Nadu) | 1995 |
| 210. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Tanjavur, RVS Campus,<br>Sultur 641 402 | President,<br>Bhaktava Memorial Trust,<br>596, A1 & A2, TNHB Colony,<br>Pariyar Nagar, Korathur,<br>Chennai 600 080 (Tamil Nadu) | 1995 |
| 211. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Distt Chidambarnar | Chairman,<br>SCAD, Cheranedevi,<br>Distt Tiunelvelli 627 414 | 1995 |
| 212. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PMT District | Vice-Chancellor<br>Tamil Nadu University of Vety.<br>& Animal Sciences, Madavaram,<br>Chennai 600 051 (Tamil Nadu) | 1996 |
| 213. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kumara Parumal Farm<br>Science Surugama,<br>Trichy 639 115 | Vice-Chancellor,<br>Tamil Nadu Agricultural Univerisity<br>Coimbatore 641 003 | 1977 |
| 214. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Regional Research Station,<br>Vridhachalam 606 001<br>South Arcot Distt. | -do- | 1985 |

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| 215. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kattupakkam 603 203,<br>Changai, MGR Distt. | -do- | 1985 |
| 216. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sri Aviwashilingam Rural Centre,<br>Vivekanadapuram,<br>Karamadai Block,<br>Coimbatore 641 113 Distt. | Secretary,<br>Sri Avinashilingam Rural<br>Centre,<br>Vivekanandapuram,<br>Coimbatore (Tamil Nadu) | 1979 |
| 217. | Training Organiser,<br>Krishi Vigyan Kendra,<br>UPASI, Glenview,<br>Coonoor 643 101<br>Nilgiri Distt. | Secretary,<br>UPASI, Glenview,<br>Coonoor 643 101<br>Nilgiri Distt. (Tamil Nadu) | 1983 |
| 218. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Gandhigram Rural Instt.,<br>Gandhigram,<br>Dindigul Anna Distt. | Secretary,<br>Gandhigram Rural Institute,<br>Gandhigram 624 302,<br>Dindigul Anna Distt (TN) | 1989 |
| 219. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Talamalai Centre of MYRADA,<br>Talawadi Block,<br>Sathyamangalam Taluk,<br>Periyar 638 461 Distt. | Executive Director,<br>MYRADA No. 2, Service Road,<br>Domlur Layout,<br>Bangalore 560 071 | 1991 |
| 220. | Training Organiser,<br>Vedapuri Krishi Vigyan Kendra,<br>Kilnelli Village,<br>Vembakkam Block,<br>Cheyyar Taluk,<br>Thiruvannamalai,<br>Samabuvarayar Distt. | President,<br>Tamil Nadu Board of Rural<br>Development No. 13,<br>Crescent Park, Street,<br>T. Nagar,<br>Madras 500 017 | 1991 |
| **Tripura** | | | |
| 221. | Training Organiser,<br>Krishi Vigyan Kendra,<br>ICAR Complex for NEH Region,<br>Birchandra Manu,<br>Manpathar 799 144 (South Tripura) | Dircetor,<br>ICAR Research Complex,<br>Umroi Road, Barapani 793 103<br>Meghalaya | 1984 |
| 222. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Divyodaya, ICAR Complex for<br>NEH Region, Dibanandapali,<br>Chebri 799 207, Khowai,<br>Sub Division, West Tripura | General Secretary,<br>Sri Ramakrishna Seva Kendra,<br>23, R.N. Mukherjee Road,<br>Calcutta 700 001 (W.B.) | 1979 |

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| **Uttar Pradesh** | | | |
| 223. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kanpur Road, Daroga Khera,<br>PO Anrawn, Lucknow | Chairman,<br>National Instt. of Agriculture<br>Kanpur Road, Daroga Khera,<br>PO Anrawn, Lucknow (UP) | 1994 |
| 224. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Bachat Bhavan, Collectorate<br>Compound, Shahjahanpur | Vice-Chancellor,<br>G.B. Pant University of Agril.<br>& Technology, Pantnagar (UP) | 1994 |
| 225. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Gulchora (Lohaghat)<br>Pithoragarh 262 524 | -do- | 1994 |
| 226. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Jalalpur, Muzzaffarnagar | President,<br>Swami Kalyan Dev Trust,<br>Muzaffarnagar (UP) | 1994 |
| 227. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Barabanki | Secretary,<br>Bharat Gramin Vikas Sanstha,<br>Barabanki (UP) | 1996 |
| 228. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Crop Research Station,<br>Behraich | Vice-Chancellor,<br>Narendra Deva University of<br>Agriculture & Technology,<br>Kumarganj, Faizabad (UP) | 1983 |
| 229. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Ballia, PO Sohoan,<br>Ballai 277 504 | -do- | 1984 |
| 230. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Haldhapur,<br>Distt. Mau 221 705 | -do- | 1989 |
| 231. | Training Organiser,<br>Krishi Vigyan Kendra,<br>S-4/50A, Mahaveer Road,<br>Ardally Bazar, Varanasi 221 001 | NDUA&T,<br>Kumarganj, Faizabad | |
| 232. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Banjaria Farm, PO Katya,<br>Distt Basti 272 302 | -do- | 1989 |
| 233. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Regional Research Station,<br>Bharari, PO Bhojla,<br>Jhansi 284 003 | Vice-Chancellor,<br>Chandra Shekar Azad University<br>of Agriculture and Technology,<br>Kanpur 268 002 (UP) | 1983 |

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|---|---|---|---|
| 234. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Dairy Farm, Vety. College,<br>Mathura 281 001 | -do- | 1984 |
| 235. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Dariapur Farm,<br>P.P. Munsiganj,<br>Distt. Rai Bareilly 229 405 | Vice-Chancellor,<br>Chandra Shekar Azad University<br>of Agricultural and Technology,<br>Kanpur 208 002 (UP) | 1984 |
| 236. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Tharion Farm, Fatehpur,<br>Allahabad G.T. Road,<br>Distt Fatehpur | -do- | 1989 |
| 237. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Central Dairy Farm,<br>Distt Aligarh | -do- | 1992 |
| 238. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Ranichauri,<br>Distt. Tehri Garhwal 249 199 | Vice-Chancellor<br>G.B. Pant University of<br>Agriculture & Technology,<br>Pantnagar 263 145 (UP) | 1983 |
| 239. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Rice Research Station, Nagina,<br>Distt Bijnor 246 762 | -do- | 1992 |
| 240. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Chandra Nagar,<br>Saharanpur 247 001 | -do- | 1992 |
| 241. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Badaun,<br>Distt Badaun 243 601 | -do- | 1992 |
| 242. | Training Organiser,<br>Krishi Vigyan Kendra,<br>243, Vikas Bhavan,<br>New Collectorate,<br>Raj Nagar, Ghaziabad 201 001 | G.B.P.U.A.T.<br>Kanpur | 1992 |
| 243. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Indian Vety. Research Institutee,<br>Izatnagar 243 122 | Director,<br>Indian Vety. Research Institute,<br>Izatnagar 243 122<br>(UP) | 1985 |

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|---|---|---|---|
| 244. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kamla Nehru Memorial Trust,<br>Sultanpur 228 118<br>(UP) | Secretary,<br>Kamla Nehru Memorial Trust,<br>Sultanpur 228 001<br>(UP) | 1976 |
| 245. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Etah Tundla Road,<br>Awagarh 207 301,<br>Distt Etah (UP) | Principal<br>Raja Balvant Singh College,<br>Bichpuri,<br>Agra (UP) | 1982 |
| 246. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Barkachha,<br>Mirzapur 231 001 | Vice-Chancellor,<br>Banaras Hindu University,<br>Varanasi 110 005<br>(UP) | 1984 |
| 247. | Officer-in-Charge,<br>Krishi Vigyan Kendra,<br>Jai-prabha Gram/Gopalgram,<br>Deen Dayal Research Institute,<br>PO Khargu Chandpur,<br>Gandhi Park, Gonda 271 001 | Chairman,<br>Deen Dayal Research Institute,<br>7-B, Swami Ram Tirath Nagar,<br>Rani-Jhansi Road,<br>New Delhi 110 005 | 1989 |
| 248. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Ganiwan,<br>Distt Banda 210 206 | -do- | 1992 |
| 249. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Allahabad Agril. Institute,<br>Distt Allahabad 211 007 | The Director,<br>Allahabad Agril. Institute,<br>Naini, Allahabad | 1992 |
| 250. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sohna,<br>Distt Sidharthnagar 272 193 | The President,<br>Leond Tel Area Develop. Soc.,<br>Village & PO Sohna,<br>Sidharth Nagar (UP) | 1992 |
| 251. | Training Organiser,<br>Swami Kalyan Dev<br>Krishi Vigyan Kendra<br>Hastinapur,<br>Distt Meerut 250 404 | President,<br>Gandhi Polytechnic,<br>(Krishi Vidyalaya Society,<br>Hastinapur) Distt Meerut (UP) | 1992 |
| 252. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Zila Panchayat Bhavan,<br>Distt Rampur 244 901 | Vice-Chancellor,<br>GBPUA&T,<br>Pantnagar (UP) | 1992 |

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|---|---|---|---|
| **West Bengal** | | | |
| 253. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Durgapur, Burdwan 713 212 | Chairman,<br>Hindustan Fertiliser<br>Corp. Ltd., New Delhi | 1994 |
| 254. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sri Niketan, Birbhum 731 236 | Vice-Chancellor,<br>Vishwa Bharti Shanti<br>Niketan, Bolepur (WB) | 1994 |
| 255. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Brackishwatr Experimental<br>Fish Farm,<br>PO Kakdwip 743 347<br>Distt South 24-Paraganas | Director,<br>Central Inland Capture<br>Fisheries Research Institute,<br>Barrackpore 743 101 | 1979 |
| 256. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Sri Ramkrishna Ashram,<br>PO Nimpith Ashram<br>South 24-Parganas 743 338 | Chairman,<br>Sri Ramakrishnan Ashram,<br>Distt 24-Parganas<br>(Sunderban) (WB) | 1979 |
| 257. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kapgari,<br>Distt Midnapor 721 505 | President,<br>Seva Bharti, Kapgari<br>Distt Midnapor (WB) 721 505 | 1976 |
| 258. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Ramshai,<br>Distt Jalpaiguri 735 219 | General-Secretary,<br>Sri Ramakrishna Seva Kendra,<br>23, R.N. Mukherjee Road,<br>Calcutta 700 001 (WB) | 1983 |
| 259. | Training Organiser,<br>Krishi Vigyan Kendra,<br>PO Sonamukhi,<br>Distt Bankura 722 207 | Executive Vice-Chairman,<br>West Bengal Comprehensive<br>Area Development Corporation,<br>6-A, Raja Subodh Mullick Square,<br>Calcutta (WB) | 1983 |
| 260. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Vivekanand Nagar,<br>Distt Purulia 723 147 | President,<br>Kalyan P.O.<br>Vivekanand Nagar,<br>Distt Purulia (WB) | 1992 |
| 261. | Training Organiser,<br>Krishi Vigyan Kendra,<br>Kalimpong,<br>Distt Darjeeling 734 301 | Vice-Chancellor,<br>Bidhan Chandra Krishi<br>Vishwa Vidyalaya,<br>Haringhata,<br>Mohanpur (WB) | 1992 |

**Trainers' Training Centres**

1. Chief Training Organiser,
Trainers' Training Centre,
NDRI, Karnal 132 001
Haryana

2. Chief Training Organiser,
Trainers' Training Centre,
ICAR Research Complex
for NEH Region,
Barapani 703 103
Meghalaya

3. Chief Training Organiser,
Trainers' Training Centre,
CRIDA, PO Saidabad,
Santoshnagar
Hyderabad 500 659
Andhra Pradesh

4. Chief Training Organiser,
Trainers' Training Centre,
CIAE, Shri Guru Tegh
Bahadur Complex,
T.T. Nagar
Bhopal 462 003
Madhya Pradesh

5. Chief Training Organiser,
Trainers' Training Centre,
CIFA, Kausalayagang Via
Bhubaneshwar 751 002
Orissa

6. Chief Training Organiser,
Trainers' Training Centre,
Prawn Culture Farm (CMFRI)
Narakkal, Cochin 682 505
Kerala

7. Chief Training Organiser,
Trainers' Training Centre,
Avineshilingam Institute for
Home Science & Higher
Education for Women
Coimbatore 641 043
Tamil Nadu

8. Chief Training Organiser,
Trainers' Training Centre,
Indain Institute of Horticultre Research
255, Upper Palace Orchards,
Bangalore 560 006
Karnataka

## APPENDIX 17

## ZONAL COORDINATING UNITS

1. Zonal Coordinator, Zone I
   Punjab Agricultural University
   Ludhiana 140 004
   (Punjab)
2. Zonal Coordinator, Zone II
   37, Belgachia Road
   Erstwhile Bengal Veterinary College
   Calcutta 700 037
   (West Bengal)
3. Zonal Coordinator, Zone III
   ICAR Research Complex for
   NEH Region
   Umroi Road,
   Barapani 703 103
   (Meghalaya)
4. Zonal Coordinator, Zone IV
   Directorate of Extension,
   CSA University of Agriculture
   and Technology
   Kanpur 208 002
   (Uttar Pradesh)
5. Zonal Coordinator, Zone V
   Central Research Institute for Dryland
   Agriculture
   Saidabad, Santosh Nagar,
   Hyderabad 500 659
   (Andhra Pradesh)
6. Zonal Coordinator, Zone VI
   Central Arid Zone Research institute
   Jodhpur 342 003
   (Rajasthan)
7. Zonal Coordinator, Zone VII
   Directorate of Extension,
   JNKVV,
   Jabalpur 482 004
   (Madhya Pradesh)
8. Zonal Coordinator, Zone - VIII,
   Southern Research Station,
   NDRI, Adugodi,
   Bangalore 560 030
   (Karnataka)

## APPENDIX 18

## TOTAL NUMBER OF EMPLOYEES IN THE ICAR AND ITS RESEARCH INSTITUTES AND NUMBER OF SCHEDULED CASTES AND SCHEDULED TRIBES

| Sl.no. Class of posts | Total posts sanctioned | Total employees in position | Total scheduled castes among them | Percentage to total employees | Total scheduled tribes among them | Percentage to total employees |
|---|---|---|---|---|---|---|
| **1. Scientific Post** | | | | | | |
| Experimental Scientist | 240 | 117 | 21 | 17.9% | 2 | 1.70% |
| Scientist | 3,215 | 2,270 | 135 | 5.94% | 15 | 0.66% |
| Senior Scientist | 1,526 | 1,411 | 105 | 7.44% | 7 | 0.49% |
| Prinicipal Scientist | 778 | 668 | 23 | 3.44% | 2 | 0.29% |
| RMP Scientist | 147 | 105 | 5 | 4.86% | 1 | 0.95% |
| **Total** | **5,906** | **4,571** | **289** | **6.32%** | **27** | **0.59%** |
| **2. Technical Posts** | | | | | | |
| Category I | 4,097 | 3,647 | 727 | 19.9% | 231 | 6.33% |
| Category II | 3,496 | 2,702 | 459 | 16.9% | 128 | 4.73% |
| Category III | 642 | 408 | 70 | 17.1% | 22 | 5.39% |
| **Total** | **8,235** | **6,757** | **1,256** | **18.58%** | **381** | **5.63%** |
| **3. Administration Posts** | | | | | | |
| (a) Dir./Under Secretary/Chief Admn. Officer/Chief Accounts Officer/Sr. Admn. Officer/ Sr. Accounts Officer/Admn. Officer/F&AO/Legal Officer | 157 | 141 | 37 | 26.2% | 9 | 6.38% |
| (b) Asstt. Fin. & Accounts Officer/Accounts Officer/Section Officer/ Hindi Officer/Desk Officer/Superintendant/ Public Relations Officer etc. | 806 | 668 | 101 | 15.1% | 77 | 11.5% |
| (c) Assistant | 978 | 926 | 182 | 19.6% | 48 | 5.18% |
| (d) Stenographer | 945 | 692 | 84 | 12.0% | 22 | 3.17% |
| (e) UDC/Senior Clerk | 1,119 | 1,101 | 188 | 17.07% | 47 | 4.26% |
| f) LDC/Junior Clerk | 1,804 | 1,457 | 305 | 21.07% | 75 | 5.18% |
| **Total** | **5,809** | **4,975** | **897** | **18.03%** | **278** | **5.58%** |
| **4. Supporting Staff** | | | | | | |
| Grade I | 9,046 | 7,838 | 2,490 | 31.7% | 446 | 5.69% |
| Grade II | 1,808 | 1,733 | 428 | 24.6% | 110 | 6.34% |
| Grade III | 893 | 852 | 243 | 28.5% | 50 | 5.86% |
| Grade IV | 407 | 367 | 117 | 31.18% | 29 | 7.90% |
| **Total** | **12,154** | **10,790** | **3,278** | **30.37%** | **635** | **5.88%** |
| **5. Supporting Staff (Safaiwala)** | **586** | **580** | **481** | **82.9%** | **6** | **1.03%** |
| **6. Auxiliary Posts** | **1,535** | **1,203** | **255** | **21.19%** | **128** | **10.7%** |

## APPENDIX 19

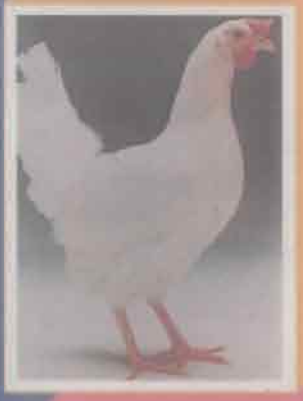
## AWARDS

| AWARD | AWARDEE |
|---|---|
| **Best Institution Awards (1995)** | *Agricultural University*<br>PAU, Ludhiana |
| | *ICAR Institutes*<br>IARI, New Delhi<br>CPRI, Shimla, CRIDA, Hyderabad |
| **Rafi Ahmed Kidwai Memorial Awards for Agricultural Research for the Triennium (1993-95)** | *Crop Improvement and Crop Protection*<br>Dr E A Siddiq<br>Dr S N Tiwari |
| | *Horticulture Science*<br>Dr Sant Ram and<br>Dr S S Negi (Jointly) |
| | *Natural Resource Management (Soil Science, Agronomy and Agroforestry)*<br>Dr N K Tyagi |
| | *Engineering and Technology*<br>Dr V M Mayande<br>Dr J C Katyal |
| | *Animal Sciences*<br>Dr N D Khanna<br>Dr A K Rai<br>Dr S P Agarwal<br>Dr V K Agarwal<br>Dr P K Sanyal and<br>Dr D K Singh (Jointly) |
| | *Fisheries and Aquatic Sciences*<br>Dr K Gopakumar Panicker |
| | *Social Life Sciences and Home Science*<br>Dr R Sathiadhas and<br>Dr K K P Panikkar |
| **Fakhruddin Ali Ahmed Awards for Outstanding Agricultural Research in Tribal Areas for the Biennium (1994-95)** | *Agricultural Sciences*<br>Dr Kumar Amrendra Singh and<br>Mr Indra Prasad Pradhan |
| | *Animal Sciences*<br>Dr R B Rai<br>Dr S Senani<br>Dr S P S Ahlawat<br>Dr A K Bandyopadhyay<br>Dr S Michael Raj<br>Dr M K Padhi |
| **Vasantrao Naik Award for Research Application in Agriculture (1995)** | Dr B S Rana and<br>Dr Swaranlata Kaul |

| | |
|---|---|
| **Jawaharlal Nehru Awards for Post-graduate Agricultural Research (1995)** | *Crop Sciences, Crop Improvement including Biotechnology and Technology* |
| | Dr V Dinesh Kumar |
| | Dr S Leena Kumary |
| | *Crop Protection including Microbiology* |
| | Dr A S M Varshadhara Wesley |
| | *Soil Science and Natural Resource Management and Agronomy* |
| | Dr R Selvaraju |
| | Dr Ramesh Kumar Sharma |
| | *Horticulture* |
| | Dr D P Kumar |
| | Dr Bhopal Singh Tomar |
| | *Engineering and Technologies and Post-Harvest Technology* |
| | Dr Saroj Kumar Nanda |
| | Dr P K Gupta |
| | *Animal Production and Veterinary Sciences* |
| | Dr S S Mishra |
| | *Fisheries* |
| | Dr Kaushalya Kumari Naik and |
| | Dr H Shivananda Murthy (Jointly) |
| | *Social Sciences including Home Sciences* |
| | Dr N Nagaraj |
| | Dr Bibudha Parasar |
| **Outstanding women Agricultural Scientist Award (1995)** | Dr (Mrs) Renu Khanna Chopra |
| **Best KVK Awards for the Biennium (1994-95)** | Gaddipalli Krishi Vigyan Kendra, Nalgonda, Andhra Pradesh |
| | Krishi Vigyan Kendra, NDRI, Karnal, Haryana |
| **Outstanding Extension Scientist/ Worker Awards for the Triennium (1993-95)** | *Agricultural Extension* |
| | Dr D Somasundaram |
| | Dr M P Srivastava |
| | *Fisheries Extension* |
| | Dr (Mrs) D Krishna Srinath |
| | *Prototype Production* |
| | Dr K C Bhardwaj |
| **National Awards for outstanding Teachers for the Biennium (1994-95)** | Dr S K Arora |
| | Dr Y Rathaiah |
| | Dr Mahendra Pal Bansal |
| | Dr (Mrs) K Saroja |

# ACRONYMS

| | | |
|---|---|---|
| ACIAR | : | Australian Centre for International Agricultural Research |
| AHRD | : | Agricultural Human Resource Development |
| AHRTD | : | Agricultural Human Resource and Technology Development |
| APAARI | : | Asia Pacific Asssociation of Agricultural Research Institutes |
| APSA | : | Asia Pacific Seed Association |
| ASSVT | : | Advance Sweet Sorghum Varietal Trial |
| AVRDC | : | Asian Vegetable Research and Development Centre |
| AVT | : | Advance Varietal Trial |
| BIPM | : | Biocontrol based IPM |
| BSPP&SA | : | British Society for Plant Pathology and Systematics Association |
| CABI | : | Commonwealth Agricultural Bureaux International |
| CCS HAU | : | Choudhary Charan Singh Haryana Agricultural University |
| CGIAR | : | Consultative Group on International Agricultural Research |
| CGPRT | : | Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific |
| CIMMYT | : | Centro International de Meformento de Maizy Trigo |
| CMS | : | Cytoplasmic Male Sterile |
| CRR | : | Controlled Release Formulations |
| CZ | : | Central Zone |
| DTI | : | Draught Tolerance Index |
| ELISA | : | Enzyme-Linked Immuno-Sorbent Assay |
| EMBRAPA | : | Brazilian Agricultural Research Corporation |
| ETL | : | Economic Threshold Level |
| FYM | : | Farmyard Manure |
| GOT | : | Grow-out Test |
| ICARDA | : | International Centre for Agricultural Research in Dry Areas |
| ICBR | : | Intcremental Cost: Benefit Ratio |
| ICGEB | : | International Centre for Genetic Engineering and Biotechnology |
| ICIMOD | : | International Centre for Integrated Mountain Development |
| ICLARM | : | International Centre for Living Aquatic Resource Management |
| ICRISAT | : | International Crops Research Institute for Semi-Arid Tropics |
| ICSC | : | International, Crop Science Congress |
| IFPRI | : | International Food Policy Research Institute |
| IIMI | : | International Irrigation Management Institute |

| | | |
|---|---|---|
| ILRI | : | International Livestock Research Institute |
| INIBAP | : | International Network on Banana and Plantain |
| IPGRI | : | International Plant Genetic Resources Institute |
| IPM | : | Integrated Pest Management |
| IRRI | : | International Rice Research Institute |
| ISCO | : | International Soil Conservation Organization |
| ISSVT | : | Initial Sweet Sorghum Varietal Trial |
| LER | : | Land Equivalent Ratio |
| MoA | : | Memorandum of Agreement |
| NACA | : | Network of Aquaculture Centres in Asia-Pacific |
| NATP | : | National Agricultural Technology Project |
| NBPGR | : | National Bureau of Plant Genetic Resources |
| NEPZ | : | North-Eastern Plains Zone |
| NHZ | : | Northern Hills Zone |
| NWPZ | : | North-Western Plains Zone |
| PAGE | : | Polyacrylamide Gel Electrophoresis |
| PCARRD | : | Philippine Council for Agriculture, Forestry and Natural Resources Research and Development |
| PEQN | : | Post Entry Quarantine Nursery |
| PZ | : | Peninsular Zone |
| RAPD | : | Random Amplified Polymorphic DNA |
| RFLP | : | Restricted Fragment Length Polymorphism |
| SAARC | : | South Asian Association for Regional Co-operation |
| SDU | : | Sorghum Diastatic Unit |
| TGMS | : | Temperature-Sensitive, Genic Male Sterile |
| TMV | : | Tobacco Mosaic Virus |
| USDA | : | United States Department of Agriculture |

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