## Indian Council of Agricultural Research

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<th>Position</th>
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<td><strong>President</strong></td>
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Foreword

The Indian Council of Agricultural Research is charged with the responsibility of setting an agricultural research and education agenda for the country and is continuously engaged in developing farmworthy, agro-production and protection technologies for enhancing productivity and production of the agricultural sector. Over the decades, the Council has grown from strength to strength, and has ushered in agricultural development with its two strong pillars—technology back-up and essential human resources. The ICAR has contributed substantially to the overall agricultural growth of the country, and this has been acknowledged globally. During 1994-95, the Council developed a number of improved, high-yielding varieties and hybrids, having inbuilt resistance to a number of pests and pathogens.

Hybrids of rice have been developed for the first time in the country. Potentials of new durum wheat varieties have opened new vistas for accelerated wheat export. Multi-cut sorghum hybrids have paved the way for augmenting fodder production for the ever-growing livestock populations. Development of new sugarcane varieties and perfection of techniques of developing test-tube sugarcane plantlets have helped in mass multiplication of promising varieties.

Accelerated programmes on germplasm conservation, utilization and addressing biodiversity issues with much-needed diversification of agriculture and technological development in fruits, vegetables and flowers have augmented their supply to the domestic and external markets. High-yielding varieties of grapes with top grade wine-making qualities have resulted in accelerated production and diversification. Production of true potato seed has helped greatly meet the seed requirement. Technological developments for diagnostics and vaccines have put the national programmes regarding animal health on a sound footing.

Coastal as well as inland fisheries is progressing with considerable pace. It is hoped that technology developed for processing, product development and value addition would go a long way in harvesting, preserving, conserving, storing and supplying value-added products.

Human resource development is considered crucial, and the present efforts in strengthening libraries, laboratories, training and communication facilities with newly launched programmes is expected to pay rich dividends. The international co-operation and development of partnerships with sister organizations are progressing well. Keeping in view the market demands to bring much-needed efficiency and effectiveness, programmes are channelized to meet the existing and emerging opportunities in the process of economic liberalization and globalization. Initiatives taken on human resource
development, information management, long-term perspective planning, policy reforms, developing incentive-and-reward system, etc. are steps considered to be in the right direction.

The report gives an account of accomplishments on research, education and frontline extension activities of the Council. It is the essence of the achievements on reforms, financial utilization, resource mobilization, capacity building and fund utilization.

It is hoped that the report would give an insight of the developments and would be useful to all those who are engaged in agricultural research and development.

(Jagannath 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 field 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 Universities.

(v) To do other things considered necessary to attain the objectives of the Society.
1. Introduction
THE Indian Council of Agricultural Research (ICAR) is the apex organization at 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. The Minister for 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 (DARE).

The General Body is the supreme authority of the ICAR. It is headed by the Minister for Agriculture, Government of India. Its members include 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.

The Governing Body 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. It is assisted by the Standing Finance Committee, Norms and Accreditation Committee, Regional Committees, several Scientific Panels and a Publications Committee.

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

The Director-General of the ICAR 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 8 Deputy Directors-General—one each in charge of (i) Crop Sciences, (ii) Soils, Agronomy and Agroforestry, (iii) Animal Sciences, (iv) Agricultural Education, (v) Transfer of Technology, (vi) Fisheries, (vii) Horticulture and (viii) Agricultural Engineering. The DDGs are responsible for the institutes and projects in their respective fields.

Presently the Society has 141 members (Appendix 1). The Governing Body of the Society has 26 members (Appendix 2). The other important bodies and committees of the ICAR are the Standing Finance Committee, Norms and Accreditation Committee, and Regional Committees. Their present composition is given in Appendices 3-5.

The senior officers posted at the Headquarters are listed in Appendix 6.

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 alleviation of 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 to a Project Directorate, initiated the National Institute of Animal Nutrition and Physiology, 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 research set-up includes 46 Central Institutes, 4 National Bureaux, 10 Project Directorates, 29 National Research Centres and 80 All-India Co-ordinated Research Projects and Networks. The details of these institutions are given in Appendices 7 to 11. Apart from financing a number of ad-hoc research schemes located at various places, the ICAR also finances research schemes through the United States-India Fund. The details
of such schemes are given in Appendix 12.

Under the National Agricultural Research Project (NARP) aided by the World Bank, the ICAR sanctioned new sub-projects with a view to strengthening the regional research capabilities of the state agricultural universities. The complete list of all the new and old sub-projects is given in Appendix 13.

The ICAR also takes the help of retired scientists for its research projects by appointing them as emeritus scientists. The existing strength of emeritus scientists, national fellows and national professors is indicated in Appendix 14. Research programmes are given the required thrust by holding workshops, seminars, summer institutes etc. The details of the summer institutes are given in Appendix 15.

For higher education in agriculture and allied fields, the ICAR has 4 deemed universities, viz. Indian Agricultural Research Institute, National Dairy Research Institute, Indian Veterinary 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.

In addition to the above, the ICAR also promotes research education and extension education through 27 State Agricultural Universities and 1 Central Agricultural University for North-Eastern Hills Region by providing financial assistance in different forms. The list of these universities is given in Appendix 16.

Overview

RESEARCH ACHIEVEMENTS

The year under review has reinforced the firm belief in our capability of keeping pace with the population growth of 2.1% per annum, as the country realized foodgrain production of 192 million tonnes during 1994-95. It resulted in a buffer-stock of over 36 million tonnes. There can be no other befitting compliment to the agricultural research and development system of our country than this. It is further reassuring that, although we are trying to industrialize at a fast pace, the agricultural sector still contributes 32% to the gross domestic product (GDP) of India with 70% of its population engaged in agriculture, compared with 2-7% in the contemporary developed world.

Presently, the National Agricultural Research System (NARS) has 46 Central Institutes, 4 National Bureaux, 29 National Research Centres, 10 Project Directorates and 80 All-India Co-ordinated Research Projects/programmes. This whole system has a symbiotic relationship with 27 State Agricultural Universities and 1 Central Agricultural University established during 1994-95 in the North East Hills Region.

Hybrids to Break Yield Barriers

During the year, our earlier efforts of starting
a mission-mode approach to develop rice hybrid resulted in the release of 4 rice hybrids: APHR 1 and APHR 2 for Andhra Pradesh; KRH 2 for Karnataka; and MGR 2 for Tamil Nadu. More are in the pipeline. Recently West Bengal has released 1 hybrid of rice. India has emerged as the second country after China to develop its own hybrid rice varieties. In addition, 17 new rice varieties were released by the State Variety Release Committee.

Production of more than 65 million tonnes wheat during the year has created a new record. Six new improved varieties of wheat including 2 of durum wheat were released. For the first time an improved variety of triticale was also released.

The research efforts to increase the productivity of coarse cereals resulted in the release of 2 hybrids of maize and a new hybrid of sorghum. For the first time, a multi-cut sorghum hybrid PCH 106 was developed yielding 20% higher than the most popular variety. Sorghum variety 'Hara Sona' was released as multi-cut material for the entire country. To help tribals, the research for improving small millets has been stepped up. Two varieties of foxtail-millet were released for Andhra Pradesh and Rajasthan.

The ICAR is providing research support to the National Technology Mission on Pulses. This year 7 varieties of field pea and 1 of lentil were identified for pre-release multiplication. These 8 varieties will further strengthen the pulse-development programme in the country.

Our pulse as well as oilseed sector is primarily rainfed. We have had a spectacular achievement in the oilseeds, where export of oilmeal and minor oil is now twice that of the edible oil. Two yellow-seeded varieties of soybean, 3 high-yielding varieties of groundnut, an open-pollinated variety of sunflower and 2 white-seeded varieties of sesame are the highlights of the varietal improvement programme in oilseeds. In addition, 2 castor hybrids were identified for pre-release multiplication.

Among the cash crops, sugarcane production regained the lost ground and surged ahead to a record production of 259.38 million tonnes. A number of new varieties were identified to replace the old sugarcane varieties in different agro-climatic zones. These varieties have high yield potential with higher sucrose content and resistance to diseases and pests. The success achieved in producing 77,760 test-tube plantlets from a single explant in 5 months and 15 days is an indicator of the potential of distributing elite planting material to sugarcane growers for breaking earlier records of productivity.

Several new hybrids of cotton have given very promising results to step-up the production of cotton. An intra-specific hybrid (CSHH 29) of upland cotton (Gossypium hirsutum) developed at the Regional Station of the Central Institute of the Cotton Research, Sirsa, recorded a yield of 2.49 tonnes/ha and ranked among the first 5 top entries at 3 locations under trials ... the All-India Coordinated Cotton Improvement Project. The seed inoculation with Azospirillum brasilense at the rate of 100 g/kg of seeds resulted in 33% more yield of jute in jute-rice sequence. The yield of rice also increased by 35%. A new flue-cured variety of virginia tobacco, resistant to black-shank disease, was released for cultivation in the northern light soils of the West Godavari district of Andhra Pradesh.

In our effort to increase forage production, 1 multi-cut hybrid and 1 multi-cut variety of sorghum were released in addition to a new variety of lucerne, Anand 3, which proved suitable for growing in Himachal Pradesh and Gujarat. Forage yield of pearl millet and oat increased significantly with the application of Azospirillum and Azotobacter.

**Conservation and Utilization of Plant Biodiversity**

A total of 130 indigenous accessions were collected and 260 exotic accessions were introduced in underutilized crops like grain-amaranth, rice-bean, faba-bean, buckwheat, Chenopodium spp., adzukibean and winged bean.

The varietal improvement by the plant breeders of the NARS is being supported continuously through the availability of indigenous and exotic collections of the most valuable germplasm. The National Bureau of Plant Genetic Resources (NBPGR) made 30 explorations in 1994-95 to different parts of the country. A total of 2,696 germplasm accessions were collected during these explorations. More than 53,500 accessions were introduced from 47 countries, and 42,000 accessions of various crops were exported. A total of 123,745 samples of germplasm and materials were processed for quarantine inspection and clearance. Over 18,690 accessions in different agri-horticultural crops were grown for preliminary evaluation, characterization, maintenance and multiplication. A dwarf compact oil palm was
identified from the Nigerian collection. Resistant strains of cumin, fenugreek and coriander were identified from the exotic germplasm and 76 wild piper lines were collected from forest areas of Karnataka and Kerala. Total germplasm accessions stored in the National Gene Bank till 31 March 1995 were 144,409.

The concern of conserving our plant wealth and efforts to utilize the biodiversity for crop improvement have to match the sustainability of crop production and its profitability is established. Protection of environment and the basic national assets is at the core of national productivity cycle. The main idea is to adopt and promote environmentally safe and cost-effective plant protection techniques such that they harmonize with other segments of crop husbandry for achieving higher crop productivity. With this in view, researches for developing biocontrol agents like Trichogramma chilonis, T. pretiosum, Epirimania melanoleuca and Bacillus thuringiensis were further stepped up. Sugarcane borer and leafhopper were effectively controlled through biological measures. Successful experiments led to biological suppression of pests of rice, pulses, oilseeds, vegetables and tree crops. Several weevils and beetles were found to suppress various weeds. Plant-based pesticides developed from extract of neem-seed kernel and from the oil of castor, pongam and mahua seeds were found effective in controlling several pests. These are being utilized to fight pests through Integrated Pest Management (IPM). Same approach is being applied to weed management. Cuscuta plant residue was found phytotoxic for aquatic weeds. Multi-locational trials are being conducted to find pesticidal residues in different crops, keeping in view the strict quality regulations of different countries to facilitate export of the Indian agricultural produce.

Export orientation

Export orientation has become quite visible in our horticultural research. Several new hybrids and varieties of fruits, vegetables and flowers were developed for export purpose. New mango hybrids are undergoing trials and new methods to improve the quality of mango varieties like Totapari and Alphonso have proved fruitful.

Six superior high-yielding varieties of grapes were developed for table purpose, juice purpose and wine-making and two of these hybrids evolved by the IARI rearing release. A banana hybrid has
been developed, in addition to several promising selections. A promising variety of litchi (Swarn Roopa) was released. New improved methods are being investigated to increase production of apple, guava, ber and pomegranate. Experiments to increase the shelf-life of pomegranate and sapota have proved successful. This will certainly increase the export potential of these fruit crops.

With the production of vegetables crossing 60 million tonnes, we are heading for a vegetable revolution. Five high-yielding varieties and 2 F2 hybrids were added to the earlier varieties of brinjal and 1 more variety (Swarna Shree) was released for cultivation in Chhotanagpur region of Bihar. ‘Swarn Poorna’ cucumber, PH 1, NDVP 4 and Arkait pea, a high-yielding variety and 4 T guava, Roo pa) was released. New improved methods are released for cultivation in Chhotanagpur region of Bihar. ‘Swarn Poorna’ cucumber, PH 1, NDVP 4 and Arkait pea, a high-yielding variety and 4 T guava, Roo pa) was released. New improved methods are released for cultivation in Chhotanagpur region of Bihar. ‘Swarn Poorna’ cucumber, PH 1, NDVP 4 and Arkait pea, a high-yielding variety and 4 T guava, Roo pa) was released. 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Three hybrids of potato developed at CPRI, Shimla, were included for multi-locational trials. Two more hybrids proved promising and are being considered for release. Thirteen more hybrids are being tested. Three hybrids of TPS (true potato seed) family have yielded 12% more tubers than the standard variety. Also support for TPS seed production was extended to private sector.

Research on other tuber crops has also resulted in development of better varieties and improved technology of production. For example, in cassava 3 early-maturing clones could be harvested in 6 months, giving 35-37 tonnes/ha. Four lines of sweet-potato proved promising. Eleven dwarf clones of Dioscorea rotundata are being evaluated.

The ornamental crops have attained a new importance due to export potential. A new variety of rose (Chitra) was developed at the IARI, New Delhi. Hunting Song, a variety of gladiolus has been released for cultivation to be exported as cutflower. Two varieties of chrysanthemum were recommended for commercial cultivation in the eastern region and in Rajasthan. Six more varieties with varied colours were also recommended for different regions including Varsha for Pune and Shyamal for Udaipur. Four cultivars of carnation were found suitable for commercial cultivation. Two promising hybrids of tuberose were released.

As a source of protein, mushroom is catching up fast in the diet of the middle class people. The National Centre for Mushroom Research and Training, Solan, has developed 7 new strains of Agaricus bisporus. Coconut waste such as coir-dust, bunch waste, leaf stalk and leaflets were found suitable substrates for cultivation of oyster mushroom, Pleurotus sajorcaju. Spawn and cropping was done in a low-cost mushroom-house built exclusively of coconut materials such as coconut wood and pleated coconut leaves inside a coconut garden.

Two F1 hybrids of cashew gave higher yield of up to 28 kg/tree. More than 300,000 grafts of cashew produced at different co-ordinating centres were distributed during 1995 planting season. Protocols were standardized in black pepper to regenerate plants from callus in 100 days. Thirty tonnes of seed rhizomes of high-yielding turmeric varieties, 23,800 seedlings/grafts of tree spices, 26,000 cardamom seedlings and 1,800 kg cardamom seed capsules were distributed as nucleus planting material. Several new varieties and hybrids of spices are being tested before releasing to the farmers.

Soils Health, Irrigation and Mechanization

To mitigate effect of degenerating soil health, the ICAR is continuously monitoring the state of soils in the country and also stepping up research for improving soil-health and restoring fertility in problem areas. A human-induced soil degradation map of the country was prepared using the GLASOD approach. About 187 million ha area is having different kinds of soil-degradation problems, which is quite alarming. Water erosion is causing loss of top soil in 140 million ha. Terrain deformation covers 13 million ha, wind erosion accounts for 10 million ha, and chemical deterioration 15 million ha. It causes salinization in 11 million ha and loss of nutrients and organic matter in 4 million ha. The total affected area demanding immediate attention is 145 million ha, representing 45% of the total area under cultivation.

The various technologies of Integrated Nutrient Management developed by the ICAR system
have proved that the soil health can be improved through nutrient application. Alternative land-use systems were successfully applied to stop degradation in different agro-climatic areas. The package includes improved cultural practices, multi-storey cropping models and mixed plantations to increase biomass cover, creating vegetative barriers to check erosion and induce stabilization of soil movement and water channels, microbiological transformation of nutrients, organic, green-manuring and biofertilization. Promising agroforestry tree species are being added for increasing biomass and providing fodder, fuel and food.

A method was developed to recommend fertilizers based only on 1-time soil test. Periodic change of the micronutrient status of the soils is being monitored. The results indicate that regular use of zinc sulphate by the farmers in northern states has improved zinc status in Haryana, Punjab, Uttar Pradesh and Gujarat.

Our effort to develop nitrogen-fixing organisms even for cereals has started yielding fruitful results, although the strains of Azospirillum for rice and Azotobacter for wheat found so far are location-specific. Suitable spraying and coating techniques are being developed. Combined inoculum of Trichoderma viride and Rhizobium spp. in pea resulted in maximum yield through biocontrol of pests and increased nodulation.

A succulent weed, Eupatorium adenophorum (locally known as forest killer), was utilized successfully for green-manuring to increase yield of wheat in western Himalayas, where it grows profusely. This is a new addition to low-cost nutrient sources being explored to supplement chemical fertilizers.

Micro-irrigation methods, though initially capital-intensive, are highly efficient for horticultural and plantation crops. Drip irrigation in sugarcane increased yield at Rahuri, by 20% and saving water up to 44%. Banana yield was also improved by 13%, saving 24% of water. Performance evaluation of solar photo voltaic pumping systems for irrigation showed that 800 watts pump was able to pump about 60,000-100,000 litres water/day, depending on solar insolation and depth of water-table. Water-utilization efficiency can be further improved by combining the system with micro-sprinklers/drips for fruit orchards and vegetable crops.
Research in developing renewable energy sources has resulted in developing a method of biphasic anaerobic fermentation of farm residues, rice husk gasifier, wind mill for fish pond aeration and biogas from bagasse and press-mud.

The highlights of research achievements for facilitating agricultural mechanization include development of several cost-effective drudgery-removing and time-saving machines and implements. An animal-drawn puddler, manual rice planter, bullock-drawn planter for bold seeds, self-propelled high clearance sprayer, reaper for tall crops and multi-crop thresher are ready to help farmers.

The globalization of markets requires competitiveness in our food products. This can be achieved through adoption of improved post-harvest technologies. The ICAR is running an All-India Coordinated Project on PHT at Bhopal and has started the Central Institute of Post-harvest Engineering and Technology at Ludhiana. This has resulted in various technologies that can be adopted even at village level. Some of the post-harvest technologies developed during the year under report are: cleaner-cum-grader for spices, fruit grader, fruit and vegetable dehydrator, fluidized bed dryer for mushroom, pedal-operated dal-mill, gur drying-cum-storage bin and gur-moulding frames. Several new developments in post-harvest technologies of cotton, jute and other fibres are also noteworthy. These include mote grooving device for cotton gins and foot-operated ginning machine. Fabric suitable for Safari suiting was developed from cotton warp and ramie/acrylic-blended weft yarn. For producing kusmi lac, a new host *Flemingia semulata* was found suitable. It is an erect shrub growing throughout India and particularly in Andamans islands. This can help introduce lac cultivation in newer areas. A new variant of Kusmi strain of lac was found having high potential for resin production. An improved method for preparing lac dye from lac-waste effluent was developed. A compound releasing musk-like odour was isolated from lac for use in the perfumery industries and technology was transferred to a company.

**Animal Sciences**

We have made phenomenal progress in animal production. Dairy sector alone in India has grown to Rs 200,000 million annually. We are the second largest producer of milk and by the turn of the century about 16 million crossbred cows with high productiviety potential would add to the growth of dairy industry.

Efforts are being made to preserve indigenous breeds, and a new-data bank has been prepared for recording various performance traits of the indigenous breeds. Thousands of semen straws belonging to Hariana and Ongole bulls and others have been frozen for future breeding programmes. Analysis of muzzle prints of Tharparkar, Sahiwal, Karan Swiss, Karan Fries cattle and Indian breeds of buffaloes as well as of some exotic breeds has been completed. Animal science research has been stepped up to improve breeds of rabbit, goat, sheep, camel, and horse. The morphology and biometric attributes of somatic chromosomes of Rathi and Hariana cattle, Surti and Bhadwari buffaloes, mithun, Indian single-humped camel, indigenous horse, Marwari goats and Magra sheep were established. It was hypothesized that yak and cattle have been domesticated simultaneously from the common ancestor, *Aurochus*, which has now become extinct. The red-cell antigens of yak were investigated to explore the possibility of sharing of physiological traits of red cells between yak and cattle. In poultry, several studies were made to locate genes in birds carrying naked neck and other genes. These genes will be used as a source of sex-linked recessive dwarfing gene for use in research for broiler dwarf dam line populations.
In animal health the major achievements were the large-scale production of vaccine for monovalent and polyvalent foot-and-mouth disease virus by fermentor technology using BHK-21 cell-suspension system. Diagnostic techniques are being developed using monoclonal antibodies, western blot technique, dot-ELISA test, haemolysis and haemagglutination. Laboratory evaluation of 3 prototype immunodiagnostic kits for foot-and-mouth disease (FMD), viz, sandwich-ELISA antigen capture, PCR and DIG labelled hybridization, showed significant results. The technique for estimating ribose nucleic acid (RNA) and preparation of RNA profiles 1.8 million were standardized. A cell-culture vaccine was developed to control theileriosis. During 1994-95, the doses of different vaccine adjuvants were produced and supplied by the IVRI, Izatnagar. At its Bengaluru campus, 2.8 million doses of the monovalent FMD vaccine were produced, fetching Rs 1.6 million. Monoclonal antibodies were also raised for controlling rinderpest virus. A very useful technique for production of monoclonal antibodies with frozen and thawed splenocytes was developed.

Many traditional methods of feeding are being evaluated scientifically. The age-old practice of feeding mustard-cake proved beneficial. It avoids the use of external source of thiocyanate for milk preservation, which may pose risk of iodine deficiency in milk consumers, particularly in infants. Leucaena leafmeal can replace groundnut-cake, cottonseed-cake and soybean-meal as protein source in the rations of ruminants. It is more economical and has the advantage of acting as a natural by-pass protein. A process technology for increasing by-pass protein value of groundnut-cake without affecting digestibility was developed. From semi-arid regions, 89 species of plants were collected and classified according to their nutritive values. Research undertaken to screen feedstuffs for poultry revealed that the rice bran (kani) has high metabolizable energy equivalent to maize and can be used as alternative feed.

Antiserum against progesterone 7-alpha-carboxyethyl thioether was produced from rabbit serum. It can detect hormone concentrations as low as 8 pg/tube. Development of this antiserum will save considerable foreign exchange.

In buffaloes, 2 pregnancies were confirmed through IVF embryo transplantation. Another major achievement in endocrinology was the development of a highly sensitive immunoassay for progesterone estimation in buffalo follicular fluid. The assay requires only 0.05 microlitre (µl) of follicular fluid. The technique of deep freezing of buck semen was standardized with a post-thaw mortality of 56%. This is comparable to results from the developed countries. A ready-reckoner chart was developed to judge age of small, medium and large-sized breeds of Indian goats by examination of teeth.

Technology was standardized for the preparation of whey-based mushroom soup powder, ultrafiltration cheese powder, carrot-milk spray-dried powder, low-cholesterol mozzarella cheese, an instant mix for pizza, plain, fruit and flavoured kefir, spray-dried and roller-dried skim-milk powder from milk concentrated by reverse osmosis and a high quality Mishtidoi. All these nutrition milk products can generate income in rural areas, and have export potential.

Fisheries

Remote-sensing technology is being used for short-term forecasting of potential fishing zones along the Kerala coast. Satellite data on prospective fishing zones are being supplied. Tagging experiment on hilsa revealed its movement from downstream to upstream during flood season at Farakka (West Bengal). Eco-based studies of the Himalayan river, the Kosi and the lake Nau Kuchiatal, were undertaken to identify suitable potential for development of cold-water fisheries. Hazards to fisheries due to environment and commercial fish farming are being monitored continu-
A vaccine for white-spot disease of shrimps is under trial. This disease caused large-scale mortality in shrimp farms.

The pond-breeding technique for pearlspot was perfected through environmental change in salinity and provision of nesting material. A microparticulate feed of 200-500 micron size was prepared with indigenous feed ingredients containing 50% protein. This was successfully tested on the post-larvae of the tiger prawn. Shrimp-feed pellets made of maida and wheat flour (15%), processed in combination with clusterbean gum (3%), proved stable under water for 6 hr.

Induced breeding in an air-breathing catfish, Singhi, was achieved in the laboratory. In a significant breakthrough, technology was standardized for intensive raising of fingerlings of the golden mahseer in farm. This will help conserve this endangered fish of cold-waters. Cryopreservation of the milt of mahseer, Indian major carps and hilsa was undertaken at the Mini Fish Gene Bank at the NBFGR. Spermatophore from an adult male of tiger prawn was transferred artificially to a female of the same species, which subsequently spawned viable 1 million eggs. This successful experiment of artificial insemination will go a long way in overcoming failure in spawning. A low-cost technology for broodstock maintenance and seed production of *Penaeus semisulcatus* was perfected.

A new semi-pelagic trawl with 51 m long wing was designed and finalized for operation. Technique for preserving minced fish for 22 weeks at room temperature was perfected. A method was worked out for partial smoking and drying of freshwater fishes. Under a collaborative project a commercial dehydration plant at Agatti island of Lakshadweep is being set up to handle 2 tonnes of tuna/day and 500 kg waste material for production of fish-meal. Fish farmers and farm women were trained in different operations related to fish farming.

**Education**

During the year under report Rs 135 million were allocated by the ICAR to support 27 state agricultural universities for strengthening their infrastructural facilities including laboratories, libraries, housing, sports, training, communication etc. Agricultural facilities of the central university and of 4 deemed university of the ICAR are also being supported. The Central Agricultural University for the NEH Region started functioning with its headquarters at Imphal, Manipur. The programmes of scholarships, fellowships and sum-
mer institutes were carried out for human resource development; 36 centres of advanced studies are being established in the agricultural universities in addition to 11 centres in frontier areas.

Ten centres for development and use of hybrid rice technology are functioning at 8 SAUs with the UNDP contribution of US$ 3,010,650. Phytotron building at the IARI, New Delhi, is nearing completion.

The assessment of nutritional adequancy of composite diets of rural families, food-consumption pattern of farm families and their nutritional status continued under the All-India Co-ordinated Project on Home Science which utilized Rs 5.1 million out of Rs 6.5 million allocated.

The National Agricultural Research Project launched with the assistance of World Bank helped in strengthening regional research capabilities of 27 SAUs and provided infrastructural support to 343 research stations in 120 agroclimatic zones. The scope of the project was enlarged in Phase II by including new areas. Training programmes for national and international agricultural community were conducted at the NAARM. Directors of the Agricultural Research Institute of Nigeria received training in the management of agricultural research during the year.

Under the NARP II, basic research project on livestock biotechnology and a subproject to establish databases and information systems to support biotechnology research in crops, livestock, poultry, fishery, and agroforestry, are being implemented. Programmes of training in computing and information technology will also be conducted.

International Co-operation

The major thrust in co-operation with international institutions and under bilateral co-operation with other agriculturally developed countries is in new emerging technologies such as biotechnology, information technology and remote sensing in addition to rainfed agriculture, water-use efficiency, development of drought-resistant varieties, more efficient use of inputs, nutrient management and integrated pest management (IPM).

The ICAR has close collaboration with CGIAR system, UNDP, FAO, SAARC, SAREC, CABI, ACIAR and Swedish Academy for Research Co-operation among Developing Countries. Among the CGIAR system ICAR has entered into partnership with the ICRISAT, CIMMYT, IRRI, CIP, ICARDA and WARDA. In agroforestry the ICAR has entered into an
agreement with the International Centre for Research in Agroforestry (ICRAF). For nutrient management the ICAR signed a Memorandum of Understanding with the International Fertilizer Development Centre (IFDC). A workplan for scientific and technical co-operation was also signed with Cuba. A project on 'Plant genetic resources' is being implemented by the NBPRG through the support of the USAID. Sixty-nine United States-India Fund Projects by the USA are in operation in various ICAR institutes and SAUs. Indo-China workplan for co-operation in the field of agriculture was also signed. Twenty slots for training Indian scientists in various disciplines were signed under the Colombo Plan under Indo-UK collaboration. Other countries actively seeking India's expertise in agriculture for mutual benefit are Mongolia, Syria, Arab Republic of Emirate, Bangladesh, Nepal, Bulgaria, Mauritius, the Philippines, and Iran. A workplan between the ICAR and the Rockefeller Foundation of the USA was signed for promoting rice biotechnology.

Publications and Information

Two quarterly newsletters were added during the year to the 9 periodicals already being published by the Publications and Information Division of the ICAR. These are ICAR Reporter and ICAR News. The former is acting as a bridge to close the communication gap between the ICAR headquarters and its institutes, whereas the latter disseminates activities and achievements of the National Agricultural Research System in science and technology. The Publications and Information Division also supported actively the newly started reforms in administration and management system of the ICAR by publishing the Revised Rules of Technical Service, Delegation of Powers, Mandates of ICAR Institutes and other publications. A process of revamping the Publications and Information Division of the ICAR through modernization and adoption of new Information and communication technologies was also started.

Reforms

The National Agricultural Research System (NARS) of India has so far served our nation well in order to meet the food needs of ever-growing population. Now is the right time for revamping the system so as to re-orient it to meet the increasing internal and global challenges. To exist as a forceful organization, we will have not only to compete but also attain the required excellence in frontier agricultural technologies. We now need to have perspective planning and policy directions for the next 25 years to ensure better output, visibility and sustainability. A document on 'Perspective Plan of Research till 2020 AD' is under preparation. A National Agricultural Technology Project with an outlay of Rs 8,000 million with World Bank assistance was initiated. A committee under the chairmanship of Dr S.S. Johl, former Chairman, Agricultural Prices Commission, was constituted to devise suitable guidelines for undertaking partnership, resource generation, training, consultancy, contract research/contract service, and incentives and reward systems.

The on-going efforts to liberalize policies, rules and regulations to facilitate globalization of agriculture, formation of World Trade Organization (WHO) and opening up of markets require fresh initiatives to have a new Agricultural Policy and Plant Variety Act. This is an indication of change for the better. The new wave of change has already started. Indian agriculture has all the advantages of capitalizing on the new opportunities of globalization. We have good cultivable land, agroclimatic conditions, trained scientific and development-related manpower, required infrastructure for input generation, hard-working farmers, committed NGOs, innovative private sector as well as cheap labour.

The ICAR is aiming to grasp this golden opportunity to capitalize on our strengths and to indicate appropriate actions to overcome our deficiencies. Also we intend to strengthen our market intelligence studies and the international co-operation. Time is ripe for an aggressive approach and see no reason why we cannot be competitive to take advantage of globalization process in the world of agriculture. This annual report of the Council provides an insight into various programmes and activities undertaken during 1994-95.
ADMINISTRATION AND FINANCE

In administration, the Director-General is assisted by the Secretary (who is also the Joint Secretary to the Government of India in the 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).

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.

<table>
<thead>
<tr>
<th>Recruitment</th>
<th>Scheduled castes (%)</th>
<th>Scheduled tribes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct recruitment on an all-India basis:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) by open competition</td>
<td>15%</td>
<td>7.5%</td>
</tr>
<tr>
<td>b) otherwise than at (a) above</td>
<td>16.66%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Direct recruitment to Group C and Group D (Class III and IV) posts normally attracting candidates from a locality or a region</td>
<td>Generally in proportion to the population of SC and ST in the respective states/territories</td>
<td></td>
</tr>
</tbody>
</table>

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 in the ICAR headquarters and its research institutes/national research centres/project directorates is indicated below:

<table>
<thead>
<tr>
<th>Category of posts</th>
<th>Scheduled castes (%)</th>
<th>Scheduled tribes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific</td>
<td>6.25</td>
<td>0.60</td>
</tr>
<tr>
<td>Technical</td>
<td>17.9</td>
<td>5.02</td>
</tr>
<tr>
<td>Administrative posts (excluding safaiwala)</td>
<td>1.7</td>
<td>5.6</td>
</tr>
<tr>
<td>Supporting staff</td>
<td>25.2</td>
<td>4.9</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0.11</td>
<td>6.5</td>
</tr>
</tbody>
</table>

The position regarding reservation of posts in the category of scheduled castes is satisfactory except in scientific posts. This is because scientific posts for conducting research or for organizing, guiding and directing research are exempted from the purview of reservation orders. The Indian Council of Agricultural Research has made specific provisions for scheduled castes and scheduled tribes in scientific posts in consonance with the social commitment of the Government, but it is not possible to make up the backlog because each scientific position in the system has specific qualifications, both at the M.Sc. and Ph.D. levels, along with the experience relevant to the job to be handled, and it may not be desirable to keep the scientific posts vacant for very long time as this will hamper research.

A statement showing the total number of employees in the ICAR and its research institutes and the number of scheduled castes and scheduled tribes among them is given in Appendix 17.

Progressive Use of Hindi

Since the ICAR is a registered society, the Official Language Act, 1963 and the Official Language Rules, 1976 were not applicable to the ICAR. However, in the wider interest of the nation, they have been adopted by the ICAR with the approval of the Governing Body and in addition to 24 of its institutes, the headquarters of the ICAR has also been notified in the gazette of India under Rule 10(4) of the above said Rules and 4 sections, viz., Personnel-II, IA-IV, Establishment-V and General Administration-I, have been specified under rule 8(4) of the above Rules for doing their cent per cent work in Hindi. Similarly, 2 sections each of the Central Institute of Fisheries Education (CIFE), Bombay, 5 sections each of the Indian Agricultural Research Institute (IARI), New Delhi, and Indian Agricultural Statistics Research Institute (IASRI), New Delhi, and 7 sections of the National Bureau of Plant Genetic Resources, Pusa, New Delhi, have also been specified under Rule 8(4) for the same purpose.

The Joint Implementation Committee of the Department of Agricultural Research and Education (DARE) and the ICAR constituted under the Chairmanship of the Joint Secretary, DARE/ICAR is meeting every quarter regularly. Instructions have been issued to all the institutes for similar action and 46 institutes have so far constituted such committees and are holding their meetings regularly. Remaining institutes have also been asked to do so.

Rosters have been prepared to impart Hindi training to the non-Hindi knowing officers and staff, typists and stenographers and they are being
deputed for training in respective classes in a phased manner.

Posts of 30 Assistant Directors (OL) and 75 Hindi Translators have been provided to various institutes for the implementation of the OL (Official language) policy. Similarly, the DG ICAR has sanctioned Hindi posts for the ICAR headquarters, for the same purpose. Necessary action has been initiated to fill up these posts.

The Hindi Week was celebrated during 14-19 September 1994 in the ICAR and its institutes. In a printed message issued on this occasion, the Hon'ble Agriculture Minister appealed to all the officers and staff of the ICAR to strictly adhere to the Official Language Policy and ensure compliance of the statutory provisions related to it. Cash awards were given away to the officers and staff for doing maximum possible work in Hindi and it was pledged to use Hindi to the maximum possible extent in official work in a meeting held on this occasion.

The Director (Hindi) visited a number of the ICAR institutes to review the progress made and ensure compliance of the Official Language Policy of the government and to provide guidance in this regard. He also represented the ICAR before the Committee of Parliament on Official Language during their visits to the ICAR institutes and their offices.

"Rajbhasa Shield" and "Commendation Certificate" were awarded to CMFRI, Cochin (Kerala), and CIHNP, Lucknow (Uttar Pradesh), respectively, by the Regional Official Language Implementation Committee during 1994-95 for excellent work done in Hindi, while "Chal Vaidyajanti" (Rolling Shield) was awarded to NAARM, Hyderabad, by the City Official Language Implementation Committee, Hyderabad.

Keeping in view the importance of implementation of the Official Language Policy in the ICAR, an apex body of agricultural research and education in the country, a separate Hindi Salahakar Samiti has been constituted under the chairmanship of the Hon'ble Minister of Agriculture to suggest ways and means for proper compliance of the policy. The first meeting was held on 12 December 1994.

**Vigilance**

The Secretary, ICAR, and Joint Secretary, DARE, functions 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). During the year disciplinary cases against 20 scientists and 15 staff members of Administrative (Technical category) were initiated. Out of these, 1 case culminated into imposition of a minor penalty and in 1 case charges were dropped. In addition, out of 57 cases initiated during the previous years, major penalty in 3 cases and minor penalty in 6 cases were imposed during the year, besides dropping of disciplinary proceedings in 6 cases.

Appeals/review petitions in respect of 17 disciplinary cases, were received and 10 cases received during earlier year were taken up. Out of these 27 cases only 17 cases were finalized resulting into enhancement of penalty in 2 cases, reduction of penalty in 1 case and exoneration in 1 case.

During the year, disciplinary proceedings were initiated against 4 Scientists and 2 Administrative/Technical staff. One case of major penalty initiated during earlier years culminated in imposition of major penalty. Similarly, 1 case of minor penalty culminated in imposition of minor penalty, whereas 1 more minor penalty case was dropped. Further, 2 appeals against earlier penalty orders were rejected. In addition to the above, 11 enquiries for major penalty action and 2 for minor penalty are in progress.

**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.

The total allocation of Rs 473.50 crores for 1994-95 was significantly higher by Rs 46.60 crores than the allocation for 1993-94.

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.
The break-up of the ICAR’s internal resources available as additional resources for ‘NON-PLAN’ expenditure are given below:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Revenue receipts</td>
<td>9.50</td>
<td>10.00</td>
<td>10.50</td>
</tr>
<tr>
<td>*Income from interest on short-term deposits of surplus funds in SBI as per Ministry of Finance instructions</td>
<td></td>
<td>*5.66</td>
<td></td>
</tr>
<tr>
<td>(ii) Recoveries of loans and advances</td>
<td>3.00</td>
<td>3.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Total (i to ii)</td>
<td>12.50</td>
<td>18.66</td>
<td>14.50</td>
</tr>
</tbody>
</table>

The Budget estimates were approved by the Standing Finance Committee on 30 March, 1994 and the Governing Body on 30 March, 1994.

Audit Observations

A total of 2,992 Audit Reports with 1576 Audit Paras relating to 83 ICAR institutes, including its HQrs. office, were outstanding as on 31.3.95. The zone-wise break-up details of the outstanding Audit Reports/Audit Paras are as given below:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of Zone</th>
<th>Number of institutions</th>
<th>Number of Audit Reports</th>
<th>Number of paras</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>West Zone</td>
<td>8</td>
<td>32</td>
<td>206</td>
</tr>
<tr>
<td>2</td>
<td>South Zone</td>
<td>26</td>
<td>86</td>
<td>256</td>
</tr>
<tr>
<td>3</td>
<td>East Zone</td>
<td>12</td>
<td>67</td>
<td>269</td>
</tr>
<tr>
<td>4</td>
<td>North Zone</td>
<td>37</td>
<td>107</td>
<td>845</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>83</td>
<td>292</td>
<td>1576</td>
</tr>
</tbody>
</table>

2. Directors/Project Directors of the various institutes/NRCs/PDs have been urged to take up clearance of the pending Audit Reports/Paras on priority basis.

Awards

In order to give incentive to scientists and to encourage them for conducting outstanding research in the field of agriculture, carry cash prizes, certificates, citations and scrolls of honour. The details of these awards for 1994 are given in Appendix 19.

Agricultural Scientists Recruitment Board

1. Agricultural Research Service Examination/ National Eligibility Test - 1992: The result of ARS Exam./NET-1992, which was conducted in October 1993 for filling up 332 vacancies for Scientist Grade I of ARS, was declared by the Board in September 1994.

On the basis of written examination and viva-voce a total of 263 (208 General, 46 SC and 9 ST) candidates were finally selected; 523 candidates (453 General, 60 SC and 10 ST) were found qualified for NET. The result of ARS was sent to the ICAR for making appointment of selected candidates to ARS. NET certificates were issued to all candidates who qualified the National Eligibility Test and the list of successful candidates was also forwarded to various State Agricultural Universities for their record. It is pertinent to mention that the ARS Exam. 1992 was a special drive to recruit ARS scientists for the ICAR institutes located in difficult and far-flung areas of the country. As such, the vacancies were also notified Institute-wise and discipline-wise.

2. Agricultural Research Service/National Eligibility Test/Senior Research Fellowship Examination - 1994: The Agricultural Scientists Recruitment Board (ASRB) conducted a Combined Competitive Examination for filling up vacancies of Scientists of the Agricultural Research Service (ARS) in the pay scale of Rs 2200-4000 in the ICAR Institutes combined with National Eligibility Test (NET) for recruitment of Lecturers and Assistant
Professors by the State Agricultural Universities (SAUs) and for award of Senior Research Fellowship from 16-19 October 1994 at 24 Centres in India. In all, 8,756 candidates applied under various professional subjects, out of which 4,266 candidates appeared. Reservation for OBC candidates has also been given in ARS for the first time. The viva-voce of ARS candidates, who secured the minimum qualifying marks in the professional papers, started on 2 March 1995 and continued beyond 31 March 1995.

3. Direct Recruitment by Advertisements: The ASRB issued 3 advertisements during the period under report.

These advertisements included 48 Scientific posts, 4 Technical posts, 1 Administrative post and 2 Auxiliary posts as per details given below:

(i) Deputy Director-General and Directors of National Institutes (Rs 7600/- fixed)
(ii) Assistant Directors-General, Directors of Institutes, Project Directors and Joint Directors of National Institutes (Rs 4500-7300)
(iii) Project Co-ordinators and Zonal Co-ordinators (Rs 4500-7300)
(iv) Heads of Divisions/Regional Stations (Rs 4500-7300)
(v) Technical Posts
(vi) Auxiliary Posts
(vii) Administrative Posts

The Board conducted interviews for 120 posts during the period under report and forwarded the recommendations to the ICAR. The details of these posts are given below:

(a) Scientific Pay Scale No. of Posts
(i) Deputy Directors-General/Directors of National Institutes Rs 7600/- (fixed) 4
(ii) Directors/Joint Directors of National Institutes/Assistant Rs 4500-7300 19

Directors-General/ Project Directors
(iii) Zonal Co-ordinators/ Project Co-ordinators -do- 12
(iv) Heads of Divisions -do- 81

(b) Technical
(i) T-6 Rs 2200-4000 1
(ii) T-8 Rs 3000-5000 1
(iii) T-9 Rs 3700-5000 1

(c) Auxiliary Rs 3000-4500 1

Total: 120

A summary of this statement is presented below:

(i) No. of posts for which interviews were held during the period 120
(ii) Total No. of candidates applied 1,471
(iii) No. of candidates called for interview after screening 870
(iv) No. of candidates actually appeared for interview 571
(v) No. of posts reserved for SC candidates 1
(vi) No. of candidates selected from SC candidates 1
(vii) No. of posts reserved for S.T. candidates -
(viii) No. of S.T. candidates selected -

In addition, there were 9 posts where no candidate was found eligible at the screening stage itself. One post was withdrawn by the ICAR.

4. Assessment/Review Assessment/Induction: Twelve cases of scientists at various levels were assessed during the period. Two cases of assessments were also reviewed during the period. Three cases of induction were considered during the period under report and recommendations sent to the ICAR. Out of these, 2 cases related to Research Management Position and one to 'S' grade.

5. Examination for Administrative Posts: During the period under report, the following administrative examinations were conducted/ notified to fill up the posts of Administrative Officers, Finance and Accounts Officers, Section Officers and Assistants.
A. Combined Competitive Examination for Recruitment of Finance and Accounts Officers and Administrative Officers: A third All-India Competitive Examination for recruitment to the posts of Finance and Accounts Officers and Administrative Officers in the pay scale of Rs 2200-4000 was conducted from 16-19 June 1994, at 6 centres for filling up 9 posts (2 General, 4 SC and 3 ST) for Finance and Accounts Officers and 12 posts (9 General, 1 SC and 2 ST) for Administrative Officers.

In all 5,800 candidates applied for the examination, out of which 1,310 finally appeared. A total of 105 (85 General, 17 SC and 3 ST) candidates qualified in the written examination and called for interview. Two lists were prepared by the Board in order to merit for both the categories and forwarded their names to the ICAR for appointment as under:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the post</th>
<th>General</th>
<th>SC</th>
<th>ST</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Finance &amp; Accounts Officer</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>2.</td>
<td>Administrative Officer</td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

The result was sent to the ICAR on 10 January 1995.

B. Limited Departmental Competitive Examination for Recruitment of Section Officers at the ICAR Headquarters: A limited Departmental Competitive Examination for recruitment to the post of Section Officers in the pay scale of Rs 2000-3500 for filling up 6 vacancies (3 General and 3 ST out of which one was inter-changeable with SC candidate) was conducted from 6 to 10 February 1995. Twenty-five candidates applied for the examination and 14 finally appeared. Five candidates (3 General, 1 SC inter-changeable with ST and 1 ST) were declared successful. The result was sent to the ICAR on 28 April 1995.

C. Limited Departmental Examination for Recruitment of Assistants at the ICAR Headquarters: A limited Departmental Competitive Examination for filling up 11 vacancies of Assistants (8 General, 2 SC and 1 ST) in the pay scale of Rs 1400-2600 was conducted by the Board on 16 and 17 January 1995. Out of the 27 candidates, who applied for the examination, 20 finally appeared. Candidates were recommended to the ICAR for appointment, as per the applicable reservations for all the 11 vacancies.

6. Revision of Syllabus for ARS/NET/SRF examinations: A massive exercise was undertaken for revising and updating the syllabus for ARS/NET/SRF examinations in the 65 disciplines. Suggestions and views were sought from various experts of all disciplines under ARS/NET/SRF for developing a comprehensive syllabus for each discipline. Subsequently, core groups were constituted to discuss and revise the syllabus for all the 65 disciplines based on the suggestions received from various sources. The Board successfully completed this marathon job, and syllabi of all 65 disciplines were given a modern and updated shape. The ARS/NET/SRF Examination - 1995 has been conducted on the basis of revised syllabus. Publications Division, ICAR, has been requested to publish a booklet containing syllabi of all 65 disciplines which is proposed to be circulated to State Agricultural Universities/Deemed Universities and the ICAR Institutes for the guidance of students/prespective candidates for ARS/NET/SRF examination.

7. Functional and Finance Autonomy: Based on the recommendations of G.V.K.Rao Committee which were accepted by the President, ICAR, ASRB has been allotted a separate budget under Non-Plan and Plan with effect from 1.1.95. This has considerably facilitated the Board in planning and executing its programmes.

8. Research and Analysis Wing: Since one of the activities of the ASRB is to continuously monitor the performance of the scientists related to productivity in their area of specialization, it has been decided to set up a Research and Analysis Cell which will maintain a Personnel data base of all the scientists, periodically update them and study their performance. Further, based on analysis of the young scientists entering the ARS, it will be able to draw conclusions on the quality of training provided by specific institutions, which will ultimately help to improve the training and curriculum of the universities. The Cell will also be helpful in planning Human Resources Development Programme of the National Agricultural Research and Education System.
and encompassing the State Agricultural Universities and the ICAR.

9. Assessment Committees for Technical Personnel under Rule 6.6 and 6.7 of the ICAR Handbook of Technical Service Rules: The Chairman of ASRB constituted 108 Assessment Committees under Rule 6.6 of The ICAR Handbook of Technical Service Rules for categories I and II for the ICAR Institutes/Headquarters and nominated 214 experts to act as Chairman on the Assessment Committees for merit promotions/grant of advance increments for the technical personnel. Similarly, Chairman, ASRB, constituted 47 Assessment Committees under Rule 6.7 of The ICAR Handbook of Technical Service Rules for category III and nominated 89 experts to act as Chairman and 145 experts to act as Members on the Assessment Committees for merit promotion/grant advance increments for the technical personnel.

10. Career Advancement of ARS Scientists: As a follow up action on the adoption of the UGC pay package for the career advancement of ARS scientists, the Chairman, ASRB, nominated 161 experts to act as Chairman on the Departmental Promotion Committees of the ICAR Institutes/Headquarters for assessing the cases of scientists for promotion to the next higher grade.

11. Database of Experts: The Board has compiled a data base of experts with their macro/micro specialization and the field of their pursuit in all the disciplines of Agricultural Sciences—Plant Sciences, Animal Sciences, Physical Sciences, Social Sciences, Engineering and Technology, etc. The services of these experts are utilized by the Board for its various Selection/Assessment Committees. During the period under report services of 555 experts of various disciplines were utilized.

12. Physical Facilities Developed: To improve the working conditions and make ASRB a most modern and efficient organization a number of physical facilities have been improved/developed in the Board which include renovation and furnishing of 2 interview rooms, 1 Committee room, which serves as a multipurpose room for meetings and other examination work.

13. Computer Facility: To carry out various functions in the Board effectively and efficiently it has been decided to develop a multicomputer system linked through LAN (Local Area Network). Two Desktop Top Printing Units (DTPUs) will also be added to the system to facilitate production of professional documents that can be easily reproduced for examinations and other purposes.

To start with computers, 4 PCs have already been procured in the office for the use of Senior Officers.

14. Analysis of the ARS/NET Examinations: For the first time the Board attempted to critically analyse the results of ARS/NET examinations to identify the trends of the successful candidates and the institutions they studied. This information has been circulated to Vice-Chancellors of various agricultural universities to help them in evaluating their own programmes, identifying deficiencies and make improvements, wherever necessary.

(R.S. Paroda)
2. Major Research Achievements
Major Research Achievements—Crop Sciences

Conservation of Plant Genetic Resources

* The NBPGR collected 2,696 germplasm accessions and introduced more than 53,500 accessions

* During quarantine *Peronospora manschurica* in soybean, *Brucophagus roddi* in *Medicago*, *Sitophilus zeamais* in maize and *Bruchus elvi* in lentil recorded for the first time.

* About 18,700 accessions grown for evaluation and multiplication

* Total 15,918 accessions conserved for long-term storage

The National Bureau of Plant Genetic Resources (NBPGR) is the nodal agency for assembling, safeguarding, assessing and distributing the crop genetic diversity, including wild relatives of crop plants, for utilization in crop-improvement programmes in the country.

Exploration and Collection

Thirty explorations were made in different parts of the country for collection of genetic diversity in various agri-horticultural crops. A total of 2,696 germplasm accessions were collected, which included 250 of cultivated types and 195 of wild forms. Rich diversity was collected in pulses from western ghats and Goa; oilseeds from Madhya Pradesh, Maharashtra and Bundelkhand region of
Uttar Pradesh; rice from Arunachal Pradesh and Telangana region of Andhra Pradesh; maize from Bihar; *Amaranthus* spp. and buckwheat from Himachal Pradesh; banana from Sikkim, West Bengal and Assam; temperate fruits from western Himalayas; forage legumes and grasses from Lahul and Spiti; jackfruit from Bihar; and cucurbits from Maharashtra.

**Germplasm Exchange**

More than 53,500 accessions, which included materials received for conducting international trials from 47 countries, were introduced. The germplasm included lines of salinity-tolerant wheat from the UK and bacterial wilt-resistant rice from the Philippines. The ICRISAT (India) and ICARDA (Syria) also supplied materials of cotton and gram. Materials of gram received from the ICARDA have proved suitable for rainfed conditions. They have also shown multiple-disease resistance, winter hardiness and vascular wilt resistance. The yellow-coloured flesh watermelon and forage crops with highly palatable leaves were introduced from the USA. More than 42,000 accessions of various crops were also exported to different countries. Besides, 36,377 germplasm accessions of various agronomic crops which were either imported from other countries or collected within the country were found promising for various traits. The samples of germplasm were supplied to various research institutes and individual research workers within the country.

**Plant Quarantine**

A total of 123,745 samples of germplasm and materials received for conducting international trials were processed for quarantine inspection and clearance. Out of these, about 815 were introduced into India and 42,167 samples were meant for export. Of the total germplasm tested for quarantine, 1,483 samples were infested with insects, pathogens and parasitic nematodes. Efforts were made to free the infested germplasm and materials free from pests before these were dispersed for further utilization.

Some of the interceptions not yet recorded in India were *Peronospora manschurica* in soybean, *Bruchophagus roddi* in *Medicago*, *Sitophilus zeamais* in maize and *Bruchus elvi* in lentil.

**Germplasm Evaluation**

Over 18,600 accessions in different agri-
horticultural crops were grown for preliminary evaluation, characterization, maintenance and multiplication. These included germplasm of wheat, barley, oat, cowpea, lentil, gram, sunflower, rapeseed-mustard, radish, carrot, spinach, tomato, Chinese cabbage, maize, clusterbean, brinjal and other vegetable crops, blackgram, rice bean, pearl millet, sorghum, and medicinal plants. Besides these accessions, 44,838 accessions of various crops were also grown at the different regional stations of the NBPGR during this period. During the evaluation some promising germplasm having useful characters were identified. These included okra lines free from yellow-vein-mosaic virus; chilli lines tolerant to leaf-rot, leaf-spots, root-rot and aphids; Frenchbean lines tolerant to rust, powdery mildew and yellow mosaic at Bhowali; early-maturing rice bean lines at Shimla; early-maturing cowpea and mungbean at Jodhpur; and early-maturing and heavy-bearing ridgegourd and bottle gourd at Delhi.

Germplasm Conservation

In all 15,918 accessions of various crops which meet the gene-bank standards of germination and purity were conserved in long-term storage in the National Gene Bank (Table 1). Total germplasm accessions stored in the gene bank till 31 March 1995 were 144,409. Besides germplasm conservation of seed species, significant progress was also made for in-vitro and cryopreservation programme. In-vitro multiplication methods were standardized for Colocasia sp., sweet potato, ginger, turmeric and banana. Seeds of several species of Plantago, Withania and Andrographus of medicinal value were also processed and cryopreserved. Pollen from 8 species of Brassica and citrus and shoot-tips of an

<table>
<thead>
<tr>
<th>Crop</th>
<th>Number of accessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>4,446</td>
</tr>
<tr>
<td>Millets</td>
<td>523</td>
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<tr>
<td>Pulses</td>
<td>7,700</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>1,284</td>
</tr>
<tr>
<td>Vegetables</td>
<td>330</td>
</tr>
<tr>
<td>Fibre crops</td>
<td>387</td>
</tr>
<tr>
<td>Spices</td>
<td>60</td>
</tr>
<tr>
<td>Other released varieties of</td>
<td>172</td>
</tr>
<tr>
<td>different crops</td>
<td></td>
</tr>
<tr>
<td>Voucher specimens of exotics*</td>
<td>1,016</td>
</tr>
</tbody>
</table>

*Stored in medium-storage condition.
tergeneric hybrid of *Brassica* received from Biotechnology Centre of the IARI (New Delhi) were also cryopreserved. Soluble sugars in embryonic accessions of tea, cocoa and jackfruit were correlated with desiccation tolerance. Isozyme studies with 70 cultivars of *Musa* using 7-enzyme system were completed.

**Food Crops**

* Seventeen rice varieties released for cultivation
* Several promising varieties of rice identified for harsh environment of eastern India
* Seventeen populations of *Porteresia coarctata*, wild species of cultivated rice, collected
* New record of wheat production achieved (more than 65 million tonnes)
* Six varieties of wheat including 2 of durum released
* Gene combination *Yr 9 + Yr 18* identified for yellow-rust resistance in wheat
* A single-cross hybrid 'Paras' of maize yielded 6.6 tonnes/ha in Punjab
* Yellow maize flour with low cholesterol found suitable for preparation of *bhujia*
* Multi-cut hybrid 'PCH 106' of sorghum developed for the first time; gave 20% higher yield than most popular 'SSG 59-3'
* Fingermillet variety 'VR 708' showed high degree of resistance to blight disease

Scientists of the ICAR constantly strive at imparting as many as desirable qualities as possible into a single variety. The endeavour of the ICAR is to constantly upgrade the productivity of all the crops and thus increase the total food and feed production to meet the ever-increasing demand. A
large number of improved varieties of crops combining high yield and resistance to important pests and diseases have been developed during the year. The important findings are reported here.

RICE

Crop Improvement

Varietal improvement programme was continued with added emphasis on achieving yield stability in irrigated rice and higher yield with better stability in rainfed rice. Seventeen varieties have been found to perform well in different states during the year.

A total of 180 rice hybrids were evaluated in multilocation trials. Out of these, 72 experimental hybrids were found promising. Four rice hybrids, viz. 'APHR 1' and 'APHR 2' for Andhra Pradesh, 'KRH 1' for Karnataka and 'MGR 1' for Tamil Nadu, have already been released for commercial cultivation. Two more hybrids, one ('RH 1') from the DRR (Hyderabad) and the other ('PBH 1') from Pioneer Overseas Corporation were identified.

Frontline demonstrations conducted with new rice varieties under harsh environments of eastern India have helped in identifying promising varieties like 'Bahadur' and 'Ranjit' for Assam; 'Rajashree' and 'Kanak' for Bihar; 'Mahalaxmi' and 'Manika' for Orissa; 'Mansarover', 'IR 42', 'IET 8002' and 'IET 5914' for West Bengal; 'Jalahari', 'Kranti' and 'Mahamaya' for eastern Madhya Pradesh for rainfed, shallow-water lowland-rice ecosystem. Similarly, for rainfed, semi-deep water ecosystem varieties like 'Dinesh' and 'Sabita' for West Bengal and 'Madhukar' for eastern Uttar Pradesh have been found promising. However, in the upland rice situations 'Tulasi' and 'Vandana' proved good for Bihar; 'Nilagiri Ghanteswari' and 'Khandagiri' for Orissa; and 'Blhuben', 'Heera', and 'Annada' for West Bengal.

Collection of 17 populations of *Porteresia coarctata*, a wild species of cultivated rice, is a significant achievement. These populations possess high degree of saline and submergence tolerance from Bhiterkanika mangrove of Orissa. Besides, a photosensitive genotype of cultivated rice was also isolated having stiff straw, medium height and long and heavy panicles. It may do better under shallow-water ecosystem.

Crop Production

In order to remove the current imbalances in
the NPK consumption, experiments were designed at different test sites. Nitrogen influenced the grain yield significantly at all sites. Direct effect of phosphorus proved superior at Coimbatore, Pusa, Chinsura and Arundhatinagar. Potash deficiency emerged as the major constraint at Hyderabad (DRR), Titabar, Maruteru and Mandya. Under direct seeding in lines the use of herbicide Butachlor (1.25 kg/ha), split application of K in 2 doses and of N in 3 doses (at basal + tillering + panicle-initiation stages) and full dose of P and zinc as basal application were recommended for getting a grain yield comparable to transplanted rice.

Under the transplanted conditions, a combination of herbicides like Anilphos + 2,4-D EE and Butachlor + 2,4-D EE was found most effective in controlling the weeds. Continuous application of Zn increased the available Zn (2.5) status, causing antagonistic effect in terms of nutrient ratio.

**Crop Protection**

Continuous efforts through multilocation trials enabled the identification of 1 variety 'Ambica' resistant to both brown planthopper and white-backed plant hopper. The prevalence of a fifth biotype of gallmidge in Moncampa (Kerala) has been confirmed. Stem-borer pheromone-trapping system was found useful in monitoring the occurrence and abundance of the pest population in rice crop. Male annihilation technique involving mass trapping and killing of male moths with pheromone traps could also suppress the stemborer populations and resulted in increased grain yield.

'Rice varieties released by the State Variety Release Committee during 1994

<table>
<thead>
<tr>
<th>State</th>
<th>Variety</th>
<th>Salient features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>'Bhadrapali'</td>
<td>G written resistant</td>
</tr>
<tr>
<td>Bihar</td>
<td>'Prabhat'</td>
<td>Brown-spot, sheath-rot resistant</td>
</tr>
<tr>
<td>Karnataka</td>
<td>'Akash'</td>
<td>Blast resistant</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>'Mahamaya'</td>
<td>Gall-midge resistant</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>'Kajat 2'</td>
<td>Gall-midge resistant</td>
</tr>
<tr>
<td></td>
<td>'Kajat 3'</td>
<td>Leaf-blast, neck-blast resistant</td>
</tr>
<tr>
<td></td>
<td>'Ranagiri 3'</td>
<td>Rainfed upland variety, blast resistant</td>
</tr>
<tr>
<td></td>
<td>'Mahasugandha'</td>
<td>Blast and gall-midge resistant</td>
</tr>
<tr>
<td></td>
<td>'Pant Dhan 12'</td>
<td>Aromatic</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>'PMK 2'</td>
<td>Bacterial leaf-blight resistant</td>
</tr>
<tr>
<td></td>
<td>'ADT 42'</td>
<td>Brown planthopper resistant</td>
</tr>
<tr>
<td></td>
<td>'Arazavinder'</td>
<td>Blast and brown planthopper tolerant</td>
</tr>
<tr>
<td></td>
<td>'Himalaya 2216'</td>
<td>Brown planthopper and rice tungro virus (RTV) tolerant</td>
</tr>
<tr>
<td></td>
<td>'RP 2421'</td>
<td>Leaf-blast and neck-blast tolerant</td>
</tr>
<tr>
<td></td>
<td>'Ranbir Basmati'</td>
<td>Blast and grain-discoloration resistant</td>
</tr>
<tr>
<td></td>
<td>'SKAU 23'</td>
<td>Aromatic</td>
</tr>
<tr>
<td></td>
<td>'SKAU 27'</td>
<td>Low altitude and plains of Jammu and Kashmir</td>
</tr>
</tbody>
</table>
Somatic mitotic karyotype study of rice gallmidge indicated that the female insect has 8 chromosomes and the male insect has only 6. A new source of resistance to rice-gallmidge (Biotype II) has been found in *Oryza glaberrima* ('Acc No. TOG 7442') and in the wild rice (*Oryza etichangeri*).

**Rice-Fish-Prawn Seed System**

Freshwater giant prawn (*Macrobrachium rosenbergii*) seed (post-larvae to juveniles) was successfully raised up to 50,000/ha with ‘Gayatri’ rice in rainfed lowlands. Under the rice-fish farming system, ‘Panidhan’ rice recorded highest grain yield (3.5 tonnes/ha), followed by ‘Utkalprabha’ (2.8 tonnes/ha), ‘Seema’ (2.4 tonnes/ha) and ‘Tulasi’ (2.0 tonnes/ha).

**Agricultural Implements**

A winnower has been developed with a blower having 0.5 HP motor and a grain-feeding system. As much as 2000 kg of clean grain per hour can be obtained.

**WHEAT**

Wheat production reached a new record of more than 65 million tonnes during 1994-95 compared with 59.1 million tonnes during 1993-94. Punjab has achieved a productivity rate of 4.08 tonnes/ha. Uttar Pradesh has also increased pro-

<table>
<thead>
<tr>
<th>Wheat varieties released by Central Variety Release Committee</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variety</strong></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Bread wheat</strong></td>
</tr>
<tr>
<td>'UP 2338'</td>
</tr>
<tr>
<td>'HP 1731'</td>
</tr>
<tr>
<td>('Rajlakshmi')</td>
</tr>
<tr>
<td>'DL 803-3'</td>
</tr>
<tr>
<td>('Kanchan')</td>
</tr>
<tr>
<td>'DWR 195'</td>
</tr>
<tr>
<td>('Anuradha')</td>
</tr>
<tr>
<td><strong>Durum wheat</strong></td>
</tr>
<tr>
<td>'HI 8381'</td>
</tr>
<tr>
<td>'WH 896'</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Triticale</strong></td>
</tr>
<tr>
<td>'DT 46'</td>
</tr>
</tbody>
</table>

"APHR 1" hybrid rice is suitable for conditions of Andhra Pradesh. The hybrid has already been released for commercial cultivation.

‘UP 2338’ wheat released for North-western plains zone is suited to irrigated, timely and late-sown conditions.
ductivity to 2.5 tonnes/ha compared with that of last year.

**Crop Improvement**

Six new improved varieties, including 2 of durum wheat have been released for general cultivation. A improved variety of triticale has also been released—the first strain approved by all-India programme.

**Crop Production**

Frontline demonstrations organized in different parts of country have shown that a large gap exists in realized and reliaizable productivity with adoption of improved technology.

**Crop Protection**

Gene Yr 9 has conferred complete resistance against yellow rust. However, a new strain of a stripe rust has broken the resistance of Yr 9. The strain has been isolated from several samples in northern India, but the hilly regions have climatic situation where the disease can spread. To diversify the genetic base for yellow-rust resistance, gene combination of Yr 9 + Yr 18 could be identified in several new released varieties, viz. 'HS 240', 'HS 277', 'PS 299', 'PBW 343', 'UP 2338', 'WH 542' and 'HPW 42'.

**MAIZE**

Of the 1,200 germplasm lines maintained at the DMR (New Delhi), 732 were received from different countries.

**Crop Improvement**

A single-cross hybrid 'Paras' was released for general cultivation in Punjab. It yielded 6.6 tonnes/ha. Another double-cross hybrid 'JH 3021' was released for Zone II, III and V, which gave yield 4.5 tonnes/ha and showed early maturity. 'VL 42' and 'MMH 114' varieties were found suitable for baby corn production. These varieties gave grain yield as high as 1.85 tonnes/ha, with the fodder yield of 30-40 tonnes/ha. Pre-release varieties 'MMH 69' and 'Dholi 8644' responded well up to 240 kg N/ha during the winter. Maize transplanted in the last week of November can yield up to 0.36 tonne yield/ha, which is much higher than the yield in direct-sown crop.

DT 46 triticale, the first strain approved by all-India programme, performed well under rainfed, timely sown conditions of Northern-hills zone.
Crop Production
The maize yield could be substantially increased by following maize-wheat, maize-groundnut-wheat or maize-grain legume - wheat rotations. In intercropping, a basal dose of NPK-Zn was found beneficial.

Yellow-maize flour proved more economical in preparing 'bhujia' than that of gram flour. It also possesses lower cholesterol level.

Crop Protection
Stripping of lower 2-3 leaf-sheaths in banded leaves and sheath-blight-infected plants proved simple and economical measure to control the disease.

SORGHUM

The research was aimed at developing dual-purpose varieties and hybrids and production technology to increase the productivity and profitability.

Crop Improvement
A new hybrid 'SPH 677' showed very good promise under dryland situations for winter (rabi) season sowing in Maharashtra, south Karnataka and south-west Andhra Pradesh. It gave 22% higher yield than the most popular variety 'M 35-1'. It possesses a high degree of resistance to shootfly and is more tolerant than 'M 35-1' to charcoal rot. The grains are bold and attractive, typical of the rabi types. This is the first hybrid based on rabi cytoplasmic male-sterile (CMS) line, which will also enable easy seed production in Maharashtra. Significant progress has been made to develop dual-purpose hybrids. 'CSH 13R' has been identified for cultivation both in rabi and kharif seasons. It gives both high grain as well as fodder yields.

For the first time a multicut-forage sorghum hybrid 'PCH 106' has been developed. It yielded 20% higher than the most popular variety 'SSG 59-3'.

Crop Production
Fodder yield of dual-purpose, high-yielding variety could be significantly increased by enhancing the plant population from 0.12 million to 0.18 million/ha. Dry rabi sorghum responded well to application of 60 kg N/ha. Deep sowing has
shown distinct advantage to withstand drought and enable higher production. *Rabi* sorghum responded very favourably to irrigation and gave a yield of 4.78 tonnes/ha.

**Crop Protection**  
Bio-control of grain-mould using *Trichoderma viride* was found useful in controlling the disease. Virulence study of anthracnose indicated the possibility of existence of different populations of pathogens in north-western India where it is a major leaf disease. Seed treatment with Imidacloprid @ 50 g/kg seed was found very effective in controlling shootfly.

**SMALL MILLETS**

**Crop Improvement**  
To the 11,154 germplasm accessions of the 6 different small millets maintained at Bangalore, 518 new accessions (including 500 African fingermillet) were added. Total 806 accessions were rejuvenated and 932 accessions were supplied to scientists. The multilocational evaluation of the second set of African fingermillet was continued for the second year at the same 5 locations.

Fingermillet variety 'VR 708', maturing in about 90 days and showing high degree of resistance to blast disease, was found very promising in coordinated trials. Two varieties of foxtail-millet, viz. 'Narasimharaya' for Andhra Pradesh and 'Gouri' for Rajasthan, were released. The former matures in 80-90 days and has the yield potential of 2.0-2.5 tonnes/ha. 'Gouri' foxtail-millet matures in 75 days and gives an yield of 1.5 - 1.6 tonnes/ha. It also provides fodder yield of 4.5 tonnes/ha under semi-arid conditions of Rajasthan. The potential application of somaclonal varieties obtained from plant-tissue culture has been explored in fingermillet. *In-vitro* mutagenesis was attempted to enlarge the variability and more than 2,000 somaclonal progenies were grown in R1 generation.

**Crop Production**  
Transplanted fingermillet and pigeonpea intercropping (8 : 2) was found profitable in transitional belts of Karnataka. However, in Bihar 6 : 2 proportion was found better than sole crop. Intercropping of sesame or niger with little-millet in a ratio of 1 : 1 was found beneficial in Madhya Pradesh.
Crop Protection

In foxtail-millet damping-off disease was reported for the first time from Ranichauri hills of Uttar Pradesh. The variety 'SIA 2669' of foxtail-millet was, however, found free from this disease. Another variety 'SR 16' of foxtail-millet has shown moderate resistance to downy mildew at Nandyal. Variety 'VL 129' of barnyard-millet was found free from grain smut.

Seed Production

Breeder’s seed produced was found in the order of finger millet > kodomillet > little millet > prosomillet.

Pulse Crops

* In gram 'H 86-18', 'GF 89-36', 'GNG 663' and 'KWR 108'; in urd bean 'WBW 108'; in field pea 'DMR 7'; and in lentil 'KL 133' identified for pre-release multiplication

* 'KBG 2' and 'ICCV 90201' gram identified as donor parents for wilt resistance

* In mung bean 4 varieties and in field pea 3 varieties recommended for different zones

* Frontline demonstrations in pulse crops indicated 19-49% increase in yield with improved varieties

Seven varieties, viz. 'H 86-18', 'GF 89-36', 'GNG 663' and 'KWR 108' of gram; 'WBW 108' ('Sarada') of urd bean; 'DMR 7' ('Alankar') of field pea and 'KL 133' of lentil, were identified for pre-release multiplication.

PIGEONPEA

Evaluation of promising genotypes was undertaken in different maturity groups.

- Early group: 'AF 286' (1.17 tonnes/ha) in Central zone and 'MTH 23' (1.8 tonnes/ha) in Southern zone.
- Medium-early group: 'AK 88-11' (1.5 tonnes/ha) and 'BWR 23' (1.4 tonnes/ha) in Southern zone.
Varieties of pulses identified for pre-release multiplication

<table>
<thead>
<tr>
<th>Variety</th>
<th>Production condition</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>'H 88-18'</td>
<td>North-western plains zone</td>
<td>Bold-seeded, moderately resistant to wilt and Ascochyta blight</td>
</tr>
<tr>
<td>'GF 89-36'</td>
<td>North-western plains zone</td>
<td>Resistant to wilt and moderately resistant to Ascochyta blight</td>
</tr>
<tr>
<td>'GNG 663'</td>
<td>North-western plains zone</td>
<td>Good seed colour, tolerant to wilt and Ascochyta blight</td>
</tr>
<tr>
<td>'KWR 106'</td>
<td>North-eastern plains zone</td>
<td>Bold-seeded, resistant to wilt, tolerant to yellow-mosaic virus</td>
</tr>
</tbody>
</table>

Urdbean

<table>
<thead>
<tr>
<th>Variety</th>
<th>Production condition</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>'WBU 108'</td>
<td>North-western and ('Sarada') North-eastern plains zones</td>
<td>Resistant to powdery mildew</td>
</tr>
</tbody>
</table>

Field-pea

<table>
<thead>
<tr>
<th>Variety</th>
<th>Production condition</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>'DMH 7' ('Alankar')</td>
<td>North-western plains zone</td>
<td>Resistant to powdery mildew</td>
</tr>
</tbody>
</table>

Lentil

<table>
<thead>
<tr>
<th>Variety</th>
<th>Production condition</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>'KL 133'</td>
<td>North-eastern plains zone</td>
<td>Tolerant to rust</td>
</tr>
</tbody>
</table>

Pigeonpea genotypes showing resistance to different diseases

<table>
<thead>
<tr>
<th>Disease</th>
<th>Genotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilt</td>
<td>'GPS 36-6', 'ICPL 89049'</td>
</tr>
<tr>
<td>Wilt and sterility mosaic</td>
<td>'ICPL 11298', 'ICP 14271(B)', 'DPPA 85-8'</td>
</tr>
<tr>
<td>Nematodes*</td>
<td>'KM 34', 'PBNA 47-2', 'Pusa 30'</td>
</tr>
</tbody>
</table>

*Heterodera cajani, Meloidogyne incognita and M. javanica

- Medium-maturity group: 'AKT 9221' (1.5 tonnes/ha) in Central zone and 'AKPH 2080' (1.3 tonnes/ha) in Southern zone.
- High-yielding and late-maturity group: 'Pusa-B 24' (2.2 tonnes/ha) in North-eastern plains zone and 'KA 26-4' (1.6 tonnes/ha) in Central zone.

'Pusa-B 26' is a suitable genotype for pre-rabi season in North-eastern plains zone (2.92 tonnes/ha) and Central zone (2.7 tonnes/ha). 'Pusa 85' and 'ICPL 86023' are suitable varieties for sequential cropping with wheat in irrigated areas of North-western plains zone.

Conversion of male sterility in early-maturing 'Pusa 33' and late-maturing 'MA 97' has been completed. The 2 sources are being multiplied to diversify male-sterile parents. 'PPH 98', 'AKPH 1209', 'AKPH 4101', 'MTH 23', 'MYPH 1115', 'AKPH 2080' and 'AKPH 1150' showed promising performance in advanced hybrid trials. The ratio of 6 MS lines : 1 pollinator was found appropriate for hybrid-seed production. Genotypes of pigeonpea showing resistance to diseases have been identified. The genotypes 'GPS 36-6', 'ICPL 89049', 'ICPL 11298', 'ICP 14271(B)' and 'DPPA 85-8' were recommended as donor parents for resistance-breed-
eties showing high degree of resistance were 'PDA 88-2E', 'PDA 89-2E', 'PDA 92-1E' and 'PDA 92-2E'. These varieties showed 60-70% less damage. Varieties 'PDG 90-2E', 'PDG 90 -3E' and 'PDE 2-2' were found resistant to gram pod borer (Helicoverpa armigera).

**GRAM**

Variety 'PBG 1' gave the highest yield (2.4 tonnes/ha), followed by 'KPG 59' (2.1 tonnes/ha) at 30 cm row spacing at optimum plant population of 33 plants/m², under late-sown conditions. An intercropping with mustard was very remunerative under conditions of North-eastern plains zone.

The yield loss due to weeds in irrigated crop was 1.15 tonnes/ha (57.3%). Two hand-weedings at 30 and 60 days after sowing or 1 hand-weeding at 45 days and pre-emergence application of Pendimethalin 0.75 kg/ha gave satisfactory control of weeds, with yield increase of 120.8 and 123.8% respectively. Application of S @ 20 kg/ha improved the productivity at all locations, with mean response of 28.3%. The nutrient-use efficiency was very impressive (208 kg grain/kg S). Among sulphur fertilizers, ammonium sulphate was found the most effective, followed by single superphosphate and gypsum. Response to micronutrients (B, Mo and Zn) was also very favourable. Application of Borax @ 10 kg/ha yielded 2.24 tonnes/ha compared with 1.65 tonnes/ha from the control.

Variety 'JG 315' was most efficient under water stress situation and 'ICCC 32' under irrigated condition. On the basis of total dry-matter yield (kg/day/ha), 'KPG 173-4' was the best genotype and 'Phule G 81-1-1' was the poorest. The genotypes with high seed yield under stress situation also maintained high tolerance to drought. Variety 'ICCC 42' showed best drought-tolerance index, followed by 'ICC 4958'.

Varieties 'KBG 2' and 'ICCV 9020' have been identified as donor parents for wilt resistance.

**MUNGBEAN**

Four high-yielding varieties have been recommended for different zones, 'ML 515' (1,050 kg/ha) for North-western plains zone, 'PDM 91-243' (864 kg/ha) for North-eastern plains zone, 'ML 611' (836 kg/ha) for Central zone and 'GM 84-26' (904 kg/ha) for Southern zone. Seven varieties have
been recommended for various zones. Variety 'PDM 199' was found most suitable for summer and spring planting, as it gave 734 kg/ha yield with 30-35 kg/ha seed rate in summer and with 25-30 kg/ha seed rate in spring.

Scientific use of non-monetary inputs [improved genotypes, timely planting (onset of monsoon), timely weed control (3 weeks after sowing) and line-sowing] increased the productivity by 213% compared with the traditional system. Among various inputs, planting time was most important one.

Response to S application was observed up to 40 kg S/ha. The mean increase in yield due to 20 kg N/ha and 40 kg S/ha was 28.0 and 43.8% respectively. The nutrient-use efficiency at these levels was 67.9 and 6.2% kg grain/kg S respectively. Among various sources, gypsum was most important, followed by single superphosphate.

Average avoidable yield loss due to root-knot nematodes was found 19%. Seed-coating with neem-kernel extract/Replin and Achuk was found effective in the management of root-knot nematodes.

**Mungbean genotypes suitable for different seasons and zones**

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Yield (kg/ha)</th>
<th>Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>'MG 368'</td>
<td>1,148</td>
<td>North-eastern plains zone</td>
</tr>
<tr>
<td>'HUM 1'</td>
<td>693</td>
<td>Central zone</td>
</tr>
<tr>
<td>'HUM 1'</td>
<td>1,167</td>
<td>Southern zone</td>
</tr>
<tr>
<td>'PDM 90-239'</td>
<td>989</td>
<td>North-eastern plains zone</td>
</tr>
<tr>
<td>'HUM 2'</td>
<td>971</td>
<td>Central zone</td>
</tr>
</tbody>
</table>

**URDBEAN**

Two high-yielding improved varieties have been recommended, viz. 'K 300' (1,169 kg/ha) for North-western plains zone and 'WBG 26' (830 kg/ha) for Southern zone. In the spring season, 'UG 606' (916 kg/ha) was found promising for North-eastern plains zone and in the rabi season 'LBG 685' (1,146 kg/ha) for Southern zone.

Judicious use of non-monetary inputs [improved genotypes, timely planting (onset of the monsoon) and timely weed control (3 weeks after sowing)] substantially improved the productivity. Application of S @ 20 kg/ha improved the grain yield by 226 kg/ha compared with the control. The nutrient-use efficiency was 11.3 kg grain/kg S, and gypsum was most efficient source, followed by single superphosphate.

**FIELD-PEA**

Three high-yielding, dwarf varieties have been recommended, viz. 'HFP 8909' (2,354 kg/ha) for North-western plains zone, 'KPMR 249' (1,984 kg/ha) for North-eastern plains zone and 'KPMR 297 A' (1,904 kg/ha) for Central zone. Tall varieties 'VL 24' (2,310 kg/ha) for Northern-hills zone, 'DMW 7' (2,310 kg/ha) for North-western plains zone and 'KPMR' (1,808 kg/ha) for North-eastern plains zone were found high yielding. Two irrigations, each at branching and pod-formation stage were optimum for dwarf pea at Pantnagar, giving yield 2,090 kg/ha compared with the control (167 kg/ha). Application of potassium @ 60 kg/ha recorded yield 3,900 kg/ha compared with 3,100 kg/ha in the control. The rust incidence was noticed where potash was not applied.

**OTHER PULSES**

In lentil, high-yielding and small-seeded varieties were identified, viz. 'VL 105' (2,047 kg/ha) for Northern hills zone and 'HUL 12' (1,419 kg/ha) for North-eastern plains zone. The promising bold-seeded genotypes identified were 'Sehore 82-6' (1,930 kg/ha) and 'Sehore 82-6' (1,882 kg/ha), suitable for Central zone. Application of N, P, K and S (18, 46, 20 and 20 kg/ha) along with Rhizobium inoculation increased the yield by 213 (34.4%), 220 (35.5%), 127 (20.5%) and 211 kg/ha (36.2%) respectively. Combined application of the inputs increased the productivity by 140.4% compared with the control. Application of S @ 20 kg/ha improved the productivity (497 kg/ha) by 45.7%. The nutrient-use efficiency was 24.8% kg grain/kg S. Pre-emergence application of Pendimethalin @ 0.75 kg/ha or 2 hand-weedings (30 and 50 days after sowing) resulted in 52% higher yield.

Frenchbean or rajmash showed superiority to other pulses during rabi in Western plains. Variety 'OPR 86-6' was found promising (1,524 kg/ha) in Central zone. The nutrient-use efficiency was 9.2
kg grain/kg N. Full basal application was found as efficient as split application at Akola. Inoculation with Rhizobium strain Raj 2 increased the yield by 217 kg/ha (25.4%) corresponding to 235 kg N/ha.

In Lathyrus, 3 high-yielding varieties have been identified, viz. 'Pusa 93-1' (1,319 kg/ha) for North-western plains zone, 'Pusa 28' (1,042 kg/ha) for North-eastern plains zone and 'RL 57' (1,352 and 2,347 kg/ha) for Central zone and Southern zone respectively.

**Protection Technology**

Use of economic threshold levels (ETL) for decision-making of important pests was found highly effective in gram and pigeonpea. The ETL for Helicoverpa armigera in gram is 1 larva/m row length and in pigeonpea 1-2 larvae/plant. The ETL for spotted borer (Maruca testulalis) in pigeonpea is 3.7 larvae/plant. Rhynchosia minima was found to serve as an alternate host of podfly (Melanagromyza obtusa), which was known to feed on pigeonpea only.

Application of nuclear polyhedrosis virus (NPV) @ 250 larval equivalent (LE)/ha or NPV 250 LE + 0.035% Endosulfan thrice at 10-day intervals gave excellent control of Helicoverpa armigera on gram and pigeonpea. Campoletis chloridea, a naturally occurring larval parasite of Helicoverpa armigera, was found promising in suppressing its population on gram. Insecticides of plant origin, viz. Achuk, Nimbecidine, Neem WDP, Neem oil and Neem EC, were found significantly superior in suppressing Helicoverpa armigera on gram and pigeonpea. Neem-seed-kernel extract (NSKE) was, however, found most effective compared with other chemicals.

**Frontline Demonstrations**

Frontline demonstrations (FLDs) were organized at farmers' fields by scientists working at 22 research centres in 11 states. An increase in productivity of newly developed improved varieties was 19-49% compared with local varieties. The FLDs on management technology, viz. irrigation, fertilizer, insect pests and weed management, increased the yield by 9-40% than local practices.

**Oilseed Crops**

* Two yellow-seeded, high-yielding varieties 'JS 335' and 'MACS 124' of soybean released
* Introgression of high-protein character from wild species increased the protein up to 47.5% in cultivated soybean

* 'BAU 13' groundnut of less aflatoxin identified

* A simple device developed for rapid determination of oil in groundnut seed

* In mustard and *toria* cytoplasmic male-sterile system developed

* 'TNAU-SUF' sunflower (40% oil content) and 'RT 103' and 'RT 125' sesame (912-993 kg/ha yield) recommended for cultivation

**SOYBEAN**

More than 2,500 germplasm accessions including 69 new accessions were maintained, evaluated and identified and exploited through hybridization with elite early-maturing varieties. Introgression of high-protein character from wild *Glycine soja* to cultivated varieties resulted in stable selection, possessing high seed protein (47.5%; average 43.8%) and low oil (average 9.8%).

Of the 2 yellow-seeded, early-duration (90-105 days) and high-yielding improved varieties, 1 has been released for cultivation in Madhya Pradesh, Gujarat, Rajasthan and Bundelkhand region of Uttar Pradesh, and the other for Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh.

<table>
<thead>
<tr>
<th>Soybean varieties released for cultivation in Central and Southern zones</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Zone</strong></td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Central</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Southern</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

'DCS 9', a wilt-tolerant variety of castor forrainfed situation
Besides, ‘PK 1029’ has been identified for pre-release multiplication and cultivation in Southern zone. It has resistance to yellow-mosaic virus and soybean-mosaic virus.

Intercropping with pigeonpea gave 23-82% higher gross returns than the sole crop at 45 cm row distance in Malwa plateau.

Commercial products, Biolep and Biobit from *Bacillus thuringiensis* (BT), were found effective in controlling lepidopterous defoliators and in reducing yield loss. Pre-sowing furrow application of Phorate (Thimet) 10 G @ 10 kg/ha followed by 2-3 foliar sprays of Endosulfan 0.01% or Monocrotophos 0.04% or Phosphamidon 0.02% at 10-day intervals 20 days after sowing was recommended for the control of insect-pest complex.

More than 1,100 frontline demonstrations were organized at farmers’ field to show that improved production technology can increase yield up to 46.01% (from 1.4 to 1.9 tonnes/ha), with an average additional return of Rs 3,887/ha. The benefit: cost ratio was 3.54.

**GROUNDNUT**

More than 4,800 germplasm accessions, including 36 new accessions of different group habits, were maintained and evaluated for economic attributes, such as pod and oil yields, multiple- or single-disease resistance and other desirable features. As a result, a number of promising accessions have been identified for further exploitation or hybridization. Besides, a working collection of 5,222 germplasm accessions was maintained and utilized in varietal improvement programme at 11 research centres of groundnut.

About 100 accessions of medium bold-seeded Virginia type have been evaluated for pod yield, pod loss at harvest, shelling outturn, sound mature kernel (SMK) and seed weight. Out of these, 9 accessions were identified for further evaluation. Seeds of 27 promising accessions were analysed for oil and sugar contents. The oil content ranged from 45.3 to 54.8% and the sugar content from 4.9 to 15.6%. Eight interspecific cross-derivatives as female parent and a number of wild species have been developed, with high-yield potential and appreciable degree of resistance to rust and early and late leaf-spot diseases. Four interspecific derivatives with stable high oil content (53-55.5%) have also been identified. Three high-yielding varieties have been released for cultivation in
different zones.

‘BAU 13’ a bold-seeded variety with less aflatoxin has been identified for pre-release multiplication.

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### High-yielding varieties of groundnut released for cultivation in different zones

<table>
<thead>
<tr>
<th>Variety</th>
<th>Cultivation</th>
<th>Zone</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>'R 8806'</td>
<td>Rabi or summer</td>
<td>IV</td>
<td>Orissa, West Bengal, parts of northern Andhra Pradesh</td>
</tr>
<tr>
<td>'2K 134'</td>
<td>Kharif</td>
<td>III</td>
<td>Madhya Pradesh, Maharashtra</td>
</tr>
<tr>
<td>'DRG 17'</td>
<td>Kharif</td>
<td>V</td>
<td>Karnataka, Andhra Pradesh, Tamil Nadu</td>
</tr>
</tbody>
</table>

Mulching with wheat straw and black polythene increased the seed germination, and retention of polythene up to pod-development stage increased the pod yield by 6.3%. Application of 25 kg N/ha + wheat straw as a basal dose removes N-deficiency symptoms during early-crop stage. However, retention of polythene mulch up to maturity significantly reduced the yield. Intercrop combinations were found remunerative with greengram (2:1 row ratio) in Rajasthan, with pigeonpea (2:1) in Gujarat, with urdbean or sunflower (4:6:2) in Karnataka and Maharashtra, and with pigeonpea or soybean (6:1) in Tamil Nadu.

A simple device for rapid determination of oil content in seed was developed, on the principle of inverse relationship between oil content and specific gravity.

Pheromones, trap crops like pearlmillet and castor and selective insecticide mixture were found effective in reducing the incidence of foliar diseases and insect pests. Seed treatment with Carbendazim 50 WP @ 2 g/kg, intercropping with pigeonpea (3:1), spray of fungicidal mixture (Carbendazim 0.05% + Mancozeb 0.2%) at 55 days after sowing and spray of cell-free culture filtrate of *Penicillium islandicum* 70 days after sowing effectively reduced the intensity of early and late leaf-spots. Seed treatment with 2% neem-seed powder and 2% dried leaf powder of *Eucalyptus* spp. effectively controlled the seed and seedling diseases.

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### RAPESEED-MUSTARD

More than 2,280 germplasm lines comprising mustard (1,840), yellow sarson (155), brown sarson (215) and *Brassica napus* (72) were maintained through sibmating or selfing and evaluated as per the descriptors prepared. Out of these, 210 promising lines comprising mustard (47), brown sarson (56), yellow sarson (57) and *Brassica napus* (50) possessing desirable economic attributes were selected for multi-location evaluation or exploitation. Over 1,000 F₁ hybrids were evaluated to identify restorers, but none could show perfect restoration. Fertility-restoring genes are photosensitive. Wide hybridization was carried out to develop new CMS lines. The CMS systems based on *Sinapis alba* and *Diplotaxis catholica* have been developed in mustard; and in *toria* a new CMS system has also been developed from back-cross substitution of *Brassica campestris* in *Enarthocarpus lyratus* cytoplasm.

*Torja* grown after green-manuring recorded the highest yield. In West Bengal 'TWC 3' *torja*-rice was the most economic crop sequence, giving a gross income of Rs 6,480/ha. Mustard plants raised under the influence of soil-applied N (100 kg/ha), P (40 kg/ha) and K (40 kg/ha) and sprayed with Mancozeb showed significant decrease in the severity of *Alternaria* blight and gave significantly higher seed yield than the plants raised with only N and P. It indicates the importance of K in disease management. Reduced sunshine hours below 6 hr/day and rainfall (100 mm) during flowering period were associated with occurrence of severe stag-head phase of white-rust and pod infection of *Alternaria* blight. Iprodione @ 0.2% has been found quite effective in controlling the *Alternaria* blight and *Sclerotinia* and increasing the seed yield of mustard. Application of lime and oil-cake (300 and 150 kg/ha respectively) in acid soil was found effective in controlling club-root disease.

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### SUNFLOWER

An open-pollinated variety 'TNAU-SUF 7' has been released for cultivation. It matures in 95 days, having average yield of 1.0 tonne/ha and oil content 40%. An 8-day staggered sowing (8 days earlier to female parent) of male parent 6D-1 recorded significantly higher seed yield (833 kg/ha) than 4-day staggered sowing (682 kg/ha) and the control (476 kg/ha). Block system of planting was found optimum compared with planting male and female in 1:3 row proportion. Staggering male
parent (8 days earlier to female) with recommended dose of N, P₂O₅ and K₂O @ 60, 90 and 60 kg/ha respectively was found optimum for seed production of 'KBSH I' hybrid.

**SESAME**

Two white-seeded varieties have been recommended for cultivation in different regions.

<table>
<thead>
<tr>
<th>State</th>
<th>Yield (kg/ha)</th>
<th>Salient features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gujarat, Maharashtra, Telangana region of Andhra Pradesh</td>
<td>993</td>
<td>'RT 103' Early duration (75-80 days), suitable for kharif season, tolerant to Macrophomina stem or root-rot, phyllody, Antigastra</td>
</tr>
<tr>
<td>Jammu and Kashmir, Himachal Pradesh</td>
<td>912</td>
<td>'RT 125' Moderately resistant to Macrophomina stem or root-rot, Alternaria, Cerospora leaf-spot, Antigastra</td>
</tr>
</tbody>
</table>

An intercropping with groundnut (2:4) gave maximum net returns of Rs 4,110/ha and with gram (3:3) gave net returns of Rs 3,315/ha at Vriddhachalam. Sesame intercropping with urdbean (1:3) showed least incidence of Phytophthora blight. Sesame when intercropped with maize recorded least incidence of Alternaria leaf-spot and with pigeonpea (3:1 row proportion) minimized the phyllody and increased the economic returns. Inter- or mixed-cropping with mothbean or mungbean minimized the Macrophomina stem or root-rot incidence.

Pre-sowing seed treatment with Apron 35 SD (0.25%) minimized the incidence of Phytophthora blight. Vitavax 75 WP or Bavistin 50 WP or Thiram 75 D (0.25%) protected the plants, to some extent, from seed- and soil-borne pathogens. Spraying of neem oil (1%) was found superior to Endosulfan (1.5 litres/ha) in minimizing incidence of phyllody.

**CASTOR**

Two castor hybrids, viz. 'SHB 145' and 'DCH 30', have been identified for pre-release multipli-
cation. 'SHB 145' is a medium-duration (180-240 days) hybrid, suitable for irrigated tracts in castor-growing states, with 12.5% higher yield than hybrid 'GCH 4'. 'DCH 30' is early-maturing and suitable for rainfed tracts of south India, with 17.8 and 40% higher yield than 'GCH 4' and 'Aruna' respectively.

Nipping of auxiliary buds to retain only main head recorded significantly higher seed yield (1,425 kg/ha) than without nipping (972 kg/ha). An intercropping with groundnut in 1:2 row proportion gave the highest gross returns (Rs 15,960/ha) at Tindivanam.

SAFFLOWER

After critical evaluation of germplasm lines at DOR (Hyderabad), 7 wilt-resistant lines have been identified for exploitation or utilization in breeding for resistant varieties. Besides, 11 most-promising aphid-tolerant lines were identified.

Intercropping with *toria* (6:2) and mustard (6:2) at Indore, and with linseed (2:1) and gram (2:1) at Phaltan under irrigated conditions was found more profitable than sole cropping.

NIGER

A number of crop combinations gave increased economic returns, viz. niger + kodomillet (2:2) and niger + kodomillet (1:1) at Chhindwara, and niger + urdbean (4:2) and soybean + niger (4:2) at Semiliguda.

LINSEED

Two varieties 'Garima' and 'Janaki' were found suitable for intercropping with mustard at Palampur and Kanpur. Application of S @ 30 kg/ha through gypsum resulted in the highest mean yield (710 kg/ha) at Nagpur. Economic threshold levels of budfly were determined 3.47 and 4.87% on the basis of 5.70 and 6.97% economic injury levels for application of single and double fortnightly sprays of Phosphamidon 85 SL (0.03%) respectively. Need-based (2-3) spray application of Rovral (0.2%) and of Mancozeb (0.25%) effectively controlled *Alternaria* blight and increased the grain yield.

Early-maturing castor hybrid 'DCH 30' has been identified for rainfed tract of southern India. It yields 17.8 and 40% higher than 'GCH 4' and 'Aruna' respectively.
Commercial Crops

* Mid-late, high-yielding varieties 'Co 86032', 'Co 87025' and 'Co 87044' (120 tonnes/ha) of sugarcane identified for Peninsular zone

* Bio-agents proved effective antagonists against rot pathogens

* A ridger-type, paired row-cum-conventional cutter-planter developed for sugarcane, performing several operations in a single pass

* In cotton conventional hybrid 'CSHH 6' (2.75 tonnes/ha) superseded 'Fateh' in Punjab, and 'HLS 72' an extra-long staple proved better than 'MCU 5' at Coimbatore

* Robillardia fungus isolated from cotton cotyledons for the first time

* New strains 'CO 32' and 'CO 14' of tossa jute yielded better than standard 'JRO 524'

* A new flue-cured virginia tobacco variety 'CM 12 (KA)' yielded 2 tonnes/ha and showed resistance to black-shank disease

* Biological Insecticide BTK-I and BTK-II effectively controlled the Spodoptera in tobacco nurseries

SUGARCANE

Crop Improvement
Three mid-late, high-yielding varieties, viz. 'Co 86032', 'Co 87025' and 'Co 87044', have been identified for peninsular zone. The varieties possess high-yield potential up to 120 tonnes/ha and sucrose 17-19%. These varieties will replace 'Co 740' and 'Co 7219' in Maharashtra and 'Co 6304' in other states. Two varieties 'Co 87263' and 'Co 87268' have been identified for North-eastern zone. These varieties possess red-rot tolerance, moderate sugar and yield potential up to 80 tonnes/ha. Variety 'Co 85019' has been released for commer-
cultural cultivation in Tamil Nadu. At Coimbatore S₁ progenies having red-rot tolerance from *Saccharum spontaneum* and superior genetic stock from intra-specific improvement programme of *S. officinarum* and *S. robustum* were identified. At Lucknow proliferation of 5 auxiliary buds per shoot apex explant or individual shoot *in vitro* under a proper set of cultural conditions made it possible to produce 77,750 plants from a single explant in 5 months and 15 days. The cost of each plantlet was Rs 1.50.

**Crop Production**

At Coimbatore, application of 25 tonnes/ha of pressmud or farmyard manure in trenches before planting followed by trash mulching recorded cane yield of 85 tonnes/ha, whereas the control (ridge and furrow method without farmyard manure or pressmud and trash mulch) gave only 50 tonnes/ha. Application of pressmud @ 10 tonnes/ha enriched with *Pleurotus* or *Trichoderma* or Bioearth (10 tonnes/ha) resulted in cane yield at par with the yield obtained from recommended dose of NPK. Specific diazotrophic bacteria, which are capable of utilizing atmospheric nitrogen, were isolated from stem, leaf and root tissues of sugarcane. It was estimated that *Saccharum spontaneum* ('SES 24'), *Saccharum sinense* (var. Pansahi) and *S. barberi* (var. Karakatu) derived respectively 60, 48 and 30% of total N through associative nitrogen fixation. In some popular sugarcane varieties, it ranged from 17 to 30%. At Lucknow integrated use of green-manure residues obtained from intercropping of prickly sesban or *dhaincha* for 6 weeks with plant cane and 150 kg N/ha recorded better yield than use of 150 kg N/ha alone.

**Crop Protection**

A system of rapid evaluation of sugarcane clones (within 10-15 days) against red-rot disease was developed at Coimbatore. At Lucknow bio-agents, viz. *Trichoderma harzianum*, *Chaetomium globosum*, *Gliocladium* sp. and *Aspergillus niger*, proved effective antagonists against red-rot pathogen under laboratory conditions. Release of *Cotesia flavipes*, an exotic larval parasitoid, significantly reduced the infestation of stalkborer (*Chilo auricilius*) during July-October.

**Farm Mechanization**

A ridger-type, paired row-cum-conventional cutter-planter was developed for planting sugarcane. All operations from cutting of whole cane
into setts to its covering with a blanket of soil and light tamping of soil cover, and applying fertilizer, insecticide and fungicide are accomplished in a single pass of the equipment. It has an output of 0.25 ha/hr on employing only 4 labourers. The equipment costs Rs 22,000.

**Jaggery and Khandsari**

At Lucknow, a new formula has been developed for calculating juice extraction from dry-crushing process of whole cane as:

$$RE = \frac{12.5}{FC} (JE-100) + 100$$

where RE, the reduced juice extraction at 12.5% fibre; JE, the actual juice extraction (% cane); and FC, the fibre content (% cane). The jaggery drying-cum-storage bin (capacity 100 kg) developed by IISR (Lucknow) proved very effective for retaining jaggery quality during the monsoon season at Anakapalli—a high-humidity area in Andhra Pradesh. The IISR technology of moulding jaggery into brick shape has become popular in Kolhapur area of Maharashtra.

**COTTON**

**Crop Improvement**

The conventional hybrid 'CSHH 6' recorded the highest seed-cotton yield (2.75 tonnes/ha) in Northern zone, showing 22% increase compared with released hybrid 'Fateh' for Punjab. An intra-\textit{hirsutum} hybrid 'CSHH 29' developed at Regional Station, CICR, Sirsa, recorded very high yield (2.49 tonnes/ha) and ranked among first 5 top entries at 3 locations. Hybrid 'CICR DH 1' (\textit{G. herbaceum} x \textit{G. arboreum}) performed well, ranking within first 5 at 7 centres in Central zone under trials of All-India Co-ordinated Cotton Improvement Project. Five intra-\textit{arboreum} hybrids gave 79.8-97.8% more yield than 'AKH 4' and 131.4 - 154.6% more yield than 'AKA 8401'. In \textit{G. hirsutum}, 20 colour-linted genotypes were multiplied and evaluated. Out of 4 \textit{G. arboreum} brown-linted NCA cultures, 'NCA 4' gave higher yield than the controls 'AKH 4' and 'AKH 8401'. At Coimbatore 'HLS 72', an extra-long staple variety of \textit{G. hirsutum}, was found superior to 'MCU 5' in yield and quality.

A culture 'VRS 7' tolerant to \textit{Verticillium} wilt, showing spinning ability up to 60 counts and seed-cotton yield of 1.57 tonnes/ha, was found superior to 'MCU 5' by 21.7%. Genetic male-sterile hybrid 'CGHH 1' recorded the highest seed-cotton yield of 2.0 tonnes/ha compared with 1.81 tonnes/
ha of 'CAHH 468' (control).

In the tissue culture study with hypocotyl and mesocotyl, callus-growth rate, colouration and quantity varied, depending on the genotypes, hormone combination and 2,4-D culture conditions. Low dose of 2,4-D alone or in combination with kinetin led to the formation of embryogenic callus. Coker cultivars were found to be of high embryogenic type. The varieties ‘PKV 081’ and ‘Khandwa 3’ were classified under medium-embryogenic category. Intensive rooting was also noticed during callus culture in some Indian genotypes like ‘Khandwa 3’, ‘PKV 081’ and ‘PKV Hy 2’.

A total genomic and a plasmid library of ‘Bt KHD 1’ was constructed in Escherichia coli, from which genes Cry IAA and Cry IAB corresponding to crystal toxins were identified. The gene products expressed toxicity to Helicoverpa armigera nearly equal to that of the parent strain. The enzyme-linked immunosorbent assay (ELISA) was standardized using anti-crystal antibodies and is being utilized to screen the toxin production and libraries.

**Crop Production**

Cotton in rotation with sorghum and pigeonpea gave 31% higher yield than monocrop. Cotton + soybean intercropping system was established more remunerative than other systems. The highest land-equivalent ratio (1.70) was obtained for pigeonpea + soybean intercropping. Among soybean genotypes, intercropping of ‘Monetta’ and MACS types in 1 : 1 ratio and that of ‘Punjab 1’ and TAS types in 1 : 2 ratio resulted in higher gross monetary returns than sole cotton.

**Crop Protection**

A pycnidial fungus Robillardia, isolated from cotyledonary infections, was found infecting cotton for the first time. Incidence of leaf-curl virus disease of cotton was noticed in adjoining areas of Pakistan border in Rajasthan, Punjab and a few places in Haryana. All varieties of upland cotton grown in the areas were found affected by the disease, and incidence ranged from 5 to 95%. The desi cotton varieties were, however, free from leaf-curl virus disease.

Large-scale mass production of Trichogramma sp. was taken up for biological control. A total of 103 native Bacillus thuringiensis (bt) isolates were collected and preserved and 56 isolates were sent for identification to the Pasteur Institute, France.
At Coimbatore significant mating disruption in pink bollworm (*Pectinophora gossypiella*) was recorded with gossyplure. Spraying humic acid with Fenvalerate increased the seed-cotton yield by 10%. At Sirsa incorporation of pheromone in the insecticide schedule replacing 2 sprays of synthetic pyrethroids (3 sprays of conventional insecticides + 2 sprays of pheromone) showed better management of bollworms compared with 4 sprays of conventional insecticide alone. Insecticide resistance in *Helicoverpa armigera* was monitored and the pest was found resistant to Cypermethrin, Fenvalerate, Endosulfan and Quinalphos, to varying degree. The degree of resistance was higher to synthetic pyrethroids than to organophosphate insecticides.

**JUTE AND ALLIED FIBRES**

**Crop Improvement**

Newly developed strains of tossa jute, viz. '32 S' ('CO 32') and '19 BP' ('CO 14'), have outyielded (3.94 and 3.73 tonnes/ha respectively) standard variety 'JRO 524' (3.7 tonnes/ha) in multilocation testing.

In sunnhemp germplasm, 'SUEX 015' has been identified as day-neutral, early-flowering type.

**Crop Production**

The fibre yield in jute increased by 33% using jute-rice sequence and seed inoculation with *Azospirillum brasilense* (100 g/kg seed). The rice yield was also increased by 35%.

A new ribboner for jute and mesta was developed, in which initial peeling of bark and full ribboning are integrated on the same frame. The new ribboner increases the production by 20% compared with the existing ones.

**Crop Protection**

Application of Fluchloralin or Pendimethalin @ 1.0 - 1.5 kg/ha before planting was found very effective in controlling weeds infesting sunnhemp and mesta. Sunnhemp and pearl millet sown in alternate rows were found effective in keeping incidence of wilt at low level. Soil application of Carbofuran 3 G (0.75 kg ai/ha) 20 days after sowing followed by 2 sprays of Carbaryl 50 WP (0.1%) reduced the incidence and intensity of top shoot borer in sunnhemp.
TOBACCO

Crop Improvement
A new flue-cured Virginia tobacco variety ‘CM 12 (KA)’ with yield potential of 2 tonnes/ha has been released for cultivation in northern light soils of West Godavari district of Andhra Pradesh. The variety is resistant to black-shank disease. In traditional black soils of Andhra Pradesh, flue-cured Virginia lines ‘V 3634’, ‘V 3643’ and ‘V 3603’ proved better than ‘Hema’ with 15% increase in cured-leaf yield. Hybrid ‘Hema’ x ‘7654-2-1’ proved superior to ‘Jayasri (MR)’ and ‘Hema’ for both quality and productivity.

Crop Production
Cropping sequences of mungbean-tobacco, sesame-tobacco and cowpea-tobacco were found more profitable than sole cropping of tobacco. In the newly released variety ‘Virginia Tobacco 1158’, 50 kg N/ha with 70 cm x 60 cm spacing and judicious topping gave maximum yield under southern light soil conditions of Andhra Pradesh. In ‘Vaishali Special’, a new chewing tobacco variety, 250 kg N/ha and 100 kg K₂O/ha were found optimum in Bihar. On-farm replicated trials with flue-cured tobacco in northern light soils have shown that 60-70 kg N/ha resulted in significantly higher sugars, low nicotine and total N than higher N levels (80, 90 and 100 kg N/ha) in both X₀ and L₀ grades. The N 60-70 kg/ha was found optimum for northern light soils, in achieving yield of good-quality leaf. Inoculation with vesicular-arbuscular-mycorrhiza helped in economizing P up to 25 kg/ha in southern light soils. This was more prominent under low-available P conditions.

Crop Protection
Among the 3 biological insecticides based on Bacillus thuringiensis var. kurstaki, BTK-1 (sporogenic with 3,000 IU/mg) and BTK-II (sporogenic with 3,000 IU/mg) @ 2 kg/ha were very effective in controlling Spodoptera litura in tobacco nurseries. Bacillus thuringiensis strains, viz. Dipel, Delfin and Bactospeine, were found superior to Endosulfan and the control (no application) in reducing tobacco-caterpillar damage in tobacco nurseries. Release of Chrysoperla larvae @ 6 per plant at the start of aphid infestation was found very effective in controlling tobacco aphids. Application of Trichoderma culture or dry-leaf powder of Polyalthia @ 300 g/m was found on a par with 2 sprays of BTK-1.
Ridomil MZ-72 WP 0.2% in reducing damping-off incidence in tobacco nursery. Akomin, an inorganic source of plant nutrient containing P salt, can be included as one of the components in the combined schedule of chemical control of blight and black-shank diseases in tobacco nurseries in Karnataka.

**Forage Crops**

**Crop Improvement**

A sorghum variety 'Harasona' was released as multicut material for entire country. Lucerne variety 'Anand 3' was released for growing in Himachal Pradesh and Gujarat. A Persian clover or *shaftal* variety 'SH 48' has been released for Punjab. Another multicut sorghum variety 'Punjab Sudex Chari 1' has also been released for Punjab. However, this variety was also found suitable for north India.

**Crop Production**

Forage yield of pearlmillet increased significantly with the application of non-symbiotic nitrogen fixers. The yield increased by 22-25% with *Azospirillum* and 11-14% with *Azotobacter*. These non-symbiotic nitrogen fixers also increased the yield by 8-20% in forage oat.

Rice-Egyptian clover proved most productive crop rotation in alkali soils of Faizabad, whereas pearlmillet-gram proved most remunerative system at Hisar. Intercropping of cowpea with paired row of sorghum at Rahuri and of cowpea with normal-spaced finger millet at Dapoli increased the yield up to 41-60% compared with pure crop of sorghum.

In subtropical environment of Himachal Pradesh, *tarai* region and foothills of Himalayas, and north-east hills, *shaftal* has proved a better crop than Egyptian clover. *Bhimal (Grewia optiva)* gave 112.87 kg green leaves/tree. Its leaves contain 2.83-3.12% N. Grassland manawa gave the highest green-forage yield of 21.05 tonnes/ha among different grasses in Kumaon hills, followed by perennial rye and tall fescue.

Rumen-degradable dietary protein (RDP) content of graminaceous forages (oat and maize) and legume forages (cowpea, Egyptian clover and lucerne) ranged from 5.20 to 5.59% and 9.35 to 22.87% respectively, whereas the undegradable dietary protein (UDP) content of the same ranged.
from 2.40 to 4.17% and 2.79 to 4.26% respectively. Rate of dry-matter digestion was in general higher in the animals receiving partially protected protein.

**Seed Production**

A total of 20 tonnes elite seeds of range grasses and legumes were produced. The total breeders’ seed production of fodder crops was 52 tonnes against an indent of 34 tonnes. Suitable production sites for stylo seed could be identified in south, where the production was 1.5-2.5 tonnes/ha compared with the normal production of 0.4 tonne/ha. Stylo-seed grader prototype was fabricated and demonstrated to the farmers of Andhra Pradesh and Karnataka, which will reduce the cost of seed processing and improve the seed quality.

**Under-utilized Crops**

A total of 130 indigenous accessions were collected and 260 exotic accessions were introduced in under-utilized crops like grain amaranth, ricebean, fababean, buckwheat, Chenopodium spp., adzukibean and winged-bean.

**Crop Improvement**

Two improved varieties of grain amaranth, viz. ‘Suvarna’ for Karnataka and ‘PRA 8801’ for hills of Uttar Pradesh, have been identified. One variety ‘RBL 6’ of ricebean has also identified for plains. Ricebean has been found a potential pulse crop, with very little problem of diseases and insect pests. Hybridization programme has also been started at Hisar. Varieties ‘RBS 2’ and RB 53’ of ricebean with low phenol content have been identified.

**Crop Production**

Grain amaranth responded well to the application of 60 kg N/ha. An intercropping of finger millet with amaranth in proportion of 6 : 1 gave higher economic returns than the sole crop of finger millet. Similarly, amaranth intercropped with pigeon pea in ratio of 1 : 2 with rows spaced at 90 cm provided higher economic returns.

**Seed Production**

Breeders’ seed of grain amaranth varieties ‘Annapurna’ and ‘GA 1’, buckwheat varieties ‘Himpriya’ and ‘VL 7’, winged-bean variety ‘AKWB
1', ricebean variety 'RBL 1' and guayule variety 'HG 8' was produced to meet the indented demand.

**Seed Technology**

* Seed-aperture size and shape of grading screens optimized for seed sizing of various crops

* Total production of breeders' seed in different crops increased by 24.16% over the Indented quantity

**SEED PRODUCTION, CERTIFICATION AND VARIETY CHARACTERIZATION**

An isolation of 200 and 500 m was found adequate in years for production of certified and foundation seeds of pearl millet hybrids respectively. This recommendation has already been approved by the technical committee of Central Seed Certification Board for inclusion in Indian Minimum Seed Standards.

In sorghum, parents of 'CSH 9', 'CSH 13R', 'CSH 14' nicked well in kharif and early rabi seasons at Parbhani, in summer at Rahuri and in kharif at Akola. At Hyderabad, synchronization could be achieved by the delayed sowing (7-8 days) of the pollen parents. Flowering in female parents of 'CSH 9' could be advanced by 2-3 days on foliar application of 3% urea at 4, 5 and 6 days after sowing. In sunflower, flowering in the parents of 'APSH II' hybrid was found synchronous, whereas in 'KBSH 1' and 'LDMRS 3' the parents were non-synchronous. Foliar spray of urea or diammonium phosphate @ 2% advanced the flowering by 2-3 days in southern parts but was not effective in northern parts of the country. Supplementary pollination daily or on alternate days, increased the seed yield in southern parts of the country. However, in northern parts open-pollination by honeybees alone was adequate.

Planting ratios of 2:4 and 2:6 were found better for sorghum hybrid 'CSH 14', 2:14 for pearl millet hybrid 'Shradha' and 1:6 for sunflower hybrid 'KBSH 1' at Bangalore, and 1:8 for 'LSH 3' at Coimbatore and Parbhani; 1:4 for pigeonpea hybrid 'PPH 4' at Ludhiana; and 2:6, 2:8 and 2:12 for rice 'IR 58025 A' at Delhi, Ludhiana and Karnal respectively.
Seed Physiology, Storage and Testing

Storability of seed was generally improved by fungicide treatment and by packaging in moisture-resistant containers (polythene-lined or polythene-coated gunny bag or cloth bag). Akola, Parbhani and Rahuri were found to be good places for storage of a wide variety of seeds. The storability period of different crops, viz. soybean, pearl millet, groundnut and rice, was found to be 6-13, 12-33, 8-15 and 4-16 months respectively at different locations in the country.

In sponge gourd, brinjal, chilli and cabbage germination remained above minimum seed certification standards (MSCS) for a significantly longer period in Thiram-treated seeds packed in moisture-impervious packets than paper packets. Thus, germination could be maintained above MSCS for 9-16 months in these crops at different locations, such as Faizabad, Ludhiana, Kanpur, Bhubaneshwar and Jaipur.

Hybrids and parental lines of castor could be identified on the basis of seed-coat pattern, size and shape of the endosperm (as revealed by the scanning electron microscopy) and protein profiles. The sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE) of soluble seed proteins and isozyme patterns of esterase (EST), peroxidase (POX) and glutamate dehydrogenase provided good markers for variety identification. In rice hybrids A, B and R lines were distinguishable on the basis of isozyme-banding patterns for EST, POX, malate dehydrogenase (MDH) and alcohol dehydrogenase (ADH). Simple laboratory tests, viz. standard and modified phenol reactions, and seedling response to GA₃ and KClO₃ were also found very useful in grouping these genotypes. The electrophoretic patterns of soluble seed proteins were able to identify cotton varieties and could also be used to the test genetic purity of seed lots of the crop. Results were reproducible and comparable to grow-out tests. The SDS-PAGE profiles of seed proteins showed good polymorphism for identification of gram varieties.

Rice seeds produced at 2 locations in Orissa and Andhra Pradesh did not indicate any adverse effect of coastal conditions on seed quality immediately and 4 months after harvest. However, seed produced in coastal areas recorded a poor storability than that produced in other areas.

Seed Health

Rice-bunt infection could be controlled effectively by spraying Tilt @ 0.1% at flag-leaf stage. It was confirmed that leaf-crinkle virus disease of mungbean and urdbean is seed-borne and the rate of transmission is greatly influenced by time of sowing, i.e., seed transmission was higher in July-sown crop than that in August-sown crop. The germination of infected seeds was also poor. Seed grading improved the germination and reduced the infection (%) of Alternaria brassicae in the seed lot of mustard. Seed infection of A. brassicae got auto-eliminated before sowing season at Karnal and Pantnagar; however, some inoculum remained active in the seed after sowing season at Ludhiana, Jaipur and Jabalpur. Seed treatment of mustard with Thiram completely controlled seed-borne infection in mustard.

In rice 2-3 fumigations were found better at Bangalore in controlling insect infestation during seed storage. The seed could maintain germination above the standard for 20 months. The light traps caught maximum number (45%) of insects in stores compared with other traps or methods. The lesser grainborer was found the most abundant during June-October when temperature and humidity were high.

Seed Processing

Sieve-aperture size and shape of grading screens for seed sizing of sorghum, mungbean, urdbean, soybean, sunflower and safflower were optimized for maximizing the seed recovery, germination and vigour. Raspbar threshing of soybean at peripheral speed of 7 m/sec was found effective. Marginal lots of sorghum averaging more than 67% germination can be upgraded by gravity separation, to meet the standards. Reprocessing of the lots with less than 66% germination was not useful. Sunflower seeds can be threshed by rubbing, which is economical and less damaging. Pre-processing fumigation done immediately after harvesting and threshing proved beneficial in mungbean.

Breeders' Seed Production

The total production of breeders' seed in different crops during 1993-94 was 2,007.69 tonnes and the indent for it was 1,522.52 tonnes. Thus Andhra Pradesh recorded a poor storability than that produced in other areas.
total production of breeders' seed indicates an increase of 24.16% over the indent quantity.

**Plant Protection**

* The controlled release formulations of Chlorpyriphos proved more effective than emulsifiable concentrate formulations in white-grub management

* Five species of entomogenous nematodes resulted in mortality of important species of white-grubs

* Reflective ribbons significantly reduced the bird damage in maize

* In Kerala *Apis mellifera* gave 80 kg honey/colony

* In Punjab honey yield increased from 21 to 53 kg by short-distance intra-state migration of bee colonies

* Ribovirin with sugar syrup proved effective against Thai sac brood virus in honey-bee

This section deals with the major achievements of the all-India co-ordinated programmes on biological control of crop pests and weeds, pesticide residues, rodent pest management, agricultural acarology, white-grub management, honeybee research and training, agricultural ornithology and integrated nematode control.

**BIOLOGICAL CONTROL**

**Introduction, Quarantine and Basic Research**

Successful egg-laying and partial larval development of *Trichogramma chilonis* and *T. pretiosum* were recorded on artificial diets with *Helicoverpa armigera* haemolymph and laying stimulants. This is an important step in the *in-vitro* production of these parasitoids. In an attempt to develop Endosulfan-resistant strain of *Trichogramma chilonis*, the parasitoid has been reared up to 170 generations under pesticide pressure of 0.09525% con-
Chrysoperla carnea could successfully be reared up to 5 generations on diets containing abdomen powder of Spodoptera littura and H. armigera. Campomis chloridae an effective endoparasitoid of Helicoverpa armigera could also be reared on Spodoptera littura in the laboratory.

The introduced american serpentine leaf-miner (Liriomyza trifolii) was found on more than 3 dozen hosts and some indigenous natural enemies, which have adapted to this pest, were recorded. Attempts are under way to import some natural enemies of this pest from the USA.

The polyhedral inclusion bodies (PIV) of both Spodoptera littura and Helicoverpa armigera have been successfully encapsulated into beads using calcium alginate and polysaccharide sodium alginate solution with gustatory stimulants, ultraviolet (UV) protestants and screeners incorporated in it. The virus-infected larvae of Helicoverpa armigera and Spodoptera littura consumed more oxygen (4,490 µl/g/hr and 3,625 µl/g/hr, respectively) than healthy larvae (916 µl/g/hr and 873 µl/g/hr). A new rickettsia-like organism was recorded on Helicoverpa armigera at Bangalore. Studies using S1-NPV revealed that 1 x 16^7 PIB/ml concentration showed 90% mortality of the larvae and is being used for further study for use with UV protestants obtained from mango and guava leaves.

The sugarcane-borers, Chilo auricilius and Chilo infuscattellus were kept under check at Ludhiana by 16 releases of Trichogramma chilonis @ 50,000/ha. Trials to compare the effect of release of Indonesian and indigenous strains of Cotesia flavipes to control the sugarcane-borers, Chilo auricilius, Chilo infuscattellus and Acigona steniellus at Ludhiana and Lucknow revealed reduced incidence of the borers, but differences between the strains were not found. The release rate of more than 2,000/ha at weekly interval gave best results. At Lucknow the Indonesian and indigenous strains of Cotesia flavipes preferred third-fifth instar larvae of Chilo auricilius. At Ludhiana and Lucknow release of Epiricania melanoleuca @ 5,000/ha kept a check on the population of sugarcane leafhopper (Pyrilla perpusilla). More than 30% of the adults and nymphs of Pyrilla perpusilla were found infested with Metarrhizium anisopliae at Pravaranganagar.

The integrated pest-management (IPM) strategy consisting of release of Trichogramma and
Chrysoperla and application of Bacillus thuringiensis and nuclear polyhedrosis virus on cotton pests was compared with the regular-spray schedule at Punjab, Gujarat and Andhra Pradesh. The results showed that IPM practice resulted in low incidence of bollworms, with yields comparable to chemical control. In Andhra Pradesh seed-cotton yield of 1.32 tonnes/ha was obtained in plots of IPM which was at par with the yield of 1.44 tonnes/ha obtained in plots of regular-spray schedule. The IPM resulted in higher returns of Rs 26,280 than regular-spray schedule (Rs 17,840). The returns obtained from regular-spray schedule were even less than untreated check (Rs 18,620).

Addition of boric acid 0.025% to Bacillus thuringiensis preparations (Defin and Dipel) could reduce the dosage by half to 0.5 kg/ha in a cost-effective strategy to control Spodoptera litura in the tobacco nursery at Rajahmundry. Similarly, addition of 125 larval equivalent (LE)/ha of SI-NPV also reduced the dosage of Bacillus thuringiensis to 0.5 kg/ha and gave effective control. Similar results were obtained for Bacillus thuringiensis formulation and Ha-NPV combination in controlling Helicoverpa armigera in the tobacco crop at Rajahmundry and Anand.

The IMP practice for the control of Spodoptera litura, consisting of trap crop of castor, S1-NPV spray, Bacillus thuringiensis application, neem-seed-kernel extract spray, use of Chrysoperla sp., Telenomus remus and Apanteles africanus, proved cost effective with cost:benefit ratio of 1:2.74 compared with 1:1.52 for chemical control.

**Biological Suppression of Pests of Pulses and Oilseed Crops**

Coccinellids and syrphids were the major predators of mustard aphid (Lipaphis erysimi) during February-March in Punjab, followed by the parasitoid Diaretiella rapae during the end of March.

Use of Ha-NPV in combination with Endosulfan (0.035%) at half the dosage (125 LE/ha) as 1 spray following Ha-NPV @ 250 LE/ha proved effective in reducing pod damage caused by Helicoverpa armigera in gram at Hyderabad and Ludhiana.

Establishment of Trichogramma chilonis was not seen in pigeonpea intercropped with sorghum at Hyderabad. Three rounds of Ha-NPV @ 250 LE/ha at 10-day intervals effectively reduced the larval population and pod damage at Hyderabad and Ludhiana. Amongst several Bacillus thuringiensis formulations, BTK-II was found the...
best in controlling Helicoverpa armigera.

**Biological Suppression of Rice Pests**

*Trichogramma japonicum* released @ 50,000/ha at 1-week intervals for 6 weeks could effectively reduce the dead-hearts (%) caused by rice-stemborer (*Scirpophaga incertulas*) in Assam, Punjab and Maharashtra. This treatment was found on a par with insecticidal sprays.

The rice leaf-folder (*Cnaphalocrosis medinalis*) could be effectively controlled by 6 releases of *Trichogramma chilonis* @ 50,000/ha, which resulted in 9.2% leaf damage compared with 7.7% in Monocrotophos-sprayed plot and 19.4% in the control.

**Biological Suppression of Tree-Crop Pests**

Release of *Contiozus nepanthidis*, *Elasmus nepanthidis* and *Brachymeria nosatori* @ 20.5, 49.4 and 31.9% respectively in relation to the percentage of larvae, pre-pupae and pupae of *Opistinia arenosella* significantly reduced the pest population in Kerala.

Coccinellid predators, *Chilocorus nigrita* and *C. circumdatus* effectively controlled the green scale (*Coccus virdis*) on acid lime. *Cryptolaemus montouzieri* effectively predated and suppressed the population of the mango green shield scale (*Chloropulvinaria polygonata*) and also the citrus spherical mealybug (*Nipaecoccus viridis*). The pomegranate white-fly in Bangalore was parasitized up to 90% by the aphelinid parasitoid, *Encarsia inaron*. *Leptomastix dactylopii* effectively controlled mealybug (*Planococcus citri*) on pomegranate. A lycaenid predator (*Spalgis epius*) was found feeding on the ber mealybug (*Planococcus lilacinus*) at Bangalore and could effectively clear the infestation.

Cypermethrin was found to be toxic to the ber scale parasitoid (*Anicetus ceylonensis*) even up to 50 days, whereas Dichlorvos, Endosulfan and Methyl demeton were found non-toxic a week after application.

**Biological Suppression of Vegetable Pests**

*Trichogramma pretiosum* alone @ 500,000/ha and in combination with Ha-NPV @ 250 LE/ha effectively reduced the fruit damage caused by *Helicoverpa armigera* at Bangalore, Anand and Pune. Early second-instar larvae of *Chrysoperla carnea* released in a ratio of 1 : 5, 1:10, 1:15 reduced the population of *Myzus persicae* on...
**Capsicum** sp. by 80.34, 61.59 and 55.93% respectively at Bangalore.

Potato tubermoth (*Phthorimoea operculella*) could be effectively controlled in field at Pune on releasing *Chelonus blackburni* and *Copidosoma koehleri* alone and in combination with granulosis virus. Only the parasitoids were found effective in the store.

**Biological Suppression of Weeds**

The weevils, *Neochetina eichhorniae* and *N. bruchi* have established well in Jorhat area of Assam. These have also been noticed 200 km away from the original release site. Studies on the factors and physiological changes associated with diapause in *Zygogramma bicolorata* revealed that the diapause was facultative and about 70% of the beetles showed dispause during December. Diapause was induced by depletion of food. It affected reproduction as revealed by atrophied ovary. The fat-body reserves showed an increase and the flight muscles were degenerated making the adults incapable of flight.

**AGRICULTURAL ACAROLOGY**

Early sowing during May-June in Bangalore conditions, resulted in heavy incidence of pigeonpea sterility-mosaic disease and its vector, *Aceria cajani* compared with sowing during July-August. High incidence of vector and disease on early-sown crops was due to dispersal of vector mites from the diseased ratoons or stubbles and voluntary plants of the previous season. *Atylosia* sp., a wild relative of pigeonpea, was suspected to serve as a source for the carry-over of the vector mite. This plant besides remaining green throughout the year, showed mosaic symptoms with many eriophyid mites.

Damage to okra by spider mites was severe during May-June and September at Coimbatore, during August at Navasari and during October-November at Ludhiana. Peak population of okra mites was recorded during May at Varanasi and Kalyani due to high temperature (40-42°C) and low relative humidity (40-50%). At Ludhiana the crop of brinjal was attacked by spider mites during January-February and June. However, the predatory mites were abundant during May-June and August-October. Among the okra varieties screened against mite pest, 'Pusa Sawani' and 'Co 2' were found fairly tolerant at Coimbatore.
The oil of castor, pongam and mobra or mahua (Madhuca longifolia) resulted in high mortality (60%) of spider mite (Tetranychus urticae) and phytoseiid predators (Amblyseius longispinosus and A. tetranychivorus). Neem-seed-kernel extract 3-5% was found less effective, resulting in 15-20% mortality. At Pusa and Kalyani synthetic pyrethroids were found more toxic to phytoseiid predators than organophosphorous compounds.

Phytoseiid predators, Amblyseius longispinosus and A. tetranychivorus survived and developed better on prey mites reared on Frenchbean plants, but their developmental period was prolonged when the prey mites were fed on soybean leaves. Mass-multiplication study showed that 25-30°C and 90% relative humidity were optimum for faster development of A. longispinosus, whereas temperature higher than 30°C resulted in complete mortality.

A new natural enemy of plant-feeding mite Oligota ovalis (Coleoptera : Staphylinidae) was studied. All the stages of Oligota ovalis preferred eggs and nymphs of Tetranychus urticae and required 16-17 days to complete its life-cycle. The females and last-instar grubs devoured 26-27 mites nymphs per day.

**WHITE-GRUB MANAGEMENT**

Like last years white-grub population in Marathwada showed its upward swing. Severe white-grub damage in groundnut was reported from several parts of Saurashtra. Reports of white-grub damage in different crops including medicinal plants and spices were received from new areas, indicating need for regular monitoring of population.

Five species of entomogenous nematodes, viz. Heterorhabditis bacteriophora, Heterorhabditis sp. (Ecomax strain), Steinernema glaseri, Steinernema feltiae and Steinernema sp. (Ecomax strain), were successfully tested against 5 important white-grubs, viz. Holotrichia consanguinea, H. serrata, Anomala bengalensis, Maladera insanabilis and Leucopholis lepidophora, resulting in grub mortality within 2-3 days of inoculation. All 5 nematodes were mass-multiplied successfully using Galleria mellonella and Corcyra cephalonica, of which the first one proved a better host. In local surveys, 2 strains of entomogenous nematodes were isolated and their pathogenicity confirmed against...
Holotrichia consanguinea.

Two entomophagous fungi (Beauveria bassiana and Metarrhizium anisopliae) were tested against the grubs of Holotrichia consanguinea. The grubs released on the fungi-inoculated soil developed the disease within 20-45 days. Addition of compost to the soil further enhanced the efficacy of the treatment. These fungi have been mass-multiplied on whole grain sorghum.

Further work was carried out to isolate female sex-pheromone of Holotrichia consanguinea, in which the biological efficacy of various fractions of extracts of female-sex pheromone gland was evaluated in the field. Traps loaded with few fractions attracted the beetles in large numbers, though all fractions showed pheromonal activity.

Mixing Phorate granules (Phorate 10 G, @ 12 kg/ha) with pearl millet seeds is widely accepted and adopted by the farmers because of lower input cost of the insecticide. The addition of organic manure preparation containing castor-cake and tobacco waste @ 500 kg/ha to the phorate-seed mixture resulted in yield increase of 400-500 kg/ha.

AGRICULTURAL ORNITHOLOGY

Forest crow (Carcous macrorhynchos) and common myna (Acridothes tristis) are the major bird pests, causing 3.12-29.55% damage at ripening stage of oil-palm in Andhra Pradesh. In Punjab the average grain damage in maize due to different species of birds was up to 20.7%, whereas in Gujarat and Rajasthan it was 5-6%. At Ludhiana, house-crow was the dominant bird visiting maize field, followed by pied myna, common myna, ring dove and bank myna.

At Kota the podborer (Helicoverpa armigera) was regulated by 7 bird species. Out of 7 species, grey wag tail (Motacilla citreola) was the most important one with a relative abundance of 61.58%, followed by cattle egret, Indian pipit, black drongo, bank myna, jungle babbler and house-sparrow. Significant difference in podborer infestation was observed between plots with T-shaped perches and those without perches. Similar results were obtained at the farmers field in Andhra Pradesh.

The feeding behaviour of pied myna revealed that 58-62% of the diet constituted plant matter and 39% animal matter at Ludhiana. Among plant matters, fruit seeds predominated in both

**CHLORPYRIPHOS FORMULATIONS**

Seed treatment with controlled release (CR) formulations of Chlorpyrphos was more effective than conventional EC formulation in controlling white-grub in groundnut, in experimental farm trials conducted for last 3 years. In confirmation trials conducted at several locations at farmers' fields, CR formulations (CRCH I 90 SC, CRCH II 82 SC, CRCH III 70 SC) caused plant mortality of 4-10% compared with 60-90% in adjoining untreated fields. Extra-slow formulation of Chlorpyrphos, CRCH III 70 SC, provided protection even to early-sown groundnut at farmers' field and gave pod yield of 2.4 tonnes/ha, with less than 10% plant mortality.
the sexes. At Kota the feeding behaviour of house-sparrow from December to April showed that wheat grains formed the major diet component, followed by weed seeds. Insect food constituted predominantly from December to March. The diet of cattle egret nestlings constituted 61.5% of arthropods, of which 27.3% was coleopteran and 22.2% orthopteran.

Seed treatment with Chlorpyriphos 0.01% in maize was significantly superior to untreated check in reducing bird damage. In Rajasthan, IPM methods on maize revealed that reflective ribbon at 5 m inter-tape distance and wrapping of cobs up to 1 m on all the cobs was found significantly superior in reducing bird damage to the control. In Gujarat reflective ribbon at 800 m/ha installed at 0.5 m above the kharif groundnut crop during last 40 days of maturation proved effective for the management Demoiselle cranes.

HONEY-BEE RESEARCH AND TRAINING

Apis mellifera introduced for the first time in Kerala in 1993, is performing very well. They avail rich flow of rubber which was earlier not considered to be their flora. In some cases up to 80 kg honey has been extracted per colony. The experience with this bee in Andhra Pradesh is also very encouraging. Beekeepers were convinced with the performance of this exotic bee in these states.

Reduced fruit set in apple due to less number of pollinators was improved by increasing the number of bee colonies from 4 to 8 ha in Himachal Pradesh. In Assam bee pollination increased the yield of buckwheat by 132% compared self-pollination.

Long-distance, inter-state migration of bee colonies is a widely adopted practice; however, short-distance migration is preferable to make full use of local nectar resources. With this view, intra-state migration was standardized for Punjab. Honey yield increased from 21 kg to 53 kg by this short-distance, intra-state migration.

Only 2-5% of Apis cerana indica colonies survived the infection of Thai sac brood virus in Kerala and other southern states. The surviving colonies were surveyed and collected from different parts of Kerala and screened against Thai sac brood virus. Colonies showing virus resistance could be selected and they are being multiplied. Different dosages of Ribovirin (Virazide) with sugar syrup at 3-day
interval have shown very good promise for controlling the disease infection. Metronidazole has been proved effective against the control of the disease. Hydroxyquinoline derivative, Etakon-M @ 25 and 45 ppm in sugar was found effective against the protozoan disease. The green-bee eater, *Merops* sp., which is a serious bee predator in apiaries, especially in summer, could not be controlled by physical and mechanical measures like beating drums, using bird scarer, reflective taps, playing distress voice of injured bee eater and hanging dead birds in the apiary. The predation was, however, less in the apiaries under thick canopy of trees, as foliage hindered the free flight of birds. Raising poplar and mulberry trees around apiary reduced the predation on bees.

The production of royal jelly—another valuable bee product—was standardized. It was possible to get royal jelly 253 and 329 mg per graft after 72 hr of grafting in 5 and 10 frames bee strength colony respectively. Grafting 12 hr-old larvae gave more royal jelly after 72 hr than the grafting of 24- and 36-hr-old larvae. Physico-chemical analysis of honey from 4 bee species, viz. *Apis mellifera*, *A. cerana indica*, *A. dorsata* and *A. florea*, showed only minor differences.

Pesticides-residue analysis in honey has shown traces of HCH (3.03 ppb), HCH (4.817 ppb), pp' DDT (0.518 ppb), op DDT (2.004 ppb), p-p DDD/TDE (0.435 ppb), Endosulfan (1.406 ppb) and Aldrin (0.205 ppb).

**PESTICIDE RESIDUES**

Multilocation trials conducted at Pusa, Kalyani, Delhi, Hisar, Kanpur, Jorhat, Jabalpur and Hyderabad on residues of Carbofuran 3 G and Endosulfan 35 EC on maize showed that Carbofuran residues were present below-detectable level and Endosulfan residues were present below the maximum residue limit at the harvest. Multilocation trials on residues of Quinalphos 25 EC and Chlorpyriphos 20 EC in groundnut were carried out. These were applied to seed @ 25 ml and 40 mg/kg seed separately at the time of sowing at Bhubaneswar, Rahuri and Jaipur. No detectable residues of the 2 insecticides were found in soil, groundnut kernel and straw at harvest. Quinalphos and Chlorpyriphos are therefore safe for the control of groundnut pests.

The multilocation trials carried out at Coim-
batore, Delhi, Ludhiana, and Solan on residues of Mancozeb on brinjal and tomato indicated waiting period of 5-7 days for Mancozeb in brinjal and of 1-3 days in tomato. Multilocation trials conducted with Carbaryl 50% WP, Dimethoate 30 EC and Cypermethrin 20 EC on mango at Kalyani, Rahuri and Bangalore did not show detectable residues in mango. Supervised trials were carried out at Solan using Mancozeb, Bitertanol and Mycobutanil on apples. Mancozeb was applied @ 4.5 and 9.0 kg ai/ha, 3 times at fruiting at 2-day intervals, Bitertanol @ 0.6 and 1.2 kg ai/ha twice at 20-day intervals and Mycobutanil @ 0.2 and 0.4 kg ai/ha twice at 15-days intervals. Based on the results, the waiting period of 1 month was recommended for all the 3 fungicides.

Monocrotophos and Quinalphos at recommended dose (0.05%) and double the recommended dose (0.1%) sprayed separately thrice at 1-month interval on ber ('Umran') dissipated 90-97% in 7 days. A waiting period of 3 days for Monocrotophos and that of 7 days for Quinalphos was suggested to avoid health hazards due to toxic residues.

A supervised trial carried out on residues of Carbofuran, Aldicarb and Phorate at Bangalore indicated no detectable residue of the 3 insecticides in the grape berries.

To study the magnitude of pesticide contamination of soil and water in Haryana, 20 soil samples were collected from Hisar and surrounding areas for monitoring residues of DDT and HCH. All the samples were found contaminated with HCH residues ranging from 0.07 and 0.317 ppm and with DDT residues from 0.024 to 0.072 ppm.

Monitoring of pesticide residues in fish was done at Kalyani, Jorhat and Hyderabad. Out of 29 samples, 9 contained Endosulfan above the maximum residue limit.

**RODENT CONTROL**

The lesser bandicoot rat (*Bandicota bengalensis*) continued to be the predominant rodent pest of Indian agriculture. The 2 commensal rodents spp. (*Rattus rattus* and *Mus musculus*), the cutch rock rate (*Rattus cutchicus*) and lesser bandicoot rat were dominant in residential premises in Gujarat. In the rice-wheat zone of Kymore plateau and rice zone of northern hills region of Chattisgarh in Madhya Pradesh, the predominant rodent pests
were *Millardia meltada, Bandicota bengalensis, Mus booduga, Rattus rattus* and *Golunda elliotti*. In Himachal Pradesh, *Mus musculus, Bandicota bengalensis, Rattus meltada* and *Mus platythrix* were recorded from orchards of apple, peach, pecan, plum and fields of vegetable crops.

The damage due to rodents in groundnut and sugarcane was 4.22-6.69% and 4.48-6.45% respectively. It ranged from 6.13 to 7.33% in wheat and 5.37 to 6.16% in cotton in Saurashtra region of Gujarat. In gram pod damage was 3.45-14% in single and 7.74-31.58% in double-cropping systems respectively. In pecan and apple nurseries, rodents gnawed and cut the roots completely resulting in death of the plants. The damage was 6.67% in pecan and 7.03-16.83% in apple crops.

Acceptability and bio-efficacy of modern rodenticides were studied in various cropping systems. Among 3 rodenticides evaluated against field rodents in groundnut and wheat crops, Bromadiolone (0.005%) wax cake showed the highest control in groundnut (95.32%) and wheat (98.08%), followed by Cholecalciferol (0.075%). However, minimum number of live-burrows 3 days after treatment were recorded in Zinc phosphide (2%) poison bait. Regular trapping reduced the rodent population in vegetable crops at Solan, Sirmour and Kangra in Himachal Pradesh. Fumigation with aluminium phosphide, burrow baiting with Zinc phosphide (2.5%), Bromadiolone (0.005%), Flocoumafen (0.005%), and dusting the burrows with Racumin tracking powder caused respectively 60, 58.33, 66.67 and 50% reduction in counts of live-burrow. In poultry, Zinc phosphide (1%), Bromadiolone and Brodifacoum (0.005%) in cereal baits and trapping were found effective methods for rodent control.

Among the various rodenticides evaluated in different poultry farms in Gujarat, Bromadiolone (0.005%) wax cake was found superior in reducing rodent population (80.95-86.36%) and egg damage due to rodents (77.59-89.57%) compared with Cholecalciferol (0.075%) wax cake and Zinc phosphide (2%) poison bait.

Two apex-level training programme on rodent control were organized at ICAR RC-NEH Region, (Barapani, Shillong) and at ARS, APAU (Maruteru). The objective was to create nucleus of trained personnel on rodent control.
NEMATODE MANAGEMENT

Newer areas of infestation of rice with *Meloidogyne graminicola, Heterodera oryzicola* and *Ditylenchus angustus* were detected. Maize-cyst nematode (*Heterodera zeae*) was recorded from the hitherto unrecorded areas of Bihar, Himachal Pradesh, Uttar Pradesh and Madhya Pradesh. The high frequency and population density of this nematode in newer areas indicated that it could be an important limiting factor in cultivation of maize in Bihar.

Pigeonpea-cyst nematode (*Heterodera cajani*) was predominantly associated with pigeonpea, mungbean and gram in Tamil Nadu, Uttar Pradesh, Gujarat, Bihar and Maharashtra. Heavy population of this nematode was also recorded on sesame from Periyar and Coimbatore districts of Tamil Nadu. Sunflower in Chhindwara, Jabalpur and Khandwa districts of Madhya Pradesh was severely infested with lesion nematode (*Pratylenchus thornei*) and reniform nematode (*R. reniformis*).

Rotation of rice crop with wheat, jute or groundnut checked the population build up of rice-root nematode (*Hirschmanniella oryzae*) and also resulted in increased yield. Soaking rice seeds in Carbosulfan 25 EC solution @ 0.1% for 12 hr was effective in raising nematode-free healthy rice seedlings. Transplanting of these seedlings in main field having high infestation of *Meloidogyne graminicola* resulted significant increase in yield in Assam and Orissa.

Root-knot nematode (*Meloidogyne incognita*) and wilt disease complex of gram was managed most effectively by treating the seeds with Carbosulfan 3% w/w and Bavistin @ 0.2% followed by sowing of these treated seeds in solarized field with 100 m polythene sheet. Such treatment reduced the root-knot nematode and wilt incidence, and increased the yield up to 54.2%. Infestation of root-knot nematode in pigeonpea was checked by field application of Carbofuran or Phorate @ 1.5 kg ai/ha, resulting in yield increase up to 16%.

Various organic amendments used against root-knot nematode (*Meloidogyne javanica*) indicated that castor, neem- and mustard-cakes each @ 1,000 kg/ha increased the germination, showed better plant stand, higher pod yield and decreased root-knot disease. Neem-cake was found the most effective organic amendment in increasing seed germination, plant stand and pod yield.
<table>
<thead>
<tr>
<th>Nematode species</th>
<th>Resistant variety or hybrid</th>
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<tbody>
<tr>
<td><em>Meloidogyne javanica</em></td>
<td>'Mangla', 'Hisar Lalit', 'PNR 7', 'NT 12', 'NT 9'</td>
</tr>
<tr>
<td><em>Meloidogyne incognita</em></td>
<td>'Mangla' hybrid, 'Karnataka' hybrid, 'PNR 7', 'BT 1', 'BT 17', 'Sel 120'</td>
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In vegetable crops nursery bed treatment with Carbofuran, Sebufos or Phorate @ 0.6 g ai/m² produced healthy, nematode-free seedlings, which on transplanting gave increased yield by 25-86% in brinjal. Seedings of tomato, brinjal and pointed gourd or *parwal* treated with Carbosulfan and Monocrotophos each @ 500 ppm before transplanting in root-knot nematode-infested field, showed significant reduction in gall index and increase in yield.
Horticulture

Fruit Crops

* Three hybrids, 'H 13-1', '122' and '123', of mango have shown promise.

* Biointensive integrated management of the citrus nematode achieved.

* Six superior high-yielding varieties of grape developed for different purposes.

* A high-yielding selection of 'Dwarf Cavendish' banana found promising in Tamil Nadu.

* 'CP 81', a hybrid line of papaya identified for high yield and quality.

* 'Swarna Roopa', a promising variety of litchi identified.

* An early clonal selection from 'Umran ber', 'CHES Sel 1' identified.

Mango

A high yielder mango hybrid 'H 13-1' ('Amrapali' x 'Sensation') with medium-size fruits, sweet taste and excellent shelf-life has shown promise at IARI, New Delhi. Two hybrids, viz. '122' ('Alphonso' x 'Neelam') and '123' ('Alphonso' x 'Neelam'), were found promising for fruit qualities at RFRS, Vengurla, Maharashtra.

Studies on development of soil and leaf nutrient guides for major and secondary micronutrients on 'Totapuri' mango suggest the optimum range of N in leaf to be 0.84-1.53%, P 0.06-0.15%, K 0.52-13.6 ppm, Mg 200-449 ppm and S 0.49-9.77 ppm. Fertilizer use efficiency studies in 9-year old 'Alphonso' mango showed higher absorption of P at 60 cm depth in 60-120 cm radii from tree trunks.

A combination of 100 g N, 170 g P₂O₅ and 80 g K₂O per plant every year to be stabilized by tenth year was found optimum for maximum fruit yield, while application of 100 g each of N and K₂O per plant/year of age from first to tenth year and
continuation was found appropriate for maximum economic returns in cv. 'Alphonso'.

Early flowering with regular bearing in 'Dashehari' mango was achieved with the use of a growth retardant Paclobutrazol. Soil application @ 4 g/tree was proved more effective.

Two neem-based preparations, viz. 1.5% oil extract and 0.5% kernel extract, and an insect growth regulator, Buprofezin (0.0125%), significantly controlled mango hoppers (Idioscopus nitidulus).

Citrus

Rangpur lime as rootstock for sweet orange and mandarin has proved its superiority. Application of 120 g N, 400 g P₂O₅, and 400 g K₂O per plant in mandarin in 13th year of age recorded highest yield of 1700-1800 fruits. The N, P and K status of Nagpur mandarin leaves budded on Rough lemon varied from 1.45-2.18%, 0.05-0.14% and from 1.13-1.91% respectively.

Biointensive integrated management of the citrus nematode, Tylenchulus semipenetrans infecting acid lime was achieved by the rational combination of oilcakes (neem/karanj) with biocontrol agents Paecilomyces lilacinus/Vermouvium lecanii or Vesicular arbuscular mycorrhizae (Glomus mosseae/G. fasciculatum).

Grape

Six superior high-yielding varieties of grape, viz. 'Arka Shweta' ('Anab-e-Shahi' x 'Thompson Seedless'), 'Arka Majestic' ('Angur Kalan' x 'Black Champa'), 'Arka Chitra' ('Angur Kalan' x 'Anab-e-Shahi') for table purposes; 'Arka Krishna' ('Black Champa' x 'Thompson Seedless') for juice purposes; and 'Arka Soma' ('Anab-e-Shahi' x 'Queen of Vineyards') and 'Arka Trishna' ('Bangalore Blue' x 'Convent Large Black') for wine purposes have been developed at IIHR, Bangalore.

Grape downy mildew was effectively controlled by foliar application of Acltiele (0.25%) + Dithane M-45. Powdery mildew could be effectively controlled by spraying Bayleton systhane (0.1%) or Rubigan (0.05%).

Under an eco-friendly IPM strategy, spraying of neem-cake extract (4%) and Azadirachtin 7.5 ppm during pre-bloom, following April and October pruning, significantly reduced thrips scab on berries caused by Scirtothrips dorsalis.
Banana

A hybrid developed at Kannara, Kerala was found highly promising at Kovvur, Andhra Pradesh for yield and tolerance to leaf spot disease. High-yielding selection made at Gandevi, Gujarat in ‘Dwarf Cavendish’ was found promising in Tamil Nadu. The selection has potential to yield 80-85 kg bunch with average production of 55-60 kg bunch. Early maturing clone in ‘Dwarf Cavendish’ has been identified.

Silt and silt + FYM application on ‘Elakki’ banana was found to provide phosphorus more efficiently than single superphosphate. Fertigation with N @ 100 g/plant/year was sufficient to realize higher banana yield both in plant and ratoon crops as compared to 200 g N applied through soils.

Carbaryl (0.2%) or Monocrotophos (0.05%) effectively reduced the population of scarring beetle. Phosphamidon (0.05%) given twice checked the incidence of pseudostem borer. Double paring + dip in Monocrotophos (0.05%) + sunhemp intercrop was effective for management of nematode. Bavistin (1%) alternated with the same reduced the incidence of sigatoka leaf spot disease.

Papaya

A hybrid line, ‘CP 81’ (‘Coorg Honey Dew’ x ‘CP 85’) was identified for high yield and quality. A promising hybrid from the cross of ‘Co 5’ x ‘Thai-land’ was obtained and purified. In Bihar, planting was found to be the best in September and November. A spacing of 1.6 m x 1.6 m was found economical for ‘Co 6’ papaya and for obtaining high papain yield. Spraying of Zn + Bo enhanced the yield.

Guava

Foliar spray of 10% aqueous solution of urea produced 77 kg fruits/plant in cv. ‘Allahabad Safeda’ as compared to 38 kg produced by control plant in winter. In cv. ‘Sardar’ the highest yield/plant (85 kg) was, however, obtained with 15% urea spray. Unsprayed control trees give only 20 kg yield during winter.

Litchi

A promising variety of litchi, ‘Swarna Roopa’, has been identified at CHES, Ranchi. The fruits are almost round, 27-30 mm in diameter, with deep rose blush covering 100% fruit surface. The TSS acid ratio is high and the TSS sugar ratio is comparable to cv. ‘China’. Seed is deep brown and the fruits are highly resistant to cracking.

Apple

Indofil M-45 (0.5%) and Syllit (0.15%) gave satisfactory control of apple scab when sprayed at green tip stage in single application technique both in Himachal Pradesh and Jammu and Kashmir. Contaf (0.03%), Baycor (0.05%), Atemi (0.02%), Scabicide 50 F (0.10%), Indofil M-45 (0.30%) and Rubigan (0.04%) gave satisfactory protection of plants against apple scab, whereas Bavistin gave poor control both in Himachal Pradesh and Jammu and Kashmir. Therefore, there is an urgent need for monitoring fungicide resistance in these states.

Arid Fruits

The CHES, Godhra has identified a clonal selection from ‘Umran ber’, ‘CHES Sel 1’, which is early and has better shelf-life. It ripens about 3 weeks earlier than ‘Umran’. Under rainfed conditions in situ budding method has been recommended for establishment of ber orchards on a large scale.

Fruits of ‘Ganesh’ cultivar of pomegranate could be stored for 80 days at 8°C by individual shrink wrapping of the fruits. Hybrid ‘21/15’ of anona had a shelf-life of 9-10 days as compared to 4-5 days in ‘Balanagar’ cultivar. The shelf-life of sapota was 6-7 days at 25°C and it could be kept for 15 days at 20°C.

Mulching with residues of crops such as paddy and groundnut in pomegranate orchard at Anantapur, and with black polythene in date palm and berorchards at Bikaner and Sardarkrushinagar proved effective in prolonging moisture storage in soil and in checking growing weed growth.

For the control of berpowdery mildew, 8 sprays with 0.2% wettable sulphur at 10 days interval starting from 50% flowering stage proved the best at Rahuri and Sardarkrushinagar.

Vegetable Crops

* A high-yielding variety of brinjal ‘Swarna Shree’ released. Five high-yielding varieties and two F1 hybrids recommended for release
* ‘Swarna Poorna’ cucumber released
* Three high-yielding and disease-resistant vari-
eties of pea recommended for release

* A high-yielding variety and 5 F1 hybrids of tomato recommended for release

* One F1 hybrid of cabbage, ‘BSS 32’ recommended for cultivation

* Sponge gourd variety, ‘Sel99’, recommended for release

* Okra variety, ‘HRB 55’, resistant to yellow vein mosaic virus recommended for release

* Three varieties and one F1 hybrid of onion recommended for release

**Brinjal**

Five high-yielding varieties, viz. ‘DBSR 44’ (30 t/ha), with small, oval-round, glossy, dark purple fruits; ‘DBR 31’ (43 t/ha) with oval-round, glossy, purple, medium size fruits; ‘DBR 8’ (41 t/ha) with round, glossy, dark purple, medium size fruits developed at IARI, New Delhi; and ‘KS 224’ (12.6 t/ha) from Kalyanpur; ‘Sel 4’ (28.17 t/ha) from Hyderabad and two F1 hybrids, viz. ‘NDBH 6’ (43.21 t/ha), developed at Faizabad and ‘ABH 2’ (40.64 t/ha) from Anand, Gujarat were recommended for release by AllCRP on Vegetable Crops.

‘Swarna Shree’, a high-yielding, round, white coloured variety of brinjal with moderate resistance to bacterial wilt developed at CHES, Ranchi was released for cultivation in Chotanagpur region of Bihar.

**Cucumber**

A variety ‘Swarna Poorna’ with long fruiting period and resistant to powdery mildew was released for cultivation in Bihar.

**Capsicum**

For higher yield and cost benefit ratio (1 : 2.53), application of 240 kg N/ha and 60 kg P2O5/ha was recommended for capsicum hybrid ‘Pusa Shephali’ under Solan conditions.

**Chilli**

Application of 40 kg N as basal dose+10 kg N as top dressing+10 kg N as foliar spray in trans
planted chilli resulted in the highest yield of 23 t/ha with cost benefit ratio of 1:5.78 under Jorhat conditions.

**Peas**

One high-yielding, mid-season pea variety 'PH-I' developed at Hisar; two powdery-mildew-resistant varieties, 'NDVP 4' developed at Faizabad and 'Arka Ajit' developed at IIHR, Bangalore were recommended for release.

**Tomato**

A high-yielding variety, 'Sel 1-6-4' developed at Ludhiana, and 5 F₁ hybrids, viz. 'FMH 1' developed at IIHR, Bangalore; 'DTH 4' and 'KT 4' developed at IARI; and 'NA 501' and 'NA 601' developed by Nath Seeds were recommended for release by AICVIP. 'BT 10' variety developed at OUAT, Bhubaneshwar has been identified as resistant to bacterial wilt disease.

Application of 180 kg N and 120 kg P₂O₅ under Durgapur conditions and 120 kg/ha each of N and P₂O₅ under Pantnagar conditions for hybrid 'ARTH-3' were recommended with a cost benefit ratio of 1:2.44 and 1:1.32, respectively.

Application of Pendimethalin @ 1.00 kg ai pre-emergence +1 hand weeding at 45 days after transplantation has been recommended for effective control of weeds under mid-hill conditions of Almora with a cost benefit ratio of 1:1.68 (11.47 t/ha).

**Cabbage**

One F₁ hybrid 'BSS 32' from Beejo Sheetal (39.61 t/ha) has been recommended for cultivation. Diamond-back moth could be successfully managed by sowing mustard as a trap crop between the rows of cabbage, 15 days before cabbage planting along with 2-3 sprays of Dichlorvos @ 1 kg ai/ha in mustard and two sprays of Cartap hydrochloride @ 500 g ai/ha or 5% neem-seed extract in cabbage starting from primordial stage of crop at 15 days interval waiting under Raburi conditions.

**Cauliflower**

Useful lines of cauliflower which give satisfactory curd during May-June at temperature 20-40°C have been identified. For seed production of mid-season cauliflower var. 'Pant Subhra', application of 120 kg N/ha and 60 cm x 60 cm spacing proved most effective with seed yield (0.6 t/ha) and cost benefit ratio of 1:4.82 under Faizabad.
conditions. In late variety, ‘Snowball-1’, planting at 60 cm x 45 cm spacing coupled with 150 kg N/ha proved most remunerative for seed production under mid-hill conditions of Almora.

**Sponge gourd**

‘Sel 99’, a variety developed at IARI, New Delhi with a yield potential of 10-14 t/ha has been recommended for release.

**Bitter gourd**

NPK dose of 60:60:30 kg/ha proved most remunerative under Coimbatore conditions and resulted in the highest yield (20.5 t/ha), with a cost benefit ratio of 1:3.37. Application of NPK @ 90:60:60 kg/ha was found beneficial under Faizabad conditions for local variety ‘Jaunpur Karela’.

**Carrot**

Application of N @ 150 kg/ha and planting of carrot steckling of variety ‘Pusa Meghali’ at 60 cm x 30 cm for seed production resulted in a yield of 1.25 t/ha with 1:4:03 cost benefit ratio under Faizabad conditions.

**Okra**

‘HRB 55’, a variety resistant to yellow vein mosaic virus and developed at Hisar, has been recommended for release.

**Onion**

‘Agrifound Light Red’, a variety (29.29 t/ha) developed at NHRDF, Nasik has been recommended for release by the AICRP on Vegetable Crops. Rose onion ‘Arka Bindu’ (25 t/ha), ‘Arka Pitambar’ (35 t—ha), and F, hybrid ‘Arka Kirtiman’ (45 t/ha) developed at IIHR, Bangalore have been recommended for release for cultivation in Karnataka. Application of Fluchloralin @ 1.00 kg (PPI) + 1 hand weeding after 45 days of transplantation proved most effective for weed control in onion under Durgapura conditions resulting in an yield of 17.88 t/ha with cost benefit ratio of 1:2.93.
**Potato**

* A number of potato hybrids have shown promise at different locations

* 2,600 tonnes seed of 7 potato varieties and 3 hybrids produced

**Crop Improvement**

At CPRI, Shimla, three hybrids, viz. 'SM/85-45' (32.5 t/ha), 'SM/85-60' (27.9 t/ha) and 'SM/85-162' (31.2 t/ha), proved promising and are included in multilocational trials. In on farm trials, hybrids '83-P-142' and 'MS/82-638' were promising and are being considered for release. At CPRS, Modipuram, 5 hybrids of the early bulking and medium bulking groups were promising and gave 10-35% more yield than the best variety 'Kufri Bahar'. At Jalandhar, 8 hybrids in early bulking group and 12 in medium bulking group, and 3 hybrids at Patna were promising. In breeding varieties for processing quality, chipping test showed that hybrids 'MP/91-69', 'MP/92-30', 'MP/92-117' were at par with imported best varieties available for chipping quality.

At CPRS, Modipuram 3 hybrids of TPS families, viz. 'HPS II/255', 'HPS 255/13' and 'HPS 415/255', yielded 10 to 12% more than the standard variety 'Kufri Bahar' (47.3 t/ha). At Chhindwara the crop raised from TPS family 'HPS-I/13' (earlier recommended for release) gave an average net return 31% higher than the seed tuber crop of 'Kufri Bahar'.

**Crop production**

Nutritional requirement studies showed that the combination of N and P fertilization - 50 kg P₂O₅ + 160 kg N/ha at Bhubaneshwar and 100 kg P₂O₅ + 240 kg N/ha at Kalyani gave the highest yield and net profit, while 60 kg K₂O and 250 kg N/ha gave the highest yield and net profit at Faizabad.

The optimum planting time was found to be 15-25 October at Jalandhar (up to 240 kg N/ha), first week of November at Kota (up to 150 kg N/ha), second week of November at Bhubaneshwar (up to 120 kg N/ha) and second week of January at Palampur (up to 200 kg N/ha). Beyond these dates, the response of N application tended to decline with a corresponding reduction in yield.

With 300% cropping intensity, potato-watermelon-cowpea at Pantnagar, potato-maize-radish at Palampur, and potato-moong and kharif rice at Jorhat were the most remunerative potato-based cropping systems. At Dharwad, potato-cotton intercropping system was found to be the most profitable.

An increase in seedling tuber size from 10 g to 20-30 g had a positive effect on yield at most locations. However, use of small seed (10 g) was economical.

**Crop protection**

For quick and effective detection of brown rot disease (Pseudomonas solanacearum) latex agglutination test was standardized.

The bioagents, viz. Bacillus subtilis, B. cereus, Enterobacter sp. and avirulent P. solanacearum, were identified to reduce potato bacterial wilt by 80-89% and increase yield by 53-80%. Preponing of planting healthy seed in February instead of March and April in Kumaon hills reduced wilt by 21.6% and increased yield by 10.2%.

At Bhubaneshwar, crop rotation with cereals was found to reduce the incidence of bacterial wilt by 50-86% and in combination with application of stable bleaching powder to almost nil. At Kota, delayed planting of crop between third and last week of October in combination with weekly spray of Monocrotrophos proved effective for the control of the stem necrosis.
**Tuber Crops**

- 1,557 accessions of cassava maintained. Three early maturing clones gave higher yield at 11 locations.

- Use of synthetic sex pheromone against sweet potato weevil gave excellent results.

- Hybrid selections of *Dioscorea alaterea* and *D. rotundata* gave higher yields.

- Three hybrids of colocasia proved promising.

**Cassava**

At CTCRI, Thiruvananthapuram, 1,557 accessions including 762 exotic and 795 indigenous lines of cassava are being maintained. Three early maturing clones, viz. 'CI 649', 'CI 731' and 'CI 732', which could be harvested at 6 months gave significantly higher yield (35-37 t/ha) than standard variety 'Sree Prakash' (30.5 t/ha), when tested at 11 locations. These clones have good cooking quality as well. Cassava hybrid '119', a short duration line, was promising at Tamil Nadu.

A fertilizer dose of 100:25:100 NPK is found to be optimum for the 'Sree Prakash' variety when raised as a second crop after *kharif* rice.

Application of neem-coated urea followed by sulphur-coated urea gave the highest tuber yield at Tamil Nadu. In Assam, french bean as intercrop in cassava recorded highest cost benefit ratio of 1:1.9 with yield of cassava of more than 25 t/ha.

**Sweet Potato**

At CTCRI, 963 accessions of sweet potato were maintained. To this 35 accessions from CIP, Lima, Peru have been added during the period under report. On evaluation of 10 exotic accessions against sweet potato weevil, 3 accessions, viz. 'S 1157', 'S 1162;' and 'S 1203', were found to be tolerant to weevil.

Four lines of sweet potato, viz. 'KV 4'(17.5 t/ha), 'A 144' (16.2 t/ha), '90-91-13'(14.8 t/ha) and '91-7'(13.8 t/ha), were promising at CTCRI.

'Rajinder Sakarkand'('X47'), a variety recommended for release for Bihar plains, was tested in neighbouring states. The result shows...
that it is consistently superior (30-35 t/ha) to local cultivars.

Inoculation with VAM alone and a combination of rock phosphate (12.5 kg/ha) and FYM (5 t/ha) applied with VAM recorded a total tuber yield of 15.62 and 15.91 t/ha respectively. In Tamil Nadu, 2/3 of recommended dose of nitrogen (26 kg N) + 2 kg of Azospirillum as soil application gave higher tuber yield.

In an IPM technology, synthetic sex pheromone was used against sweet potato weevil under field condition at the Institute’s farm and also at farmer’s field at Pattambi (Palakkad District). The IPM package was compared with the recommended chemical control (spray of Fenthion 0.05% at monthly intervals) and untreated control. The yield of marketable tuber in the IPM package was 14.4 t/ha and the tuber damage was only 4.3%. In chemical control and untreated control, the yield and damage were 4.6 t/ha and 18.3% and 1.6 t/ha and 50.7% respectively. In addition, very heavy weevil population build up in the chemical treatment and untreated control in the ratio of 1:9.8 and 1:15.3, respectively, in comparison with IPM was also observed.

Yams

The existing collection of the germplasm of 3 edible species of Dioscorea, viz. *D. alata* (221), *D. esculenta* (113) and *D. rotundata* (337), were maintained by field planting.

In on-farm trials, 3 superior hybrid selections of *D. alata* recorded significantly higher yield (33.2 to 35.5 t/ha) as compared to control (23.4 t/ha). The tuber yield of the 3 hybrid selections of *D. rotundata* (49.1 - 59.5 t/ha) was also significantly higher than of the control variety (48.7 t/ha).

Seven dwarf clones of *D. rotundata* produced by hybridization were evaluated in a yield trial. The tuber yield ranged from 15.7 to 20.2 t/ha, while the control ('Sree Dhanya') recorded 18.4 t/ha. Four dwarfs were selected for further evaluation.

Edible aroids

A total of 350 accessions of taro (colocasia), 72 of elephant foot yam (*Amorphophallus*) and 30 accessions of tannia were maintained at CTCRI.

In colocasia, 3 hybrid progenies, viz. ‘H 2’, ‘H 11’ and ‘H 115’, were identified as promising with a mean yield of 30.0, 34.5 and 25.8 tonnes of
cormels per hectare respectively. The colocasia varieties, ‘Nadia Local’ and ‘Panchmukhi’, proved promising in West Bengal.

Spray of Zineb (0.25%) at monthly intervals has been recommended for colocasia-blight control.

In Bihar, intercropping of 3 rows of onion in between 2 rows of colocasia has recorded the highest net return of Rs 20,000/ha under irrigated conditions.

In elephant foot yam, hybridization was successfully carried out and a wide spectrum of variability for yield and other characters was obtained.

In West Bengal, bacterial blight of elephant foot yam could be effectively controlled by dipping the seed corm in Agrimycin for 12 hr.

**Mushroom**

Seven new strains of *Agaricus bisporus* were developed at NCMRT, Solan. The yield of strain ‘MS-39’ was significantly higher than of other strains evaluated at Udaipur, Faizabad and Ludhiana centres of AICRP on Mushroom. Among the *Pleurotus* species, *P. sajor-caju* gave the highest yield at Udaipur, Faizabad and Pune centres.

Use of water leached casing material for cultivation of white button mushroom has shown promise for cultivation of *A. bisporus* and *A. bitorquis*. Use of decomposed coir pith as casing material alone and in various combinations with spent compost @ 50:50 (v/v) resulted in significantly higher yield in comparison to control.

Spray of calcium chloride on white-button mushrooms helps in improvement and retention of whiteness of fruit-body for a longer period and increased its shelf-life.

Techno-economic feasibility reports for 2 companies have been prepared for commercial cultivation of mushroom. A total of 12,000 bottles of spawn were produced under Revolving Fund Scheme and sold to mushroom growers.

**Ornamental Crops**

* ‘Chitra’, a new variety of rose developed

* Gladiolus, ‘Hunting Song’ recommended
for commercial cultivation and for export as cut flower

* Several cultivars of chrysanthemum and carnation recommended for commercial cultivation in different regions of the country

* Hybrids, 'Shringar' and 'Suvasini', of tuberose released

**Rose**

A new variety 'Chitra', developed as a result of spontaneous mutation from the variety 'Janina', has been released by the IARI, New Delhi. It has creamish-white and golden yellow prominent strips and spots on the vermillion-orange base colour. Application of NPK @ 60:10:20 g/m² plus a basal application of FYM at 10 kg/m² has been found to be optimum for production of maximum number of flowers/plant for cv. 'Gladiator' in Maharashtra region. NPK dose of 75:150:50 g/m² has proved optimum for getting the maximum number of flowers/plant and highest profit in Tamil Nadu region. NPK application @ 100:100:75 g/m² is recommended for getting good growth and flowering in cv. 'Montezuma' in Eastern region.

For the control of black leaf-spot disease (Diplocarpon rosae) a spray of Mencdzeb (0.2%) or Captan (0.2%) or Copper oxychloride (0.2%), 6 times at an interval of 10 days during June to August, has been proved effective in Maharashtra region. To control die-back disease (Diploidiia sp., Botrydiploidiia sp. and Colletotrichum sp.) a spray of Captan 50 WP (0.2%) or Mencdzeb (0.2%) or Copper oxychloride 50 WP (0.2%), immediately after pruning and 2 sprays thereafter at an interval of 10 days, is recommended for Maharashtra region.

**Gladiolus**

The variety 'Hunting Song' has been recommended for commercial cultivation in Hessaraghatta, Ludhiana, Pune and Udaipur conditions and for export as cut flowers.

A dose of 40 g N, 10 g P and 20 g K/m² is recommended for Punjab, Karnataka and Maharashtra regions. For Eastern India, a dose of 50 g N, 30 g P and 20 g K/m² is recommended.

Use of Captan (0.3%) or Thiram (0.3%) or Emisan (0.2%) has been recommended for control
of Fusarium wilt for Maharashtra region. Dipping the corms for 15 min in the Captan 50 WP (0.3%) or Thiram 75 WP (0.3%) or Benlate (0.2%), after harvesting of corms, has been recommended for the control of storage rot of corms (Fusarium sp.) for Maharashtra region.

**Chrysanthemum**

Among the white cultivars, 'KLS 6' for Eastern region and 'IIHR Sel-5' for Rajasthan region have been recommended for commercial cultivation. 'IIHR Mut-9' for Karnataka region and 'Nanake' for Eastern region are the recommended yellow cultivars for commercial cultivation. Among other coloured varieties, 'Red Gold' for Coimbatore and Pune, 'IIHR Sel-5' for Udaipur, and 'Varsha' for Pune conditions are recommended for commercial cultivation. The variety 'Shyamal' is recommended for cut flower production under Udaipur condition.

**Carnation**

Cultivars 'Red Gorse' for Solan and Ludhiana; 'Scania' for Pune, Kodaikanal and Kalimpong; 'Arthur Sim' for Kodaikanal; and 'Pamir' for Solan conditions were found suitable for commercial cultivation.

A dose of 30 g N, 20 g P, 10 g K/m² and 40 g N, 20 g P, 10 g K/m² were found optimum for standard type cv. 'Arthur Sim' and spray type cv. 'Sam's Pride', respectively, under Solan conditions for best results of growth and flowering.

The extension of light for 2 and 4 hr during winter months is recommended for the production of quality flowers under Ludhiana conditions.

**Tuberose**

Two promising hybrids, viz. 'Shringar' (with single flowers and pinkish buds) and 'Suvasini' (with double flowers), were released by IIHR, Bangalore. Dipping of tuberose bulbs in neem-leaf suspension, containing spores of Paecilomyces lilacinus for 2 hr before planting effectively controlled root-knot nematodes and increased the flower yield.

**Orchids**

Embryo rescue technique was used to raise hybrids between Dendrobium 'Sonia' and D. 'Kasim White'.

Earthen pot with many holes was the best container for Cattleya orchids. Charcoal alone was the best potting material for Dendrobiums.

Ohio WH was the best nutrient spray at an interval of 14 days. Growth regulator IBA at 2.3 mg/litre gave the maximum number of new shoots.

### Plantation Crops

* Coconut-based vegetable cropping system proved profitable. Coconut wastes proved suitable substrate for cultivation of oyster mushroom.
* A dwarf oilpalm identified.
* Two hybrids of cashew, 'H3/28' and 'H2/16', gave higher yields. A higher success rate achieved in soft wood grafting of cashew.
* Cardamom 'Mudigese 2' and coriander 'UD 20' released. Four cumin entries under various stages of release. Two turmeric varieties, 'Acc. 360' and 'Acc 361' proposed for release.

### Coconut

In the coconut-based vegetable cropping system, snake gourd variety, 'Arka Sheetal' (Rs 6,378/ha) and brinjal variety, 'Pusa Purple Cluster' (Rs 7,255/ha) were highly profitable during the rainy season. In the rabi season, bottlegourd variety, 'Arka Bahar' (Rs 5,477/ha) and okra variety, 'Pusa Sawani' (Rs 2,756/ha) were better. Among the summer vegetable crops, brinjal variety, 'Pusa Purple Cluster' (Rs 8,344/ha) was more profitable. Amaranthus variety 'Kannara Local' (Rs 5,374/ha) was also profitable. The oil percentage in coconut (var. 'WCT') showed an increase of 12% in 8-9 month-old nuts as compared to 6-7 month, which was maintained up to maturity. However, after 12 months, a decrease of 2.9% was observed. Iodine value and free fatty acids were higher in the early stages.

Coconut wastes such as coir dust, bunch waste, leaf stalk and leaflets were found to be suitable substrates for cultivation of oyster mushroom, Pleurotus sajor-caju. Spawn and cropping was done in a low cost mushroom house built exclusively of coconut materials such as coconut wood and pleated coconut leaves inside a
coconut garden. The yield of mushroom per bed of 3 kg wet substrate was highest in bunch waste, followed by leaf stalk, leaflets and coir dust.

In the coconut-based HDMSCS trial at Kahikuchi, model 1 with crop combination coconut + black pepper + banana + Assam lemon + pineapple + ginger was found most remunerative with net return of Rs 15,348/ha compared to Rs 8,147/ha in control plot.

In the management of Thanjavur/Ganoderma wilt disease, *Trichoderma harzianum* with green leaves, neem-cake and FYM + Bordeaux mixture continued to give less disease intensity than control. At Ailyarnagar, application of neem-cake combined with Tridemorph followed by Kitazin 2% root feeding as well as application of *P. fluorescens* were found effective for the control of Ganoderma wilt.

**Oilpalm**

A dwarf compact oilpalm was identified from the Nigerian collection. Under FAO-TCP-funded programme, germplasm of cold tolerant oilpalm were collected from Camaroon, Tanzania and Zambia. The new collection is very useful for India to develop high-yielding cold-tolerant hybrids of oilplam.

At Gangavathy, Rhinoceros beetles in oilpalm were treated with baculovirus culture and released in the compost pit. The post-treatment observation after 5 months revealed that there was reduction in the leaf damage.

**Cashew**

Two hybrids, viz. 'H 3/28' (T.No. 56 x M 10/4) and 'H 2/16' (T.No. 1 x T.No.40), from Bapatla, Andhra Pradesh gave a yield of 18.1 kg - 28.0 kg/tree in evaluation of *F*₁ hybrids.

Foliar application of urea along with insecticides (2%) increased the yield at Bapatla, Bhubaneshwar and Jhargram; and 4% was found effective at Vengurla and Vridhachalam research stations.

In vegetative propagation of cashew by soft wood grafting, 82% success was recorded at Bapatla, 76.25% at Bhubaneshwar and 75.1% at Vridhachalam centres.

A total of 306,165 grafts of cashew produced at different co-ordinating centres were distributed during 1995 planting season.
SPICES

Seventy-six wild Piper collections were made from Gorusappa, Akumbe, Kudremukh and Thalakaveri forest areas in Karnataka, and Sugandhati and other forest areas in Kerala. The most significant among the collections were the bold-berried P. nigrum and P. sugandhi types with a spike length of more than 25 cm.

The cardamom acc. 'CL 683' has been recommended for release as variety 'Mudigere 2' by the State Variety Release Committee of Karnataka. Coriander variety 'UD-20' has been released by the State Variety Release Committee for Rajasthan. Turmeric 'PCT 19', and ginger 'V_S_7' and 'V_S_2' are under pre-release seed multiplication at the Pottangi centre (Orissa). The promising ginger line 'SG 666' of Solan centre has been recommended for cultivation in Himachal Pradesh.

Two turmeric varieties developed through open pollinated progeny selection are being proposed for release. The characteristic features of these varieties are given in Table 1.

Table 1. Salient features of new turmeric varieties proposed for release

<table>
<thead>
<tr>
<th>Identity</th>
<th>Pedigree</th>
<th>Av. yield (fresh) (t/ha)</th>
<th>Maturity (days)</th>
<th>Dry recovery (%)</th>
<th>Curcu-min (°)</th>
<th>Curcu-min per ha*</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Acc. 360'</td>
<td>Open pollinated progeny selection</td>
<td>35.67</td>
<td>206</td>
<td>19.0</td>
<td>7.2</td>
<td>432.95</td>
</tr>
<tr>
<td>'Acc. 361'</td>
<td>-do-</td>
<td>38.60</td>
<td>198</td>
<td>18.0</td>
<td>7.0</td>
<td>423.00</td>
</tr>
</tbody>
</table>

* Provisional.

Cumin entries, viz. 'UC 216', 'UC 217', 'UC 218' and 'UC 198', under various stages of release. Cumin 'UC 198' has higher tolerance to wilt and possesses maximum volatile oil content (4.9%).

Protocols have been standardized in black pepper to regenerate plants from callus in 100 days.

Surveys conducted in Idukki, Wynad and Kodagu districts of Kerala and Karnataka have indicated that the coleoptera predators Chilocorus circumdatus, Pharoscymnus horni, Pseudoscymnus sp., Cybocaphalus sp. and the hymenopteran parasite Encarsia lousburjil were the important natural enemies of the scale insects Lepidosaphes.
piperis and Aspidiotus destructor infesting black pepper.

A fertilizer dose of 125 kg N, 100 kg P and 100 kg K /ha has been recommended for ginger in Orissa, which gave the highest yield (14.35 t/ha). A seed rate of 25 kg/ha and fertilizer level of 40 kg N/ha and 40 kg P₂O₅/ha in fenugreek has been recommended for Rajasthan.

Exotic cumin entries, viz. 'EC 243373', 'EC 243375' and 'EC 232684', were found to be resistant against Fusarium wilt disease, when tested under sick plot conditions in Jobner, and fenugreek 'EC 257566, (Bulgaria) showed resistance against powdery mildew (Erysiphe polygoni) under field conditions at Jagudan (Gujarat). In the screening of coriander germplasm at Jobner (Rajasthan), 'UD 20' and 'UD 21' showed resistance against root-knot nematode (M. incognita).

Root cuttings (0.2 million) of popular high-yielding varieties, viz. 'Sreekara', 'Subhakara', 'Panchami' and 'Pournami', 30 tonnes of seed rhizomes of high-yielding turmeric varieties, viz. 'Suvarna', 'Suguna', 'Sudarshana' and 'Alleppey'; 23,800 seedlings/grafts of tree spices; 26,000 cardamom seedlings; and 1,800 kg of cardamom seed capsules were distributed as nucleus planting materials to various developmental agencies and progressive farmers for further multiplication and field planting.

**Medicinal and Aromatic plants**

* Two varieties each of palmarosa oil grass, and vetiver released

* First variety of Pipal, 'Cheemathipalli', released

* For the first time, a large number of crosses made in betelvine

Two new varieties of Palmarosa oil grass ('CL 80-68' and 'TW 4498'), two of vetiver ('NC 66403' and 'NC 66416') and one of pipal (Piper longum) were released. Pipal variety 'Cheemathipalli' is the first ever released variety of the crop.

Black gram-poppy rotation has been found to be more remunerative over maize-poppy system (practised in Madhya Pradesh). Application of 45
kg P₂O₅/ha, either in kharif or rabi season, fulfilled the need of the opium crop for phosphorus nutrient and gave optimum crop yield.

Seed treatment with Trichoderma harzianum alone and in combination with Bavistin @ 1 g/kg of poppy seed significantly reduced the root-rot incidence in opium poppy crop. Similarly, spraying of Methyl demeton (0.5%) effectively controlled the green peach aphid in opium poppy.

Betelvine
For the first time, a large number of successful crosses were made in betelvine in the country and seedlings were raised. Evaluation of hybrid seedlings are in progress.

Three applications of inoculated oilcake with Paecilomyces lilacinus @ 500 kg/ha showed maximum control of root-knot nematode and also yielded maximum number of leaves.

A unique software on Disease Expert System has been developed for the first time under the AICRP on betelvine to help the growers and field level extension workers to diagnose the diseases effortlessly with the help of a PC. It also helps in getting the recommended control measures at finger-tips.

Post-harvest Technology
PI-IMA (Imidizole) was found to be very effective for the control of post-harvest anthracnose and stem end rot diseases of mango. Mango powdery mildew was controlled by Calixin, Karathane and Systhane @ of 0.1%.

In mango, a post-harvest fruitfly (Bactrocera dorsalis) control, useful for quarantine and exports was standardized. Immersion of fruits immediately after harvest in hot water (48°C) or salt solution (5%) for 1 hr gave 100% infestation-free fruits.

A mobile multipurpose starch separation plant for separation of starch in sweet potato tubers was designed and fabricated. The plant can be operated with or without using cellulolytic and pectinolytic enzymes. Recovery of starch was enhanced to the extent of 6-7% over control using enzymes. Value-added products like jams, sauce and pickles were produced from sweet potato.

In rose, pulsing with sucrose (3%) + citric acid (300 ppm) + 8-HQC (200 ppm) has been recommended to achieve the best keeping quality of cut flowers for Punjab region. Pre-cooling of
rose flowers at 4°C-8°C for 24 hr followed by simulated transit for 24 hr under ambient conditions is recommended for improving the vase life of cut flowers.

After 3 years of trial at Ludhiana, it has been recommended that flowers of gladiolus should be harvested at tight bud stage and should be treated with 20% sucrose and 200 ppm 8-HQC for 24 hr for extending the vase-life of cut flowers.

Mobile, multipurpose starch extraction unit, developed at CTCRI, Thiruvananthapuram is useful for the extraction of starch from sweet potato.
Soils, Agronomy and Agroforestry

- Agro-ecological unit (AEU) maps for 6 districts of Gujarat and Maharashtra prepared to minimize limitation of generalizing technologies to wider domains
- Surveys indicated nearly 151 m ha area of India as having moderate to severe land degradation problems
- Estimations showed 6.1% table-lands as going out of cultivation in 20 years due to ravine problems in Kota and Baran districts of Rajasthan alone
- Grasses such as Arundo donax and Saccharum munja found very useful in channel stabilization
- Mixed covers proved more effective in conservation of soil and water
- A high-yielding variety of Lasiurus sindicus developed to improve fodder availability in the north-western parts of Rajasthan
- Conjunctive use of organics in cropping systems not only saved fertilizer-N but also sustained the benefits of fertilizer
- Sulphur deficiency was on increase
- Compatibility of bio-inoculants, Trichoderma viride and Rhizobium, in pea crop suggested a possible reduction in agrochemical use
- Recommended tillage practices not only overcame different physical constraints of soils but also significantly improved crop yields
- Simultaneous planting of sugarcane and wheat in December in northern India greatly improved the crop yields and profits of the farmers
- Water-efficient cropping systems identified for Gandak, Mula and Bhavani Sagar irrigation commands
- In rainfed situations, regions identified wherein productivity of pearl millet could be enhanced or stabilized with response farming strategies
- Species of trees for furrow planting technique identified
- In arid regions survival and growth of tree plantations enhanced significantly by practising saline irrigation

SOIL MANAGEMENT

Agro-ecological Zones in Gujarat/Maharashtra

For district level land-use planning, information on eco-unit level is necessary. Using the basic criteria and methodology for delineating agro-ecological regions (AER), subregions (AESR) and zones (AEZ), agro-ecological units (AEU) were delineated by narrowing the limits of soil and climatic attributes which influence plant growth.
most. Maps for 6 districts, viz. Rajkot, Ratnagiri, Nagpur, Jalna, Aurangabad and Pune, were finalized.

**Soil Degradation Study**

A human-induced soil degradation map of India has been prepared using the GLASOD approach. About 187.7 m ha is having different kinds of soil degradation problems. Water erosion is causing the loss of top soil in 132.5 m ha. The terrain deformation covers an area of 16.4 m ha. Wind erosion, which is mostly dominant in western region, accounts for an area of 13.5 m ha. The chemical deterioration is in 13.8 m ha, causing salinization (10.1 m ha) and loss of nutrient and organic matter (3.7 m ha). An area of 11.6 m ha is affected to varying levels by waterlogging. If the area under slight severity of problem is excluded, the total affected area comes to 151.0 m ha which represents 46% of the total area.

**An Alternate Land-use System for Marginal Rainfed Lands of the Doon Valley**

For the rainfed conditions of Doon Valley, CSWCR & TI, Dehradun, developed a multistorey cropping model which consisted of 3 components. Kinnow planted as top storey at a spacing of 5m x 5m, turmeric planted as ground cover in interspace of kinnow and mulberry (Morus alba) all round the orchard as border hedge row. After 5 years of establishment, kinnow-turmeric-mulberry system provided 4.6 tonnes of kinnow fruits, 1.02 tonnes of turmeric, 1.58 tonnes of sticks for basket making, 2.04 tonnes of fuelwood and 0.81 tonnes of mulberry leaves per hectare.

**Ravine Ingression Rates in Kota**

Approximately 30% of the ravines in Rajasthan are in the districts of Kota and Baran along the river Chambal and its tributaries. Eight villages in Kota district were resurveyed after 20 years to...
assess the ingress of ravines into table-lands. The average compound rate of advancement of ravines was 0.87% per annum. A 100 ha ravine area would thus expand to 104, 109 and 119 ha in 5, 10 and 20 years respectively. The area under shallow, medium-deep (depth 1–5 m) and deep ravines increased by 3.7, 2.0 and 0.4% respectively. The study suggested that the area of table-lands would decrease by 6.1% in 20 years. The diagnostic survey revealed the need for immediate corrective measures in this region.

**Effect of Monoculture and Mixed Forest Covers**

Run off and soil loss from identical areas planted with *Eucalyptus globulus* (blue gum) and *Acacia mearnsii* (black wattle) singly or in mixture were compared with undisturbed sola (*Aeschy-nome ne aspera*) cover in a small catchment at Udthagamandalam (Tamil Nadu). Wood yield from the mixed plantation was much higher (600 m³/ha) than the pure plantations of blue gum (456 m³/ha) or black wattle (322 m³/ha). Mixed plantations thus provide greater biomass, satisfy people's need and maintain ecological balance.

**Grass Species for Channel Stabilization**

For checking sediment movement into reservoirs and stabilization of channels, measures such as brushwood check dams, vegetative gully plugs and vegetative filters are commonly used. *Arundo donax* (bara nal) and *Erianthus murya* (sarkanda) were most suitable for channel stabilization. *S. munja* grass was also an effective vegetative barrier in arresting silt and stabilizing bund and slopes.

**ARID ZONE RESEARCH**

**Groundwater Resources along the River Saraswati in Jaisalmer, Rajasthan**

To improve water availability, the scientists at CAZRI, Jodhpur, undertook geophysical investigation on exploration of groundwater along the palaeo-channels of the Saraswati in western parts of Jaisalmer district in Rajasthan. A potential aquifer was located about 3.5 km east of Tanot and towards Ghantial. From available lithologs a provisional 3/D perspective graphics of the aquifer characteristics was prepared.

**Simple Technique to Remove Tannins**

The leaves of khejri plant (*Prosopis cineraria*) contain tannins which adversely affect fodder quality. To remove tannins, a simple technique involving 12-hour soaking of leaves in 5.3% sodium carbonate was evolved. This greatly improved the quality of top feed.

**High-yielding Cultivar of *Lasiurus sindicus* Grass**

A high-yielding strain of *Lasiurus sindicus* ('CAZRI 30-5'), developed at CAZRI, was recommended for release in north-west India. Its foliage is dark green, leafy and highly nutritious. Cultivar yields 9.71 tonnes of green fodder and 3.26 tonnes of dry fodder per hectare, on an average.

**FERTILIZER MANAGEMENT**

**Long-term Effect of Chemical Fertilizers and Crop Productivity**

Long-term fertilizer experiments conducted in intensely irrigated rice-rice and rice-wheat systems showed that despite application of recommended doses of NPK fertilizers there was a decline in soil organic carbon content vis-a-vis rice productivity. However, the productivity of wheat in calcareous soils was maintained in rice-wheat system with integrated use of NPK fertilizers and farmyard manure. In acidic soils continuous application of nitrogenous fertilizer alone led to degradation in soil health and fertility due to increased solubilization of aluminium and iron. Liming and incorporation of farmyard manure along with recommended doses of NPK fertilizers ameliorated the harmful effects of toxic aluminium and iron concentrations and restored productivity in acidic red loam soils.

**Microbiological Transformation of Nutrients in Soybean-based Cropping System**

Effect of selected fertilizer treatments on microbial biomass dynamics and release of C, N and P was studied in soybean-based cropping system in the black soil regions of Madhya Pradesh. The cumulative evolution of CO₂ and the net release of C, N and P markedly increased with addition of urea-N and/or FYM. However, the combined effects of urea-N and FYM on CO₂ evolution were not of additive nature. Thus combined use of chemical and organic fertilizers improved the available pool of soil nutrients and built up the microbial activity of soils (Table 2). The reduced annual biomass
turnover (ratio of biomass C loss/biomass C build up) improved the soil health and also the yield of soybean and wheat.

**Table 2. Biological activity and release of C,N, and P upon application of fertilizer N (kg/ha) and organics**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Cumulative CO₂ evolution (pg/g)</th>
<th>Enzyme activity</th>
<th>Net release of biomass nutrients to soil (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DHA (µg)</td>
<td>Urease (µg)</td>
<td>C</td>
</tr>
<tr>
<td>Control</td>
<td>86</td>
<td>53</td>
<td>85</td>
</tr>
<tr>
<td>50 kg N</td>
<td>95</td>
<td>80</td>
<td>164</td>
</tr>
<tr>
<td>8 tonnes FYM</td>
<td>103</td>
<td>82</td>
<td>95</td>
</tr>
<tr>
<td>50 kg N + 8</td>
<td>169</td>
<td>99</td>
<td>101</td>
</tr>
</tbody>
</table>

**Critical Limits of Sulphur in Soils and Plants of Soybean**

Although sulphur (S) deficiency in soybean is said to be emerging in intensively cultivated areas of Vertisols in Madhya Pradesh, the reliable critical limits of sulphur in soils and plants are not known. These were investigated in 30 field experiments conducted on Islamnagar series (Vertic Ustochrepts). A critical limit of 11.25 mg S/kg soil (0.05 M CaCl₂ extractable) and 0.34% S in plant differentiated the S-deficient soils from those of the non-deficient. The application of 40 kg S/ha increased the grain yield by 70-450 kg/ha and seed oil content by 16-24%.

**Fertilizer Recommendations for Cropping Sequences on One-Time Soil Test**

In India, 429 soil testing laboratories serve 164.6 million ha of cropped lands of 97.16 million holdings through analysis of 5.33 million samples. Testing soil before every sowing season is costly and difficult. All-India Co-ordinated Research Project on Soil Test Crop Response developed a method wherein fertilizer recommendations were based only on initial soil test values. This method were for fingermillet-sorghum cropping sequence. Fertilizer adjustment equations were worked out for targeted yields of fingermillet. Soil test values were computed after the harvest of fingermillet. Input soil test value for the succeeding sorghum crop was estimated without actual soil analysis, using the initial soil test values, fertilizers applied to previous crop, the yields of first crop in the sequence and the coefficients for these factors. The method is very useful for reducing soil sample congestion in the laboratories.

**Enhancing the Population of Azospirillum**

For increasing the yield of rice crop, location-specific strains of *Azospirillum* spp. with higher population are required. Treatment of soil with 2,4-D applications up to 1-5 µg/g soil enhanced the colonization of *Azospirillum brasilense* CA-10 in 'IR 50' rice crop both in the rhizoplane, and histosphere and rhizosphere regions.

![Graph showing log numbers of Azospirillum](image)

Population of *Azospirillum* spp., which is used for increasing the rice yield, can be induced by using different concentrations of 2,4-D. A, nil; B, 0.5 ppm; C, 1.0 ppm; D, 1.5 ppm; E, 2.0 ppm.

**Evaluating Azotobacter-inoculation Methods in Wheat**

*Azotobacter*-inoculation techniques (i) spraying, (ii) coating and (iii) spraying and coating, were evaluated with 6 varieties of wheat in a field trial. *Azotobacter* inoculation of wheat cultivars increased grain yield by 2-20%. Maximum improvement in grain yield (18-19%) was in wheat varieties 'HUW 213' and 'HUW 234'. The crop cultivars differed considerably in their ability to develop symbiotic association with microbes. Spraying and coating technique performed better than spraying or coating.

**Eupatorium adenophorum for Green Manuring**

*Eupatorium adenophorum*, a weed locally known as *banmara* (forest killer), grows profusely in the north-west Himalayas. The succulent weed has on an average 1.8% N, 0.3% P and 2.0% K. The experiments for utilization of the weed as organic manure showed that incorporation of weed in soils...
Banmara (Eupatorium adenorum) weed improves the fertility and yield when used as organic manure along with nitrogenous fertilizer. A, control (zero N); B, Eupatorium @ 2.5 tonnes/ha; C, Eupatorium @ 5.0 tonnes/ha; D, Eupatorium @ 2.5 tonnes and N @ 60 kg/ha; E, Eupatorium @ 5.0 tonnes and N @ 60 kg/ha; F, N @ 100 kg/ha (CD at 5%, 0.26) along with 60 kg N/ha improved the fertility and wheat yield.

Compatibility of Biocontrol with Biofertilizer on Pea Crop

*Trichoderma viride* is used for disease control in place of chemical pesticides, whereas the *Rhizobium* culture packets (biofertilizers) are used as biological nitrogen fixers to legume crops. Compatibility of these inoculants with pea crop was studied. Results revealed no inhibitory effect with *Trichoderma viride* alone or in combination with *Rhizobium* spp. Response to inoculation varied from variety to variety but in general maximum yield was observed with combined inoculum of *T. viride* and *Rhizobium* spp. over single inoculum.

Overcoming the Soil Physical Constraints for Enhanced Productivity

Field trials showed that adoption of appropriate tillage practices on different types of soil can significantly improve the crop yield over the conventional practices. Table 3 indicates that adoption of raised and sunken beds in black soils improved the soybean yield by more than two folds. Other simple practices such as ploughing across the slopes, compaction and clay mixing, residue incorporation and chiselling to a depth of 35 cm at 100 cm interval can improve the yield of crops by 17–56%.

Periodic Changes in Micronutrients Status of Soils

To forecast emerging trends of micronutrient deficiencies, resulting from intensive cropping, increased use of fertilizers, increased irrigation and overall better crop management practices, compilation of large information generated by various centres of scheme for 8 states was done. It revealed that deficiency of zinc has declined by 25, 18, 7 and 5% in soils of Haryana, Punjab, Gujarat and Uttar Pradesh, respectively (Table 4), whereas incidence of zinc deficiency in soils and crops of Tamil Nadu, Madhya Pradesh and Bihar increased to 7–16%. This might be attributed to the regular use of zinc sulphate by the farmers of northern states. Awareness about use of zinc sulphate and easy availability of genuine zinc fertilizer need to

Table 3: Effect of adoption of improved tillage practices for different soils on rainfed crop yields (tonnes/ha)

<table>
<thead>
<tr>
<th>Soil</th>
<th>State</th>
<th>Matching tillage</th>
<th>Farming system</th>
<th>Crops grown</th>
<th>Yield</th>
<th>Conventional</th>
<th>Improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy/loamy soil</td>
<td>Rajasthan</td>
<td>Clay mixing-cum-compaction</td>
<td>Rainfed</td>
<td>Pearl millet</td>
<td>1.12</td>
<td>1.55</td>
<td></td>
</tr>
<tr>
<td>(Ushtipsamment)</td>
<td></td>
<td>Ridges across slope, incorporation of rice husk</td>
<td></td>
<td>Taramitra</td>
<td>1.09</td>
<td>1.44</td>
<td></td>
</tr>
<tr>
<td>Red sandy loam</td>
<td>Andhra</td>
<td>Chisel ploughing 35 cm deep and at 100 cm interval</td>
<td>Rainfed</td>
<td>Sorghum</td>
<td>1.73</td>
<td>2.03</td>
<td></td>
</tr>
<tr>
<td>(Ustos ortent)</td>
<td>Pradesh</td>
<td></td>
<td></td>
<td>Castor</td>
<td>1.61</td>
<td>1.47</td>
<td></td>
</tr>
<tr>
<td>Red sandy loam</td>
<td>Tamil</td>
<td></td>
<td>Rainfed</td>
<td>Tomato</td>
<td>16.90</td>
<td>20.62</td>
<td></td>
</tr>
<tr>
<td>(Haplustall)</td>
<td>Nadu</td>
<td></td>
<td></td>
<td>Castor</td>
<td>1.88</td>
<td>2.35</td>
<td></td>
</tr>
<tr>
<td>Black soil</td>
<td>Madhya</td>
<td>Raised and sunken beds</td>
<td>Rainfed</td>
<td>Black gram</td>
<td>0.36</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>(Chromustert)</td>
<td>Pradesh</td>
<td></td>
<td></td>
<td>Black gram</td>
<td>2.53</td>
<td>3.22</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tomato</td>
<td>1.53</td>
<td>1.97</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sorghum</td>
<td>1.36</td>
<td>1.59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Black gram</td>
<td>0.13</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Soybean</td>
<td>0.98</td>
<td>2.31</td>
<td></td>
</tr>
</tbody>
</table>
Table 4. Periodic changes in zinc deficiency over a decade in soils of various states

<table>
<thead>
<tr>
<th>State</th>
<th>1970-79 (a)</th>
<th>1980-89 (b)</th>
<th>Net decrease (-) or increase (+) in % deficiency (b-a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of soil samples</td>
<td>Samples deficient (%)</td>
<td>No. of soil samples</td>
</tr>
<tr>
<td>Haryana</td>
<td>7,511</td>
<td>77</td>
<td>13,350</td>
</tr>
<tr>
<td>Punjab</td>
<td>8,706</td>
<td>55</td>
<td>6,641</td>
</tr>
<tr>
<td>Gujarat</td>
<td>7,072</td>
<td>29</td>
<td>18,944</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>4,488</td>
<td>67</td>
<td>5,570</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>2,619</td>
<td>54</td>
<td>3,300</td>
</tr>
<tr>
<td>Bihar</td>
<td>6,314</td>
<td>42</td>
<td>6,746</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>4,537</td>
<td>58</td>
<td>8,069</td>
</tr>
<tr>
<td>Tamil Nadu*</td>
<td>4,255</td>
<td>32</td>
<td>19,433</td>
</tr>
<tr>
<td>Total</td>
<td>45,502</td>
<td>52</td>
<td>82,053</td>
</tr>
</tbody>
</table>

*Includes value for Pondicherry

be created to avoid further depletion of soils of Madhya Pradesh, Bihar and Tamil Nadu.

**Sulphur Status of Indian Soils**

Analysis of 3,822 surface soil samples collected from Bihar, Gujarat, Haryana, Punjab and Madhya Pradesh indicated that availability of sulphur(S) ranged from 0.5 to 798.3 ppm. The mean value of available S was 26.5 ppm for the soils of above states. The mean available S content of Madhya Pradesh, Gujarat, Punjab, Haryana and Bihar soils was 18.0, 18.9, 22.2, 32.0 and 88.6 ppm respectively. Sulphur deficiency ranged from 2 to 64% in soil samples from different states. On an average 28.4% soil samples were S deficient. Deficiency of S was widespread in shallow black soils of Madhya Pradesh and loamy sand soils of north Gujarat, whereas it was minimum in Punjab and western parts of Haryana which may be attributed to higher content of S in irrigation water and use of gypsum for reclamation of salt-affected soils. The clayey *tal* land of Bihar had low S deficiency compared to medium black clay soils of Madhya Pradesh as well as Calciorthents of Bihar. Groundnut and other oilseeds and pulses grown in S-deficient soils showed significant response to S application. Application of 20 kg S/ha at Coimbatore, Anand and Hyderabad increased the pod yield of groundnut by 1.4-2.9 q/ha and seed yield of mustard by 2.2 q/ha at different centres.

**RAINFED AGRICULTURE**

**Efficient Use of Harvested Rainwater**

For efficient, cost-effective utilization of rainwater harvested in the farm ponds, 2 crops in each season, particularly a cash crop with high returns, need to be grown. At Bangalore, net return of Rs 18,908/ha was achieved in 1 year by following groundnut-chilli double-cropping system (Table 5). Irrigation of 5 cm to groundnut increased the pod yield by 15%, the net return from 1 irrigation being Rs 576/ha. The response of chillies to irrigation was much higher than groundnut.

**Table 5. Yield and economics of groundnut-chilli in double-cropping system at Bangalore during 1993-94**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (q/ha)</th>
<th>Net return (Rs/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No irrigation</td>
<td>14.4</td>
<td>6,096</td>
</tr>
<tr>
<td>One irrigation (5 cm)</td>
<td>16.6</td>
<td>7,672</td>
</tr>
<tr>
<td>Chilli</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No irrigation</td>
<td>6.8</td>
<td>4,844</td>
</tr>
<tr>
<td>One irrigation (5 cm)</td>
<td>10.0</td>
<td>12,732</td>
</tr>
<tr>
<td>Two irrigations (5 cm each)</td>
<td>10.4</td>
<td>13,084</td>
</tr>
<tr>
<td>Three irrigations (5 cm each)</td>
<td>12.9</td>
<td>18,908</td>
</tr>
</tbody>
</table>

**Using Organics to Substitute Fertilizer Nitrogen**

In rainfed agriculture, fertilizer use remains low mainly due to inherent risk and poor economic condition of the farmers. Therefore, low-cost nutrient sources need to be explored to supplement the chemical fertilizers. An experiment was conducted for 3 years to evaluate the performance of farm residues fitted in an integrated N-supply system. Information on N availability and use and grain yield of sorghum as affected by N management system is presented in Table 6.

Mineral N (KCl extractable) in soil, sampled at 50 days after seeding (DAS), was higher with *Leucaena-* and *Glicieidia*-based systems, particul-
larly under conjunctive use with urea-N (47-55 ppm), compared to control (41 ppm). Apparent use efficiency of applied N and agronomic efficiency were higher with urea and conjunctive N use systems.

**Control of Seepage Losses in Farm Ponds**

In drylands rainwater is stored in dug-out ponds and recycled during dry spells. Control of seepage losses in farm ponds continues to be a problem.

Unit cost of stored water and useful life of ponds with different lining materials (for 500 m³ pond), A, CL 3; B, asphalt; C, soil-cement; D, brick masonry with plaster.

Four pond lining materials, viz. CL 3, asphalt, soil cement and brick masonry plaster, were compared for their effectiveness and the cost of stored water. The unit cost for storing water was least with brick lining because of the longer life span of 20 years. The initial cost was, however, maximum in brick lining amounting to Rs 40,000 as against Rs 10,000–16,000 in other materials which were having a short life span of 3–5 years.

**Low-cost Plough Planter for Seeding Rainfed Crops**

A low-cost plough planter was designed and field tested for sowing rainfed crops like groundnut, maize, castor, pigeonpea, etc. This is similar to the drill plough developed by CRIDA earlier except that the precision seed metering mechanism is based on inclined plate. With its use, saving in labour and seed (Rs 900/ha) was achieved and also more uniform stand of crop was obtained. The plough-planter costs around Rs 800 but is subsidized by the Government of Andhra Pradesh. Its commercial production has been taken over by Andhra Pradesh Agro-Industries Development Corporation.

**Table 6. Nitrogen availability, grain yield and N-use efficiency by sorghum in an integrated nutrient management system (average of 40 and 80 kg N/ha applied)**

<table>
<thead>
<tr>
<th>Management system</th>
<th>Mineral N at 50 days after seeding (ppm)</th>
<th>Grain yield (tonnes/ha)</th>
<th>Apparent N-use efficiency (%)</th>
<th>Agronomic efficiency (kg grain/kg N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>46</td>
<td>1.80</td>
<td>47.2</td>
<td>20.5</td>
</tr>
<tr>
<td>Sorghum stover</td>
<td>41</td>
<td>0.91</td>
<td>5.2</td>
<td>5.0</td>
</tr>
<tr>
<td>Leucaena loppings</td>
<td>47</td>
<td>1.12</td>
<td>14.9</td>
<td>8.5</td>
</tr>
<tr>
<td>Gliricidia loppings</td>
<td>57</td>
<td>1.54</td>
<td>27.4</td>
<td>16.5</td>
</tr>
<tr>
<td>Urea + sorghum stover</td>
<td>42</td>
<td>1.78</td>
<td>39.1</td>
<td>20.0</td>
</tr>
<tr>
<td>Urea + Leucaena loppings (1:1)</td>
<td>52</td>
<td>1.78</td>
<td>41.6</td>
<td>19.5</td>
</tr>
<tr>
<td>Urea + Gliricidia loppings</td>
<td>57</td>
<td>2.01</td>
<td>49.9</td>
<td>25.5</td>
</tr>
<tr>
<td>Control</td>
<td>41</td>
<td>0.61</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CROPPING SYSTEMS RESEARCH

Response of Rice-Wheat System to Phosphorus and Farmyard Manure Application

Both rice and wheat responded significantly to phosphorus (P) application (Table 7) on a P-deficient Ustochrept soil (Olsen's P-6.8 mg/kg soil). The response was higher in wheat (33.4%) than rice (20.5%). Skipping of P application to either of the crops resulted in significant yield depression. FYM applied to rice @ 10 tonnes/ha along with N and K fertilizers benefited both the crops but could not meet the P demand of the system. With FYM application, however, P fertilization in one of the crops (rice or wheat) can be skipped without adversely affecting yields.

There was a general decline in productivity of both the crops with the passage of time. The yield decline, however, was lower in rice (10.4%) than in wheat (22.6%). FYM application helped in improving yields initially but that could not be sustained.

Crop Response to Sulphur in Rice-Wheat System

Field experiment on S-deficient Ustochrept soil (available S, 5.8 mg/kg soil) of Project Directorate for Cropping Systems Research, Modipuram, Meerut, indicated that application of 60 kg S/ha,

Table 7. Effect of P and FYM (10 tonnes/ha) application on the grain yield (tonnes/ha) of rice-wheat system (pooled data of 4 crop cycles)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rice No FYM</th>
<th>FYM</th>
<th>Wheat No FYM</th>
<th>FYM</th>
<th>Total No FYM</th>
<th>FYM</th>
</tr>
</thead>
<tbody>
<tr>
<td>No P₂O₅ (control)</td>
<td>4.47</td>
<td>5.00</td>
<td>2.98</td>
<td>3.47</td>
<td>7.45</td>
<td>8.47</td>
</tr>
<tr>
<td>60 kg P₂O₅ to rice</td>
<td>5.36</td>
<td>5.68</td>
<td>3.66</td>
<td>4.03</td>
<td>9.02</td>
<td>9.71</td>
</tr>
<tr>
<td>60 kg P₂O₅ to wheat</td>
<td>4.99</td>
<td>5.53</td>
<td>3.96</td>
<td>4.22</td>
<td>8.95</td>
<td>9.75</td>
</tr>
<tr>
<td>60 kg P₂O₅ to both</td>
<td>5.53</td>
<td>5.87</td>
<td>4.20</td>
<td>4.37</td>
<td>9.73</td>
<td>10.24</td>
</tr>
</tbody>
</table>
using gypsum as a source of S, increased the yield of rice and wheat up to 19 and 23%, respectively, over control. In the sandy loam soil at Modipuram, 90 kg S/ha to rice left residual effect for wheat crop. The effect was equivalent to 30 kg S/ha applied directly to wheat. At lower rates of S application in rice, the residual effect was not substantial. At 30 kg S/ha application, efficiency of S use (based on grain yields per kg S applied) was 14 and 19 kg in rice and wheat respectively. The response of crops to S (kg grain/kg S) declined with the increase in the level of S application.

**New Planting Technique for Sugarcane and Wheat in a Cropping System**

In western UP, Haryana, Punjab and some parts of Bihar, sugarcane is planted after harvest of wheat. It gets little tillering span, and hence yields low. An agro-technology was developed to plant sugarcane and wheat simultaneously in December. Sugarcane was planted in 72 cm apart rows and 3 rows of wheat were adjusted between 2 rows of sugarcane. To complete the planting and sowing together, a tractor-drawn planter-cum-seed drill was also developed.

The technology resulted in a yield of 73 tonnes/ha millable canes and 3.3 tonnes/ha wheat grains (Table 8). This cane yield was 79% higher than that obtained by planting sugarcane after harvest of wheat (40.6 tonnes/ha)

**WEED MANAGEMENT IN CROPPING SYSTEM**

**Parthenium hysterophorus**

Experiment on efficacy of sulfonyl urea herbicides against *Parthenium hysterophorus* L. in non-cropped situation revealed that chlorimuron ethyl (20 g/ha) gave good control of *Parthenium*. It was similar to 2, 4-DEE (2.0 kg/ha) and Glyphosate (1.5 kg/ha). Application of Atrazine considerably reduced the number of flowers and seeds of *Parthenium*.

Post-emergence application of Bentazon @ 1.5 kg/ha (25 DAS) gave good control of *P. hysterophorus*, other broad-leaved weeds and

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Wheat</th>
<th>Sugarcane</th>
<th>Total productivity of the system (tonnes/ha)</th>
<th>Net profit (Rs/ha/crop sequence)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(tonnes/ha)</td>
<td>(tonnes/ha)</td>
<td>(sugarcane equivalent)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grains</td>
<td>straw</td>
<td>Plant</td>
<td>Ratoon</td>
</tr>
<tr>
<td><strong>T₁</strong>: Wheat- sugarcane- ratoon (Dec (May)</td>
<td>3.9</td>
<td>4.8</td>
<td>40.6</td>
<td>47.7</td>
</tr>
<tr>
<td><strong>T₂</strong>: Sugarcane (72 cm) + wheat (3 rows)-ratoon (simultaneously in Dec)</td>
<td>3.3</td>
<td>5.1</td>
<td>73.0</td>
<td>62.9</td>
</tr>
<tr>
<td><strong>T₃</strong>: As in <strong>T₂</strong> +25% high seed rate</td>
<td>3.5</td>
<td>5.4</td>
<td>69.4</td>
<td>59.5</td>
</tr>
<tr>
<td><strong>T₄</strong>: Sugarcane (90 cm) + wheat (4 rows) ratoon (simultaneously in Dec)</td>
<td>3.5</td>
<td>5.8</td>
<td>69.4</td>
<td>61.6</td>
</tr>
<tr>
<td><strong>T₅</strong>: As in <strong>T₂</strong> + 25% high seed rate</td>
<td>3.6</td>
<td>5.8</td>
<td>66.8</td>
<td>60</td>
</tr>
<tr>
<td><strong>T₆</strong>: Sugarcane (Feb) - ratoon*</td>
<td>NA</td>
<td>NA</td>
<td>74.7</td>
<td>63.2</td>
</tr>
<tr>
<td><strong>CD at 5%</strong></td>
<td>0.4</td>
<td>1.3</td>
<td>10.6</td>
<td>3.6</td>
</tr>
</tbody>
</table>

*: To compare sugarcane yields only.
Cyperus spp. and thus increased soybean yield.

Saccharum spontaneum
The integrated management of Saccharum sp. was studied with the application of Glyphosate (1.5 kg/ha) alone and in combination with summer ploughing. The highest reduction in shoot numbers was recorded during rainy season with Glyphosate (1.5 kg/ha) + summer ploughing in dhaincha-wheat rotation followed by soybean-wheat rotation.

Cyperus sp.
The density of Cyperus sp. was more in soybean-mustard-moong (300% cropping intensity) followed by soybean-fallow (100% CI) and soybean-wheat (200% CI).

Weed and Farming System
The long-term effect of farming system on the distribution of weeds showed that weeds caused 35.34% reduction in grain yield in soybean and 14.15% in wheat. Application of Pendimethalin @ 1.25 kg/ha in soybean and Isoproturon @ 1.0 kg/ha in wheat significantly reduced the weed population and weed dry matter and increased the grain yield of both the crops.

In maize-pea system, the weed caused 36.89% and 16.62% reduction in grain yield of maize and pea respectively. Application of Atrazine (2.0 kg/ha) in maize and Pendimethalin (1.25 kg/ha) in pea significantly reduced the weed population and dry matter production and hence increased the yield of maize by 31.37% and of pea by 7.20%.

Weed Physiology
Cuscuta (Cuscuta trifoia) plant residue was phytotoxic to aquatic weeds at 0.25-0.50% on dry weight basis. Etheral at 1000 ppm caused total germination in Cyperus iria and Sporobolus sp. Gibberlic acid at 1000 ppm caused germination of Polypogon sp.

Parthenium leaf residue at 1% (w/v dry basis) acted as a herbicide and also as nutrient medium for paddy plants grown in sand culture. The evapotranspiratory loss of water was replenished with tap water. The medium fully controlled aquatic weeds placed in it and all paddy plants gave ears and yields near normal.

Diara Land Research

Efficient Cropping Sequences
In Brahmaputra diara of Assam, cropping sequence involving sweet potato followed by rice was found most economical with benefit: cost ratio of 2.87. Cropping sequence involving buck-wheat followed by rice (ahu season) was also economical with benefit: cost ratio of 2.50. Highest rice equivalent production of 17.471 kg/ha/year was obtained in greengram-potato-rice sequence. In late-sown conditions potato-rice sequence resulted in highest productivity of 22.844 kg/ha/year. The sequence involving potato+rajmah intercropping followed by rice was also worth adopting with productivity of 15,266 kg/ha/year.

Development of Agro-techniques
In Saryu diara of Uttar Pradesh, intercropping lentil with mustard, both in 4:1 and 6:1 row ratio, was distinctly better than raising wheat with mustard and lentil in 6:1 or 9:1 row ratio. The highest gross income of Rs 12,048/ha and wheat equivalent of 33.5 q/ha was obtained in lentil+mustard (6:1 rows) intercropping system. Among the pure stands of wheat, lentil and mustard, lentil gave highest gross return of Rs 8,250/ha.

Application of 60 kg P₂O₅/ha was significantly better than other levels for obtaining higher yield of gram (18.0 q/ha) in Ganga diara of Bihar. For effective weed management in wheat, application of 2, 4-D at 1.5 kg a.i./ha followed by hoeing was the best, resulting in a yield of 35.4 q/ha.

Agrometeorology

Model for Predicting Phenophases of Pigeonpea
Agrometeorological studies in pigeonpea brought out the importance of temperature on leaf area development, dry matter production, development of phenophases and yield.

The following linear regression model was developed for predicting the onset of different phenophases of pigeonpea (Y) at Anand in Gujarat, using temperature data:

\[ Y = -0.2314 + 0.056 \text{GDD} \quad R² = 0.98 \]

A multiple regression model developed to predict grain yield accurately, 30-40 days in advance, is:
\[ Y = -12.245 + 0.011 \text{RF}_4 - 0.58 \text{MinT}_8 + 0.83 \text{VP}_2 + 0.018 \text{GDD}_8 - 0.012 \times \text{PAR}_8 \]

Where, \( Y \) is grain yield (q/ha); RF (P4) is total rainfall during the initiation of secondary branches to flower bud initiation; Min T (P8) is average minimum temperature in phenophase P8 (50% flowering to 50% podding); VP2 (P8) is average afternoon vapour pressure (mm of Hg) in phenophase P8; GDD (P8) is accumulated growing degree days in P8 (emergence to flower bud initiation); and PAR (P8) is accumulated photosynthetically active radiation (MJ/m²/day) in the phenophase P8 (flower bud initiation to 50% podding).

Characterization of Crop-growing Environment of Pearl Millet

In the north-west India, pearl millet is the most important kharif crop predominantly sown in rainfed areas. The spread and productivity of the crop are controlled by climate, soil, biotic and abiotic factors. Studies on characterization of crop-growing environment of pearl millet in Haryana based on the above factors led to the demarcation of the state into 6 zones having (i) high spread and high productivity comprising Hisar district, (ii) high spread and low productivity comprising Bhiwani and Mohindargarh districts, (iii) medium spread and high productivity covering Jind district, (iv) medium spread and medium productivity in Rohtak and Gurgaon districts, (v) low spread and high productivity covering Karnal and Kurukshetra districts, and (vi) low spread and medium productivity comprising Ambala, Sirsa and Faridabad districts. Based on these studies the regions where the crop productivity can be enhanced and stabilized with appropriate response farming strategies were suggested.

At Solapur, a significant and inverse relationship was observed between grain yield of pearl millet and the average stress degree days (STD) up to grain formation stage, i.e. canopy-air temperature differential \((T_c - T_a)\) experienced by the crop up to grain formation stage. The relation obtained was:

\[ Y = 392.0 - 239.3 \text{STD} \quad R^2 = 0.79 \text{ for grain yield} \]
\[ Y = 716 - 557 \text{STD} \quad R^2 = 0.73 \text{ for stover yield} \]

It would thus be possible to predict the expected yields and explain the yield variations as influenced by different drought-management practices using the STD. In spite of low rainfall during the kharif cropping season (174 mm) the studies brought out that preparation of ridges and furrows before sowing helped in better conservation of the scarce soil moisture leading to slight decrease in mean daily stress degree days (-0.4) leading to a significant (100 kg) increase in grain yields.

Effect of Rainfall on Groundnut Productivity

Studies on productivity potentials of various districts in Saurashtra region revealed that mean productivity of groundnut was directly influenced by the mean seasonal rainfall of the district (Table 9).

<table>
<thead>
<tr>
<th>District</th>
<th>Mean seasonal rainfall (mm)</th>
<th>Mean productivity (kg/ha)</th>
<th>Coefficient of variation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amreli</td>
<td>543.5</td>
<td>716.3</td>
<td>45.73</td>
</tr>
<tr>
<td>Bhavnagar</td>
<td>528.9</td>
<td>671.3</td>
<td>53.07</td>
</tr>
<tr>
<td>Jamnagar</td>
<td>506.8</td>
<td>568.8</td>
<td>71.39</td>
</tr>
<tr>
<td>Junagadh</td>
<td>807.9</td>
<td>957.3</td>
<td>41.00</td>
</tr>
<tr>
<td>Rajkot</td>
<td>526.7</td>
<td>587.8</td>
<td>61.01</td>
</tr>
</tbody>
</table>

Based on the analysis, Jamnagar and Rajkot were classified as lowest productivity potential districts for groundnut production.

At Anantapur, pod and haulmyields of groundnut were positively related with the moisture availability index (MAI), i.e. ratio of actual evapotranspiration (AE) and potential evapotranspiration (PE) from eighth week after sowing to harvest.

Both at Jabalpur and Ludhiana, the length of growing period was more under early-sowing conditions. With each successive delay in sowing the growing period decreased, adversely affecting the number of ear heads/m², weight of ear head and seed weight per plant resulting in reduction in grain yield by more than 20%. The requirement of heat units was more for early sowing and least for delayed sowing as the phenophases were hastened. It resulted in less energy capture for photosynthesis leading to lesser biomass production and lower grain yield.

MANAGEMENT OF PROBLEM SOILS

Repeat Application of Gypsum on Reclaimed Alkali Soils

Long-term observation in farmers' fields revealed that repeat application of gypsum is neces-
sary for sustainable crop yields in soils where pH value increases. For sandy loam soils having pH (1:2) 8.8 and 9.2 with exchangeable sodium percentage (ESP) of 18 and 25, repeat application of 1.9 and 3.0 tonnes/ha of gypsum, respectively, are considered necessary whereas up to pH 8.5 gypsum application is not required.

**Low-cost Biological Amelioration Technology for Alkali Soils**

Potentialities of low-cost biological amelioration technology involving growing of salt-resistant varieties of paddy ('CSR 10') and wheat ('KRL 1-4') along with a small dose of gypsum, were demonstrated on alkali soils in Aligarh (Uttar Pradesh). The technology is financially feasible.

**Establishing Tree Plantations through Saline Irrigation**

Afforestation programmes in arid areas suffer mainly due to low rainfall, high evaporative demands, high salt content of ground-water and impediment of kankar (calcareous) sub-soil layer for root proliferation. In trials conducted since 1991 at Hisar, tree species like Acacia nilotica, A. tortilis, Azadirachta indica, Prosopis juliflora, Melia azedarach, Tamarix articulata, Cassia siamea, Prosopis cineraria, and Eucalyptus tereticornis performed better. Saline water was utilized by applying reduced amounts of water to only a limited area of furrows. In addition to creation of favourable water regimes in the rooting zone during irrigation, this method pushed the salts towards inter-row areas with monsoon rains. Thus water equal to 10% of the open pan evaporation in the area sufficed for plantations.

**Rainwater Recycling in Lowland Plains of Sunderbans**

In Sunderbans, 20% watershed area should be converted into ponds (with bund). These ponds should be placed at the bottom of the watershed area for high assurance. Based on weekly values of 80% rainfall up to 37th week, 2 supplemental irrigations in 10 years were suggested. Further, using linear programming to optimize rice-based cropping pattern during rabi season with labour and water constraints, different optimal land allocations were suggested.

**Plant Genetic Resources Tolerant to Salinity/Alkalinity and Waterlogging Stress**

**Rice.** The national trial (Saline Alkaline Tolerant Varietal Trial-93) confirmed the superiority of 'CSR 13', 'CSR 19' and 'CSR 18' at many locations. At Ramchandrapuram and Kumarganj, 'CSR 13' ranked second, whereas 'CSR 19' and 'CSR 18' ranked fourth and sixth, respectively, at Kumarganj.

**Wheat.** The All-India Co-ordinated Salinity/Alkalinity Tolerant Varietal Trial conducted at 10 locations indicated that CSSRI wheat varieties, viz. 'KRL 2-22' and 'KRL 13', ranked first and second, respectively, on overall basis. A new variety 'KRL 16' also ranked first in the North-Western Plains Zone.

**WATER MANAGEMENT IN IRRIGATION COMMANDS**

**Efficient Irrigation Methods**

Micro-irrigation methods, though initially capital intensive, are highly efficient for horticultural and plantation crops. At Rahuri, in black clay soils, drip irrigation on alternate days produced 157 tonnes/ha cane yield, about 20% higher than the traditional surface irrigation methods. It also saved irrigation water up to 44%. The sugarcane was planted by paired-row method and the drip laterals were installed within the pair of sugarcane crop to economize the cost of the drip system.

At Parbhani, in heavy clay soils, alternate-day drip irrigation in banana produced bunch yield of 55 tonnes/ha, 13% higher than the surface check basin method of irrigation. Drip method economized 24% irrigation water.

Alternate-furrow irrigation in cotton at Parbhani in deep black clay soils economized about 39% irrigation water, as compared to irrigation in each furrow, without adversely affecting seed cotton yield. Similarly, at Bhatinda in Punjab, alternate-furrow irrigation increased seed cotton yield by 28% over check basin irrigation (1,873 kg/ha) besides substantial saving in irrigation water.

**Water-use Efficient Cropping Systems**

In Gandak Irrigation Command at Pusa (Bihar), rice-sunflower-blackgram crop sequence in sandy loam soil gave the maximum net return with 3 irrigations, each of 7 cm depth, applied to rice crop after 3 days of subsidence of ponded water; 1
irrigation to sunflower at IW: CPE (irrigation water: cumulative pan evaporation) 0.6 with 6 cm irrigation depth and 1 irrigation to black gram at 30 days after sowing besides 1 pre-sowing irrigation.

In Mula Irrigation Command at Rahuri, when water was sufficient for 3 irrigations, sunflower-sorghum was the most remunerative crop sequence with 2 irrigations in kharif and 1 in rabi, followed by groundnut-sorghum crop sequence with similar levels of irrigation. With availability of 5 irrigations, groundnut-sorghum gave higher net returns with 2 irrigations in kharif and 3 in rabi.

At Bhavanisagar, in sandy loam soils, turmeric intercropped with onion gave additional net return of Rs 3,500 over turmeric alone (Rs 71,038/ha). This was followed by turmeric intercropped with soybean.

**Efficient Irrigation Schedule for High-value Crops**

**Sunflower.** At Kota, in clay soils, 3 irrigations of 6 cm depth, 1 each applied at bud initiation, disc formation and achene development, produced achene yield of 2.36 tonnes/ha of sunflower during rabi season. At Hisar, in spring-planted sunflower, 5 irrigations applied at IW: CPE 0.5 with 6 cm depth produced significantly higher achene yield (1.91 tonnes/ha) over lower irrigation regime. The interaction between irrigation and fertilizer levels was significant and the treatment combination of IW: CPE 0.5 and 120 kg N + 60 kg P₂O₅/ha produced highest achene yield of 2.45 tonnes/ha.

**Cotton.** At Bhatinda (Punjab), in sandy loam soils, 6 irrigations, each of 7.5 cm depth, applied at IW : CPE 0.9, produced seed-cotton yield of 2.63 tonnes/ha. Delay in first irrigation up to 49 days did not significantly depress the yield compared to that with irrigation at 21 or 35 days after sowing. At Navasari, in clay soils, 8 irrigations each of 8 cm depth applied at IW : CPE 0.75 produced the highest seed cotton yield in rabi season.

**Banana.** In sandy loam soils at Bhavanisagar (TN), application of 5 cm irrigations at IW : CPE 1.0 in first 7 months followed by IW : CPE 1.2 till maturity with gradual widening of the basin, produced high fruit yield (42 tonnes/ha). At Chalakudy, banana (cv. Nendran) produced the highest fruit yield of 8.12 kg/plant with irrigation applied at 20 mm CPE (total delta 220 cm). Delay in irrigation to 40 or 60 mm CPE reduced the fruit yield significantly.

**Vegetables.** At Navasari, on clayey soils, 7 irrigations, each of 8 cm depth applied at IW/CPE 0.8 to tomato produced a fresh fruit yield of 26 tonnes/ha. Further increase in irrigation was not of any benefit. At Memari, in silty loam soils, 4 irrigations at IW : CPE 1.2 with 5 cm depth produced highest curd yield of cauliflower (12.2 tonnes/ha).

**Evaluation of Open Drains in Delta Area of Orissa**

Effectiveness of open drains was evaluated in Kushbhadra Bhargavi doab. The study revealed that the surface drainage has modified the rice ecosystem by reducing depth and duration of ponding, thereby decreasing the risk of submergence of kharif paddy. It induced the farmers to use high-yielding varieties and more chemical fertilizers. Paddy yield increased by 29-34%. Cropping intensity also increased marginally (3-5%).

**Improving Hydro-thermal Regime and Crop Productivity by Straw Mulching**

Application of straw mulch @ 5 tonnes/ha in groundnut and 16 tonnes/ha in pointed-gourd improved hydro-thermal regime and suppressed weed growth resulting in significantly higher crop yield than no mulch treatment.

**OPTIMIZATION OF GROUNDWATER UTILIZATION**

**Suitable Pumps for Varying Water-table**

Studies based on annual cost of pumping and power requirements showed that farmers should install centrifugal pumps if the water level below ground surface is up to 13 m and opt for submersible pumps below 13 m depth.

**Augmenting Groundwater Recharge**

At Shingve (Rahuri) in the hard rock region of Maharashtra, it was found that out of total pond storage of 30.50 ha-m, a total volume of water recharge to wells located up to 2 km downstream of the pond was to the tune of 24.68 ha-m. It increased the number of wells and well yields for better crop production in the dry region.
Solar Photovoltaic (SPV) Pumping System for Irrigation

Performance evaluation and optimal utilization of solar photovoltaic pumping system are being carried out under a collaborative project of ICAR and MNES. It was found that 800 watts pump was able to pump about 60,000-100,000 litres of water per day depending upon solar insolation and depth of water-table. It irrigated an area of 0.6-1.5 ha under different crops. Water-utilization efficiency can be improved further by coupling the system with microsprinklers/drips for irrigating orchards and vegetable crops.

Agroforestry

Diagnostic and Design Survey

Studies were undertaken to diagnose the problems of agroforestry and suggest suitable interventions in the farming systems. These studies revealed the shortage of fuel, fodder and timber in different agro-ecological zones. At Solan, the shortage of wood for packing cases was the main constraint. In Maharashtra, fuel deficiency was observed in all the zones. It was more acute in Ghat zone. There was considerable wasteland in Marathwada region with poor tree density in agricultural land. Here the farmers preferred planting of fruit trees along with teak and neem.

In salt land of Rajasthan, Uttar Pradesh, Punjab and Haryana, some halophytes like Suaeda fruticosa, Aeleuropus lagopoides and Cressa cretica could tolerate salinity up to 72.6/dsm.

In Gangetic plains of Faizabad under subtropical climate agri-horti system of agroforestry was dominant. Prosopis cineraria is an important silviculture tree in Rajasthan with a density of 20-25 trees/ha. Acacia senegal planted as fence is a source of fuel too. Usually the large and medium farmers keep 10-20% of their land for silvi-pastoral or pastoral purposes.

Tree leaves are utilized as green fodder during lean periods. The leaves of P. cineraria and Ziziphus nummularia are the major top feed as stall feeding. Flushes of A. nilotica, A. tortilis, Capparis aphylla and Salvadora oleoides are also browsed by the camel.

Plantation of poplar and sissoo in agri-silviculture and citrus in agri-horticulture system is common in plains, irrigated and brackish groundwater areas of Haryana. Silvi-pastoral system of agroforestry involving tree species of P. cineraria, A. nilotica and Allantus excelsa, and grasses like Chenchus ciliaris and Dichanthium annulatum is the most suitable system for sand dune areas.

Promising Agroforestry Tree Species

Tree species were raised in arboretum at Solan and Manipur centres and identified for different altitudes and their uses. Neem (Azadirachta indica), bakain (Melia azedarach) and eucalyptus, from large, medium and small crown groups, respectively, were most promising under rainfed conditions of Maharashtra. Casuarina, a root nodulated tree, was tolerant to salinity and suitable for coastal areas in Tamil Nadu. At Midnapore in West Bengal, the height, number of branches and girth were maximum in Acacia auriculiformis and Leucaena leucocephala among 30 tree species tested. G-3 and G-48 clones of Populus deltoides showed better performance among 30 clones evaluated for their growth and breeding characteristics at Pantnagar.

Management of Agroforestry System

At Pantnagar, wheat yield was relatively higher under the canopy of bakain (M. azedarach), shisham (Dalbergia sissoo), siris (Albizia lebbeck) and gutel (Trilivia nudiflora). A marginal effect of fertilizer up to 150% levels was found better. Lemon grass (Cymbopogon flexuosus) in agrilivicultural system with poplar showed only marginal response to nitrogen application. Fodder tree species like Bauhinia variegatea, Albizia lebbeck and Melia azedarach with wheat at 5 m row-to-row and 4 m plant-to-plant spacing produced 30 q of wheat grain, 45-50 q wheat straw, 75-90 q leaf fodder and 60-100 q of fuelwood/ha annually when the trees were lopped twice or thrice a year.

The reduction in ragi (Eleusine coracana) yield was 43% when transplanted in between the 2 lines of Acacia auriculiformis and 32% in case of Leucaena leucocephala. At Konkan region in Maharashtra, ragi with Acacia auriculiformis has been recommended for maximum income from marginal lands.

The maximum biomass production of 85.82 tonnes/ha in Casuarina equisetifolia and 72.15 tonnes/ha in Acacia auriculiformis was recorded at closer spacing under Konkan condition. Agave americana planted at 0.5 m x 0.5 m spacing was a suitable fencing tree at Dapoli.

At Dehradun, better crops were obtained in east-west direction probably due to more reception of solar radiation. Both side trenched plots.
Established silvipasture gave dry forage yield of 6.78 tonnes/ha, whereas it was 2.98 tonnes/ha with natural grassland. Besides dry leaf fodder, trees also provided 3.62 tonnes/ha fuelwood. I recorded 19% higher yield of sorghum fodder and 39% higher of oat than non-trenched plots. Significant reduction in yield was up to 4 m from the tree base line.

The productivity of ginger as an under-storey crop in a 4-year-old *Ailanthus* plantations was substantially altered by the density of over storey trees at Kerala Agricultural University, Thrissur. A comparison of 32 plant data, however, showed that root competition between *Ailanthus* and ginger is of a relatively lower magnitude in such an agri-silvicultural system. The relative proportion of photo-synthetically active radiation intercepted by the tree crowns increased with the tree population density. The highest density, i.e. 3,333 trees/ha, intercepted as much as 65% of the incoming solar radiation at a height of 50 cm above the ground level.

Planting of *M. azedarach* and growing of *dhaincha (Sesbania aculeata)* in the rainy season, for green manuring, followed by wheat or barley during the winter, brought down the salinity to one-third (from ECe 9.35 to ECe 3.40) and to one-sixth (ECe 0.61) if *dhaincha* is followed by berseem, in just 3 years.

Close planting (5 m × 5 m) of trees in agroforestry at Hisar decreased the yield of under-storey crops drastically besides causing problem in tractor movement. A 10-m spacing between plants facilitated inter-cultural operations and provided sufficient light to the under-storey crops.

In sissoo/jamun-based agri-horti system of agroforestry, fodder crops were least affected by shade followed by wheat and the most affected were pulse crops. Wheat varieties 'WH 542' and 'WH 533' were more shade tolerant than other varieties.

At Dharwad, growing of teak, papaya and pasture crop along with field crops in different spatial adjustment in alley cropping resulted in higher net return by Rs 9,146-10,563/ha/year than growing field crops only. Similarly, benefit cost ratio was 11.08 in agroforestry system as against 10.39 in field crops. In clayey soils, teak.
fodder grasses and field crops pay more with sapota.

At Shillong, Indian alder (*Alnus nepalensis*), tree bean (*Parkia roxburghii*) and champak (*Michelia champaca*) proved more suitable multipurpose trees for biomass production and for ameliorating fertility of acid soils. Tea flourished well in the shade of Indian alder as the system created favourable microclimate. Trees also enriched soils with 5.2 tonnes/ha/annum from litter and root biomass.

A sequence of ginger/turmeric followed by french bean-groundnut as intercrops with guava and khasi mandarin was highly remunerative without affecting fruit yields. From third year onwards pineapple was the most promising intercrop with guava.

Mulberry variety ‘BC 259’ gave best rate of rearing of ‘NB 18’ silkworm (10,000 larvae) followed by varieties ‘TR 10’ and ‘TR 4’. The silk ratio was highest in ‘Kanva 2’ under sericulture-based agroforestry system at Barapani, Meghalaya.

Under saline sodic soil conditions of Faizabad, *Eucalyptus officinalis* and *Psidium guajava* in an silvi-horti system of agroforestry gave encouraging results. Under silvi-pastoral system, napier performed well in association with *Dalbergia sissoo*.

Under rice-based cropping system in mahua and *karonda* plantations, rice - spinach gave better yield of rice and also showed maximum growth of trees.

**TRIBAL AND HILLY AREAS**

**New Selections**

Two selections of *bai* and *yamuk* rice were found promising for upland. These had an yield potential of 28-30 q/ha. ‘RCPL 3-2’ and ‘RCPL 3-6’ are being recommended for commercial cultivation in mid-altitude wetland areas of Sikkim. ‘TRC 87-251’ and ‘TRC 229-41’ were promising in Tripura, ‘RCPL 3-5’ and ‘RCPL 3-6’ did well under mid-altitude areas of Manipur.

In pulses, the performance of 10 selections from cross of urdbean (RUC lines) and field pea (TRC-pea lines) was promising and these selections are in F₅ generations.

**Conservation Farming**

Coconut-growing undulating areas are subject to severe soil erosion @ 5-15 tonnes of soil/ha/year. Vetivar grass and lemon grass can be effec-
tively utilized as life bunding to check soil erosion, whereas growing of leguminous cover crop like calopo (*Calopogonium mucunoides*) decreased the soil erosion, increased soil fertility and checked moisture loss from the soil.

**Improving Productivity of Vegetable and Fruit Crops**

Vegetable growing is difficult in Andaman and Nicobar Islands, due to high level of rainfall, temperature and humidity. Cowpea variety ‘Arka Garima’ was promising yielding about 12 tonnes/ha of eatable pods through application of GA-3 and NAA 20 ppm.

**Double Cropping of Rice**

Short-duration rice varieties suitable for the agronomic condition of 7-month-long rainy season of Andaman and Nicobar Islands were developed. Rice genotypes IR- 18350-2293, S, P, 681032 and NJ 50707 yielded 4.7, 4.26 and 4.1 tonnes/ha respectively.
Farm Implements and Machinery

* Production of manually operated rice transplanter taken up by 3 manufacturers in Punjab

* Three out of 4 commercially produced units of self-propelled high clearance sprayer costing about Rs. 110,000 purchased by farmers

* Circular saw attachment to power tiller developed for use as tree felling machine

* Work-rest-cycles for different draft animals evolved at various locations

* Solar dryer for onion flakes developed

* Plant based materials from neem, pongam and nochi found effective against insects in foodgrain storage

* Use of plastics found promising in some aquaculture activities

* Foot-operated ginning machine for use by cotton breeders for small samples developed

* Process for making isoamerttolide from aleuritic acid transferred to chemicals manufacturer

Animal-drawn Puddler

An animal-drawn lugged wheel puddler developed at Bhopal has a draft of 60 kgf, covers 1-1.2 ha/day and saves 30 - 40% time compared to the local wooden comb puddler.

Manual Rice Transplanter

The 6-row manually operated rice transplanter was further improved at Bhopal by providing reverse screw in place of chain and sprocket, and 2 seedling trays instead of 1. This transplanter covers 0.18 ha/day with missing hills being 1-5%. The cost of transplanting was Rs 600/ha.

The Ludhiana Centre demonstrated manually
operated rice transplanters in farmers' fields covering 28 ha. The Centre supplied 35 transplanters to the farmers for their extensive use. They have also organized training programmes for its popularization. Three manufacturers have taken up its production.

**Bullock-drawn Planter for Bold Seeds**
A bullock-drawn multicrop planter as an attachment to tool frame was developed and tested at the CIAE, Bhopal. Feasibility trials of this equipment revealed satisfactory performance with average field capacity of 0.22 ha/hr for maize and pigeonpea, and 0.15 ha/hr for groundnut seeds.

**Self-propelled High Clearance Sprayer**
The self-propelled high clearance sprayer developed by the Ludhiana Centre has been taken up for commercial manufacture in Punjab. Four units including 3 to farmers have already been sold. This machine can cover 1.75-2.0 ha/hr and costs about Rs 110,000.

**Harvesting of Tall Crops**
At Ludhiana Centre the vertical conveyor reaper wind-rower has been modified for harvesting tall fodder crops like maize and pearl millet. The modified machine has 3 conveyors instead of 2. Its star wheel height has been raised. Extensive trials are in progress.

**Multicrop Thresher**
Feasibility trials of the high capacity thresher on farmers' fields revealed that the output capacity was 0.79, 1.30, 1.34 and 0.73 t/hr for pigeonpea, gram, wheat and soybean respectively.
At Jabalpur Centre the improved multicrop thresher on sunflower was evaluated. The output was 0.32 t/hr with 100% threshing efficiency and 92% cleaning efficiency.

**Vibration Studies on Power Tiller**
The vibration level on power tiller operator's seat was measured, using appropriate instrumentation in different terrains like tar road, farm road, tilled/untilled fields, submerged fields etc. at different throttle settings. The vibration level values obtained were compared with those specified in ISO 2631/1 (1985) in relation to working efficiency, health and safety of the operator. The exposure time to these vibrations should not exceed 2.5 hr.
Higher exposure time may cause severe discomfort, pain and injury.

**Attachments for Power Tiller**

Under the Co-ordinated Project on Power Tillers, new attachments have been developed to make them versatile power sources. One of the attachments is till plant machine developed at Bhopal. It can be used for simultaneous seedbed preparation and sowing operations in soybean and Bengal gram. A single bottom disc plough attachment developed at Pusa can cover an area of about 0.4 ha/day. A rear-mounted power-tiller-operated single row, semi-automatic potato planter with fertilizer applicator was developed at Faizabad. It saves about 40% cost and 85% labour compared to the traditional methods of potato planting. The reaper for harvesting soybean and Bengal gram which is mounted in front of the power tiller covers an area of about 1.2 ha/day. A circular saw attachment to power tiller can be used as a tree felling machine. Its use however is restricted to the trees having stem diameter up to 150 mm.

**AGRICULTURAL DRAINAGE**

**Sub-surface Drainage**

Sub-surface drainage system has been very effective in leaching out harmful chemicals from soil profile. Salts to the tune of 600 kg/ha-cm of drained water have been removed. This resulted in a considerable reduction in soil salinity in the root zone. As a consequence of operating sub-surface drainage, paddy production increased by a minimum of about 0.4 t/ha to a maximum of 1 t/ha.

**Solute Transport Model**

A solute transport model has been developed and validated. Using this model, the predicted values of soil EC, pH, bicarbonates and Ca+Mg were found to be at par with the observed values. The model may be used to determine the irrigation and reclamation strategies for saline-sodic soils.

**ENERGY IN AGRICULTURE**

**Energy Requirement in Crop Production**

For puddling, the energy requirement varied between 1,400 and 2,800 MJ/ha under different treatments with rotavator attached to power tiller.

Locally Available Organic Filters

Cheap and locally available organic filters, e.g. coir fibre and paddy straw, are as effective as the more expensive and conventional mineral filters. Use of organic filter will reduce the layout cost of sub-surface drainage system.

**Effect of Water-table on Yield**

Yields of *kharif* soybean and *rabi* gram have been quantified with respect to water-table depth. A 50% reduction in yield was observed for both the crops when the water-table varied within 1 m as compared to when the same was deeper than 3 m during the crop growth period.
Energy used by small engine and tractor-operated harvesters were found to be 193 and 246 MJ/ha respectively.

A study of energy use in hilly region of Uttar Pradesh showed that domestic activities, crop production and animal care account for 87, 8.4 and 4.6%, respectively, of the total annual energy use in rural areas. Improved chulhas can reduce the energy consumption in cooking besides better environment. Use of domestic biogas plant can supplement cooking energy needs and also provide slurry as manure.

**Fatigue in Animals due to Weather**

A study of physiological response of draft animals at rest and during work in hot, hot humid and winter seasons at 5 locations revealed that fatigue score due to heat load was 4 points higher in summer than in winter under similar conditions. The animals, therefore, should be used during early morning/late afternoon in summer season.

**Work-Rest-Cycle for Animals**

Based on studies for bullocks at Ludhiana, Rewari and Allahabad; for buffaloes at Pantnagar; for camels at Udaipur and Rewari; and for donkeys at Raichur, schedules of work - rest-cycles, from the point of view of comfort to the animals and maximum work output, have been evolved.

**Rotary Mode Operations using Animals**

Operations research trials on use of animals for rotary mode operations revealed that farmers prefer to use animals in this mode for operating chaffcutter, feed grinder and flour grinder.

**RENEWABLE ENERGY SOURCES**

**Biphasic Anaerobic Fermentation of Farm Residues**

Laboratory and pilot plant studies on two-phase digestion of a few selected substrates, viz. banana stem, water hyacinth, eupatorium and poultry litter, gave encouraging results. The biogas yield for deep poultry litter was found to be 1 m$^3$/m$^3$ of digester volume as compared to 0.4 m$^3$/m$^3$ digester volume in case of cattle dung. Volatile-fatty-acid rich liquor obtained from acidogenesis of eupatorium and mixed with cattle dung in batch digester of 1 m$^3$ capacity replaced 40% of the cattle dung. The biogas yield was consistently higher.

**Rice-husk Gasifier**

A 20 kW rice-husk-based, rotating grate-type throatless gasifier has been developed for power generation. The gasifier system produced engine quality gas. Tar content of the gas after cooling and cleaning has been found to be in the range of 70 to 90 mg/Nm$^3$. The system is being evaluated for operating a diesel engine in dual-fuel mode.

**Wind-mill for Fish Pond Aeration**

A savonius wind-mill for aeration of fish pond has been designed. The power required was 0.55 hp. The force and torque involved in the operation of the paddle were 20.5 kgf and 4.1 m-kg respectively. Savonius rotor of 90 cm diameter with 10 cm overlap and 1.5 m height would deliver the required power. The power will be transmitted through a step-up 1:2.5 bevel gear system so as to obtain 90 rpm for paddle wheel aerator.

**Solar Dryer for Onion Flakes**

A solar dryer of 100 kg onion flakes batch capacity developed at Vallabh Vidyanagar can dry the onion flakes to a moisture level of 8% from the initial 80% level at drying temperature of 60$^\circ$C in 4 hr. Colour and flavour of the dried product have been found to be better than of the commercially available product. The dryer consists of 72 m$^2$ of solar air heaters, electrical heaters and blowers.

**Biogas from Bagasse and Press-mud**

A technology for producing biogas from bagasse and press-mud, available to the extent of
Status of Commercially Installed Solar Water Heaters

One hundred and forty solar water-heating systems of capacities 500-80,000 litres per day had been installed in Madhya Pradesh by 1991, mainly in government dairy plants, hospitals, college canteens/hostels etc. Energy savings to the extent of 70-80% were reported in large installations. Scale deposit, breakage of glass and leakage from joints were some of the problems encountered by the users.

About 40 million and 10 million tonnes, respectively, has been developed at CIRCOT, Bombay. With this technology about 60 m³ of biogas has been produced from 100 kg of material in 90 days in an experimental plant of 25 kg capacity. The methane percentage of the gas was around 60%. When bagasse and press-mud were mixed in the ratio of 1:1 and fermented anaerobically with mixed microbial consortia, as much as 50 kg of bio-manure was also produced after the fermentation period was over.

POST-HARVEST TECHNOLOGY

Cleaner-cum-Grader for Spices

A 0.5 hp motor-operated, 100 kg/hr capacity cleaner-cum-grader for spices, based on fluidization principle developed at Bhopal, was evaluated for coriander, cumin and aniseed. The cleaning efficiency of the grader is 95% and the estimated cost Rs 4,000.

Fruit Grader

A fruit grader for round fruits like kinnow, and having capacity of 200 - 250 kg/hr has been developed at the CIPHET, Ludhiana. The commercially produced prototype is estimated to cost Rs 22,000.

Fruit and Vegetable Dehydrator

A solar fruit and vegetable dehydrator developed at the CIPHET, Ludhiana has a capacity of 15 - 20 kg per batch. Potato chips, 2 mm thick could be dried to a moisture of 1.5% from the initial level of about 98% in 8 hr against 30 hr taken for open sun-drying.

Fluidized Bed Dryer for Mushroom

A 2 kg/hr batch capacity dryer for oyster mushroom designed at the TNAU, Coimbatore takes only one-fourth of the time taken by sun-drying. The mushrooms are dried at 50°C after pre-treatment with 0.5% potassium metabisulphite.

Water Chestnut Decorticator

A motorized water chestnut decorticator was developed at the JNKVV, Jabalpur with the decortication efficiency of 99% at 35 rpm and 21% screen perforations. Its capacity was found 150 kg/hr.

Cassava Peeling Knife and Banana Slicer

One person can peel about 114 kg of cassava
per hour by using the knife developed at the CTCRI, Trivandrum. A triple blade rotary banana slicer operated by 75 W motor was designed at Bhopal. It could cut 60 kg bananas per hour into 1.5-2 mm slices.

**Pulse Milling**

A pedal-operated *dal* mill developed at GBPUAT, Pantnagar, can be used for soybean, blackgram and greengram with capacities of 50, 43 and 42 kg/hr, respectively, at milling efficiencies in the range of 73-88%. The mill is estimated to cost Rs 2,000. Mini *dal* mill developed at the PKV, Akola, earlier was improved on the basis of feedback from users. Similarly, the Pantnagar *dal* milling system was improved upon by incorporating sodium bicarbonate pre-treatment for pigeon pea. This system’s cost is estimated to be Rs 150,000 and it requires about 9 m² of floor area.

**Use of Plastics in Aquaculture**

Experimental trials on plastic hatcheries developed at CIFA, Bhubaneshwar, showed that the hatching rate of incubated eggs varied between 60% and 75% depending on the season and fertility percentage. When FRP tank was used for intensive seed rearing, the survival rate was 94% at high stocking density (20-30 million/ha). Temperature of fish ponds water went up by 3.5°-4.5°C, on use of polyhouses.

**Sugarcane Crushers**

Evaluation of bullock as well as power-operated sugarcane crushers having different number of rollers, revealed that increasing the number of rollers beyond 3 is not advisable for dry cane crushing because the increase in juice extraction is limited (1-1.5%), whereas decrease in cane crushing capacity is quite significant (30%).

**Preservatives for Liquid Jaggery**

Out of different preservatives tried for liquid jaggery, only 0.1% potassium metabisulphite or 0.5% benzoic acid worked well with liquid jaggery under sterilized condition.

**Soy-cereal Slurry Dryer**

The soy-cereal slurry dryer developed at the CIAE, Bhopal, can dry 5 kg of slurry (soybean, blackgram and rice in the ratio 20:40:150) in 5 hr from 70% moisture (w.b.) to 5% at drying temperature of 45°C. This dryer is useful for drying of pre-mixed and fermented slurry for idli/dosa ready mixes. Its estimated cost is Rs 10,000.

**Protection of Stored Grains**

At the PAU, Ludhiana it was observed that exposure of wheat/flour kept in metal containers to biogas inhibits infestation. A formulation of *Acorus calamus* and *R. serpentina*, each at 25% was effective in controlling 3 most important insect pests of stored cereals at Pantnagar for 6 months. Exposure of redgram to 70° - 80° C for 15 min killed all life stages of *Callosobruchus chinensis*. Exposure of greengram to a mixture of 80% CO₂, 4% O₂ and 16% N₂ for 24-36 hr could control infestation of a few insects.

Use of leaf bits or extracts of leaf/kernel of neem (*A. indica*), pongam (*P. glabra*) and nochi (*V. negundo*) was found to be effective against certain insects in food grain storage, at the CIAE, Bhopal.

**Safflower Oil/Oilcake Storage**

Safflower oil with initial FFA content of 0.9% could be safely stored in glass, tin and plastic containers for 9 months at the CIAE, Bhopal with FFA content rising to 1.5-3.%. Similarly, safflower oilcake could also be safely stored in gunny and polyethylene bags for about 1 year.

**Gur Drying-cum-Storage Bin**

A gur drying-cum-storage bin of 1 q capacity made of GI sheet was evaluated at Anakapalle.
(high humidity area) and Kolhapur. It proved superior over other methods in use when compared in terms of drying during summer and retaining gur quality during monsoon season.

**Gur-moulding Frames**

Gur-moulding frames developed earlier at the IISR, Lucknow, have become popular in Kolhapur area because of ease in moulding, effectiveness in drying/storage, convenience in handling, packaging and transportation.

**COTTON TECHNOLOGY**

**Mote Grooving Device for Cotton Gins**

A mote grooving device was designed and fabricated at the CIRCOT, Bombay, to cut and maintain mote grooves in gin roller. The device consists of a guide roller, a cutting tool and 2 piece adjustable base fixture. The ginning tests carried out on different cottons using the roller mote grooved by this new device revealed an increase in ginning out-turn by 30-40%. It also showed reduced tendency for chokages resulting in roller damages, prevention of mass irregularities including tags from the ginned lint, reduced effect of lint back-lash that damages the knives, reduced fibre breakages, faster ginning etc.

**Survey of Ginning Factories**

A survey was undertaken by the CIRCOT, Bombay, on the conditions of ginning factories in Andhra Pradesh such as ginning capacity, conditions of machinery, infrastructure facilities available, storage of kapas and ginned lint, pre-cleaning machinery being used etc. A report based on the findings with several recommendations was prepared for distribution to interested ginning factories and the Government agencies concerned.

**Foot-operated Ginning Machine**

A foot-operated ginning machine was designed and fabricated at the Ginning Training Centre of the CIRCOT at Nagpur for ginning of small cotton samples pertaining to different stages of initial trials for evolving new varieties sent by cotton breeders. The machine consists of 2 ginning rollers, a doffer, a lint slide and a chain and sprocket type mechanism. The machine is very sturdy and could be operated even by an unskilled labourer.
Cotton Colour as Grading Index

As the colour of cotton gives a reasonably good idea about the exposure to which cotton has been subjected to in the field for grading purposes, investigations on various aspects of colour determinations using HVI Colorimeter were conducted at the CIRCOT, Bombay. The results indicated that colour is adversely affected by increase in the exposure time and storage period. The presence of trash lowered the whiteness of cotton. The Colorimeter - 930 measurement can be used as a simple tool for grading Indian cottons. It is imperative that absolute measure of colour for raw cotton is essential to assess quantitatively the colour variation present within the bale and to ensure uniform colour of processed material.

JUTE TECHNOLOGY

Jute Composites

Jute-reinforced unsaturated polyester (USP) resin composites exhibited about 50% improvement in flexural strength and modules when the jute non-wovens were either cyanoethylated or acetylated before preparation of the composites. The moisture resistance of jute non-wovens was also improved by the treatments.

Tubular Fabric from Jute

Tubular fabric woven out of composite jute

De-inking of Waste Paper Pulp

While exploring the possibilities for different applications of cellulase enzyme from *Penicillium funiculosum*, it was found that this enzyme could be successfully used for the de-inking of waste paper pulp. It could degrade newspaper pulp to fibrillar level releasing ink, thereby simultaneously accomplishing fibrillation as well as de-inking.

Corrugated Packaging Boxes

The technology for the preparation of writing and printing grade paper as well as kraft paper suitable for the preparation of corrugated boxes for packaging of fruits and vegetables was developed a couple of years back. To ascertain the technical feasibility and economic viability of the technology of preparation of corrugated boxes, large-scale trials were undertaken for the preparation of laminated and non-laminated corrugated boxes suitable for packaging of different fruits by the CIRCOT, Bombay. These boxes prepared from kraft paper of cotton stalk pulp conform to all the specifications and are superior in their performance, as compared to boxes made from conventional raw materials.
yarn as warp and ordinary jute yarn as weft may be made into bags which contain jute as high as 96.5% by weight.

**Safari Suiting from Cotton and Ramie**

Fabric suitable for safari suiting has been developed from cotton warp and ramie/acrylic blended weft yarn.

**LAC TECHNOLOGY**

**New Host for Kusmi Lac**

*Flemingia semialata* is an erect shrub found in tropical or sub-tropical regions throughout India and particularly in Andaman Islands. This shrub is a good host for *kusmi* lac cultivation. During 1994-95 *aghani* crop an average yield of 350 g of broodlac and 166.7 g of sticklac per plant was recorded. The encrustation of *kusmi* lac on this host was quite thick and showed loosening and shattering tendency at the time of crop maturity. This character has great potential and can be used in the host plant improvement programme.

**Improvement in Lac Cultivation Techniques**

A new variant of *kusmi* strain is found to hold significantly high potential for resin production than the conventional variety, as evidenced by the results of trials. A record yield of 21 q of broodlac and 2.10 q of sticklac was obtained from 40 *kusum* trees in *jethuti* crop as against previous records of maximum 17 q only.

**Screening and Evaluation of Safer Insecticides**

The synthetic pyrethroid insecticides Cypermethrin and Fenvalerate (0.00025 - 0.001%) are safe against both the sexes of lac insect without disturbing the sex ratio, and thus maintaining the yield of lac. These insecticides are effective against the early stages of the lac predators.

**Improved Method for Lac Dye Preparation**

An improved method for preparing lac dye from lac waste effluent has been developed. Ca-salt of lac dye gives different shades with different mordants on wool. A spectrophotometric absorption method has been evolved for estimation of lac dye content in commercial samples.

**Fine Chemical from Lac**

A process for making Isoamberttolide (a compound used in perfumery industries shaving musk-like odour) from Aleurtic acid on bench scale has been developed and demonstrated. This technology has been given to M/s Okhla Chemicals, New Delhi. The purity of Isoamberttolide was 99.87% by GLC.
Animal Sciences

* Field progeny testing of crossbred bulls finalized under field conditions

* Second set of test buffalo bulls replaced first set of bulls

* Breeding value of Murrah buffaloes for milk estimated

* Selection Indices constructed using genetic parameters of Alpine crossbred goat

* Improvement of Jamunapari and Barbari goats through selective breeding is in progress

* Fifth Random Sample Broilers Test conducted at Poultry Project Directorate, Hyderabad

* Naked-Neck-gene-carrying population propagated

* Database on various performance traits of indigenous breeds of livestock and poultry prepared at the NBAGR, Kamal

* Yak population of India surveyed and studied

* Field survey of Hariana cattle completed

* Pilot survey conducted on Siri cattle-A threatened cattle breed

* Survey of mithun germplasm completed

Animal Genetics and Breeding

Cattle

Under the Frieswal Project, 473 Frieswal cows were in production stage. The overall least square means for milk yield in 300 days and less, total yield, lactation length and peak yield in first lactation after making adjustments for years and season effects were $2,667.5 \pm 61.7$ kg, $2,923.1 \pm 81.3$
kg, 325 ± 6.1 days and 12.9 ± 0.3 kg respectively. The fertility of Frieswal cows was 50.9% and of bulls 31.9%. So far 163 bulls have been reared at the bull rearing unit and 35 calves were added during the year under report. At the semen freezing laboratory, 88,752 doses of 14 bulls (Frieswal - 11 and Sahiwal - 3) were frozen and 32,675 doses were distributed to 28 military farms. There were 163,340 doses of frozen semen available.

The Frieswal cows dropped their first calf at the age of 910 days with a body weight of 370 kg. The service period ranged from 123.7 ± 10.8 to 221.1 ± 9.8 days and calving interval from 404.2 ± 12.9 to 488.3 ± 11.6 days.

Under the Indigenous breeding project at Ongole Unit, APAU, Lam, 30,655 doses of semen were produced, out of which 6,140 were distributed. Overall conception rate at the germplasm unit was 62.9% and at the associated unit it varied from 23.1 to 77.3%. Average age at first calving, service period and calving interval were 41 months, 139 days and 439 days respectively. The average lactation yield was 645 kg in 212 days with a peak yield of 4.9 kg.

At the Hariana unit, CCS HAU, Hisar, 7,141 doses of semen were produced, out of which 2,930 doses were distributed to different herds. The female conception rate varied from 44 to 58%. Average age of calving was observed to be 1,149 days. Lactation yield in the first lactation was 750.9 ± 56.7 kg in 195.2 ± 10.9 days with a peak yield at 3.9 ± 0.3 kg. The dry period was observed to be 435.0 ± 56.4 days.

Under the field progeny testing programme at the BAIF, Utrikanchan, and the KAU, Mannuthy, semen of 13 Holstein crossbred bulls of which 9 were common was used. A total of 1,123 daughters have been born at the KAU and 204 at the BAIF Unit. Similarly at the PAU Unit, 150 daughters of 10 bulls have been produced.

**Buffaloes**

The first set of test bulls has been replaced by second set of test bulls. The germplasm unit has 60,000 frozen doses in stock. Total milk yield during 1994-95 has been recorded as 402,300 kg as against 314,740 kg indicating an increase by about 23%. Young buffalo bull calves were selected on the basis of dam’s yield (>2,500 kg). Breed characters will also be examined later on.

The breeding values (BV) of Murrah buffaloes for milk production estimated using multiple re-

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**DERMATOGLYPHICS IN FARM ANIMALS**

![Diagram of Muzzle Printing](image)

Muzzle printing in livestock, like finger printing in human beings, has been referred to as possible system of identification. Livestock identification is extremely important for day-to-day management, selection of breeders as well as livestock insurance. Analysis of muzzle prints of Tharparkar, Sahiwal, Karan Swiss, Karan Fries and buffaloes among Indian breeds and German Black and White and German Red and White cattle among exotic breeds has been done. The muzzle prints of each animal could be divided into base, middle and upper sectors, and based on the number of beads, ridges and pattern ridges available in each sector the print could be classified into grooved, non-grooved and special categories. Based on detailed analysis of these patterns, the individual animals could be identified. However, no genetic association between muzzle pattern and production was observed.
gression analysis (MRA) and principal component analysis (PCA) were comparable. The PCA would be more effective if traits are considered.

Study on body weight changes on 215 Murrah buffaloes during the lactation revealed an average body weight loss of 25.7 kg during first month of lactation and animals continued losing more weight up to 5 months of lactation, from then on till the end of lactation (10 months), on an average, buffaloes regained the weight lost during the early month of lactation. Pattern of body weight change over different parities indicated lesser proportion of body weight loss and faster rate of regaining the weight lost in first parity as compared to buffaloes in the later lactations. High producing buffaloes lost significantly more body weight than low producing buffaloes.

**Sheep**

Bharat Merino performed excellently, although there was a slight reduction in annual wool yield compared to the previous year. The body weights were very good — 4.2, 19.7, 23.9 and 32.4 kg — at birth, 3, 6 and 12 months of age. The Gaddi Synthetic showed an annual wool yield of 1.8 kg; and body weights at birth 3, 6, 9 and 12 months were 3.0, 15.5, 17.8, 23.4 and 29 kg respectively. Adult body weights varied from 26.4 to 30.14 kg. Average annual greasy fleece weight in Avikalin was 1.9 kg, close to the target of 2 kg. Rams/ram lambs (52) were made available for breeding purposes. Selection index incorporating greasy fleece weight and body weight at 6 months of age was used for selecting Chokla ram at the CSWRI, Avikanagar. Average performance of progenies of selected rams for body weight and greasy fleece weight at 6 months of age were 20 and 1.2 kg, respectively, as compared to the population average of 17.66 and 1.03 kg respectively.

At the CSWRI, Bikaner, the selective breeding programme was continued by selecting Marwari rams based on an index incorporating 6-month body weight and wool yield. The overall mean in Malpura sheep for 12-month weight was 24.69 kg and the annual greasy wool production was 1.086 kg in Malpura. Annual per cent tupping and per cent lambing and ewes available was probably the highest ever achieved since the inception of the project. Rams (37) were sold for breeding to State Departments and Development agencies. Lambs of Malpura ewes × Awassi rams were heavier at birth and had better growth than the native lambs.
Goat

The genetic parameters in Alpine crossbred goats were estimated and used to construct different selection indices. The 'optimum' index produced expected genetic gain of 1.84% per generation incorporating weight at 18 months, age at first kidding, first lactation milk yield, first lactation length and first kidding interval. First lactation 150 days yield and first kidding interval were found to be the most important traits for prediction of lifetime production in crossbred goats. Improvement of indigenous goat breeds, especially of Jamunapari and Barbari through selective breeding is in progress at the CIRG. In Jamunapari kids mean body weights at 12 months of age increased by 12.7% and milk yield for 90 days lactation by 12.9% over the figures of previous year. Male Barbari kids weighed 20.70 ± 0.40 kg and female kids 17.80 ± 0.40 kg at 12 months of age during the year. The average 90 days milk yield was 22% higher than the milk yield of the previous year. Highest kidding rate of 174% was recorded. Improved Jamunapari and Barbari breeding bucks were supplied to different organizations for evaluation and improvement of village flocks. They were also supplied to the Government of Vietnam.

Besides the breeding and improvement programme of Jamunapari and Barbari goats, a flock/village is being adopted in their respective home tracts. Reproductive performance and growth is being recorded. Bucks have been supplied to adopted villages for breeding purpose. Village flocks appear to be more variable to provide more response for improvement through selection and breeding.

Poultry

The AICRP Centres on Poultry for Egg, have started implementing intrapopulation index selection with the lines assigned to them. The APAU, Hyderabad centre, has started selecting for annual egg production as a criterion for selection. The residual egg production has improved by 11 eggs in IWD, 7 eggs in IWF and 6 eggs in IWK. The total realized improvement due to the annual egg production selection was 12 eggs in IWD, 13 eggs in IWF and 14 eggs in IWK strains in 72 weeks. The centre is continuing selection with same criterion, and is planning to reproduce S19 generation of IWD and S18 generation of IWF and IWK. The mean pureline performance in 72 weeks of age for IWD was 241 eggs, for IWF 267 eggs and for IWK...
253 eggs with satisfactory mean egg weight at 32 weeks of age. The mean egg production of IWN and IWP strains at the KAU, Mannuthy Centre, during S15 generation marginally exceeded their mean performance during S14. The Centre tried to meet the parent stock chicks requirement of poultry farmers of the state. Intrapopulation selection with IWN and IWP strains was started at the GAU, Anand Centre. The required number of chicks for the two strains were obtained from the KAU, Mannuthy Centre. They were grown and the required data have been generated to carry out selection and regeneration of these populations.

Work with Pb-1 and Pb-2 populations is continuing at the PAU, Ludhiana. The required number of chicks have been evaluated for their juvenile body weight. At the centre, hatchability of 84.3% in Pb-1 and 89.4% in Pb-2 were achieved during the regeneration process. The fertility percentage was also at a satisfactory level of 84.6% in Pb-1 and 86.9% in Pb-2 pureline populations. The centre has supplied 11,677 commercial chicks during the year. Hatching eggs from these populations were supplied to the UAS, Bangalore Centre. The Pb-1 population laid 41 eggs and the Pb-2 population laid 57 eggs during 40 weeks of age with satisfactory egg size exceeding 55 g. The survivability of chicks during 1 to 6 weeks was 96.88% in Pb-1 and 96.63% in Pb-2. The test cross made from these two populations, performed better than their parents in body weight at 6 weeks, FCR and survivability during 0 to 6 weeks.

The CARl, Izatnagar Centre, has been working with synthetic broiler male line and synthetic broiler dam line. Average fertility in synthetic male line was 73.6% and hatchability 71.61%. In synthetic male line 2,718 chicks were regenerated. In this population the male progeny weighed 1,601 g and the female progeny 1,372 g at 6 weeks of age. For the synthetic broiler dam line, the required number of breeding birds were selected for regeneration. A fertility percentage of 76 on fertile eggs set was observed. The male progeny weighed 1,249 g and the female progeny 1,120 g at 6 weeks of age.

The JNKVV, Jabalpur Centre, has been working with 2 dwarfing gene carrying populations and a normal bodied sire line population, to develop a package for producing normal bodied commercial broilers from dwarf dams. During the year the third selected generation was being evaluated for
the pureline performance of the dwarfing gene carrying sub-population and the normal bodied sire line population.

At the PPD, Hyderabad, the Fifth Random Sample Broiler Test has been successfully conducted and performance of the participating entries evaluated, compared and reported. During this year, hatching eggs and day-old chicks from Pb-1 and Pb-2 synthetic broiler populations have been supplied as purelines as commercial chicks to different user agencies under the Nucleus Stock Population Unit.

A broiler control and a layer control population have been maintained. Hatching eggs from these populations were made available to different units of the AICRP. In a test mating broilers of this synthetic broiler population weighed more than 1,500 g at 6 weeks of age when grown in battery brooders.

A small population of Naked Neck-gene-carrying birds is also being propagated by repeated backcrosses to the synthetic broiler population birds. Heterozygous Naked Neck chicks from a test mating weighed 1,442 g when fed 20% protein and 2,900 Kcal in battery brooders during winter. The females carrying Naked Neck gene in heterozygous condition matured at 170.3 days and laid eggs weighing 54.57 g at 32 weeks of age and 61.11 g at 40 weeks of age. Their HH egg production was 66.47 eggs and survivor egg production was 69.67 eggs up to 40 weeks of age. These birds will be used to establish a dwarfing gene carrying population and it will serve as a source of sex-linked recessive dwarfing gene for use in research for broiler dwarf dam line populations.

Selection programme is in progress for genetic improvement of 4 White Leghorn populations, viz. G, H, I and J for egg production and other traits of economic importance at the CARI, Izatnagar. The genetic response in egg production up to 40 weeks of age ranged from 1.28 to 1.93 eggs per generation in different populations. ILI-80 commercial layer developed and released by the Institute for Commercial Exploitation topped the Fifth Random Sample Test, Gurgaon. In RIR line, genetic response per generation for egg mass was 76 g up to 40 weeks of age. GHI 3-way cross produced maximum number of eggs up to 40 weeks of age followed by single cross JG.

Five generations of selection resulted in an improvement of 152 g in 6 weeks body weight and Naked Neck birds are performing very well. A dwarfing-gene-carrying population is being established to carry out further research.
318 g in 7-week body weight in OBNP broiler population. In the coloured broiler line the response in 6-week body weight was 50 g per generation. Feed efficiency improved as a correlated response in the body weight line. Positive response, both for growth and feed efficiency, were observed in the index line. These studies also revealed slightly better response in the index line compared to growth line.

The FCR up to 6 weeks of age was 2.09 in SDL and 2.28 in control. The response realized per generation was estimated to be 27.26 g in male and 28.31 g in females for 7-week body weight.

The overall fertility and hatchability in guineafowl were 61.3 and 65.9% respectively. Age at first egg, part and annual egg production had moderate to high heritability. Annual egg production showed high positive genetic as well as phenotypic correlations with part period egg production.

**Camel**

The overall calving rate in a camel herd was 43%. Height, heart girth, sex and breed showed significant effect on birth weight and body weight at 3 months. Bikaneri and Kachchi breeds showed higher potential for milk production, and it showed an increasing trend up to fifth month of lactation. Quantitative differences in amylase, alkaline phosphatase, acid phosphatase and beta dehydrogenase in sera samples from different breeds/sex and age groups were analysed. Age group and sex differences were observed. For immunogenetics studies 180 immunization and hetero-immunizations were used. Work on purification and characterization of immunoglobulins was continued.

**Rabbit**

The target weight of 2 kg at 12 weeks could be achieved in Soviet Chinchilla (SC) and White Giant (WG) rabbits by feeding complete feeds. Litter size at birth (LSB) and weaning (LSW) were 8.1 and 5.9 in SC, and 6.2 and 5.8 in WG at Mannavanur. At Garsa and Avikanagar also LSB was 7 - 8 and LSW 5 - 6.
Animal Genetic Resources

Development of Database on Economically Important Domestic Livestock

A new database has been prepared for recording various performance traits of indigenous breeds of livestock and poultry at the NBAGR, Karnal. Livestock census data for 1987 and 1992 for various states have been added to Livestock Census Data Bank. Sheep and goat population statistics of 15 agroclimatic regions of the country has been estimated. The estimates of various traits on different breeds along with their source of publication were computed and added to breed characteristics data bank. Software package for storing information on the breeding programmes of cattle and buffalo has been developed. Another programme developed makes it possible for the PC to read the data entered into micro-32 in C-language.

Survey, Characterization and Evaluation

The yak (Poephagus grunniens) has excellent adaptation for production in cold arid mountainous ecology. It is a vital source of milk, meat, hide, fibre and draught power to a sizeable population living at high altitudes in India. Average milk-fat % and SNF % of Ladakhi and Kinnauri yaks were 4.40 and 10.82, and 7.00 and 12.46%, respectively. Haemoglobin content of yaks of Ladakh is relatively lesser (11.20%) than those of Himachal Pradesh. Karyotypes of male and female yaks indicated that they have a close homology with domestic cattle. Peripheral blood culture studies showed that yaks possess 60 somatic chromosomes (60, XY and 60, XX complement in male and female respectively). The Y chromosome is submetacentric and all the autosomes are acrocentric. It has been hypothesized that yak and cattle have been domesticated simultaneously from the common ancestor, Aurchos which has now become extinct.

A pilot survey was conducted on Siri cattle of Sikkim and parts of West Bengal. Siri bullocks are the only source of draught animal power available in hilly terrains of Sikkim and Darjeeling district of West Bengal. The main tract of this breed is between 1,220 and 305 m altitude. Siri animals are generally black and white having small hump with compact body, strong legs and prominent hairy pol. The horns are curving outward, forward and inward.

Field survey of Hariana cattle

A field survey on Hariana cattle from selected areas of the breeding tract covering districts of Rohtak, Bhiwani and Sonepat was completed. Further information on the morphometric and performance traits have been collected and salient results are presented as under:

(i) Socio-economic levels of farmers/breeders revealed that small farmers have highest proportion of households rearing Hariana cattle

(ii) Because of shift towards intensive agriculture and disappearing village common grazing lands, the Hariana cattle is now being kept under stall-fed conditions and this has resulted in significant decline in their population. The existing Hariana animals are now being reared for milk production (65.4% of total respondents).

(iii) Hariana cattle herds in the field are still subjected to natural service, in spite of...
network of AI centres in the tract. There were inadequate superior Hariana bulls for maintaining AI services.

(iv) The Hariana cattle is the main component (90%) of total cattle population but this constitutes only 15.4% as compared to 74.4% that of buffaloes in total livestock.

(v) The existing Hariana cattle are white with varying degree of grey and having short, glossy and straight hair, muzzle, black eyelids, black tail switch and prominent poll. Hump, dewlap and naval flap are of medium size. The Hariana bullock is a very good draught animal having sound physique, high working capacity and heat tolerance.

(vi) The average age at first calving, lactation milk yield, lactation length and postpartum open period are 40.1 ±0.21 months, 1,054.9±14.93 kg, 220.0±3.95 days and 81.4±2.89 days respectively.

The existence of Siri breed is threatened because of extensive crossing with Jersey germplasm. Presently it is found in pure form only in the areas which are not motorable.

Animal Genetics

The Bhadawari buffalo has 50 somatic chromosomes comprising 5 pairs of meta/submeta-centric and 19 pairs of acrocentric autosomes. The X chromosome is the largest acrocentric and the Y chromosome is the smallest acrocentric. The gene loci for nucleolus organization were located on chromosome pairs 3, 4, 6, 21, 22 and 24.

The diploid complement of the Kathiawari horse was 64 with characteristic XX and XY sex elements. Total chromosomal abnormalities in equines account for 2-3% of the metaphase spreads. The most common abnormality was tetraploid cells.

The diploid count of guineafowl varied from 70 to 76 chromosomes. The chromosomes could be classified into two sets depending upon their size. Eight pairs of the large-sized chromosomes including a pair of sex-chromosomes were termed as macro-chromosomes. The remaining were micro-chromosomes.

The number of blood group antigens of Ongole and Sahiwal herds at the APAU Lam Farm, Military Dairy Farm, Meerut and NDRI, Karnal, were identified to develop requisite number of antisera for blood typing of cattle.

A sera bank for generating antisera against erythrocytic antigen of cattle has been developed. It has 30 polyvalent antisera ranging from 400 to 800 ml. These sera have been investigated in detail using immunoabsorptions. For typing various indigenous cattle breeds, 40 standard blood group reagents, potent in blood grouping, are available.

Survey of mithun germplasm was completed: Mithuns are only confined to Arunachal Pradesh, Manipur, Nagaland and Mizoram in descending order. Arunachalees (a dual-purpose breed), and Nagamees (a meat-purpose breed) were identified.

The gene frequency of HbA allele was 0.99 in Jamunapari goat and in 1.0 in Marwari, Barbari and Beetal. Frequency of HbA allele in Jamunapari was 0.01. Sodium concentration was highest (40.1 ± 7.45 m.q/litre) in the milk of Barbari goats in fifth week of lactation and lowest (18.3 ± 0.91 m.q/litre) in first week. Sodium concentration showed an increasing trend up to fifth week, remained constant up to eighth week and thereafter declined. Potassium concentration was highest in second
week and lowest in third week. No definite trend in potassium concentration was noted during different stages of lactation.

**RFLP Studies in Cattle and Buffaloes**

Restriction fragment length polymorphisms (RFLPs) are the DNA markers inherited in a Mendelian fashion. Their detection is independent of the phenotypic expression. RFLPs analysis provides a much more potentially powerful and efficient alternative strategy for selection and improvement of livestock.

Studies using RFLPs in zebu cattle and buffaloes indicated that Sahiwal cattle, and Murrah and Nili-Ravi buffaloes were monomorphic for Pst I digests hybridized with bovine growth hormone (GH) and prolactin (PFL) probes. Some species-specific bands of repetitive DNA were observed of Pst I-digested genomic DNA. In buffaloes with PCR-amplified product only K-CN B variant was detected by Hind III and Hind I PCR-RFLP. This indicated that from this locus point of view, buffaloes are different from Sahiwal cattle. A buffalo-specific Rsa I site was detected on restriction analysis of K-CN (K-casein).

**Animal Health**

* Large-scale production of monovalent and polyvalent FMD vaccine

* Map on the prevalence of goat diseases prepared

* Indigenously prepared Aluminium hydroxide gel provided the suitable alternative

* Equine foetus capable of synthesizing IgM and IgG

* Locking loop technique using silk proved the best as suture material.

* Monoclonal antibody production technique developed with frozen and thawed splenocytes

Animal Health is the backbone of the livestock.
industry and tremendous progress has been made in this field during the past three decades. Exotic germplasm has been introduced to improve and upgrade indigenous population. The resulting new generation of crossbred animals and the exotic animals are highly susceptible to a variety of endemic infections. Further, huge and diverse livestock population distributed in different agroclimatic conditions, management and migratory practices and poor sanitary measures have contributed significantly to the current magnitude of animal disease situation.

The major achievements made in the field of animal health comprise large-scale production of monovalent and polyvalent foot-and-mouth-disease virus vaccines by fermentor technology using BHK-21 cell suspension system. Clones from FMD virus types O, A 22, and Asia 1 were prepared, purified and characterized. Equine infectious anaemia (EIA) and equine coital exanthema were detected and identified for the first time in the country. Equine influenza outbreak in 1987 was successfully contained through surveillance and controlling movement of horses. Equine influenza A/Equi 2 was isolated and characterized. Experimental vaccine prepared with the local isolate was found effective under field conditions.

A clear shift in the prevalence from FMD virus type 'A' to type 'O' was observed throughout the southern states. Asia 1 and A 22 are the types showing increased activity in the Western and Northern States. Subtype A5 was recognized after a lapse of 4-5 years. Its identity was duly confirmed by the World Reference Laboratory, Pirbright, UK.

**Epidemiology**

The surveillance data (1981-92) of rinderpest, haemorrhagic septicaemia, black-quarter and anthrax were processed and pattern of each disease has been analysed. Similarly, data (1986-91) of diseases of sheep and goat were also analysed. In sheep 83% mortality was due to digestive and respiratory diseases. Epidemiological profile of theileriosis has also been studied in and around Bhubaneswar. This information will help in formulating programmes for the Centre.

Bluetongue disease continues to be the major problem in sheep. Serosurvey conducted in various states revealed wide distribution of disease in sheep-raising areas. The CIRG, Makhdoom, collected information from Orissa, Rajasthan, Maharashtra, Kerala and West Bengal, to map out
the prevalence of mange, coccidiosis, FMD, liverflukes, viral diarrhea, enterotoxaemia and goat-pox in the country. Detailed mapping out of the diseases in different states is being worked out to formulate integrated prevention strategy of goat diseases in the country.

Serosurveillance was conducted by the NRCE, Hisar, to keep vigilance against equine influenza and equine infectious anaemia (EIA). ELISA tests indicated EIA-positive status of 3 horses in Amritsar (Punjab) and 1 in Meerut (Uttar Pradesh). The EIA-positive animal at Meerut was eliminated. The NRCE, Hisar, continued seroepidemiological studies against equine herpes virus-1 (EHV-1) in race horses, aborted mares and foals. A survey on faecal and blood samples from equines indicated infections due to Strongylus sp. (6%), Trichonema sp. (2.10%), Anoplocephala sp. (0.25%) and Oxyuris equi (0.57%).

Salmonella mbandaka, a rare serotype, has been reported for the first time from disease outbreaks occurring in poultry farms in and around Bangalore.

Qualitative data collected on the prevalence of various parasitic infections revealed that cattle, sheep, goats and yak and its hybrids with cows suffer from 14 species of gastro-intestinal nematodes, 3 species of flukes, 3 species of adult cestodes, 5 species of Eimeria (coocidia) and 2 species of blood protozoans. The morbidity losses suffered by ruminants in remote and desolated areas of Uttar Pradesh hills has been of considerable significance, as revealed from moderate to very high prevalence of these infections in them. Ecotoparasitic infection included mange, mites, lice and ticks. About 5 different species of flies of veterinary importance are prevalent in the study area. A prevalence rate of 2.8% of Eimeria leuckarti infection in donkey has been observed. This happens to be the first report from India. A detailed morphology and measurements of E. leuckarti oocytes have been described.

Diagnostic Techniques

The monoclonal antibodies, once fully characterized, can be applied for diagnosis of rinderpest and also for antigenic characterization of rinderpest virus. The vero-adapted GTV at passage 10 retained its immunogenicity in cattle as was evident from vaccination and challenge experiments. Western Blot technique was standardized and applied for detection and comparison of immunogenic
polypeptides of tissue culture rinderpest virus, lapinised virus (Nakamura III strain) and GTV. No difference in immunogenic polypeptide profile was detected between these 3 strains. Western Blot could convincingly detect presence of rinderpest virus in infected vero cell within 48 hr post-infection. It could be useful for confirming of virus isolation in cell-culture.

Single radial haemolysis, reverse phase passive haemagglutination and dot-ELISA were standardized for goat-pox diagnosis. The tests were more effective than conventional tests (AGPT and CIE) in various aspects. Indirect-ELISA was standardized to diagnose goat-pox from skin material. Vero cell-adapted goat-pox virus was used as vaccine under limited trial and encouraging results were obtained. The aluminium hydroxide gel, imported so far, has been replaced by indigenously prepared gel on quite a large scale at the Bangalore Campus. This is a major achievement. The quality of gel is quite comparable to the other indigenously available gels. Significant results have been obtained in laboratory evaluation of 3 prototype immunodiagnostic kits for FMD, viz. sandwich-ELISA antigen capture, PCR and DIG labelled hybridization. Encouraging results have been obtained in the standardization of serum-free medium for production of monoclonal antibodies. Work was conducted on sequencing of hypervariable region VP 1 in respect of FMDV types.

The technique for estimating RNA was standardized and different isolates of blue-tongue disease were observed for their RNA profiles in starch-gel electrophoresis. The ELISA antigen was prepared for sero-diagnosis of BT disease. The antigen is being evaluated for field, using locally available ELISA plates. The restriction pattern of DNA will be a very good tool for rapid diagnosis of IBR disease in future. A dot-ELISA using lipid A moiety of S99 was developed for detecting Brucella specific antibodies. This test was much sensitive and specific than CFT and RBTP. Mycobacterium bouils infection can be diagnosed with greater sensitivity by an in vitro assay of gamma interferon in the serum/plasma. This assay can detect even the chronic and advanced cases of bovine tuberculosis which become negative to PPD skin test. For Brucella diagnosis gel-diffusion test using poly B antigen, IHLT using LPS antigen and dot-ELISA using sonicated antigen, autoclaved antigen and LPS fraction antigen were standardized. Efforts were
also made to standardize CIE test using protein antigen. Work on the comparative efficacy of these antigens/test will be carried out in the ensuing year. CSF nitrate gave better indication of nitrite toxicity than blood and urine nitrite values in goats.

At the NRCE, Hisar, an indirect ELISA has been standardized to detect anti ovalbumin antibodies (AOVAb) in equine sera to differentiate between equine influenza varieties and naturally infected equines. Polymerase chain reaction (PCR) has been successfully used to detect EHV-1 in aborted foetus; for this purpose a sandwich ELISA was also standardized. A field-oriented immunostick ELISA was developed for the diagnosis of equine influenza.

**Immunoprophylaxis**

Immunogenicity of various proteins of *Pasteurella multocida* 6:B was studied to evolve an improved immunoprophylactic preparation. PSAP, PSAP-DI, OMP and protein in sliced gel section IV could provide protection in rabbits against the homologous challenge and in mice through transfer of antiserum. *In vitro*, the antiserum against these proteins was also bactericidal, maximum being with anti-OMP serum.

Somatic *Salmonella* antigens provided satisfactory results both on plate and tube tests even after storage for 6 years. Avirulent strain S99 of *Brucella abortus* was found to be superior to S19 in generating immune response in bovine on the basis of lymphocyte transformation tests, ELISA and delayed type hypersensitivity. Characterization of *Brucella*-specific T-cell clones with BOCD markers revealed the propensity of BOCD$_4^+$ followed by BOCD$_8^+$ cells. Few clones were even BOCD$_4^-$BOCD$_8^+$.

A cell-culture vaccine has been developed against theileriosis and tested for infectivity. Large-scale production of the vaccine has been taken up for protecting the animals under field conditions. The efficacy of vaccine derived from *Babesia bigemina* MASP culture is further being tested. Results obtained till now are encouraging.

During the period under report 1,805,535 doses of different vaccines/diagnostics were produced and 1,766,833 doses supplied by Biological Products Division of the IVRI, Izatnagar. Using BHK$_21$ cell suspension system in fermenters the conventional FMD vaccine to the tune of 2.8 million monovalent doses was produced at the

[Monoclonal antibody-based antigen capture-ELISA protein content were estimated.]
Bangalore Campus. As per target fixed Rs 1,600,000 were realised through sale. The oil vaccine for pigs has been supplied for use in different piggeries. The field feedback is quite satisfactory. As per schedule F-1 of Drugs and Cosmetics Act and Rules 1979 and International Standards, 61 batches of veterinary immunologicals received from various production institutes of the country were tested for their standard.

To study the immunogenicity of IBD vaccine strains, 2 commercially available IBD live vaccines (Intermediate strain) and 1 strain developed in the division were tested for their immune response in 3-week-old chicks. One commercial vaccine and also the strain developed in the Division caused seroconversion at third week post vaccination, whereas, with another commercial vaccine chicks became positive by fourth week. Maternal antibody against IBD virus in chicks persisted up to 8 days of age. The chicks harbouring maternal antibody when vaccinated at 1, 4 and 8 days of age with IBD vaccine (Intermediate strain) did not respond to vaccination.

Basic Research

Monoclonal antibodies were raised against rinderpest virus. The antibody concentration and isotypes of clones were determined. A simple dot-blot assay using Mab for detecting RDV antigen has shown encouraging results. An acidic protease from *Haemonchus contortus* that specifically degrades proteins of stomach lining has been identified. The protease is secreted by adult worms during *in vitro* culture of parasite.

Fenvelerate, a synthetic pyrethroid, enhances hepatic ATPase, GST and alkaline phosphatase in rats indicating effect on membrane permeability and detoxification system. Mimosine formed conjugate with reduced glutathione which is competitively reversed by CDMB. Mimosine appears to act as both allosteric effector at high concentration and substrate competitive inhibitor at low concentration.

The 5'-nucleotidase level in chicken seminal plasma decreased significantly from 24 weeks to 27 weeks of age and increased significantly during 28 and 29 weeks. Two protein fractions (MW 93,000 and 65,000 daltons) exhibiting endoglucauase activity have been purified from intact cells and extra-cellular culture supernatant of *Clostridium thermocellum* NCIIMB 10682.

The proteins acid extracted from buffalo PMN
cell granules was fractionated by molecular sieve sephacryl 1-S-200 (superfine). The separation revealed presence of 2 major peaks and 5-6 minor peaks.

Studies conducted at the NRCE, Hisar, on the passive transfer of immunoglobulins (Igs) from dam to offspring revealed that concentrations of IgA, IgM, IgG and IgG(T) were almost similar in sera and colostrum of horse and donkey mares indicating no selective secretion of any Ig class (isotype) into the colostrum. Equine foetus was also capable of synthesizing IgM and IgG. Locked loop technique using silk as suture materials appeared superior compared to the other techniques. Medetomidine @ 30 µg/kg body weight provided good analgesia/sedation for 100.00 ± 5.70 min.

Three indigenous preparations of Eclipta alba, Adonisonia digitata and Lawsonia alba were evaluated in healing of experimentally created contaminated wounds. Relatively faster and better healing was recorded in wounds with Eclipta alba and Adonisonia digitata, than those treated with Lawsonia alba and normal saline.

Biotechnology

The beta toxin (DNase) from C. chauvoei culture filtrate was isolated, purified and characterized. A protein of 36 KDa having DNase activity was detected on SDS-PAGE after purification by precipitation with ammonium sulphate, gel filtration, ion-exchange and high pressure liquid chromatography. This protein was unaffected by repeated freezing and thawing and was thermostable up to 70°C. The DNase protein degraded DNA of eukaryotic, prokaryotic and viral origins. Fibronectin was isolated and purified from plasma of buffalo. The arginine content of fibronectin differed from that of human and bovine. The molecules of fibronectin had helical organization. Buffalo plasma fibronectin interacted with cells, DNA and heparin and other biomolecules. A new binding assay for interaction was developed using HPLC as a micro-chemical technique.

A very useful technique for production of monoclonal antibodies with frozen and thawed splenocytes was developed. This technique was used to produce specific monoclonal antibodies to bovine - herpes-virus-1. The yield of total number of clones and that of clones-secreting antibodies with previously frozen splenocytes was comparable to that obtained with fresh splenocytes. This technique is very useful in saving valuable cell

WILDLIFE HEALTH PROGRAMME

A rhino having more than 15 full thickness 15-20 cm long skin cuts was treated successfully by surgical intervention at Dudhwa National Park, Dudhwa. Moderate to heavy infestation of Fasciola and Amphilostomesp. was recorded in elephants at the same park. Proper treatment and improved managemental practices prevented mortality in alligator hatchlings at Endangered Species Project, Kukrail, Lucknow; and Musk Deer Farms, Kandulakhark Gopeshwar and Tarikhet, Ranikhet. Important conditions/diseases diagnosed during the year included rabies in an elephant and a rhino; tuberculous pneumonia in an orangutan; pneumonia in alligator and intestinal disturbances in a hippopotamus.
material and immunized mice for convenient scheduling of fusion.

Important Diseases Recorded
The occurrence of ataxia-cystitis syndrome in horses on prolonged feeding of *Sorghum vulgare* fodder was recorded for the first time in the country. The disease was characterized by ataxia, incoordination of hindlegs, incontinence of urine and haematuria.

Animal Nutrition

* Mustard-cake feeding proved beneficial

* *Leucaena*-meal can replace protein source up to 100%.

* Endosulfan-sprayed fodder proved less harmful

* Tannin-extraction technique optimized

* White-rot fungal strain treatment improved feed value of wheat straw and pine needles

* Proximate composition of 89 plants estimated

* Seasonal effect on synthesized pastures estimated

* Live herbarium of promising plants prepared

* Nutritive value of pelleted feeds for goats estimated

* Toxic contents of poultry feeds studied

* Naked Neck performed well on low energy diets, thus reducing the cost on feed

* Nutritive value of meat-meals estimated

Cattle and Buffalo
At the NDRI, Karnal, the age-old practice of feeding mustard-cake proved beneficial. It avoids the use of external source of thiocyanate for milk preservation which may pose the risk of iodine deficiency in milk consumers particularly
in infants. The body growth rate in crossbred and Murrah buffalo males was higher when fed with feed containing higher level of bypass protein than those fed with feed containing lower level of bypass protein. Sodium-bentonite-treated GNC and soybean-cake showed increase in \textit{in vitro} DM digestibility. Leucaena leaf-meal can replace the groundnut-cake, cotton seed-cake or soybean-meal as protein source up to 100\% in the rations of ruminants. It is more economical and has the added advantage of acting as a natural bypass protein. Crossbred calves, reared on 100 and 50\% of their requirements for 12 weeks, demonstrated the ability to exhibit compensatory growth. Plasma thyroxine and blood glucose level decreased in restricted group, but increased upon refedding. HPLC technique for the estimation of different phytoestrogenic compounds present in the fodder was standardized. The phytoestrogenic content in \textit{Leucaena leucocephala} leaves was 213.75 mg/kg DM, of which the major fraction was genistein. Method of storage and the environmental conditions significantly affected the quality of grains of maize, barley and oats. The decline in ether extract (EE \%) was more steep after 6 months of storage when infestation with insects started especially in groups stored in open. Maize (stored in gunny bag) was heavily infested, as compared to oats. Total acidity and free fatty acids increased 4-5-folds in grains and 3-folds in cakes. Increasing the UDP (bypass protein) in the diet from 50\% of CP (T1) to 60\% of CP (T2) in concentrate increased milk yield and FCM yield significantly in crossbred cows. Feed conversion efficiency was also higher in T1 than in T2. Buffaloes degraded mimosine fastest followed by cattle and goats.

Procedure for estimation of aflatoxin M1 in milk samples was standardized on Water’s HPLC system using Nova pak C-18 column and flourescence detector system. When the lactating cows were fed two levels (50 and 100 ppb) of aflatoxin B1 in feed, its excretion in milk got stabilized after 10 days. It was between 345.7 and 350.52 ppt in 50 ppb level and 577.34 - 595.19 ppt in 100 ppb AFB1 level. A process technology for enhancing bypass protein value of groundnut-cake without affecting its digestibility has been developed at the Southern Regional Station of the NDRI, Bangalore. Inclusion of such processed groundnut-cake with increased bypass protein content in the ration enhanced growth rate in
crossbred calves and milk production in crossbred cows. Maize and sorghum fodder sprayed with pesticides, viz. BHC (HCH) and endosulfan, retained significant levels of the residues even 3 weeks after spraying. Milk of animals fed with pesticide-sprayed fodder crops had higher BHC (HCH) content. However, since contamination of milk with endosulfan is less harmful than BHC (HCH) the former may be used for spraying in fodder crops. On-farm trial with lactating cows fed with concentrate ration (formulated at the NDRI) from locally available feeds in a village of West Bengal indicated significantly better growth and higher milk production at lower cost than with traditional feedings. At the NDRI, Karnal, experiments conducted to study the exact role of protozoa in the rumen fermentation and nutrient utilization showed that the presence or absence of protozoa affects the fermentation process considerably. Protozoa were removed from the rumen of buffalo by treatment with sodium lauryl sulphate @ 9 g/100 kg body weight for 3 consecutive days after a starvation period of 24 hr. Removal of protozoa caused depression in feed intake for a few days and a loss in body weight due to starvation. Conversion efficiency was better in defaunated animals. On defaunation production of methane was significantly lowered in comparison to that in faunated animals. An easy and practical method of defaunation needs to be investigated. A number of white-rot fungal strains have been screened for lignolytic activity to increase feed value of wheat straw and pine needles. Of these 4 strains have shown potential lignolytic activity. These strains are now being tried on tree leaves. *Thysolaena maxima* (a grass) was analysed for proximate and fibre composition at 3 stages of maturity to get a better correlation of compositional changes with digestibility; kinetic studies are in progress.

**Goats**

Plants (89) belonging to different categories of above-ground vegetation from semi-arid region were collected, identified and chemically analysed for proximate composition. They were classified as feeds with high, medium and low nutritive values. Feeding value in terms of digestibility and voluntary intake of *Leucaena leucocephala* and *Acacia nilotica* was determined on Jamunapari and Barbari goats. The pH, total volatile fatty acids and rumen ciliates were identified under the feeding of *L.*

**INACTIVATION OF TANNINS**

Tannins decrease nutrient utilization in animals, and at higher levels of intake it may cause toxicity. The conditions for extraction of tannins from oak leaves have been optimized. Studies are in progress for specific inactivation of extracted tannins. These conditions can be used to develop a pilot plant for specific removal of tannins from tannin-rich feeds including agroindustrial by-products.
leucocephala. Positive correlation was observed between ciliate population and surface tension, pH and specific gravity of rumen liquor, while viscosity, electro-conductivity and osmotic pressure showed negative correlations. Ciliate population and rumen environment were different in different breeds. Live herbarium was prepared of some of the promising plants identified as goat feed. Tribulus terrestris, a ground cover seasonal summer plant has potential to meet the nutritional requirements of goats under drought conditions. Capparis hortida, Belanites aegyptica (Hingota), Salvadora parsica and Chlorocendron phalmidis and Tribulus terrestris found in waste lands were evaluated for their use as goat feeds.

Sun-dried poultry excreta (DM 18.5%, CP 18.59% and NFE 32.39%) can provide 20% of the total protein requirement of meat-purpose goats, without any adverse effect on DM, DCP, and body weight of animal. A composite pelleted feed made out of sun-dried poultry excreta and other conventional and non-conventional feed ingredients has been developed and successfully fed to goats. Nutritive value of pelleted feeds made out of sun-dried poultry excreta and other conventional and non-conventional feed ingredients was studied.

Camel

At the NRCC, Jorbeer, the observations on body weights, dry matter and water intake, and serum biochemicals of camels given UMMB are being recorded. Camel calves did not like UMMB. Concentrate supplementation in growing camels caused reduction in roughage intake, however total dry-matter intake was higher in concentrate fed animals and they also grew faster. Studies on feeding behaviour of stall-fed camels was studied. Unlike cattle and buffaloes camel eat at continuous interval. It picks up the roughage with its lips and like sheep nibbles it. Possibly due to long neck, eating and ingestion cannot be performed simultaneously. After every 12-18 sec of feeding, the animal rests for 9-12 sec during which the food is ingested. The camel consumes about 60% of feed during first 6 hr.

Poultry

Screening of poultry feedstuffs for phytin content revealed that rice kani contained least amount (0.1%) and wheat bran the highest (0.8%). Feeding of water-soaked wheat and wheat bran to growing WL chicks resulted in improved phosphorus utili-

SILVIPASTORAL COMBINATIONS

Studies have been conducted to determine production of harvestable biomass, gross energy and crude protein under 6 different silvi-pastoral combinations: L. leucocephala + D. nutan + C. ciliaris; L. leucocephala + A. nilotica + C. ciliaris; L. leucocephala + D. nutan + C. ciliaris/dactylon; L. leucocephala + C. ciliaris; D. nutan + C. ciliaris/dactylon; and A. nilotica + C. ciliaris. The production parameters of the silvipasture combinations were compared with those obtained for Heteropogon saccharum type natural grass cover at the CIRG, Makhdoom. A 2.6-, 3.3- and 8.0-fold increase in production of harvestable biomass, energy and crude protein in Leucaena leucocephala + Acacia nilotica + Cenchrus ciliaris silvi-pastoral combination against natural pasture was observed. Seasonal variation in chemical composition, influence of pasture vegetation on soil fertility, grazing behaviour of goats and meat production potential of goats on synthesized pastures have also been studied.
zation from diet as indicated by higher tibial ash content in comparison to the chicks fed untreated wheat or wheat bran diet. Rice kani has high metabolizable energy equivalent to maize, and is a useful energy source alternate to maize. Inclusion of hexane-treated cottonseed-meal at 5% level in diet was tolerated well by WL hens, but further additions affected their performance. Studies on the effect of commonly occurring levels of dietary ochratoxin A (OA) and aflatoxin B1 (AF) and their combinations on performance, energy and protein utilization in poultry indicated that WL chicks and quails were able to tolerate 1.0 and 2.0 ppm of OA respectively. Quail chicks were more resistant to ochratoxin. Significant reduction in availability of lysine and methionine from protein supplements due to toxins lead to imbalance of amino acids and poor utilization of dietary protein in layers and broilers. Experiments have been conducted to study: (a) response of two different genotypes to low energy diets in winter season; (b) performance of broilers as influenced by low dietary protein levels with or without supplementation of lysine and methionine; and (c) nutritive value of commercial meat-meals and utilization in chicks. The availability of energy through feed ingredients has become a critical factor in influencing the cost of broiler feeds. Genotypes that are capable of utilizing low energy diets without adversely affecting the growth of broilers can effectively reduce the cost on feed per unit gain in performance. Attempts have been made to evaluate the performance of Naked Neck and full-feathered broilers on three energy levels, viz. 2,900, 2,750 and 2,600 kcal/ME, with 20% protein in each diet. Feeding trial conducted with Naked Neck and full-feathered broilers indicated that in winter both the genotypes performed better for their growth and feed conversion efficiency only with diets having 2,900 kcal ME/kg. Lower dietary energy at 2,750 and 2,600 kcal ME produced inferior results for the same traits. The feather content in Naked Neck broilers was less, consequently the carcass yields were higher. Weight of skin was lesser compared to that of normally feathered birds. Naked Neck birds were most sensitive to the changes in dietary energy than the normal broilers. They performed better in summer and were as efficient as normal birds even in winter if the dietary energy was maintained at 2,900 kcal.

At the Project Directorate on Poultry, Hyderabad, a study was conducted to establish

### LOW-COST RATION FOR POULTRY

The decrease in protein by 2 to 4% in starter (21 or 19%) and finisher phases (18 or 16%) showed marginal fall in growth at 7 weeks of age compared to the controls. Supplementation of lysine and methionine to diets low in protein by just 2% improved the performance of birds significantly. Unsupplemented group showed a maximum loss of 150 g of weight at 7 weeks of age compared to the controls, but the cost on feed per bird was minimum in these groups. It is this economic factor that may have practical applicability to a farmer as he might prefer a low cost ration at the expense of marginal loss in weight.
the nutritive value of 7 meat-meals collected from different sources. The protein content varied from 52 to 83% in different meat-meals. Similarly, the ash content ranged from 15 to 50%. Consequently calcium and phosphorus contents were also estimated. Studies are being carried out to examine the protein quality of the meat-meals.

**Animal Physiology**

* Recombinantly derived bovine somatotropin (rBST) improved milk production in cows and buffaloes

* Role of inhibin in silent oestrus of buffaloes studied

* Ultrasonography used to monitor follicular changes in cows

* Role of goat colour and skin texture in thermolytic process studied

* Ready reckoner chart developed to judge age in goats

* Improved goat feeders developed at CIRG, Makhdoom

* Fatigue index prepared for camel

* Ovarian activity in camels studied

* Cytrohetadine hydrochloride improved feed intake in birds

* Electrolytes in drinking water minimized ill effects of summer temperature

**Cattle and Buffalo**

Subcutaneous administration of a slow-release formulation of recombinantly derived bovine somatotrophin (rBST) to lactating Murrah buffaloes and 3 Sahiwal cows @ 320 mg/animal at an interval of 14 days increased milk production. The respective increases in yields were 8.5 and 10.0
kg per injection in cows and buffaloes. Circulating levels of T-3, T-4 and insulin in jugular blood plasma, withdrawn before the administration of rBST and thereafter, remained similar, indicating that the levels of these hormones are not influenced by rBST administration. Chronology of nuclear maturation process in terms of chromosome dynamics in buffalo oocytes during in vitro maturation was elucidated. Antisera against progesterone 7-alpha-carboxyethyl thioether was harvested from rabbit serum. The antiserum performs very well in radioimmunoassay at a titre of 1:8,000 and is extremely sensitive. It can detect hormone concentrations as low as 8 pg/tube. Developing of this antiserum has saved considerable foreign exchange which would otherwise have been spent for importing the valuable immunochemicals. An 81% oocyte maturation has been obtained in in vitro maturation and fertilization of buffalo oocytes. Successful fertilization of matured oocytes, cleavage rates and attainment of morulae have also been improved. In buffaloes 2 pregnancies have been confirmed through IVF embryo transplantation. Advance has been made in standardizing inhibin assay in buffalo follicular fluid. This has helped in studying the role of inhibin in folliculogenesis and its possible involvement in silent oestrus. Another major endocrinological achievement has been developing a highly sensitive enzyme immunoassay for progesterone estimation in buffalo follicular fluid. The assay requires only 0.05 microlitre of follicular fluid and hence economizes on the use of follicular fluid, especially from small-sized follicles. Ultra-sonography has been carried out to monitor follicular changes in sexually mature cows, and to assist in identifying the number of ovulations, follicles, and corpora lutea formed in superovulated cows. Large follicles, of more than 10 mm diameter, present before the start of superovulatory treatment exercise an inhibitory effect over recruitment, growth and development of other follicles.

The heat-stress-induced hyperprolactemia affects oocyte quality in goats and buffaloes. Lymphocytes from normal animals store prolactin. Treatment with stress-related hormones like glucocorticoids, adrenaline and serotonin released the prolactin. However, glucocorticoids failed to release the prolactin from leucocytes collected from animals having prolonged heat stress. Glucocorticoids and adrenaline released prolactin by chang-
ing membrane permeability. Serotonin released it by rupturing the lymphocytes.

There is no advantage in extending the time of holding straws in liquid nitrogen vapour if the temperature of straws has reached -120°C. However, a small advantage was seen in semen of high initial quality. Thawing frozen semen is equally satisfactory at 14°C (room temperature), 15°C (tap water), or 18°C (pocket) when holding time is increased to 5 or 10 min. In tropics thawing time is more important than in temperate region. An improvement in post-thaw motility was seen when both additive and sugar were added than either of them was added in milk and Tris buffers. The higher levels of yolk gave better results on thawing of static ejaculates. Better freezability in terms of higher post-thaw motility, higher post-thaw acrosomal integrity and higher livability was observed in samples containing sugars as compared to control. These sugars also reduced, the spermatozoal damage during freezing by reducing the leakage of GOT and GPT. Raffinose performed better than xylose and cheeni (table sugar).

Goat

The effect of the exogenous administration of insulin on the feed intake of goats revealed that instead of anticipated stimulation of the feed intake (by insulin) there was a decrease during the third hour post-insulin treatment, despite of a significant induction of hypoglycaemia. This reflected to a possibility of a modulating action of insulin on CCK (known for its satiety action).

Goats were subjected to PGF2 treatment during induced of superovulation with PMSG. This treatment significantly lowered the number of the transferable embryos while goats fed MGA showed better results.

Oestrous cycle profile of goats (Jamunapari, Barbari and Jakhrana) showed a seasonal variation in oestrus appearance. However, it was more distinct in Jamunapari. Age and weight at puberty, symptoms of oestrus, duration of oestrus and postpartum-oestrous interval have been worked out in Jakhrana goats. The ovulation rate is 1.20 ± 0.11 (range 0.2). The right ovary appears to be more active than the left one in Jakhrana.

Parturition characteristics of Jamunapari and Barbari have been studied. It was observed that (i) duration for different stages of kidding was more in Barbari, (ii) kidding onset was more in day time in both the breeds, (iii) twinning percentage was more in Barbari, (iv) both the breeds had seasonal variation in birth weight of kids, and (v) placental weight and total numbers of cotyledons were higher in Jamunapari than in Barbari.

The technique of deep freezing of buck semen has been standardized with a post-thaw motility of 56%. This is comparable to results from developed countries. Doses (2,000) of frozen semen of superior bucks of Jamunapari, Barbari, Sirohi, Kutchi, Marwari and Jakharna breeds have been kept in Semen Bank for breed improvement programme. Caprine embryos have been preserved at room temperature (20°C) for a short period of 2-3 hr. Preservation of caprine embryos at refrigeration temperature (5°C) for 24 hr has been possible. Birth of a kid by transfer of vitrified embryo has been possible. In vivo preservation of caprine embryos for 24 hr in rabbit oviduct has been possible. In addition to in vivo embryo development, in vitro embryo generation has also been achieved in this laboratory. A good number of E.T. appliances, e.g. crate for performing laparotomy and stand for embryo freezing, have been fabricated indigenously. The specifications for economical and comfortable animal shelters in terms of orientation, roofing materials and ventilation have been worked out. Micro-environment within the shelters and its impact on physiological functions of goats have been taken as the yardstick to recommend the specifications. A convertible shed module was designed and developed to carry out the research on different aspects of animal housing. There is variability in adaptability between and within breed to different environments. This can be used in developing well-adapted high-producing strains of goats through selective breeding by using modern biotechnological breeding tools. The role of thermolytic processes like respiratory and surface evaporative heat loss in thermoadaptability has been described in different breeds of Indian goats. The biochemical responses have also been studied to understand the basic mechanism involved in such differences. The role of goat colour and texture has also been established.

A ready reckoner chart has been developed to judge the age of small-, medium- and large-sized breeds of Indian goats by oral examination of the teeth. This is very helpful in judging the age of goats in village conditions where records of birth of goats are not maintained. Two types of improved
goat feeders, viz. CIRG Hexagonal and CIRG Rectangular, have been developed for adult goats. The contamination and wastage of feed has been drastically reduced with the use of these feeders. Four types of kid feeder prototypes and kid waterers have been designed:

**Camel**

Trials have been conducted on 6 adult male camels aged 5-12 years to investigate fatigue index at the time of cart pulling. The camels hauled @ 2.8 kg/kg b.wt. continuously for 3 hr without any sign of distress. After fourth hour the animals exhibited reluctance to work and tendency to sit. The increase in CK, lactate, rectal temperature, pulse and respiratory frequency could be used as reliable markers for developing fatigue index.

Histochemical studies revealed the presence of proteins, glycogen, lipids, DNA, RNA, AT-pase, LDH, G-6 PDH, 3 β HSDH and 17 β HSDH in poll gland tissues. The poll gland secretion contained 9.46 mg/dl glucose, 1.77 g/dl protein, 0.13 g/dl albumin, 14.31 mg/dl urica, 4.15 mg/dl calcium, 103.3 mEq/litre sodium, 556.5 mEq/litre potassium, 132.90 ng/ml testosterone, 2.67 ng/ml progesterone and 247.08 pg/ml/oestradiol 17 β during rutting season.

Ovarian activity in sexually quiescent adult she-camels (16) selected during the non-breeding season (June) was induced by (i) intramuscular injection of 250 mg hydroxyprogesterone hexanoate, followed by 1,000 IU PMSG on 2 consecutive days (group 1), (ii) intravenous administration of 3,000 IU HCG (group 2), and (iii) 40 mcg GnRH (group 3). Animals in control group (group 4) received no hormones. Oestradiol 17-β levels did not exhibit any particular trend but progesterone levels suggested ovulation in 2 camels (50%) in group 2, and 3 (75%) each in groups 2 and 3. No animal ovulated in control group.

**Poultry**

Physiobiochemical parameters during summer in normal and poor performing layers and broilers were determined. Low uric acid in plasma may reflect better utilization of feed resources and body reserves during summer when other conditions remained similar. The follicular atresia in summer remained as the major cause of slump in egg production. Cholesterol levels in plasma was significantly higher in normal broilers compared to under-weight birds. No significant difference was noted with respect to other parameters. Broilers receiving cyproheptadine hydrochloride consumed more feed and had better body weight gain than the birds not given cyproheptadine hydrochloride in their feed.
Animal Products Technology

- Whey-based mushroom soup powder prepared at the NDRI, Karnal
- Good quality cheese spread powder technology standardized
- Carrot-milk spray-dried powder prepared
- Low cholesterol mozzarella cheese prepared
- Good quality skim-milk prepared
- Instant mix for pizza base prepared
- Kefir starter culture propagation method standardized
- High-quality mistidoi preparation process standardized
- HCH, DDT, malathion and iodophor adversely affected growth of lactic starter in milk

A process has been standardized at the NDRI, Karnal, for preparation of whey-based mushroom soup powder. When packaged in sealed metallized polyester bags/pouches, the powdered mushroom whey soup has very good storage stability under ambient conditions. This new product formulation offers a considerable scope for salvaging the valuable dairy byproducts, i.e. whey, in a manner which means enhanced economic returns to the processor and a nutritious convenient food to the consumer. A technology has been standardized at the NDRI to manufacture good quality cheese spread powder using ultrafiltration (UF) and spray drying processes. The UF-cheese powder contains good quality whey proteins and more minerals as compared to conventionally manufactured cheese powder. The overall acceptability of cheese spread powder has been further enhanced by incorporating lactic culture (Lactobacillus helveticus) and flavourage enzyme. The UF-cheese powder can also be used in fast foods like pizza and in many bakery products.

A technology has been evolved at the NDRI for production of carrot milk spray dried powder that promises wide ranging applications in dairy foods. It may become a source of flavouring and colouring besides nutrients such as protein and vitamins in products like icecream, burfi and biscuits. It can also make a refreshing milk shake. The new food formulation offers good scope for interstate marketing and export where carrots are normally not cultivated. The agroclimatic and

NEUTRALIZATION OF SUMMER ILL-EFFECT

Attempts have been made to optimize the managerial practices to minimize the ill effects of summer temperatures in broilers by using electrolytes like NH₄Cl and NaHCO₃ @ 0.3% in drinking water to 7-week-old broilers. Growth and feed conversion efficiency of these broilers were better than those given higher level of electrolytes. Egg production, feed consumption and shell quality improved with the addition of NaCl to water, while acidification of water had a negative effect on this trait. The influence of photo-period on the performance of broilers from 3 to 7 weeks of age was tested in a trial using both natural and artificial light. Broilers reared under 24-hr photoperiod weighed significantly more at 7 weeks of age with better feed conversion efficiency. Weight of crop and testicles was higher with 24-hr light and decreased consistently with reduction in light. Abdominal fat was more in birds exposed to less light.
soil conditions in the north-western parts of India greatly favour the cultivation of carrots and also milk production. This new technology is expected to generate additional income and employment in the villages. Technology for production of low cholesterol Mozzarella cheese by replacing milk fat by vegetable fat has been standardized at the Southern Regional Station, NDRI, Bangalore. Processes have been standardized to obtain good quality spray-dried and roller-dried skim-milk powders from milk concentrated by reverse osmosis (RO) and a scraped surface heat exchanger (SSHE). These processes require considerably less energy compared to the conventional evaporation process. Studies on preparation of an instant mix for pizza base have indicated that already mix with good baking characteristics could be obtained using wheat flour and skim-milk powder. Such a protein-enriched formulation would mean considerable convenience and time saving for the housewife.

A method for the propagation of kefir starter culture consisting of mixed strains of streptococci, lactobacilli, leuconostocs, acetic acid bacteria and lactose-fermenting yeasts has been standardized. Active kefir starter culture (KS-I) was used successfully in making various products of kefir such as plain, fruit and flavoured kefir. These kefir products were highly palatable, nutritious and therapeutic in nature. The kefir grains could be reused as an inoculum for the preparation of kefir products.

Technique for high quality mishtidoi has been standardized. The flavour and taste of the product were highly acceptable. In quality evaluation study, samples of mishtidoi sold in an around Calcutta market contained lactic acid bacteria in the following order: Lactobacillus, Lactococcus and Streptococcus species.

HCH (0.02-50 ppm), DDT, malathion and toxaphor (0.01-50 ppm) adversely affected the growth and activity of lactic starters and other bacteria in milk of cows and buffaloes. S. thermophilus was most resistant. L. bulgaricus was sensitive in cow milk but resistant in buffalo milk. L. dextranicum showed a reverse trend. Addition of xenobiotics before heating of milk was less inhibitory than their addition after heat treatment. These chemicals at 50 ppm concentrations produced some noticeable changes in morphology, viz. size, shape and cell arrangement, of these organisms.
Fisheries

* Tagging experiments revealed no movement of hilsa from Hooghly-Bhagirathi river system to the Ganga or the Padma

* Technique developed to measure urceolarid ciliate parasites, indicators of stress in aquatic ecosystem, by CICFRI

* Pond-breeding techniques for pearlspot developed at the CIBA

* Mud crabs recorded a remarkable growth under culture conditions at Kakdwip

* Two food formulae developed for tiger shrimp

* Fingerlings of golden mahseer raised under farm conditions

* Restocking of a few waterbodies depleted with mahseer fishery to repropagate the endangered mahseer fishery

* Cryopreservation of the milt of endangered mahseer and hilsa, was accomplished at the mini gene bank of NBFGR

* Second gynogenetic generation of rohu produced at CIFA

* A new semi-pelagic trawl of 51 m long wing finalized for operation

* A 15.5 m steel fishing vessel constructed by private entrepreneur as per CIFT know-how, performed better than the existing vessels

* Suitable preservatives developed for fresh-dressed fish, ideal for preserving fish products for 22 weeks at room temperature
**CAPTURE FISHERIES**

**Estimation of fish landings during 1994-95**

**Marine Sector:** Estimation of marine fish production is one of the major tasks of CMFRI in view of the importance of this information in carrying out research on exploited stocks in suggesting regulatory measures, in studying the changing pattern in marine fisheries exploitation and in providing the data to various end-users such as Government departments, industry, entrepreneurs and others. It has been estimated that 2.36 million tonnes of marine finfish and shellfish were landed during 1994 as against 2.24 million tonnes landed in 1993. The mechanized units (including motorized craft) contributed 86.5% of the total landings and the rest by artisanal craft. The northwest coast contributed the highest landings (36.4% of the total) followed by southwest coast (33.1%), southeast coast (24.5%), northeast coast (4.6%) and Lakshadweep and Andaman & Nicobar Islands (1.4%).

**Inland Sector:** The Ministry of Agriculture and Co-operation has reported the production of 2.1 million tonnes of fish from the inland sector during 1994-95. Out of this about 70% is through aquaculture in the country. The aquaculture produce of about 1.395 million tonnes is from freshwater resources whereas the remaining about 0.075 million tonnes is from the brackishwater farming system.

**Application of Remote Sensing Technology in Marine Fisheries**

Sea truth parameters have been collected under the remote sensing application project of the CMFRI that was implemented in collaboration with DOD/NRSA. Fish catches in the exploited fishing zones in relation to the sea surface temperature variations have been monitored during different seasons as part of the programme. The CMFRI, in collaboration with the NRSA, is now using remote sensing for short-term forecasting of potential fishing zones along the Kerala coast. Information based on satellite data is simplified in
the form of charts indicating the direction, depth zone and distance from each landing centre for availability of fish. This information is passed on to the fishing industry, 'MATSYAFED' and fishery department officials.

**Tagging Experiments on Hilsa**

Tagging experiments by the CICFRI on commercially important anadromous hilsa (*Tenualosa ilisha*) in the Ganga river system at Farakka revealed that the fish could migrate from downstream to upstream of barrage during flood season when the bays of the barrage are opened. Tagged hilsa (1,153) were released in upstream of Farakka barrage, downstream of barrage and feeder canal (Bhagirathi). The tag recovery has revealed that there was no movement of hilsa from Hooghly-Bhagirathi river system to the Ganga or Padma while hilsa moves freely from downstream to upstream to both feeder canal (Bhagirathi) and downstream of Ganga. The longest time interval between tagging and recovery was 2 months and the maximum distance the migratory fish covered was 300 km.

**New Methods to Identify Stressed Ecosystems**

Under the rapid survey programmes of the CICFRI, the ecology of 4 beels—2 in Maldah, and 1 each in Midnapore and Burdwan—were intensively investigated during summer and winter. The summer campaign revealed thermal and chemical stratification. Their implications on the production functions of the beel are being worked out. The CICFRI has developed a methodology to quantify the presence of urceolariid ciliate parasites (*Trichodina* sp. and *Tripartiella* sp.) as indicators of stress in aquatic ecosystems—more than 20 ciliates/0.05 ml of gill mucous indicate stress in fish.

**Cold Water Fishery Resources**

The NRC-CWF has started eco-based studies of Himalayan river (the Kosi) and lake (Naukuchiatal) to identify the areas with suitable potentials for development of coldwater fishery. Nutrient status and carrying capacities of these systems have also been assessed. To repopulate and to increase fish biomass of indigenous mahseer fishery, both for food and sport, some lakes and streams in Kumaon Himalayas were stocked with the seed of this species produced at Bhimtal hatchery of NRC-CWF.
CULTURE FISHERIES

Brackishwater Aquaculture

Shrimp health monitoring: During 1994-95 the shrimp culture industry in Andhra Pradesh and Tamil Nadu suffered a major setback due to the outbreak of diseases. A viral infection in *Penaeus monodon* and *P. indicus* caused by monodon type baculovirus was diagnosed for the first time. Another new disease of tiger prawn, diagnosed as infectious hepatopancreatic and lymphoid organ necrosis caused mass mortality of shrimps in the Kandleru creek area of Nellore. Studies are in progress at the CIA to identify the etiology of white spot disease which caused large-scale mortality in the shrimp farms. The efficacy and testing of vaccine preparations for *P. monodon* is also underway. Environmental assessment studies carried out in the shrimp farms in the Kandleru creek area indicated that environmental conditions had deteriorated.

Broodstock Development and Seed Production

At the CIA, the pond breeding techniques for the pearlspot (*Etroplus suratensis*) have been perfected by the use of environmental manipulations with regard to salinity and provision of nesting materials. The seed has been produced @ 0.6 million/ha a year. Grey mullet (*Mugil cephalus*) of size range 0.3 to 1.2 kg are being maintained in earthen ponds at Muttukadu farm of the CIA on a formulated maturation diet under the broodstock development programme.

Studies at the CIA on the induced maturation and maintenance of captive broodstock of *Penaeus monodon* with maturation diet and water quality management, revealed that within 4-5 months in captivity the number of viable spawnings decreased. The viability of sperms was higher in freshly collected males than in captive males ranging from 60-95% and 10-15% respectively.

Mud Crab Culture

At the Kakdwip, mud crab (*Scylla tranquebarica*) under culture conditions has recorded a remarkable growth (150 mm/970 g) at the end of 7-month culture period.

Shrimp Feed Formulation

At the CIA, a micro-particulate feed (200 and 500 microns) prepared with indigenous feed ingredients containing 50% protein was successfully
tested on the postlarvae of the tiger shrimp (*P. monodon*). A maturation feed formulated with indigenous ingredients containing 50% protein was also successfully tested on the broodstock of *P. monodon*.

Two feed formulae were developed for the postlarvae, juveniles and adults of *P. monodon* and *P. indicus* using indigenous feed ingredients which resulted in the best growth performance and FCR between 1.8 and 2.0. Water stability for 6 hr of shrimp feed pellets was achieved with maida and wheat flour (15%) processed in combination with clusterbean gum (3%).

**Freshwater Aquaculture**

Singhi (*Heteropneutes fossilis*), an air-breeding catfish, has been induced-bred at the CIFA, using Ovaprim under laboratory conditions. Fertilization was 95% with a hatching rate of 87%. Use of thyroid hormones solved the physiological problems encountered during the larval and fry-rearing stages. Feeding practices for spawn and fry were standardized using a combination of artificial feed, brine-shrimp nauplii and molluscan meat so as to achieve high survival and good growth rates. Breeding could again be achieved in December through hormonal manipulation and proper broodstock management.

**Fish Health Monitoring**

Extensive investigations carried out at the CIFA on the disease/mortality of spawn/larvae of carps/prawn have led to the identification of the disease-causing organisms and their remedial measures. *Edwardsiella tarda* was responsible for mass mortality of spawn/hatchlings of carp. *Escherichia coli* and *Streptococcus* sp. isolated from the affected specimens were non-pathogenic, whereas *Aeromonas* sp. and *Pseudomonas* sp. were moderately pathogenic. *Vibrio parahaemolyticus*, *V. alginolyticus* and *Pseudomonas* sp. isolated from Macrobrachium malcolmsonii hatchery were controlled by ciprofloxacin followed by clotrimazole and tetracycline. Enterotoxins from 8 strains of *E. coli* have been separated for further studies.

**Coldwater Fisheries Culture of Golden Mahseer**

In a significant breakthrough, a technology has been standardized at the NRC-CWF, for intensive raising of fingerlings of golden mahseer (*Tor putitora* Ham.) under farm conditions. Formula-
tion of diets for fry rearing and techniques for raising figerlings (size 150 mm and 40 g in weight) in pond environment in 4-5 months have been perfected. For the first time, culture trials of this species in pond environment have also been made. The fish with a record growth of average 150 g and 210 mm in size has been achieved in 1 year. Under management and conservation programme, a few waterbodies in Kumaon Himalaya depleted with mahseer fishery have been stocked with the seed of this species so as to repropagate the endangered fish.

**Culture of Common Carp in Himalayan Uplands**

At Chirapani Fish Farm, Pithoragarh, culture of common carp (*Cyprinus carpio*) has been taken up under temperate Himalayan upland agro-climatic conditions to raise maximum possible fish production per unit area of water and to produce cheap source of protein for local people in hills and remote areas in Himalayan uplands. Fishes stocked @ 5-15/ m² in cemented tanks of different dimensions with stagnant and semi-running water facilities were fed on a feed consisting of oilcake and wheat bran fortified with vitamins and mineral pre-mix @ 5-10% of their body weight at 4.5°-23.5°C. So far encouraging results have been obtained.

**Mariculture and Sea Ranching**

A breakthrough was made at Mandapam Regional Centre of the CMFRI in artificially transferring the spermatophore from an adult male of tiger shrimp (*P. mondon*) to a female of the same species which subsequently spawned viable 1 million eggs; 78% of them hatched to healthy nauplii. The present result of artificial insemination experiment goes a long way in overcoming the problem of failure in spawning due to non-mating and non-deposition of spermatophores and help in producing more seed out of less number of spawners.

**Seed Production Culture and Sea Ranching**

Farming experiments conducted using lab-reared seed of *Penaeus semisulcatus* yielded encouraging results with a production of 459 kg/ha/ harvest with survival of 76%. The possibility of introducing this species in culture system at Tamil Nadu is very bright as the CMFRI has already perfected a low cost technology for the broodstock maintenance and seed production of this species. Seed (106,000) of *P. semisulcatus* has been pro-

In Kumaon Hills some waterbodies were found mahseer-depleted; these were restocked with seeds of *Tor pupititora*. 

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duced and searched at Palk Bay.

**FISH GENETICS**

Under long-term cryopreservation programme for Gene Banking, the milt of endangered mahseers (*Tor putitora* and *Tor khudree*) and Indian major carps (*Labeo rohita* and *Cirrhinus mrigala*) are being maintained in the Mini Gene Bank of the NBFGR. Milt cryopreservation of Farakka hilsa has been initiated. Hilsa milt has been cryopreserved using different extenders.

Genetic characterization of endangered and commercially important fishes is being done through biochemical and karyological (chromosomal) studies. Biochemical characterization of exotic species like tilapia and common carp already established in culture systems of India was carried out.

Catalogue on Fish Genetic Resources of India was updated by adding more information on taxonomy, habitats, biology, bionomics, morphometrics, food and feeding habits, gonosomatic index (GSI), catch statistics, cultural possibilities, breeding behaviours, genetics and conservation status.

Several experiments have been conducted for monosex (male) production and induction of sterility in *Oreochromis mossambicus* by oral administration of 17α methyl testosterone (17α MT) to the hatchlings immediately after yolk-sac absorption stage. Feeding of 17α MT-incorporated diets (35 mg/kg feed) under long-photoperiod (16 L: 8D) resulted in 2-fold increase in growth rate and 98-100% survival. Under increased photoperiod 100% phenotypic males were produced.

At the CIFA the second gynogenetic generation of rohu (*Labeo rohita*) has been produced. These are to be top-crossed for producing hybrid vigour. Gynogenesis is of high practical value as homozygosity could be achieved in fewer generations as compared to normal selective breeding. This is an efficient tool in producing unisex populations as well.

**FISHING AND FISH PROCESSING TECHNOLOGY**

**Harvest Technology**

A new 51 m long wing, semi-pelagic trawl was designed by the CIFTR and finalized for operation.
from FORV Sagar Sampada. Cost effective polypropylene gill-nets were found equally effective as nylon gill-nets during commercial operations for landing quality fishes like seer and pomfret. An 8.5 m midwater trawl was found effective for harvesting the off-bottom fishes of the Hirakud reservoir in Burla. Studies carried out by the CIFT on the availability of fishes at different depths in the reservoir have revealed that Mystus spp., Wallago attu, Rohitee chrysea and R. cotto frequented surface water during summer and moved to deeper waters during winter. Sciaenids were available in deeper waters more in summer than in winter. Catches in general were more in shallow waters than in deeper waters. Performance monitoring of a 15.5 m steel fishing vessel constructed by private entrepreneur as per CIFT know-how was completed. The vessel is better than the existing vessels of identical size in respect of fuel efficiency and operational performance.

Post-harvest Technology

Fresh-dressed fish treated with a brine-preserve combination of 0.2% sorbic acid, 0.2% ascorbic acid and 0.2% propionic acid dissolved in 15% brine gave highly palatable and attractive products that could be preserved for as long as 22 weeks at room temperature. Minced fish treated with a preservative mixture of 0.3% calcium propionate, 0.2% sorbic acid, 0.2% ascorbic acid and 2% refined salt and stored at 2°-5°C remained in bacteriologically and organoleptically sound condition for more than 1 month. Methods worked out for partial smoking and drying of freshwater fishes (Catla catla and Labeo rohita) yielded attractive and excellent canned products. Process for preparation of surimi from 6 species of fish was standardized. Fish hydrolysate of high quality was prepared from tuna red meat as well as from fillet wastes from other fishes using alcalase enzyme, yield was 15% more than that with papain.

A commercial dehydration plant at Agatti island of Lakshadweep, under a collaborative project, is being set up to handle 2 tonnes of tuna/day and 500 kg waste material for production of fish-meal.

Amino acid content of muscle proteins of freshwater, brackishwater and marine fishes was determined. These proteins are a good source of essential amino acids. The fatty acid profile of fish dried at different temperatures was studied. Dietary fish oils lowered cholesterol in albino rats without increasing blood sugar level.
Surgical sutures made from fish gut collagen are excellent substitutes for the sutures obtained from multi-national companies. Thin films of chitosan-gelatin with tensile strength of 250 kg/cm² were prepared. Micro-crystalline chitosan was prepared from granular chitosan by a specific treatment.

**Fish Microbiology**
Muscles and intestine of giant freshwater prawn, *Macrobrachium rosenbergii* from aquaculture farms near Trichur District in Kerala revealed pathogens like *Salmonella* and *Aeromonas hydrophila*. Marine fishes and shrimps off Cochin were screened and *Vibrio alginolyticus*, *V. vulnificus*, *V. parahaemolyticus* and *V. demsela* were isolated from most of them.

**Fisheries Education**
The regular post-graduate diploma courses in fishery science and certificate courses in Inland Fisheries Administration and Management; Fisheries Extension Method and Techniques; and Inland Fisheries Operatives were conducted successfully by the CIFE, Bombay, and its Centres, in addition to their regular M.Sc. courses in Fisheries Management (FM) and Inland Fisheries Administration and Management (IFAM). The Post-graduate Education and Research Programme in Mariculture of CIFE/CMFRI continued to impart courses in mariculture leading to M.Sc. and Ph.D. degree under CIFE, Bombay.

**Extension**
A total of 548 coastal fish farmers and farm women were trained at the KVK of the CMFRI in subject areas such as prawn farming, livestock management, livestock production, poultry farming, mushroom cultivation, fish processing, food and nutrition, and fruit preservation. Apart from the above courses TTC of the Institute conducted a training programme on 'Sampling Design' for estimation of exploited marine fish landings. Altogether 6 participants from Gujarat, Karnataka, Kerala and Pondicherry attended.

During the period under report, at the CIFE, 9 short-term training programmes were organized on: (i) engineering aspects (Macro-level survey) of brackishwater aquaculture, (ii) giant freshwater prawn hatchery management using ground saline water, (iii) management of giant freshwater prawn hatchery (3 programmes), (iv) management of freshwater seed farm (2 programmes), (v) management of brackishwater fish farm, and (vi) composite fish culture.
Agricultural Economics, Statistics and Marketing

* National Centre for Agricultural Economics and Policy Research published Agriculture policy paper and policy briefs

* Model developed to predict crop yield

* Remote sensing technology used for predicting profile of cropped area and growth pattern of crop

* Model developed for forecasting marine fish catch

* Computer softwares developed for agricultural scientists

* Database is being prepared under Project on Development of Information Technology to support applied biotechnology research

The National Centre for Agricultural Economics and Policy Research (NCAP) was established by the ICAR in March 1991, to upgrade research in agricultural economics through integration of economics input in planning and designing, evaluation of agricultural research programmes and strengthening of the competence in agricultural policy analysis within the Council. This Centre is assigned a leadership role in this area not only for various ICAR institutes but also for State Agricultural Universities.

ACHIEVEMENTS

Policy Papers and Policy Briefs
The Institute has recently published 5 Policy Papers and 2 Policy Briefs. The policy papers are: (i) Impact of Tenancy Reforms on Production and Income Distribution - A Case Study of Operation Barga in West Bengal; (ii) Production Prospects and Constraints to Higher Productivity of Pulses in Madhya Pradesh; (iii) Research Priorities in Indian Agriculture; (iv) GATT and Agricultural Exports - Hopes and Realities; and (v) Small Farms

Moisture stress index was prepared to study the effect of stress on yield of rainfed crops
and Surplus Generation - A case of West Bengal.

The Policy Briefs: (i) Privatising Agricultural Research; (ii) Privatising Farm Extension - Need for a Cautious Approach. The centre organized 2 National Workshops/Seminars on important topics.

The IASRI, New Delhi, undertook a project to develop a moisture stress index for rainfed crops and examine the effect of various degrees of stress yield. The regression equation of stress index on yield showed that reduction in yield from its potential of 3,000 kg/ha is expected to be 42.71 kg/ha for per unit of stress. The model is capable of predicting yield during any time of the crop season between sowing and harvesting.

A methodological investigation on estimating seasonal fluctuations in post-harvest foodgrain losses (wheat) indicated 0.75, 0.25, 0.61 and 0.62% losses, respectively, at harvest, threshing and storage. For an area of the size of a district, a sample of 45 villages can provide estimates of percentage foodgrains losses with a standard errors at the level of 7% at harvest stage, 6% at threshing stage and 8% at storage stage.

Incomplete block designs with nested rows and columns (IBRCD) were introduced for situations requiring elimination of heterogeneity due to more sources than those that can be eliminated through blocking. The fundamental theorems on method of differences as applicable to the case of balanced incomplete block designs (BIBD) were extended to these designs. Methods of construction of series of these designs with smaller number of replications were developed (i) by extending the two fundamental theorems on the method of differences (Bose), (ii) by combining available BIBD and BIBRCD (Balanced Incomplete Block Design with Nested Rows and Columns), (iii) through EG (n,s), and (iv) using available BIBRCD with 1 treatment in excess or in short. Trial and error solutions for certain specific BIBRCD were obtained. The solutions for the case of these designs with 30 or less treatments in blocks of size 9 or less have been tabulated.

A study was taken up to develop an appropriate model for forecasting marine fish catch and to test the adequacy of models developed so as to recommend most appropriate model. Quarter-wise actual marine fish landings data for 40 points of time from Orissa, Kerala, Tamil Nadu, Pondicherry and Karaikal, Karonataka, Goa, Andhra Pradesh, Maharashtra, Gujarat and West Bengal were uti-

REMOTE SENSING FOR CROP GROWTH

The Remote Sensing Technology has great potential for monitoring the profile of cropped area and growth pattern of crops. A study was undertaken in district Sultanpur, Uttar Pradesh, for obtaining improved estimators of wheat crop yield using the yield data based on crop cutting experiments under yield estimation surveys for the district along with the satellite data from landsat (TM) for 26 February 1986. The post-stratified estimator based on satellite data is more efficient than the crop yield estimator based on conventional methods of crop yield estimation.
lized. The marine fish catch showed seasonal variations. Quadratic model in Tamil Nadu and Karnataka, and Winter's model in the remaining 8 states were most suitable for analysing the data.

Under the NARP II-Basic Research Project on Livestock Biotechnology, a sub-project entitled "Development of information technology to support applied biotechnology research" is in operation in the Division of Computing Science. The project envisages establishing databases and information systems to support biotechnology research in crops, livestock, poultry, fishery and agroforestry, and conduct training programmes in the state-of-the-art in computing and information technology.

The IASRI, New Delhi, conducted 3 training programmes, viz. 1. Sixth International Training Course on Techniques of Estimation of Outcome of Food Crops; 2. Summer Institute on Advances in Agricultural Statistics with Special Reference to General Linear Models and Applied Regression Analysis; 3. Workshop-cum-seminar on Optimality and Robustness of Design.

**SOFTWARES**

The IASRI continued to develop computer softwares to meet the requirement of scientists and research workers. A new interactive programme for North Carolina Design I was developed. Softwares were developed for

1. Development of Computerized Information System for selecting major crops;
2. Modelling a database for research in dairy cows;
3. Simulation optimization approach for predicting aphid population; and
Agricultural Education
Agricultural Education

* Funds provided for development and strengthening of State Agricultural Universities, Agricultural faculties of Central Universities, deemed Universities and Central Agricultural University for NEH Region, Imphal

* Scholarships awarded for Manpower development

* Advanced Centres on Post-graduate Agricultural Education and Research established in frontier areas of agriculture and allied subjects

* 'Best Teacher Award' conferred to recognize Professional excellence

* National Professors/National Fellows selected

One of the mandates of the ICAR is to plan, undertake, aid, promote and co-ordinate education, research and its application in agriculture, agroforestry, animal husbandry, fisheries, home science and allied sciences. This is of importance in view of the country's growing needs in teaching, research, extension, management and development. The Education Division operates several schemes, aimed at development of necessary human resources.

Development and Strengthening of Agricultural Universities

State Agricultural Universities: The ICAR is extending support to the 27 state agricultural universities for developing infrastructure in Agricultural Education. This year Rs 13.5 million were allocated for the identified items on the basis of priorities and needs projected by SAUs and approved by the ICAR. The Council has identified 26 activities for which the assistance is available. These include strengthening infrastructural facilities such as laboratories and library facilities, staff, student and farmers' housing, sports facilities, practical training facilities, centralized communication and instrumentation facilities etc. During the year 6 girls hostel and 1 boys hostel costing Rs 10.2 million were sanctioned.
**Agricultural Faculties of Central Universities:** Under this scheme financial assistance has been provided to the Central Universities, viz., Banaras Hindu University, Viswa Bharati University and Aligarh Muslim University, at a cost of Rs 39 million.

**Deemed Universities of the ICAR:** Under this scheme, funds are being provided to IARI, IVRI, NDRI and CIFE to strengthen their teaching faculties, modernization of library and strengthening of student amenities including sports at a cost of Rs 40 million during the Eighth Plan period.

**Central Agricultural University for NEH Region, Imphal:** The Central Agricultural University for NEH Region, Imphal, has started functioning with the headquarters at Imphal, Manipur, with effect from 26 January 1993. The College of Agriculture, Manipur, has been brought under the purview of this University as a constituent college. At Mizoram, land has been identified and transferred to the University for the establishment of a Veterinary College.

**Manpower Development**

**Merit-cum-means Scholarships**

The ICAR has been providing scholarships and fellowships for promoting agricultural education. To support outstanding students belonging to the economically weaker sections of the society, 600 merit-cum-means scholarships @ Rs 170/month have been awarded during the year.

**Post-matric Scholarship for SC/ST**

This scheme was initiated to provide financial support to the SC/ST students for the study at the under-graduate level in agricultural and allied sciences. During the year 46 scholarships were provided.

**ICAR Junior Fellowship**

For the award of the ICAR Junior Fellowship, a competitive examination was held on 4 September 1994 in 44 disciplines of agricultural and allied sciences, and 475 students were selected for the fellowship.

**ICAR Senior Fellowship**

Decision has been taken to award senior research fellowship (SRF) on the basis of the national test conducted by the ASRB, along with ARS/NET examination. The Education Division also initiated steps for selecting candidates for SRF on the existing pattern till ASRB conducts examination. During the year 200 candidates were selected for SRF.

**Apprenticeship/Internship**

The Council continued to provide financial assistance towards the apprenticeship/internship allowances to the veterinary graduates for 6 months @ Rs 400/month along with a contingency amount of Rs 200/student.

**Summer Institutes**

During the year 26 summer institutes and short courses were organized at the agricultural universities and the ICAR institutes. A total of 650 scientists and members of teaching faculties engaged in research, training and extension benefited by participation.

**Centres of Advanced Studies**

As a follow-up of the Centres of Advanced Studies initiated under the UNDP, the Council during the Eighth Plan approved a new scheme for the establishment of Centres of Advanced Studies in the SAUs and the ICAR Deemed Universities. These centres are to provide knowledge-update training to faculty members and researchers from SAUs and institutes. Full financial support is provided by the Council; 36 such centres have been approved; 28 centres have been identified and sanctions issued, including first instalment of fund for the establishment of the centres.

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**Chart: Number of students benefitted by fellowships/scholarships (1994-95)**

<table>
<thead>
<tr>
<th>Year</th>
<th>JRF</th>
<th>SRF</th>
<th>MMS</th>
<th>PMS (SC/ST)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>475</td>
<td>200</td>
<td>600</td>
<td>46</td>
</tr>
</tbody>
</table>

MMS, Merit-cum-means scholarships
PMS, Post-matric scholarships (SC/ST's)
Foreign-aided Projects

The following 4 on-going projects are functioning:

**Advanced Centres on Post-graduate Agricultural Education and Research-IND/85/020:** Under the project, 11 centres with UNDP assistance have been established in frontier areas of agriculture and allied subjects. The UNDP assistance has been fully utilized for faculty training project, consultants and sophisticated equipments imported from outside.

**Strengthening Post-graduate Education in Food and Nutrition, and Child Development-IND/86/012:** The project is being phased out in 1994. Full utilization of the UNDP support have been made by Home Science faculties of 5 SAUs.

**Development and Use of Hybrid Rice Technology-IND/91/00B:** Ten centres are functioning under the project in agricultural universities, their regional research stations and the ICAR Institutes with the UNDP contribution of US $3,010,650 and the ICAR contribution of Rs 38,065,900. So far 12 fellowships have been utilized for training 12 persons abroad. Six consultants visited the research network centres of the project.

**Phytotron Facility at the IARI, New Delhi-IND/90/007:** Phytotron facility at the IARI, New Delhi, has started functioning. During the year, 2 study tours for 10 days each have been availed of by the Project Co-ordinators. Two scientists were deputed abroad for training for 3 man-months each.

Recognition to Professional Excellence

**Best Teacher Award:** Some of the state agricultural universities have started awarding Best Teacher Award since 1993 on the guidelines provided by the ICAR. The total outlay was Rs 0.85 million. Some awards are being considered during the year.

**Emeritus Scientist:** The Council has been providing financial support to the retired/retiring scientists to continue their research work for a reasonable period to conclude their research efforts. The scheme provides honorarium to scientists, and contingent grant and a research fellow for carrying out approved research projects. During the year 22 scientists were selected for the award in addition to the existing emeritus scientists.

MAJOR RESEARCH ACHIEVEMENTS
Creation of Professional Chairs (ICAR National Professors/National Fellows)

In the modified scheme, 4 ICAR National Professors, including 1 B.P. Pal Chair for Plant Genetics at the IARI, New Delhi, have been awarded. In addition to the 7 existing National Fellows, 16 National Fellows have been selected. During the year each National Fellow was granted Rs 1 million. The research achievements of the National Professors are as follows:

1. The project on “Genetic Engineering on *Brassica*” is continued. Somatic hybrids were analysed for the organelle genetics. In some cases random sorting out of mitochondria and chloroplasts occurred, but in others the sorting was non-random. Mitochondrial recombination occurred in many hybrids. The somatic hybrids were used in crossing programme to transfer cytoplasm of *Moricandie arvensis*, *Trachystoma balti* and *Diploctaxis catholica* for producing stable cytoplasmic male sterile systems.

2. The project on “Development of Microbial Pathogens for Integrated Management of Pests of Groundnut, Cotton and Soybean” suggested following measures:
   (i) Endosulfan and quinalphos have been selected for combined testing against *Amphacta albistriga*.
   (ii) Seed treatment with fungal antagonist *Trichoderma viride* may reduce the root rot to 8.5% as against 44% in untreated seeds.

3. The project on “Drought Tolerance Mechanism in Crops” is in progress.

4. The project on “Molecular Biology and Immunology of Rotavirus in Neonatal Bovine Calves” is in progress. Molecular diagnostic tests were used for the reliable diagnosis of gastroenteritis in human infants. In-depth study has been undertaken to study the molecular epidemiology of rotavirus, isolation of rotavirus by development of monoclonal antibodies reacting VP7, proteins of each of the two bovine serotypes, and differentiation of virulent and avirulent strains employing monoclonal antibody to VP4 and VP7 of bovine rotavirus.

Professional Resource Utilization

**Utilization of Internal Competence:** The expertise available in well-organized agricultural universities and the ICAR institutes is made available for building up educational and research capabilities of the new universities and institutes coming up in the country. One proposal from the OUAT, Bhubaneswar, for establishing university level library was provided financial support, under this scheme.

**Preparation of University-Level Books:** During the year 6 proposals for book writing have been received. One manuscript is ready for publication. The total outlay was Rs 0.7 million, of which Rs 0.034 million was for the financial support to the authors.

Home Science

As per the technical programme of the All-India Co-ordinated Project in 3 components, viz. Food and Nutrients, Child Development, and Home and Farm Resource Management, the work continued at the 6 participating centres. During the year Rs 6.5 million have been allocated, of which Rs 5.1 million were utilized. The assessment of nutritional adequacy of composite diets of rural families, food consumption pattern of farm families and their nutritional status continued in all centres. Nutritional evaluation of new varieties have been added. The use of soybean in different products, and availability of iron in germinated maize and other pulses were also studied. Studies indicated that the processed pearl millet when fermented leads to further improvement in its nutritional value, which can successfully be used for improving the nutritional status of our community at reasonable costs.

Collection of longitudinal data on growth studies of children has brought out regional growth norms (birth to 6 years). Mother and child care practices were also studied, along with growth norms of 6 to 18/20 years. These standard growth norms can be used as base for formulating developmental activities for children.

In Home and Farm Resource Management, the existing economic resources and their utilization, training on the use of solar cookers, kitchen gardening and scientific grain storage practices were studied. Household sanitation through smokeless *chulha* and safe drinking water for proper health and safe grain storage have been introduced through action research. Awareness for these technologies are seen through their practices.
National Agricultural Research Project

- National Agricultural Research Project (NARP) built up research infrastructure in 120 agroclimatic zones covering 343 research centres

- A Zonal Research and Extension Advisory Committee (AREAC) constituted for each agroclimatic zone

- Zonal stations provided zone-specific recommendations

- States prepared zone-wise package of practices

- ICAR accepted Agricultural Research Information System (ARIS) document

- NAARM conducted workshops and trainings on management of agricultural research and management

- Forecasting the future scenario of flavours' Project submitted the findings. Indian share in global market is due to export of essential oil, some of which available only in India

The National Agricultural Research Project (NARP) was launched in January 1979 with the assistance of the World Bank to strengthen regional research capabilities of 27 SAUs of the country with respect to major cereals, pulses and oilseed crops with emphasis on rainfed farming. The project built up research infrastructure in 120 agroclimatic zones covering 343 research centres for conducting location-specific and need-based research. The scope of the project was enlarged in Phase-II of the NARP, by including new areas of research such as irrigated farming, animal-drawn farm implements, agroforestry and animal nutrition. In addition, special sub-projects were taken up for training scientists in soil survey and land-use planning, water management, animal-drawn

MAJOR RESEARCH ACHIEVEMENTS
farm implements, horticulture and post-harvest technology, water management, agroforestry and animal nutrition. To develop strong linkages between research and extension at grass-root level, a Zonal Research and Extension Advisory Committee (ZREAC) was constituted for each agroclimatic zone. The zonal stations are coming up with zone-specific recommendations. Almost all the states have now prepared zone-wise package of practices. During the year, 15 NARP training programmes were organized in the strategic fields of agroforestry, animal nutrition and management, horticulture and agricultural engineering; 278 candidates were trained. The zonal research laboratories were further strengthened through procurement of modern equipments. The building infrastructure of the zonal centres have been made fully functional by providing additional grants for civil works. Zonal research capability was further strengthened by provision of additional vehicles; personal computer training was initiated for zonal scientists. Three regional group meetings were organized to review the impact of implementation of the NARP by 27 SAUs. Based on the recommendations of these meetings further contingency support was proposed to be provided to the centres. Three overseas study tours were undertaken by the managerial-level scientists working in SAUs and ICAR (HQ); and 21 managerial scientists in all received exposure to emerging areas of research in international institutes. The training of young talented scientists from the SAUs in the reputed international institutes was initiated.

Agricultural Research Information System (ARIS) document submitted by the International Service for National Agricultural Research (ISNAR), the Netherlands, has been accepted by the ICAR for implementation.

National Academy of Agricultural Research Management

The NAARM organized various activities related to training, research, education, workshops and consultancy to fulfill the needs of the clientele groups working at various levels of management in the agricultural research and development organizations. During the period under report, 70 ARS scientists, freshly recruited into the service, completed their foundation course training. Currently 93 ARS scientists are receiving training.

The Academy also offered various specialized

FUTURE SCENARIO OF FLAVOURS

A study on “Forecasting the Future Scenario of Flavours” was conducted to forecast the future scenario of flavours in India with an emphasis on natural flavours. The forecasts were made using Delphi, trend extrapolation and expert consultation methods. The global flavour industry is expected to grow @ 7-10% in the coming decade, associated with the expected growth in food sector. USA, Europe and Japan regions contribute more than 70% of the flavour market. The findings indicated that the Indian share of global market comes through the export of essential oils, which is expected to show 7 to 9% growth rate by 2000 AD. This increase is mainly from the enhanced production of essential oils, some of which are produced only in India. In future, the beverage sector would be the highest consumer of flavours followed by confectionaries and dairy sector, both globally and nationally. In India, the forecast predicts that application of biotechnology would be highest in agriculture followed by food processing sector. It is also interesting to note that in Indian flavour sector, application of biotechnology is almost nil now. However, it will become a potential future tool largely due to demand from organized industrial houses.
programmes for developing an appreciation and providing adequate skills to various levels of scientists of the ICAR and SAUs. Senior level programmes (10) were also offered during the year.

International training workshop on “Management of Agricultural Research” was successfully conducted for the Directors of Agricultural Research Institutes of Nigeria from 21 November to 2 December 1994. Raj Bhasha Rolling Shield was awarded to the Academy in recognition of the distinguished work done in implementing the official language policy of the Union. A 3-week summer institute on “Recent Advances in Agricultural Education Technology” was organized from 7-28 May 1994. A 3-day national workshop on “Non-Pesticidal Approach to Pest Management - A New Direction” was organized on 20 September 1994. A mobile seminar on “Management of Training - Local Institutional Resources and Experiences” was organized at the Academy on 27 June 1994, to create awareness on various physical facilities, understand the innovations and pedagogy of training, know the experience available, and to chalk-out a strategy for linkages between various agricultural institutions in and around Hyderabad. A 3-day regional conference of “Peasant Women of Southern States in Agriculture, Environment and Rural Development” was organized at the Academy on 27 October 1994, in collaboration with the Centre for Women’s Development Studies (CWDS) and International Federation for Women in Agriculture (IFWA) with an objective to promote greater interaction between peasant women and scientists/technologists and representatives of government agencies involved in framing policies for agriculture, environment and rural development. A 4-day national workshop on “Manpower Development in Extension Education for Meeting Future Challenges of Agriculture” was also organized in collaboration with the Indian Society of Extension Education (ISEE) from 13 to 16 February 1995. His Excellency Dr M Chenna Reddy, the Governor of Tamil Nadu, inaugurated the workshop.

DATABASE FOR NATIONAL AGRICULTURAL RESEARCH SYSTEMS

Data have been compiled and updated on the parameters of livestock and fisheries enterprises like livestock population, production data of whole milk and dairy products, meat from different species; number of animals sacrificed and total meat produced; and data of wool, eggs, hides and skins, total catch from inland and marine resources, export and import of fisheries commodities, etc. The project is in progress.

Outreach Programme on Educational Technology

During this year, the third contact session of OPET-II was organized from 6 to 13 June 1994. Fourteen academicians of SAUs were awarded PG Diploma in Educational Technology. OPET-III was initiated during this year and the first contact session was conducted from 27 to 31 March 1995. Twenty academicians of various cadres from SAUs were registered for the programme.
Transfer of Technology

Zone I
* Frontline demonstrations on sunflower, mustard, toria, gobhi sarson and greengram increased productivity in different crops over local checks

Zone II
* Most productive rotations identified, viz. maize-paddy-mustard and maize/gram/wheat-ginger
* Cultivation of cotton demonstrated successfully without upsetting crop rotation
* Scope of "Tassar culture" increased by planting Terminalia arjuna in 60% degraded fallow lands
* Total 110 farm science clubs/mahila mandals established

Zone III
* In frontline demonstrations conducted on oilseeds and pulses improved varieties performed better than those of local checks

Zone IV
* Frontline demonstrations on oilseeds and pulses popularized improved varieties
* Total 85 farm science clubs started

Zone V
* Frontline demonstrations conducted on oilseeds and pulses
* Highest number of kisan melas conducted

Zone VI
* Frontline demonstrations conducted on oilseeds and pulses
* Total 17 farm science clubs and 18 mahila mandals organized

Zone VII
* In-service training courses offered to the grassroot level functionaries

MAJOR RESEARCH ACHIEVEMENTS

* Major technologies transferred were:
  ** ridge and furrow method of planting
  ** introduction of hybrid sunflower and mustard
  ** use of gypsum in groundnut
  ** introduction of groundnut variety 'ICGS44'

* Adaptive trials were conducted to ascertain the suitability of technology in given circumstances

Zone VIII
* Frontline demonstrations conducted on mono-, double- and multiple- cropping of cereals, pulses, oilseeds and vegetables
Yield of oilseeds in demonstrations increased between 20 and 150%.

Total 96 farm science clubs organized.

The frontline extension system of the ICAR basically plays centre extension role, a catalytic role, a supportive and complimentary role as well as a pressure role to accelerate the process of transfer of technology and services as window through which the extension agencies and the farmers can gaze at the latest agricultural technologies. The major projects are Krishi Vigyan Kendras and Trainers’ Training Centres. KVKs (183) and TTCs (8) were fully functional in 8 zones; 78 KVKs, were at various stages of establishment. The KVKs in all the zones conducted training courses for farmers including farm women, farm youth and extension workers. These courses covered crop production, plant protection, horticulture, livestock production and management, soil and water management including farm machinery, various aspects of home management and other related aspects of production; and benefited farmers, farm women, village youths and school drop outs. The zone-wise achievements of KVK with respect to various functions are reported as under.

MAJOR ACHIEVEMENTS

ZONE I (Punjab, Haryana, Himachal Pradesh, Jammu and Kashmir, and Delhi)

This zone has 23 KVKs. Three state level training-cum-workshops were organized to bring out the qualitative improvement in the working of the KVK scientists and technical staff. Frontline demonstrations (1,159) on oilseeds and pulses were conducted with an aim of showing the production potentialities of improved high-yielding varieties and production technologies. Different crops showed on an average 30 to 50% increase in productivity in comparison to the local check. A large number of extension activities to speed up the process of technologies and to sensitize the farmers and other beneficiaries were taken up. These were Field days (160), Farmers’ fairs and Kisan Gosthies (26), Farm Women’s fair (3), Agricultural exhibition (40), Clinical camps (20), Campaigms (20), Video shows and Film shows (80) and Radio/TV coverage (50).

ZONE II (Bihar, West Bengal and Union Territory of Andaman and Nicobar Islands)

There are 26 KVKs in the zone, out of which 9 are in West Bengal, 16 in Bihar and 1 in Andaman, Nicobar Islands. The KVKs conducted training programmes for practising farmers. The kendras organized 172 in-service trainings for 3,214 officials from state development departments and others including NGOs. Out of these, 1,095 were SC/ST officials. Introduction of maize in Darjeeling district has increased the cropping intensity from 110% to 200% in maize-based cropping system. The most productive rotations now established are maize-paddy-mustard and maize-gram/wheat-ginger. In Sunderban area, the KVK successfully demonstrated the cultivation of cotton without upsetting the crop rotation following the technique of raising cotton seedlings in polythene bags and transplanting the same as soon as the field is vacated. This has increased the cropping intensity from 100 to an average of 160-180%. Plantation of Terminalia arjuna in 60% degraded fallow land in Purulia along with intercrops (pulses and vegetables) has increased the scope of “Tassar Culture” resulting in employment generation for women and protection of environment and soil. The oilseed demonstrations, conducted on mustard and niger in 483.89 ha covering 3,759 farmers, showed
increase up to 241% and 176% respectively. The demonstrations were conducted on red gram 'UPAS 20' and greengram 'K 851' in 420.54 ha with 2,900 families indicating an increase in productivity by 86 and 154%, respectively, over control. The zone organized 164 field days involving 7,312 beneficiaries, 28 kisan melas benefiting 3,554 participants, 1,005 diagnostic team visits covering 7,359 farmers and the other activities like clinics, advisory services covering more than 8,000 farmers. The KVKs also provided 169 extension literatures to more than 26,000 farmers and established 110 farm science clubs/mahila mandals in this zone.

ZONE III (Assam and North-Eastern states including Sikkim)

This zone has 12 KVKs and 1 TTC, however, the achievements were reported for the KVKs which are fully established. The KVKs and the Trainer’s Training Centre organized 20 training programmes for 557 officials including 95 female participants and 431 scheduled caste and scheduled tribe officials. Two problems were identified for conducting on-farm research covering an area of 33.7 ha, their results are still awaited. The frontline demonstrations on oilseeds was conducted covering 203.50 ha and involving more than 600 farmers. Soybean varieties viz. ‘Bragg’ and ‘Gaurav’ recorded 15 to 22 q/ha yield which were more than 80% higher than the local checks. The groundnut variety ‘JL 24’ was included in all the demonstrations and it showed the highest yield of 24.5 q/ha under mid altitude area of Nagaland. The sesame variety ‘TC 25’ produced an average yield of 8.0 q/ha which was 60% higher than the local check. Mustard varieties viz. ‘Varuna’, ‘Vardan’, ‘Vaibhav’, ‘Rohini’, ND ‘Rai 8501’, ‘Krishna’, ‘Pusa Bold’ recorded an average yield of 13.0 q/ha and toria variety ‘M 27’ recorded 7 q/ha. The yield of niger varied from 5 to 8 q/ha under different altitudes. In frontline demonstration on pulses 18.5 ha were covered. The demonstration yield in red gram and greengram ranged from 8.4 to 10.5 q/ha and 6.3 q/ha, respectively. The kendras organized 46 field days involving 2,934 beneficiaries, 3 kisan melas benefitting 460 farmers, 13 visits for 359 farmers and a number of farmers’ days involving 300 farmers.

ZONE IV (Uttar Pradesh)

The kendras organized 75 refresher training courses for extension officials already working

CROP VARIETIES FOR UTTAR PRADESH

<table>
<thead>
<tr>
<th>Crop</th>
<th>Varieties</th>
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<tbody>
<tr>
<td>Rice</td>
<td>‘Saraju 52’, ‘Pant Dhan 4’,</td>
</tr>
<tr>
<td></td>
<td>‘Pant Dhan 10’, ‘Prasad’</td>
</tr>
<tr>
<td>Wheat</td>
<td>‘HD 2285’, ‘Malviya 234’</td>
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<tr>
<td>Red gram</td>
<td>‘Bahar’, ‘Pusa 85’</td>
</tr>
<tr>
<td>Field pea</td>
<td>‘Rachna’, ‘Aparna’</td>
</tr>
<tr>
<td>Gram</td>
<td>‘Awarodhi’, ‘Udai’</td>
</tr>
<tr>
<td></td>
<td>‘ICGS 37’</td>
</tr>
<tr>
<td>Sunflower</td>
<td>‘APSH 11’, ‘KBSH 1’, ‘MSFH 8’</td>
</tr>
</tbody>
</table>

In most of the demonstrations the average yield increased by 30-100% over the check plots.
in various development departments and NGOs. The frontline demonstrations on oilseeds were conducted covering 780 ha and benefitting 3,018 farmers, and demonstrations on pulses covering 400 ha involving 1,270 farmers. The other demonstrations and testings were organized covering an area of 950 ha involving 3,370 farmers including 895 belonging to scheduled caste and scheduled tribe communities.

The KVKs conducted 164 field days involving 7,312 beneficiaries. In addition 85 farm science clubs were started and 81 publications were made available to the farmers.

ZONE V (Andhra Pradesh and Maharashtra)

The 26 Krishi Vigyan Kendras of this zone organized training programmes (161) for the in-service personnel (4,435) belonging to the state development departments and NGOs. Under Lab-to-Land Programme, 1,644 demonstrations covering 1,644 families with 0.4 ha each were conducted. Under frontline demonstrations on oilseeds, 436.9 ha were covered benefitting 1,233 farmers, and on pulses covering 201.5 ha and 525 farmers. Groundnut varieties 'ICGS 44', 'ICGS 11', 'JL 24' and 'K 150', showed an increase in yield from 19 to 88%. The yield of sunflower hybrid 'APSH 11', 'DK 3839', 'Nath 110', 'Pioneer', 'PAC 36', 'MSFH 17' and 'SH 3322' ranged between 8.0 and 20.2 q/ha which was 27 to 107% higher than the control plot. The yield of sesame increased by 30% and soybean 33 to 132% over the local check. In pulse crops the increase in productivity ranged from 5 to 150% in red gram, chickpea 12 to 94%, and blackgram 17 to 88% over the local check. The improved high-yielding varieties recommended for the zone were used along with other improved practices. The kendras conducted 106 field days benefitting 8,037 farmers including 1,649 farm women; of which 2,483 belonged to scheduled castes and scheduled tribes. The centres conducted 56 kisan mela involving 21,539 farmers including 5,010 SC/ST and 5,060 farm women. There were 1,345 other extension programmes involving 14,078 beneficiaries including 4,560 farm women and 2,820 of SC/ST categories.

ZONE VI (Rajasthan, Gujarat and Union Territory of Dadar and Nagar Haveli)

There are 42 KVKs functioning in this zone, out
of which 31 are in Rajasthan and 11 in Gujarat. Under frontline demonstration, 453 ha area under oilseeds and 388 ha under pulses were covered benefitting 945 and 621 farmers respectively. A total of 215 ha was covered under various demonstrations on field crops, horticultural crops and forage crops benefitting 372 farmers. Besides, 77 demonstrations were also organized on various aspects of home science, farm machinery, agroforestry, animal husbandry and plant protection benefitting 3,099 farmers. Under Lab-to-Land Programme, survey of farm families of various categories in 46 villages was conducted and based on survey report 2,704 farm families were adopted under this programme. Under different extension activities, 116 field days benefitting 7,877 farmers, 25 farmers' fairs benefitting 32,012 participants, 111 radio talks, 148 TV programme/film shows benefitting 6,913 persons, 25 ex-trainees meeting benefitting 1,010 farmers were organized. Women in Agriculture Day on 4 December 1994 was celebrated by the KVKs and demonstrations, group discussions and field visits were organized. Farm science clubs (17) and mahila mandals (16) with the membership of 279 and 332, respectively, were organized. News coverage (187) were made and 110 other extension activities were organized.

ZONE VII (Orissa and Madhya Pradesh)

There are 29 KVKs—18 in Madhya Pradesh and 11 in Orissa—and 2 Trainers' Training Centres in the zone. In-service training courses (82) were offered to 1,493 grass-root level functionaries and other officials (164 SC/ST officials) of state development departments. The duration of courses ranged from 1 day to 48 days. TTCs also conducted 45 training programmes for 480 officials, and the duration of these courses ranged from 35 to 260 days. The field demonstrations (234) covering 114.50 ha were conducted on oilseeds. The highest yield recorded with sunflower was 26.2 q with average of 21.0 q/ha recording 179% increase over local check. In mustard, the highest yield was 22.5 q and average of 18.5 q/ha with 47% increase over local check. In groundnut the highest yield was 23.7 q/ha and average of 17.7 q/ha indicating the increase over local check by 43% in Ganjam district and by 52% with the highest yield of 31.5 q/ha in Balasore district of Orissa. The major technologies transferred were ridge and furrow method of planting and introduction of hybrid 'MSFH 8' in sunflower, introduction
of pure and quality seed with seed treatment of varieties, viz. 'Varuna', 'Pusa bold' and 'Rohini', in mustard, and introduction of variety 'ICGS 44' and use of gypsum in groundnut.

During kharif, 177 demonstrations covering 107.70 ha were on soybean, and 17 were in 10 ha on niger. A number of new varieties were introduced. The yield varied from 9 to 33 q/ha according to the agroclimatic regions, the highest yield was recorded from Malwa Plateau under irrigated situations. The highest yield of 20 q/ha was recorded in Vindhyan Plateau under rainfed situations. The highest yield of niger was 4 q/ha.

In frontline demonstrations on pulses, 36 demonstrations covering 18 ha were conducted on red gram varieties 'ICPL 87' and 'SPMA 1'; and their average yield ranged from 14.0 to 14.7 q/ha. The demonstrations on gram were conducted over 100 ha involving 169 farmers. The yield varied from 11.4 to 24.3 q/ha, the highest being in Keymore Plateau followed by Vindhyan Plateau and Central Narmada Valley. The increase in average productivity ranged from 12.4 to 21.9 q/ha and highest yield obtained was 28.2 q/ha. The programme was taken in 6 KVKs (5 KVKs in Orissa and 1 in MP). The problems identified by KVKs in Orissa were lack of plant population in paddy, low yield of groundnut due to excess of greengram plants in mixed cropping systems, low plant population in groundnut due to wide spacing, low yield of rice in Jholla land during kharif, instability in yield of toria, low productivity of kharif tomato due to water stagnation and high mortality of kids (goat) during first month and subsequent months of age due to malnutrition. In MP (KVK, Chhindwara) the problem identified was the unstability of yield in soybean. Sowing behind plough with 60 kg of seed/ha seed and mechanical weeding solved the problem on paddy plant population as the yield was 32.52 q/ha. In mixture of groundnut and greengram, variety 'ICGS 44' planted at 30 cm x 10 cm and intercropped with greengram with 1.25 kg seed produced the highest yield. The low plant population of groundnut may be improved by taking 30 cm x 10 cm spacing in 'ICGS 44'. Yield of toria can be improved, if taken after paddy with 2 ploughings and laddering immediately. The other problems are still under experimental stages. Adaptive trials were conducted in selected KVKs to ascertain the suitability of technology in given circumstances. Most of KVKs conducted the trials with tribal farmers. The KVKs conducted 108 field
days involving 4,835 beneficiaries and 18 kisan melas including 7,247 beneficiaries. In addition 149 radio talks, 23 film shows, 80 newspaper coverage and 78 other activities were organized. The KVKs published 33 research papers, 21 technical reports, 4 technical bulletins, 69 popular articles and 79 extension literatures.

ZONE VIII (Kerala, Karnataka, Tamil Nadu, Goa and Union Territories of Pondicherry and Lakshadweep)

There are 22 KVKs and 3 TTCs in this zone. During 1993 three more KVKs started functioning. The in-service trainings (179) were organized for the extension officials (4,006) of state development departments, NGOs and others already working in field. There were 73 courses in crop production, 35 in horticulture, 42 in home science, 7 in animal sciences, 2 in agroforestry, 2 in plant protection and remaining in other disciplines.

The KVKs conducted various demonstrations covering 1,112.7 ha under mono crop, double crop and multiple crop system of cereals, pulses, oilseeds and vegetables. The frontline demonstrations were conducted on oilseeds (groundnut, sunflower, safflower, soybean, niger, sesame) covering 706 ha involving 1,316 farmers and on pulses (red gram, greengram, blackgram and gram) covering 340 ha with the involvement of 664 farmers. The yield of oilseeds in demonstrations increased between 20 and 150% over the control plot and of pulses between 15 and 50%. The kendras organized 135 field days benefitting 8,224 farmers, 123 farmers' convention involving 6,036 beneficiaries, 19 farmers' fairs benefitting 1,857 participants, 196 film shows, 63 radio, 15 TV coverage and 96 exhibitions. The kendras also organized 96 farm science clubs.
3. Research for Tribal and Hill Regions
Research for Tribal and Hill Regions

* Krishi Vigyan Kendras (KVKs) implemented main extension activities in tribal and hill areas. They organized training courses for farmers, farm women and youth. Main achievements of KVKs are as follows:

* Training courses for in-service personnel
* Rehabilitation of tribal families practicing shifting cultivation in West Tripura
* Transformation of tribal economy through improvement in plantation-based farming system at Coonoor, Tamil Nadu
* Improvement of highly eroded undulating degraded land through dryland horticulture at Gandhigram, Tamil Nadu
* Demonstration of economically viable and adoptable techniques of cultivation of seasonal vegetables and soybean, rabbitry, forestry, and establishment of mushroom unit at Tehri Garhwal, Uttar Pradesh
* Establishment of non-formal education centres and community centres at Ranchi, Bihar

The main activities of the Division of Agricultural Extension are implemented through Krishi Vigyan Kendras. At present there are 258 Krishi Vigyan Kendras in the Country, of which, 9 are located in hilly areas, 33 exclusively in tribal areas and 16 in hilly and tribal areas.

The KVKs operating in hilly areas organized 1,403 training courses during 1994-95 covering
<table>
<thead>
<tr>
<th>State</th>
<th>Number of KVKs</th>
<th>Training courses</th>
<th>Field days</th>
<th>Inservice training of extension personnel</th>
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<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Number</td>
<td>Beneficiaries</td>
<td>Number</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td><strong>Hilly Areas</strong></td>
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<td>28,790</td>
<td>30</td>
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<td>9</td>
<td>1,403</td>
<td>46,446</td>
<td>83</td>
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<td><strong>Tribal Areas</strong></td>
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<tr>
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<td>Bihar</td>
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<td>779</td>
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<tr>
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<tr>
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<td><strong>Hilly and Tribal Areas</strong></td>
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<td></td>
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<tr>
<td>Arunachal Pradesh</td>
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<td>Kerala</td>
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<td>59</td>
<td>1,558</td>
<td>10</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
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<td>40</td>
<td>511</td>
<td>12</td>
</tr>
<tr>
<td>Maharashtra</td>
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<td>37</td>
<td>982</td>
<td>3</td>
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<td>Nagaland</td>
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<td>1</td>
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<td>Orissa</td>
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<td>1,026</td>
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<td>Sikkim</td>
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<td>5</td>
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<tr>
<td>Tamil Nadu</td>
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<td>258</td>
<td>3,212</td>
<td>3</td>
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<tr>
<td>Tripura</td>
<td>2</td>
<td>215</td>
<td>3,518</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>16</td>
<td>1,244</td>
<td>50,027</td>
<td>92</td>
</tr>
</tbody>
</table>
46,446 farmers, farm women and rural youth. During the period, 83 field days on various crops were organized in which 4,559 farmers participated. Training courses (41) for in-service personnel were also organized covering 616 personnel from the Department of Agriculture, Animal Husbandry and Horticulture.

In tribal areas 33 KVKs are functioning in 12 states. During 1994-95 as many as 3,145 training courses benefitting 82,848 farmers were organized in crop production, animal husbandry, horticulture and home science. Field days (468) were organized covering 35,843 farmers. Training courses (251) for in-service personnel covering 4,983 participants were also organized. Considering the total number of farmers (0.26 million) trained by the KVKs during 1994-95, the tribal farmers trained by these KVKs alone constitute to be 32%.

There are 16 KVKs located in 15 states covering both Hilly and Tribal areas. During the year 1994-95, 1,244 training courses for 50,027 farmers, farm women and rural youths were organized in different subject matter areas. Field days (192) on different crops covering 8,099 beneficiaries were held. In-service training programmes (81) were organized to update the knowledge of officials on various subject matter covering 3,025 participants.

A few case studies were conducted about the impact of KVKs in hilly and tribal areas, specially in KVK, Chebri, Tripura, Coonoor, Nilgiris hills, Tamil Nadu, Gandhigiram, Tamil Nadu, Ranichauri, Tehri Garhwal district, Uttar Pradesh, Ranchi, and Bihar.

Integrated training and demonstration for rehabilitation of the tribal families practising shifting cultivation in West Tripura district has been taken up by the Krishi Vigyan Kendra for employment generation of the farmers in livestock production enterprise, duckery composite fish culture and induced breeding, bee-keeping, and mushroom cultivation.

The KVK at Coonoor in Nilgiris district of Tamil Nadu has taken up transformation of tribal economy through improvement in plantation-based farming system with appropriate blending of enterprises like sericulture, agriculture, and rabbit rearing in collaboration with other organizations including Tea Board, Nilgiris Adivasi Welfare Association (NAWA), Coffee Board, Spices Board, Hill Area Development Project (HADP) and United Planters Association of South India (UPASI).

In view of highly eroded undulating degraded conditions of land, the KVK at Gandhigiram, Tamil Nadu, has taken up its improvement through dryland horticulture. The instructional farm of the KVK has been converted to a good productive fruit plant nursery. The model of such dryland horticulture has been adopted by the farmers.

The KVK at Ranichauri, is working in the areas of rainfed hills (600-1,200 m), mid-hills (1,200-1,700), and high hills (2,500 m and above) of Tehri Garhwal, Uttar Pradesh. It has successfully demonstrated the economic viability and adoptibility of cultivation of low volume-high value seasonal vegetables like capsicum and french bean, rabbit rearing specifically Angora breed, forestry nursery, cultivation of soybean and establishment of mushroom units.

The KVK located in Ranchi, Bihar, has successfully established non-formal education centres and community centres for taking up social forestry and village nutrition garden among the tribal families. The red poultry bird a crossbred, developed at the KVK has proved to be very suitable for the tribal families in Chhota Nagpur area.
4. International Co-operation
The Indian Council of Agricultural Research (ICAR) and the Department of Agricultural Research and Education (DARE) are co-operating with various foreign governments, institutions and multilateral agencies in the field of Agricultural Research and Education through bilateral memoranda of understanding, protocols and agreements, concluded by the Ministry of Agriculture/Indian Council of Agricultural Research, and also by other ministries of the Government of India.

The broad areas of co-operation with foreign governments and institutes cover Crop Sciences, Soil Sciences, Horticulture, Agricultural Engineering, Animal Sciences, Fisheries and Agricultural Extension.

The major thrusts in co-operation with international institutions and under bilateral co-operation terms with other agriculturally developed countries are in the areas of: (i) new emerging technologies such as biotechnology, Information technology and remote sensing, (ii) rainfed agriculture with major emphasis on water-use efficiency and developing drought-resistant varieties, (iii) more efficient use of inputs, more specifically integrated nutrient management and integrated pest management, (iv) genetic resources conservation, and (v) post-harvest technology.

**Co-operation with the United Nations, FAO and other Multilateral Agencies**

A number of multilateral co-operative programmes are implemented under the auspices of the United Nations Development Programme (UNDP), the Food and Agriculture Organization (FAO) of the United Nations, the South Asian Association for Regional Co-operation (SAARC), the Swedish Agency for Research Co-operation among Developing Countries (SAREC) and the United Nations Development Programme (UNDP).

<table>
<thead>
<tr>
<th>Institute</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICRISAT</td>
<td>Sorghum, pearl millet, chickpea, pigeonpea, groundnut</td>
</tr>
<tr>
<td>CIMMYT</td>
<td>Maize and wheat</td>
</tr>
<tr>
<td>IRRI</td>
<td>Rice</td>
</tr>
<tr>
<td>CIP</td>
<td>Potato, sweet potato</td>
</tr>
<tr>
<td>WARDA</td>
<td>Rice</td>
</tr>
<tr>
<td>ICARDA</td>
<td>Rainfed crops of barley, lentil, fababean, chickpea, livestock system, pasture and forages</td>
</tr>
<tr>
<td>IBPGR</td>
<td>Improvement in germplasm cultivation facility</td>
</tr>
<tr>
<td>IFPRI</td>
<td>Food and agriculture policy</td>
</tr>
<tr>
<td>ICRAF</td>
<td>Agroforestry</td>
</tr>
<tr>
<td>IFDC</td>
<td>Development of sustainable agriculture and environmental protection</td>
</tr>
</tbody>
</table>
Commonwealth Agricultural Bureaux International (CABI). Under the UNDP, 4 projects under the Country Programme of India are being implemented in various state agricultural universities (SAUs) and ICAR institutes. These projects are being executed through the agency of the FAO. A number of projects have also been identified for implementation during the Country Programme CP-IV (1990-1995).

A Project Agreement relating to the development and use of Hybrid Rice Technology was signed by the Government of India in the Ministry of Finance (Department of Economic Affairs) with the UNDP on 19 April 1991, and subsequently a Letter of Agreement has also been signed by the ICAR with the FAO, which is the Co-operating Agency. Besides, there was a number of inter-country projects under implementation. Some projects have also been identified for implementation with assistance from the FAO under the Technical Co-operation Programme (TCP). We have also research collaboration with the Swedish Agency for Research Co-operation among Developing Countries. Many collaborative programmes like joint research workshops, seminars and training programmes are arranged in the SAARC countries. India is a donor member of the Commonwealth Agricultural Bureaux International (CABI). At present its annual contribution to the CABI is $57,859.

Co-ordination with the CGIAR

The Consultative Group on International Agricultural Research (CGIAR) supports a network of 18 International Agricultural Research Institutes engaged in research and training, and dissemination of information relating to agriculture and allied subjects. The headquarters of the CGIAR is located at Washington, DC.

The primary goal of the CGIAR is to strengthen world food security on a sustainable basis in the less-developed countries. The primary activities of the CGIAR fall into:

- Productivity Research - Creation of adoption of new technologies for increasing productivity on farmers' fields.
- Management of Natural Resources - Protection and conservation of the productivity of the natural resources on which agriculture depends.
- Policy Improvement - Assisting developing countries to formulate and carry out effective food, agricultural and research policy.
- Institution Building - Strengthening national agricultural research system in developing countries.
- Germplasm conservation and making it available to all regions and countries.
- Building Linkages - Helping to create or strengthen linkages between developing countries, institutions and other components of the global agricultural research systems.

The ICAR has entered into agreements with various research institutes and centres of the CGIAR. The ICAR has entered into an agreement with the International Crop Research Institute for the Semi-arid Tropics (ICRISAT) for promoting research and training in scientific cultivation of sorghum, pearl millet, chickpea, pigeonpea and groundnut; and with the International Maize and Wheat Improvement Centre (CIMMYT) for scientific and technical co-operation in research on maize and wheat. Through an agreement with the International Rice Research Institute (IRRI), the ICAR has been able to augment its research efforts on rice. The agreements have enabled Indian scientists to attend international conferences, symposia, training programmes and post-graduate studies. The ICAR has also entered into an agreement with the International Potato Centre (CIP) for promoting research and training in the scientific cultivation of potato and sweet-potato, and improvement of their production techniques. Similarly, through an agreement with the West African Rice Development Association (WARDA), the ICAR has been able to promote research in the scientific cultivation of rice and improvement in its production techniques. The ICAR signed an agreement with the International Centre for Agricultural Research in Dry Areas (ICARDA) for the cultivation of rainfed crops of barley, lentil, faba-bean, chickpea, livestock systems, pastures and forages; and with the International Board of Plant Genetic Resources (IBPGR) (non-IPGRI) for improvement in germplasm cultivation facility.

The agreement between the International Centre for Tropical Agriculture and the Central Institute of Agricultural Engineering aims at accelerating the progress of research and training in tropical commodities, particularly cassava, which is one of the highly efficient producers of carbohydrates. An agreement was also signed with the
International Food Policy Research Institute (IFPRI) to promote research and training in food and agricultural policy. Under this agreement, studies on improvement in foodgrains production and consumption, efficiency of technological changes in the production and productivity of major crops, impact of waterlogging and salinity problems have been envisaged.

In agroforestry, the ICAR has entered into an agreement with the International Centre for Research in Agroforestry (ICRAF).

The objectives of the above Memoranda of Agreements and Understandings are being achieved by drawing up biennial workplans with the collaborating agencies. The collaboration mainly involves exchange of information, exchange of germplasm and exchange of scientists and experts.

**Other Bilateral Agreements of Co-operation at Government/Institutional Level**

* ICAR/DARE signed bilateral Agreements of Co-operation at government/institutional levels
* ICAR signed MoU with Rockefeller Foundation, USA, for promoting rice biotechnology
* ICAR signed MoU for scientific and technical co-operation with the Philippines, Iran, Republic of Cuba, France, Mongolia, Bangladesh, Nepal, Mauritius, China and Japan.
* Overseas Development Administration Mission identified areas for collaborative projects
* Department of Economic Affairs earmarked 20 slots for training of Indian Scientists under Colombo Plan
* Externally-aided projects approved
* World Bank contemplates implementation of the Agricultural Human Resource Development Project in India

1. Material Transfer Agreement has been signed for transferring Plasmid p BT 291 containing a Synthetic Cry IIa(b) gene from the IRRI to the ICAR. The agreement envisages formation of a research consortium to share plasmids for research purposes only, and a user-consortium to deploy genes.
in plant varieties released to farmers.

2. The Memorandum of Understanding between the ICAR and the International Fertilizer Development Centre (IFDC), Muscle Shoals, Alabama, USA, was signed on 22 April 1994 to conduct biophysical, technological and policy research jointly. This would contribute to sustainable agricultural development and environmental protection. The Memorandum of Understanding is intended to foster understanding, co-operation and partnership between the ICAR and the IFDC, in general, and to facilitate collaboration of both institutions in respect of nutrient management and its implication on environmental health, generation and dissemination of appropriate technologies, policy options and analysis, and human resource development for sustainable agriculture, in particular. This MoU will be implemented through biennial workplans that will be developed jointly describing specifically the activities to be carried out.

3. Under the MoU for scientific and technical co-operation between the Government of the Republic of India and the Government of the Republic of Cuba, both the countries have signed workplan for 1994-1995 on 11 April 1994 at New Delhi. The workplan will be implemented by the ICAR on behalf of the Government of India and by the State Committee for Economic Co-operation on behalf of the Government of the Republic of Cuba. The signed workplan includes training of Cuban scientists in India and Indian scientists in Cuba on reciprocal basis, besides exchange of germplasm and scientific information.

4. A workplan between the ICAR and the Rockefeller Foundation of the United States of America was signed on 12 April 1994 under the Memorandum of Agreement for scientific and technical co-operation for promoting rice biotechnology at the following participating institutions.

(i) Biotechnology Centre, IARI, New Delhi
(ii) Central Rice Research Institute, Cuttack
(iii) Directorate of Rice Research, Hyderabad
(iv) Haryana Agricultural University, Hisar
(v) Punjab Agricultural University, Ludhiana
(vi) Tamil Nadu Agricultural University, Coimbatore

Separate activities for separate participating institutions have been outlined in the workplan for implementation of their technical programme in rice biotechnology.

5. Under the provisions of the Memorandum of Agreement for scientific and technical co-operation, an agreement between the ICAR and the Philippines Council for Agriculture, Forestry and Natural Resources Research and Development, Los Banos, Laguna, was signed at Los Banos on 25 November 1994 for the period ending 31 December 1996.

6. The Memorandum of Understanding was signed between India and Iran on 11 November 1991. Under this the first workplan in the field of Agricultural Research and Rural Development was signed on 11 November 1992 with the Department of Agricultural Research and Education as nodal department.

Minister for External Affairs, led the interministerial delegation to Tehran for participation in 7th Session of Indo-Iranian Joint Commission.

TRAINING OF IRANIAN SCIENTISTS

For training Iranian scientists, the Government of Iran has proposed to:

(i) Train their faculty members in the course on 'Income generation activities for rural women' at the National Institute for Rural Development (NIRD), Hyderabad, through the Ministry of Rural Development.

(ii) Train Iranian personnel in pearl-oyster breeding and hatchery management, and pearl-oyster farming and pearl culture at the Central Marine Fisheries Research Institute, Cochin.

(iii) Train Iranian personnel in 'Rural Cooperatives' at the National Council for Co-operative Training and the National Co-operative Union of India.

In all these cases training courses have been formulated and communicated to Iranian Government with the request to depute their personnel for these training courses.
Indo-Iranian collaboration includes short-term consultancies of Indian scientists in Iran, training of Iranian scientists, joint research projects, exchange of germplasm and admission of Iranian students in the ICAR institutes/state agricultural universities.

As regards the short-term consultancies of Indian scientists in the field of fisheries, the Government of Iran has desired to depute experts in Fisheries Education, preferably from the Central Marine Fisheries Research Institute, Central Institute for Fisheries Technology and College of Fisheries, Mangalore, to supervise M.Sc. and Ph.D. courses being conducted in the universities of Iran.

7. In addition, the ICAR/DARE continued to participate in the following collaborations with various countries in the field of agriculture and allied sectors for which the Department of Agriculture and Co-operation, as the nodal department, has developed MoUs/Agreements.

(i) Indo-ARE Protocol on technical and scientific co-operation in the field of agriculture.
(ii) Indo-French Agreement in the field of agriculture and agro-industries. The Department of Agriculture and Co-operation has signed fresh agreement with the French Government on 6 February 1994. A work schedule has been prepared and signed in November 1994, which includes specific activities to be undertaken by both the countries for implementation of the agreement.
(iii) Indo-Mongolian Protocol for co-operation in the field of agriculture.
(v) The ICAR-BARC (Bangladesh Agricultural Research Council) Agreement in the field of agriculture.
(vi) Indo-Nepal MoU in the field of agriculture.
(vii) Indo-Bulgaria Joint Commission for economic, scientific and technical co-operation.
(viii) Indo-Mauritius Programme of Co-operation in the field of agriculture. The Department of Agriculture and Co-operation has signed first workplan for co-operation with Mauritius in the field of agriculture in
January 1994 for the biennium 1994-95; with participation from the ICAR/DARE in the form of exchange of scientists visits/training/consultancies and exchange of germplasm.

(ix) Indo-China workplan in the field of agriculture. The Department of Agriculture and Co-operation has renewed the Indo-China workplan for 1994-1995 with the participation from the ICAR/DARE.

8. During 1994-95, the Indo-UK collaboration was carried on in several disciplines under the Overseas Development Administration-assisted Indo-UK collaborative projects.

9. During 1994-95, the Department of Economic Affairs earmarked 20 slots for training of Indian scientists in the UK covering the Indo-UK collaborative projects under the Colombo Plan.

Out of 20 nominations made, 15 scientists have already been offered training courses in the UK depending upon the requirement under the collaborative projects in operation at the research institutes/state agricultural universities.

10. Under the MoU signed on 30 August 1993 between the ICAR and the National Institute for Environmental Studies (NIES), Japan, collaborative research has been taken up to evaluate interactions between biotic activities and desertification in arid and semi-arid areas of the Thar Desert of Rajasthan in India. Both the institutes have exchanged scientists as a technical support to the project.

Under the project for ‘Development of seed storage and research facilities’ at the IARI, New Delhi, and its regional station at Karnal (Haryana), the Japan International Co-operation Agency (JICA) deputed a preliminary study team to confirm and to identify the necessity and importance of extending Grant-aid assistance for the improvement of seed-storage facilities. The study team has approved the project and cleared it with its recommendation for Japanese assistance as per the agreed minutes signed between the ICAR and the JICA on 11 August 1994.

Overseas Development Administration (ODA) mission visited India in December 1993 and held discussions at the subject matter divisions to identify areas for developing collaborative projects with the financial assistance from the ODA.

**INDO-UK COLLABORATION**

Under Indo-UK collaboration following areas were identified for co-operation:

(i) Fish processing at the Central Institute of Fisheries Technology, Cochin.

(ii) Fisheries education at the College of Fisheries, Mangalore, University of Agricultural Sciences, Bangalore.

(iii) Pathology of oilseeds at the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar.

(iv) Seed technology at the Seed Technology Division, IARI, New Delhi.

(v) Forage crops and their utilization at the Indian Grassland and Fodder Research Institute, Jhansi.

(vi) Soil salinity at the Central Soil Salinity Research Institute, Karnal.

(vii) Equine influenza at the National Research Centre on Equines, Hisar.

(viii) Plant genetic resources at the National Bureau of Plant Genetic Resources, New Delhi.

(ix) Transfer of molecular biological technology (TOMBIT) at the Indian Veterinary Research Institute, Izatnagar.
EXTERNLALLY AIDED PROJECTS

1. The FAO project on the ‘Conservation and use of animal genetic resources in Asia and the Pacific’, to be implemented at the National Bureau of Animal Genetic Resources/ National Institute of Animal Genetics, Karnal, has been approved with a foreign assistance of US $ 52,500.

2. The IAEA-RCP project on ‘The use of nuclear techniques for optimizing fertilizer applications under irrigated wheat to increase the efficient use of nitrogen fertilizers and consequently reduce environmental pollution’, to be implemented at the IARI, New Delhi, has been approved with the foreign assistance of US $ 4,000.

3. The FAO/EEC project on ‘Improved utilization of low value fish’, to be implemented at the Central Institute of Fisheries Technology (CIFT), Cochin, has been approved with a foreign assistance of ECU 60,000.

4. The EEC project on ‘Investigation of efficacy of entomopathogenic nematodes for the biological control of white grubs in Indian sugarcane crops’, to be implemented at the Sugarcane Breeding Institute (SBI), Coimbatore, has been approved with a foreign assistance of Rs 5,946,850.

5. The TNAU-NRI, UK-collaborative research programme on ‘Development of technologies for processing and formulation of nuclear polyhedrosis virus of the American bollworm (Helicoverpa) to be implemented at the TNAU, Coimbatore, has been approved with a foreign assistance of £124,800.

6. Collaborative project on ‘Formulation and commercialization of molasses-urea block’ with Appropriate Technology International (ATI), Washington, DC, and the NDRI, Karnal, has been approved with the foreign assistance of Rs 4,826,585.

7. Ford Foundation proposal to make a grant of US $ 74,000 over a period of 2 years to the TNAU, Coimbatore, has been approved.

8. Ford Foundation proposal to make a grant of US $ 126,000 to the Vidya Bhavan Society, Krishi Vigyan Kendra, Udaipur, Rajasthan, has been approved.

ODA MISSION PROJECTS

The ODA Mission identified following areas for funding:

(i) Haemoparasites of livestock
(ii) Carp biodiversity
(iii) Biosystematics with the CABI
(iv) Information technology - CD Rom with CABI.
(v) Control of pests in rainfed farming.

COLOMBO PLAN

Under Colombo Plan following fields were identified for assistance

(i) Pathology of oilseeds
(ii) Plant-germplasm conservation
(iii) Soil salinity
(iv) Forage production
(v) Molecular biology technology
(vi) Equine influenza
United States-India Fund Projects

At various institutes of the ICAR and at the state agricultural universities 69 United States-India Fund Projects are in operation for undertaking collaborative research in various agricultural areas of mutual interest to India and the USA.

World Bank-assisted Projects

The World Bank contemplates implementation of the Agricultural Human Resources Development Project in India in Andhra Pradesh, Haryana and Tamil Nadu. Besides, the ICAR will also be a beneficiary under the proposed project. The Pre-appraisal Mission of the World Bank has already visited India and the credit negotiations are to be undertaken in respect of the said project with the World Bank authorities in the USA. The tentative cost of the project shall be US $ 75 million.

A study visit for 2 weeks each in respect of 22 managerial-level scientists has been arranged under the National Agricultural Research Project. Phase II. The nomination of 40 scientists has been given to the FAO for arranging their training for 3 months each in the selected institutes abroad.

Workshops/Seminars Organized in India

1. The FAO Regional Expert Consultation on 'Production of pulse crops' and International Symposium on 'Pulses research development', was held at the IARI, New Delhi, from 1 to 6 April 1994.

2. The mid-term meeting of the CGIAR was held in New Delhi from 23 to 27 May 1994. The meeting was inaugurated by the Prime Minister of India.

3. The International Rice Research Institute (IRRI) and the Asian Rice Biotechnology Network organized a meeting of the CRRI team-leaders and staff of the Rainfed Low Land Consortium at Cuttack from 28 to 29 May 1994.

4. The Asian Rice Biotechnology Network and International Rice Research Institute (IRRI) organized a workshop on 'Population genetics' at the CRRI, Cuttack, from 27 June to 1 July 1994.

5. Regional workshop on the IJO-FAO project on 'Strengthening jute and kenaf seed programme' was held at Bhubaneshwar from 23 to 27 August 1994.

6. SAVERNET mid-term review meeting was held

USAID-ASSISTED PROJECT

The United States Agency for International Development (USAID)-assisted project on 'Plant genetic resources' is being implemented by the National Bureau of Plant Genetic Resources, New Delhi, from 1 September 1988. The USAID has enhanced the outlay of the project from US $ 23.95 million to US $ 27.95 million. The USAID's share shall be US $ 18.70 million. Similarly, the project has been extended by 2 years so that it terminates on 31 August 1997 instead of 31 August 1995 as per the original agreement.
Membership/Nomination to Foreign Organizations

1. Dr. P.V. Dehadrai, Deputy Director-General (Fisheries), ICAR, has been nominated as a member of the Board of Trustees of the International Centre for Living Aquatic Resources Management (ICLARM), Manila, the Philippines, for 3 years.

2. Dr. R.S. Rana, Director, NBPGR, has been nominated as a member of the Project Steering Committee on the Rice Biodiversity of the International Rice Research Institute (IRRI).

3. Dr. S.D. Tripathi, Director, CIFE, Bombay, has been nominated as a member of the International Network for Genetics in Aquaculture (INGA) Steering Committee for 3 years.

4. Dr. M.V.R. Prasad, Project Director (Oilseeds), Directorate of Oilseeds Research, has been nominated as a Chairman of the International Safflower Germplasm Advisory Committee constituted by the International Plant Genetic Resources Institute (IPGRI).
5. Publications and Information
Information relating to agricultural and allied sciences is disseminated by the DARE through the ICAR. The ICAR brings out publications in English as well as in Hindi, in various forms, e.g. books, bulletins, reports, research journals and popular magazines. During the year 9 periodicals were published regularly, 6 in English and 3 in Hindi. Besides Annual Report, 11 titles were brought out in English and 9 in Hindi. Database on A.P. Cess Fund Schemes was computerized using Micro-CDS/ISIS package and the facilities in agricultural database were extended. A Directory of conferences, seminars, symposia, workshops in agriculture was also brought out. Besides acting as a window for agricultural communication, the Publications and Information Division earned more than 0.15 million from the sale etc. of published.

PUBLICATIONS

In English

Six periodicals were brought out regularly. Four of these are research journals, viz. *The Indian Journal of Agricultural Sciences* (monthly), *The Indian Journal Animal Sciences* (monthly), *The Indian Journal of Agricultural Engineering* (quarterly) and *The Indian Journal of Fisheries* (quarterly). Among the 2 popular magazines, *Indian Farming* (monthly) brought out 2 special issues on ‘Water for life’ on the occasion of World Food Day and on ‘Soil and water conservation challenges and opportunities’. *Indian Horticulture* (quarterly) brought out 2 special numbers on ‘Accent on fruits’ and ‘Plantation crops and spices’. Book reviews were published in various periodicals and special features useful for farmers in the magazines.

Among the important publications brought out, those worth special mention are *Mandates of the ICAR and its Institutes, ICAR Systems, Principles of Seed Technology, Isotopes in Soil Plant Studies, Soil Fertility and Crop Productivity Under Long-Term Fertilizer Use in India, Virus and Mycoplasma Diseases of Fruit Crops in India, Virus Diseases of Animal in India and Sheep and Goat Diseases.*

In Hindi

The periodicals *Kheti* (monthly), *Phal Phool* (quarterly) and *Krishi Chayanika* (quarterly), were brought out regularly. In *Kheti* special issues were brought out on ‘Jal hi Jiwan’, ‘Mrida our jal sanrakshan’, and ‘Environment’, along with accent issues of ‘Kharif crops’, ‘New vistas in agriculture’, and ‘Dairy development’. *Phal Phool* brought out a special issue on ‘Honey and honey products’ and an accent issue to ‘Seasonal flowers’. *Krishi Chayanika* too brought out an accent issue on ‘Water’.

The notable publications brought out during the year are *Bharat mein Angoor, Ber, Arandi, Shitoshna Kheton mein Chara Utpadan, Phasion ke liye Santulit Urvarak, Khad aur Urvarak, Aadhunik Kukkut Palan, Battakh Palan and Khargosh.*

ART AND PHOTOGRAPHY

The Art Unit designed and illustrated all publications and publicity material brought out by the ICAR and the DARE during this period. This includes the logo for the CGIAR (MTM-94) and a other publicity material for the mid-term meeting of CGIAR. The logo was widely appreciated by the delegates and senior officers of the ICAR.
As part of the regular job, magazines in Hindi and English brought out 2 special numbers on average. They were presented at national and international conferences and seminars, and were appreciated for professional approach and design value.

Designs for books in English and Hindi on different subjects for students, scientists, agricultural community as well as for the common public were prepared in the Art Unit.

The Art Unit has prepared black-and-white and colour sketches, charts, maps, histograms and sides for senior scientists for presentation at National and International Seminars. It also advised the ICAR institutes and other organization related to agriculture, animal husbandry and horticulture on the preparation of illustrations and designs for publications.

The Photography Unit provided photographs for various publications. It also covered other activities of the ICAR including visits of dignitaries from other countries and press conferences of Union Minister of Agriculture and State Minister of Agriculture.

The Photography Unit including Photo Library provided visuals to all the units of the ICAR. It provided transparencies and black-and-white as well as colour photographs for various publications including the magazines brought out in English and Hindi. It supplied illustrative material for the national and international exhibitions and fairs organized by the ICAR and its institutes. and covered all major meetings, workshops, seminars etc. as well as the visits of dignitaries.

SALES AND ADVERTISEMENTS

During the year the sale of publications including periodicals fetched a revenue of Rs 3 million and advertisements fetched additional Rs 0.123 million.

The ICAR participated in various book shows, fairs, seminars and conferences for promoting the sale of its publications.

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. Databases on A.P. Cess Fund schemes, Deputation reports and Research projects of institutes were computerized and updating of the databases is in progress.

The ARIC is 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-Dec., 1994), CABCD (1984-86) and CARIS-CD (1994). About 250 Scientists/Research scholars were benefited through 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. Computerized database on agricultural institutions in SAARC countries was received from SAIC and was installed in the computer system at ARIC.

The Centre is bringing out the half-yearly publication Directory of conferences, seminars, symposia, workshops in agriculture.

ICAR LIBRARY

The ICAR Library added 1,395 publications to its collection during the year. About 15,000 readers visited the library and consulted 22,000 publications for reference and information searches. Against specific request, information support was extended for consulting the database of the Centre for Agriculture and Biosciences International (formerly the Commonwealth Agricultural Bureaux International), the document-delivery service was extended to individuals and libraries against specific requests for supply of Indian documents from AGRIS database.

The Hindi library at the headquarters purchased 1,145 books and subscribed to multiple copies of Hindi magazines. It issued 5,500 books to its 750 members.

In the Eighth Five-Year Plan (1992-97) of the ICAR headquarters there is a proposal for 'Development and Strengthening ICAR Library' and its 2 new components. Work is in progress.

Since July 1994, the ICAR Library is arranging payment of newspapers/magazines to the ICAR officers who are eligible for subscribing those at
their residence.

PUBLICITY AND PUBLIC RELATIONS

The ICAR Publicity and Public Relations Unit continued its efforts in providing effective linkage with the media-print, spoken and visual-to focus attention on the activities and achievements of the scientists of the Indian Council of Agricultural Research System.

A number of press conferences were arranged during the year and were addressed by the President, ICAR, Director-General, ICAR, and other functionaries to highlight the achievements and activities of the Council. This unit also provided material for the Annual Economic Editors Conference, addressed by the Union Minister for Agriculture and President, ICAR.

Publicity material, features, press releases were issued throughout the year to project the research findings of importance. Such materials found adequate space in the print media and electronic media.

Visits by media representatives were arranged to the ICAR institutes and for projects located at the Indian Institute of Horticultural Research (IIHR), Bangalore, and its regional stations, KVK, Coorg, and National Research Centre (NRC) on Spices at Calicut. Visits of mediamen to CRRI, Cuttack, CIFFA, Bhubaneshwar, and CICFRI, Barrackpore etc. were organized during December 1994-January 1995. Based on these visits, several news items were published in the national newspapers.

The ICAR’s popular magazines like Indian Farming, Indian Horticulture, Kheti, Krishi Chayanika and Phal-Phool were regularly supplied to the mediapersons, and the material published therein was extensively used by them in news stories, features and other items.

The Unit prepared and provided special materials for the prestigious annual publication, Survey of Indian Agriculture (1994 edition).

A regular enquiry-assistance service and a newspaper clippings service are run by the Unit. The former caters to the needs of farmers, students and general public pertaining to adoption and application of the technologies generated at the ICAR institutes and projects.

EXHIBITIONS

During the year under report, the Unit designed, arranged and managed ICAR’s participation in the following national and international exhibitions:

1. International Exhibition on the eve of Mid-Term Meeting of the CGIAR at New Delhi, from 23 to 27 May 1994.
2. International Exhibition ‘Sahara 95’ at Cairo (Egypt) from 8 September to 1 October 1994.
4. All-India Industrial and Agricultural Exhibition at Trivandrum.
5. Participation in the All-India Industrial and Agricultural Exhibition at Kollam, during December 1994 and January 1995.
7. Participation in the International Agricultural Exhibition (Agri-Expo’95) organized jointly by the ITPO and Ministry of Agriculture at Pragati Maidan, New Delhi, during March 1995. Arrangements were made to present ICAR’s achievements in a big way at this International Expo.
APPENDICIES
APPENDIX 1

INDIAN COUNCIL OF AGRICULTURAL RESEARCH SOCIETY

The Society shall have the following ex-officio members:

(i) Minister-in-charge of the portfolio of Agriculture in the Union Cabinet, President of the Society

1. Dr Balram Jakhar
   Minister of Agriculture
   Government of India
   New Delhi 110 001

(ii) Minister of State in the Union Ministry of Agriculture, dealing with the ICAR, Vice-President

2. Shri S. Krishan Kumar
   Minister 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. Dr Manmohan Singh
   Minister of Finance
   Government of India
   New Delhi 110 001

4. Minister of State for Planning and Programme Implementation
   Government of India
   New Delhi 110 001

5. Minister of Human Resources Development
   Government of India
   New Delhi 110 001

6. 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/Incharge of Agriculture/Animal Husbandry/Fisheries

8. Minister for Agriculture
   Government of Andhra Pradesh
   Hyderabad (Andhra Pradesh) 500 022

9. Chief Minister holding the portfolio of Animal Husbandry and Fisheries
   Government of Andhra Pradesh
   Hyderabad (Andhra Pradesh) 500 022

10. Minister for Agriculture
    Government of Assam
    Janta Bhavan
    Guwahati (Assam) 781 006

11. Minister for Animal Husbandry
    Government of Assam
    Janta Bhavan
    Guwahati (Assam) 781 006

12. Minister for Fisheries
    Government of Assam
    Janta Bhavan
    Guwahati (Assam) 781 006

13. Minister for Agriculture
    Government of Arunachal Pradesh
    Itanagar (Arunachal Pradesh) 791 111

14. Minister for Animal Husbandry
    Government of Arunachal Pradesh
    Itanagar (Arunachal Pradesh) 791 111

15. Minister for Fisheries
    Government of Arunachal Pradesh
    Itanagar (Arunachal Pradesh) 791 111

16. Minister for Agriculture
    Government of Bihar
    Patna (Bihar)

17. Minister for Animal Husbandry
    Government of Bihar
    Patna (Bihar)

18. Minister for Agriculture and Animal Husbandry
    Government of Gujarat
    Gandhinagar (Gujarat)
19. Minister for Fisheries
   Government of Gujarat
   Gandhinagar (Gujarat)

20. Minister for Agriculture,
    Animal Husbandry and Fisheries
    Secretariat
    Government of Goa
    Panji 403 001

21. Minister for Agriculture
    Government of Haryana
    Chandigarh (Haryana)

22. Minister for Animal Husbandry
    Government of Haryana
    Chandigarh (Haryana)

23. Minister for Fisheries
    Government of Haryana
    Chandigarh (Haryana)

24. Chief Minister holding the
    portfolio of Agriculture, Animal
    Husbandry and Fisheries
    Government of Himachal Pradesh
    Shimla (Himachal Pradesh) 171 002

25. Minister for Agriculture
    Government of Karnataka
    Bangalore (Karnataka) 560 001

26. Minister for Animal Husbandry
    Government of Karnataka
    Bangalore (Karnataka) 560 001

27. Minister for Fisheries
    Government of Karnataka
    Bangalore (Karnataka) 560 001

28. Minister for Agriculture and
    Animal Husbandry
    Government Secretariat
    Government of Kerala
    Thiruvananthapuram (Kerala) 695 001

29. Minister for Fisheries
    Government Secretariat
    Government of Kerala
    Thiruvananthapuram (Kerala) 695 001

30. Deputy Chief Minister holding
    the Portfolio of Agriculture
    Ballabh Bhavan
    Government of Madhya Pradesh
    Bhopal (Madhya Pradesh) 423 006

31. Minister for Animal Husbandry,
    Dairy Development and Fisheries
    Government of Madhya Pradesh
    Bhopal (Madhya Pradesh) 423 006

32. Minister for Agriculture,
    Water Conservation
    Government of Maharashtra
    Bombay (Maharashtra)

33. Minister for Animal Husbandry,
    Dairy Development and
    Tribal Development
    Government of Maharashtra
    Bombay (Maharashtra)

34. Minister for Fisheries
    Government of Maharashtra
    Bombay (Maharashtra)

35. Minister for Agriculture
    Government of Meghalaya
    Shillong (Meghalaya) 793 001

36. Minister for Animal Husbandry
    Government of Meghalaya
    Shillong (Meghalaya) 793 001

37. Minister for Fisheries
    Government of Meghalaya
    Shillong (Meghalaya) 793 001

38. Minister for Agriculture and
    Fisheries
    Government of Mizoram
    Aizwal (Mizoram) 796 001

39. Minister for Animal Husbandry
    Government of Mizoram
    Aizwal (Mizoram) 796 001

40. Minister for Agriculture
    Government of Nagaland
    Kohima (Nagaland) 797 001

41. Minister for Animal Husbandry
    Government of Nagaland
    Kohima (Nagaland) 797 001

42. Minister for Fisheries
    Government of Nagaland
    Kohima (Nagaland) 797 001

43. Minister for Agriculture
    Government of Orissa
    Bhubaneswar (Orissa)

44. Minister for Animal
    Husbandry and Fisheries
    Government of Orissa
    Bhubaneswar (Orissa)

45. Minister for Agriculture
    Government of Punjab
    Chandigarh (Punjab)
46. Minister for Animal Husbandry and Fisheries
   Government of Punjab
   Chandigarh (Punjab)

47. Minister for Agriculture
   Government of Rajasthan
   Jaipur (Rajasthan)

48. Minister for Animal Husbandry and Fisheries
   Government of Rajasthan
   Jaipur (Rajasthan)

49. Minister for Agriculture
   Government of Tamil Nadu
   Madras (Tamil Nadu) 600 009

50. Minister for Animal Husbandry
   Government of Tamil Nadu
   Madras (Tamil Nadu) 600 009

51. Minister for Fisheries
   Government of Tamil Nadu
   Madras (Tamil Nadu) 600 009

52. Minister for Agriculture and Horticulture Department
   Government of Tripura
   Agartala (Tripura) 799 001

53. Minister for Animal Husbandry
   Government of Tripura
   Agartala (Tripura) 799 001

54. Minister for Fisheries
   Government of Tripura
   Agartala (Tripura) 799 001

55. Chief Minister holding the portfolio of Agriculture
   Government of Uttar Pradesh
   Lucknow (Uttar Pradesh)

56. Minister for Animal Husbandry and Fisheries
   Government of Uttar Pradesh
   Lucknow (Uttar Pradesh)

57. Minister for Agriculture and Horticulture
   Government of West Bengal
   Writers’ Building
   Calcutta (West Bengal) 700 001

58. Minister for Animal Husbandry and Dairy Development
   Government of West Bengal
   Calcutta (West Bengal) 700 001

59. Minister for Fisheries
   Government of West Bengal
   Calcutta (West Bengal) 700 001

60. Minister for Agriculture
   Government of Sikkim, Secretariat
   Gangtok (Sikkim) 737 101

61. Minister for Animal Husbandry
   Government of Sikkim, Secretariat
   Gangtok (Sikkim) 737 101

62. Minister for Fisheries
   Government of Sikkim, Secretariat
   Gangtok (Sikkim) 737 101

63. Minister for Agriculture and Animal Husbandry
   Government of Pondicherry
   Pondicherry 605 001

64. Chief Minister holding the portfolio of Fisheries
   Government of Pondicherry
   Pondicherry 605 001

65. Minister for Agriculture, Animal Husbandry and Fisheries
   National Capital Territory of Delhi
   Delhi

66. Minister for Agriculture
   Government of Manipur
   Imphal (Manipur) 795 001

67. Minister for Animal Husbandry
   Government of Manipur
   Imphal (Manipur) 795 001

68. Minister for Fisheries
   Government of Manipur
   Imphal (Manipur) 795 001

The Jammu and Kashmir State is at present under the president rule.

69. Minister for Agriculture
   Government of Jammu and Kashmir
   Srinagar (Jammu and Kashmir)

70. Minister for Animal Husbandry
   Government of Jammu and Kashmir
   Srinagar (Jammu and Kashmir)

71. Minister for Fisheries
   Government of Jammu and Kashmir
   Srinagar (Jammu and Kashmir)

72. Dr Jayant Patil
    Member of Planning Commission
    Incharge of Agriculture
    Yojana Bhavan, New Delhi

APPENDICES
<table>
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<th>No.</th>
<th>Name</th>
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<tr>
<td>73</td>
<td>Shri Santosh Kumar Gangwar</td>
<td>23.12.94</td>
<td>Member Lok Sabha 22. Chaudhary Mohalla Bareilly (Uttar Pradesh) and 14-D, Ferozeshah Road New Delhi</td>
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<td>74</td>
<td>Shri Bheru Lal Meena</td>
<td>23.12.94</td>
<td>Member Lok Sabha Village &amp; P.O. Titi Teh. Girwa Údaipur (Rajasthan) and 122, North Avenue New Delhi 110 001</td>
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<td>75</td>
<td>Shri Ram Prasad Singh</td>
<td>8.8.94</td>
<td>Member Lok Sabha Village &amp; P.O. Kochas P.S. Kochas Rohtas Sasaram (Bihar) and 38, South Avenue New Delhi</td>
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<td>76</td>
<td>Shri Bhawani Lal Verma</td>
<td>8.8.94</td>
<td>Member Lok Sabha Village &amp; P.O. Faghuram Via-Adhbar Bilaspur (Madhya Pradesh) and 81, South Avenue New Delhi</td>
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<tr>
<td>77</td>
<td>Shri S.S. Surjewala</td>
<td>9.12.96</td>
<td>Member Rajya Sabha House No. 495, Sector 6 Panchkula, Distt Ambala Haryana and AB 89, Shahjahan Road New Delhi</td>
</tr>
<tr>
<td>78</td>
<td>Shri Amal Datta</td>
<td>15.12.97</td>
<td>Member Lok Sabha 39, Hindistan Park Calcutta (West Bengal) 700 029 and AB 2, Purana Quilla Road New Delhi 110 011</td>
</tr>
<tr>
<td>79</td>
<td>Shri Balraj Pasi</td>
<td>15.12.97</td>
<td>Member Lok Sabha Bajpur (Uttar Pradesh) Naini Tal and 206, North Avenue New Delhi 110 001</td>
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<tr>
<td>80</td>
<td>Shri Uttamrao Dcorao Patil</td>
<td>15.12.97</td>
<td>Member Lok Sabha Mahabali Layout Vadgaon Road, Yavatmal Maharashtra 2431 and 179, North Avenue New Delhi 110 001</td>
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<td>81</td>
<td>Dr P Vallal Peruman</td>
<td>15.12.97</td>
<td>Member Lok Sabha 132, East Car Street Chindambram 608 001 Tamil Nadu 2098 and 167-169, North Avenue New Delhi 110 001</td>
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<tr>
<td>82</td>
<td>Shri Som Pal</td>
<td>9.12.96</td>
<td>Member Rajya Sabha Village &amp; P.O. Kakor Tehsil, Baghpat Block Chhapauali Meerut (Uttar Pradesh) and 28, Lodi Estate New Delhi</td>
</tr>
<tr>
<td>83</td>
<td>Dr R.S. Paroda</td>
<td></td>
<td>Director-General, ICAR Director-General ICAR, Krishi Bhavan New Delhi 110 001</td>
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<tr>
<td>84</td>
<td>Secretary (Agriculture and Co-operation)</td>
<td></td>
<td>Ministry of Agriculture Department of Agriculture Krishi Bhavan New Delhi 110 001</td>
</tr>
<tr>
<td>85</td>
<td>Secretary (Animal Husbandry and Dairying)</td>
<td></td>
<td>Krishi Bhavan New Delhi 110 001</td>
</tr>
<tr>
<td>86</td>
<td>Secretary</td>
<td></td>
<td>Secretary Planning Commission Yojana Bhavan New Delhi 110 001</td>
</tr>
<tr>
<td>87</td>
<td>Chairman</td>
<td></td>
<td>Chairman University Grants Commission Bahadur Shah Zafar Marg New Delhi</td>
</tr>
</tbody>
</table>
Chairman, Atomic Energy Commission or Director, Bhabha Atomic Research Centre, if nominated by the Chairman, Atomic Energy Commission

88. Chairman
Atomic Energy Commission
Chattarpuri Shivaji Maharaj Marg
Bombay (Maharashtra)

(xiii) Member, Finance (Secretary/Additional Secretary in the Ministry of Finance), Government of India

89. 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

90. Dr R.P.S. Tyagi 18.11.96
Vice-Chancellor (Governing Body
Himachal Pradesh
Krishi Vishwa Vidyalaya
Palampur (Himachal Pradesh) 176 062

91. Dr V. Gyanaprakasm 9.4.96
Vice-Chancellor (Governing Body
Tamil Nadu Veterinary and Agricultural Sciences University
Madras (Tamil Nadu) 600 007

92. Dr K.S. Chauhan 10.11.95
Vice-Chancellor (Governing Body
Rajendra Agricultural University member also)
Veterinary College Campus
Patna (Bihar) 800 014

93. Dr A.N. Michael 29.12.96
Vice-Chancellor
Kerala Agricultural University
Thrissur (Kerala) 680 654

(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

94. Shri B. K. Tamani
Agricultural Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

95. Dr G.L. Kaul
Horticultural Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

96. Animal Husbandry Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

97. Shri Y.S. Yadav
Fisheries Development Commissioner
Department of Agriculture
Krishi Bhavan
New Delhi 110 001

98. Dr A.K. Mukerjee
Inspector-General of Forests
Government of 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

99. Dr J.C. Bakshi 21.6.96
House No. 132 D, Kitchloo Nagar
Ludhiana (Punjab) 141 001

100. Dr P.S. Lamba 21.6.96
51, Defence Colony
Hisar (Haryana) 125 001

101. Dr Sukhdev Singh 21.6.97
House No. 419, Sector No. 36 A
Chandigarh (Punjab) 160 014

102. Dr S.K. Sinha 26.4.97
Former Director
Indian Agricultural Research Institute
Hill Side Road, Pusa
New Delhi 110 012

103. Dr O.S. Tomer 26.4.97
Director
National Dairy Research Institute
Karnal (Haryana) 132 001

104. Dr Shankar Lal 26.4.97
Acting Director
Indian Institute of Pulses Research
Kalyanpur
Kanpur (Uttar Pradesh) 208 024

105. Dr Mangala Rai 26.4.97
Assistant Director-General(P)
Indian Council of Agricultural Research
Krishi Bhavan
New Delhi 110 001

106. Dr S.K. Tripathi 26.4.97
Director
Central Institute of Fisheries Education
7, Bungalow, Versova
Bombay (Maharashtra) 400 061

APPENDICES
107. Dr S.C. Mudgal
Vice-Chancellor
Govind Ballabh Pant University of Agriculture and Technology
Pantnagar (Uttar Pradesh) 263 145

108. Dr S. Arya
Vice-Chancellor
Ch. Charan Singh Haryana Agricultural University
Hisar (Haryana) 125 004

109. Dr A.S. Khehra
Vice-Chancellor
Punjab Agricultural University
Ludhiana (Punjab) 141 004

110. Dr R.K. Patel
Vice-Chancellor
Rajasthan Agricultural University
Bikaner (Rajasthan) 334 001

111. Dr M.P. Singh
Central Agricultural University for NEH Region
Imphal (Manipur) 795 001

112. Shri Jayant Das
Senior Advocate, AMBIM
M/s Das & Associates
Opp. Orissa High Court
Cuttack (Orissa) 753 001

113. Dr Aditya Prasad Dash
Director, Incharge of the Desert Medicine Research Centre
Jodhpur (Rajasthan)

114. Shri P.K. Aggarwal
B.D. Steels
Jalandhar (Punjab)

115. Shri M.M. Thapar
Joint Managing Director
Ballapur Industries
Thapar House, Janpath
New Delhi

116. Shri Sudhir Sanghi
Company Director
Sanghi Group of Industries
Hyderabad

117. Shri Hari Shankar Singhania
President,
J.K. Organization
4, Bahadur Shah Zafar Marg
New Delhi

118. Shri H.P. Nanda
President
Escorts Limited
Scindia House
New Delhi

26.4.97
(xvii) One farmer from each region of the country as mentioned in Rule 60 (a) and four representatives of rural interest, nominated by the President

119. Shri Sher Bahadur Singh
Advocate (Nominated in the Regional Baradeeh Chauraha Committee No. I)
Mukhtiar Ganj
Satna (Madhya Pradesh)

120. Shri S. Jayaram Choudhary
Hotel Mayura (Nominated in the Regional Tirupati Committee No.II)
(Andhra Pradesh)

121. Shri R.S. Velan
974, Cross-cut-Road (Nominated in the Gandhipuram Regional Committee No. II)
Coimbatore
(Tamil Nadu) 641 012

122. Shri Rameshwar Rajora
Vice-President (Nominated in the Regional Cong. (I) Sewa Dal, Maur Committee No. IV)
Mandi, District Bhatinda
(Punjab)

123. Shri Bhagwan Sahai Saini
Ward No. 15, Chomu (Nominated in the Jaipur (Rajasthan) Regional Committee No. VI)

124. Shri K.V. Kuppusamy
Chairman and (Nominated in the Regional Managiang Trustee Committee No. VII)
Bhaktvatsalam Memorial Trust,
242 B, Trichy Road
Sulur, Coimbatore (Tamil Nadu)

125. Shri Mahadev Singh
Ex-MLA, Khandela
Sikar (Rajasthan)

126. Shri Rajender Singh Jakhar
Village & P.O. Patrewala
Tehsil Fazilka
District Ferozepur (Punjab)

115.8.98
116.8.98
117.15.12.94
118.15.12.94
119.5.2.98
120.5.2.98
121.5.2.98
122.5.2.98
123.5.2.98
124.5.2.98
125.15.12.94
126.15.12.94
127. Shri P.M. Samentray 15.12.94
IAS (Retd)
P.O. Madhupatana
Cuttack (Orissa)

128. Shri M. Tulasi Das 15.12.94
House No. 14-24
Srinivasapuram Colony
Ramanathanpur
Hyderabad (Andhra Pradesh) 500 013

129. Shri D.S. Ananth 21.6.96
Planter (Governing Body member also)
No. 513, 10th B Main WCR
III Stage, IVth Block
Bashavshwar Nagar behind P.O
Bangalore (Karnataka) 560 079

130. Shri Chengal Reddy 21.6.96
2, Shesh Villa, 3-6-293
Hyderguda
Hyderabad (Andhra Pradesh)

131. Shri Hiranand Sinha 21.6.96
S/o Kumar Tara Nadu, Sinha
Village Champa Nagar, Deorhi
District Purnea (Bihar)
P.O. Banaill

132. Shri Praveen Katewa 21.6.96
Village and P.O. Bakhtawar Pura
District Jhunghunu (Rajasthan)

136. Shri Premin Nath Vij 21.6.96
97, Patel Nagar, Abohar
District Ferozepur (Punjab)
(Governing Body member also)

(xix) Four Directors of the ICAR Research Institutes,
nominated by the President

137. Dr R.N. Verma 9.4.96
Director (Governing Body member also)
National Centre for Mushroom Research and Training
Chambaghat Solan (Himachal Pradesh) 173 213

138. Dr Harbhajan Singh 9.4.96
Acting Project Director (Governing Body member also)
National Research Centre for Coldwater Fisheries
Shilwa Hills Nursery, Roop Nagar
P.B. No. 28
Distt Naini Tal
Haldwani (Uttar Pradesh) 263 139

139. Dr A.K. Bandopadhyay 9.4.96
Director (Governing Body member also)
Central Agricultural Research Institute
Andaman and Nicobar Group of Islands, Post Box No. 181
Port Blair (Andamans) 744 101

140. Dr R.S. Rana 26.4.97
Director
National Bureau of Plant Genetic Resources
FCI Building, Pusa
New Delhi 110 012
(xx) Secretary, Indian Council of Agricultural Research

141. Shri G.S. Sahni 10.11.95
Member-Secretary
Indian Council of Agricultural Research, Krishi Bhavan
New Delhi 110 001
APPENDIX 2

GOVERNING BODY

1. Dr. R.S. Paroda
   Director-General
   Indian Council of Agricultural Research
   Krishi Bhavan
   New Delhi 110 001

   Ex-officio Members

2. Shri T.S. Krishna Murthy
   Additional Secretary to the
   Government of India
   Ministry of Finance
   Department of Expenditure
   New Delhi

3. Secretary
   Planning Commission
   Yojana 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. Dr. K. Raghu
   Head, Nuclear Agriculture Division
   Bhabha Atomic Research Centre
   Trombay
   Bombay (Maharashtra) 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. Shri Jayant Das
   Senior Advocate, AMBIM
   M/s Das & Associates
   Opp. Orissa High Court
   Cuttack (Orissa) 753 002
   and
   C-II/30, Tilak Lane, New Delhi

   Scientists

8. Dr. Sukhdev Singh
   House No. 419
   Sector 38 A
   Chandigarh (Punjab) 160 014

9. Dr. J.C. Bakhshi
   132 D, Kitchloo Nagar
   Ludhiana (Punjab) 141 001

10. Dr. P.S. Lamba
    51, Defence Colony
    Hisar (Haryana) 125 001

   Three Vice-Chancellors

11. Prof. K.S. Chauhan
    Vice-Chancellor
    Rajendra Agricultural University
    Veterinary College Campus
    Patna (Bihar) 800 014

12. Dr. V. Gyanaparakasm
    Vice-Chancellor
    Tamil Nadu Veterinary and Agricultural
    Sciences University, VEPROY
    Madras (Tamil Nadu) 600 007

13. Dr. R.P.S. Tyagi
    Vice-Chancellor
    Himachal Pradesh
    Krishi Vishwa Vidyalaya
    Palampur (Himachal Pradesh) 176 062

   Three Members of Parliament

14. Shri S.S. Surjewala
    Member Rajya Sabha
    H.No. 495, Sector 6,
    Panchkula
    Distt Ambala (Haryana)
    and
    AB 89, Shahjahan Road
    New Delhi

15. Shri Uttamrao Deora Patil
    Member Lok Sabha
    Vadgaon Road, Yavatmal
    Maharashtra
    and
    179, North Avenue
    New Delhi 110 001

ICAR ANNUAL REPORT 1994-95
16. Dr P. Vallal Peruman  
Member Lok Sabha 
132, East Car Street 
Chidambaram (Tamil Nadu) 608 001 
and 
167-169, North Avenue 
New Delhi 110 001 

17. Shri Santosh Kumar Gangwar  
Member Lok Sabha 
22, Chaudhary Mohalla 
 Bareilly (Uttar Pradesh) 
and 
14-D, Ferozeshah Road 
New Delhi 

18. Shri Bheru Lal Meena  
Member Lok Sabha 
Village and P.O. Titi 
Teh. Girwa 
Distt Udaipur (Rajasthan) 
and 
122, North Avenue 
New Delhi 110 001 

**Three Farmers**

19. Shri Prem Nath Vlj  
97, Patel Nagar 
Abohar 
Distt Ferozepur (Punjab) 

20. Shri D.S. Ananth  
Planter 
No. 513, 10th B Main 
WCR, III Stage, IVth Block 
Bashavshwar Nagar, Behind P.O. 
Bangalore (Karnataka) 560 079 

**Three Directors**

22. Dr A.K. Bandopadhyay  
Director 
Central Agricultural Research Institute 
Andaman and Nicobar Group of Islands 
Post Box No. 181 
Port Blair (Andamans) 744 101 

23. Dr R.N. Verma  
Director 
National Centre for Mushroom Research 
and Training, Chambaghat 
Solan (Himachal Pradesh) 173 213 

24. Dr Harbajan Singh  
Project Director 
National Research Centre on 
Coldwater Fisheries, Shilwa 
Hills Nursery, Roop Nagar 
P.B.No. 28 
Haldwani (Uttar Pradesh) 263 139 

**Special Invitee**

25. Shri N. Parthasarthy  
Financial Adviser (ICAR&DARE) 
Krishi Bhavan 
New Delhi 110 001 

26. Shri G.S. Sahni  
Member-Secretary 
Secretary 
Indian Council of Agricultural Research 
Krishi Bhavan, 
New Delhi 110 001
APPENDIX 3

STANDING FINANCE COMMITTEE

Chairman

1. Dr R.S. Paroda
   Director-General
   Indian Council of Agricultural Research
   Krishi Bhavan, New Delhi 110 001

Ex-Officio Members

2. Shri T.S. Krishna Murthy
   Additional Secretary to the
   Government of India
   Ministry of Finance
   Department of Expenditure
   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 J.C. Bakhshi
   House No. 132 D
   Kitchloo Nagar
   Ludhiana (Punjab) 141 001
   29.6.95

5. Dr A.K. Bandopadhyay
   Director
   Central Agricultural Research Institute
   Andaman and Nicobar Group of Islands
   Post Box No. 181
   Port Blair (Andamans) 744 001
   29.6.95

6. Dr Sukhdev Singh
   House No. 419
   Sector 38 A
   Chandigarh (Punjab) 160 014
   29.6.95

Director

7. Vacant

Farmer

8. Shri D.S. Ananth
   Planter
   No. 513, 10th B Main
   WCR III Stage, IV Block
   Bashavshwar Nagar, behind P.O.
   Bangalore (Karnataka) 560 079
   29.6.95

Member of Parliament

9. Shri Santosh Kumar Gangwar
   Member Lok Sabha
   22, Choudhary Mohalla
   Bareilly (Uttar Pradesh)
   and
   14-D, Ferozeshah Road
   New Delhi
   23.12.94

Management Expert

10. Dr P.S. Lamba
    51, Defence Colony
    Hisar (Haryana) 125 001
    29.6.95

Vice-Chancellor

11. Dr V. Gyanaprakasm
    Vice-Chancellor
    Tamil Nadu Veterinary and Animal Sciences University
    VEPROY
    Madras (Tamil Nadu) 600 007
    29.6.95

12. Dr Harbajan Singh
    Project Director
    National Research Centre on Coldwater Fisheries, Shilwa
    Hills Nursery, Roop Nagar
    P.B. No. 28
    Haldwani (Uttar Pradesh) 263 139
    9.4.96

Special Invitee

13. Shri N. Parthasarthy
    Financial Adviser (ICAR & DARE)
    Krishi Bhavan, New Delhi 110 001

14. Shri G.S. Sahni
    Member-Secretary
    Secretary
    Indian Council of Agricultural Research
    Krishi Bhavan, New Delhi 110 001

ICAR ANNUAL REPORT 1994-95
NORMS AND ACCREDITATION COMMITTEE

1. Director-General Chairman
   Indian Council of Agricultural Research
   Krishi Bhavan
   New Delhi 110 001

Members

2. Chairman
   University Grants Commission
   Bahadur Shah Zafar Marg
   New Delhi 110 001

3. Dr K.V. Devraj
   Vice-Chancellor
   University of Agricultural Sciences
   Bangalore (Karnataka) 560 065

4. Dr R. Govindbhai Shekhada
   Vice-Chancellor
   Gujarat Agricultural University
   Banaskantha (Gujarat) 385 506

5. Dr S.K. Dorge
   Vice-Chancellor
   Mahatma Phule Krishi Vidyapeeth
   Rahuri (Maharashtra) 413 722

6. Dr K.S. Johar
   Vice-Chancellor
   Jawaharlal Nehru Krishi Vishwa Vidyalaya
   Jabalpur (Madhya Pradesh) 482 004

7. Prof. M.A. Dar
   Vice-Chancellor
   Sher-e-Kashmir University of Agricultural Sciences and Technology
   Srinagar (Jammu and Kashmir) 191 001

8. Deputy Director-General (Education) Member-Secretary

APPENDICES

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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
   Yojana Bhavan, New Delhi
   (For the Regional Committee No. IV)

Six Member of Parliament (Four elected by Lok Sabha
and two elected by Rajya Sabha)

4. Shri S.S. Surjewala Up to 9.12.96
   Member Lok Sabha
   House No. 495, Sector 6
   Panchkula, Distt Ambala (Haryana)
   and
   AB 89, Shahjahan Road
   New Delhi

5. Shri Santosh Kumar Gangwar Up to 23.12.94
   Member Lok Sabha
   22, Chaudhary Mohalla
   Bareilly (Uttar Pradesh)
   and
   14 D, Ferozeshah Road
   New Delhi

6. Shri Bheru Lal Meena Up to 23.12.94
   Member Lok Sabha
   Village & P.O. Titi
   Teh. Girwa
   Distt Udaipur (Rajasthan)
   and 122,
   North Avenue
   New Delhi 110 001

7. Shri Amal Datta Up to 15.12.97
   Member Lok Sabha
   39, Hindistan Park
   Calcutta (West Bengal) 700 029
   and
   AB 2, Purana Quilla Road
   New Delhi 110 001
   (For the Regional Committee No. II)

8. Shri Balraj Pasi Up to 15.12.97
   Member Lok Sabha
   Bajpur, Naini Tal (Uttar Pradesh)
   and
   206, North Avenue
   New Delhi 110 001
   (For the Regional Committee No. IV)

9. Shri Uttamrao Dcorao Patil Up to 15.12.97
   Member Lok Sabha
   Mahabali Layout
   Vadgaon Road,Yavatmal
   Maharashtra 2431
   and
   179, North Avenue
   New Delhi 110 001
   (For the Regional Committee No. VII)

10. Dr P. Vallal Peruman Up to 15.12.97
    Member Lok Sabha
    132, East Car Street
    Chidambaram (Tamil Nadu) 608 001
    and
    167-169, North Avenue
    New Delhi 110 001
    (For the Regional Committee No. VIII)

11. Shri Ram Prasad Singh Up to 8.8.94
    Member Lok Sabha
    Village & P.O. Kochas
    P.S. Kochas
    District Rohtas
    Sarsaram (Bihar)
    and
    38, South Avenue, New Delhi

12. Shri Bhawani Lal Verma Up to 8.8.94
    Member Lok Sabha
    Village & P.O. Faghuram
    Via-Adhab
    District Bilaspur (Madhya Pradesh)
    and
    81, South Avenue, New Delhi
13. Shri Som Pal
   Member Rajya Sabha
   Village and P.O Kakor
   Tehsil Bagpat
   Block Chhaprauli
   Distt Meerut (Uttar Pradesh)
   and
   28, Lodi Estate
   New Delhi
   All Secretaries in the Ministry of Agriculture

14. Secretary (Agriculture and Co-operation)
    Ministry of Agriculture
    Department of Agriculture
    Krishi Bhavan
    New Delhi 110 001

15. Secretary (Animal Husbandry and Dairying)
    Krishi Bhavan
    New Delhi 110 001

Secretary, Planning Commission

16. Secretary
    Planning Commission
    Yojana Bhavan
    New Delhi
    (For the Regional Committee No. IV)

Chairman, UGC

17. Chairman
    University Grants Commission
    Bahadur Shah Zafar Marg
    New Delhi
    (For the Regional Committee No. IV)

Chairman, Atomic Energy Commission, or Director,
Bhabha Atomic Research Centre, if nominated by the
Chairman, Atomic Energy Commission

18. Chairman
    Atomic Energy Commission
    Chhatarpati Shivaji Maharaj Marg
    Bombay (Maharashtra)
    (For the Regional Committee No. VII)

Member Finance (Secretary /Additional Secretary in
the Ministry of Finance), Government of India

19. 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

20. Dr R.P.S. Tyagi
    Up to 9.12.96
    Vice-Chancellor
    Himachal Pradesh Krishi Vishwa Vidyalaya
    Palampur (Himachal Pradesh) 176 062
    (For the Regional Committee No. VIII)

21. Dr V. Gyanaprakasam
    Up to 9.4.96
    Tamil Nadu Veterinary
    and Animal Sciences University
    Madras (Tamil Nadu) 600 007
    (For the Regional Committee No. VIII)

22. Dr K.S. Chauhan
    Up to 10.11.95
    Rajendra Agricultural University
    Veterinary College Campus
    Patna (Bihar) 800 014
    (For the Regional Committee No. IV)

23. Dr A.M. Michael
    Up to 29.12.96
    Vice-Chancellor
    Kerala Agricultural University
    Thrissur (Kerala) 680 654
    (For the Regional Committee No. VIII)

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

24. Agricultural Commissioner
    Department of Agriculture
    Krishi Bhavan
    New Delhi 110 001

25. Horticultural Commissioner
    Department of Agriculture
    Krishi Bhavan
    New Delhi 110 001

26. Animal Husbandry Commissioner
    Department of Agriculture
    Krishi Bhavan
    New Delhi 110 001

27. Fisheries Development Commissioner
    Department of Agriculture
    Krishi Bhavan
    New Delhi 110 001

28. Inspector-General of Forests
    Government of India
    Department of Environment and Forests
    CGO Complex
    Lodi Road
    New Delhi 110 001
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.

29. Dr J.C. Bakhshi  
   House No. 132D  
   Kichhoo Nagar  
   Ludhiana (Punjab) 141 001  
   (For the Regional Committee No. IV)

30. Dr P.S. Lamba  
   51, Defence Colony  
   Hisar (Haryana) 125 001  
   (For the Regional Committee No. IV)

31. Dr Sukhdev Singh  
   House No. 419, Sector 38 A  
   Chandigarh (Punjab) 160 014  
   (For the Regional Committee Nos IV & VI)

32. Dr S.K. Sinha  
   Director  
   Indian Agricultural Research Institute  
   Hillside Road, Pusa  
   New Delhi 110 012  
   (For the Regional Committee No. IV)

33. Dr O.S. Tomer  
   Director  
   National Dairy Research Institute  
   Karnal (Haryana) 132 001  
   (For the Regional Committee No. VI)

34. Dr Shankar Lal  
   Director (Acting)  
   Indian Institute of Pulses Research  
   Kalyanpur, Kanpur (Uttar Pradesh) 208 024  
   (For the Regional Committee No. IV)

35. Dr Mangala Rai  
   Assistant Director-General (P)  
   Indian Council of Agricultural Research  
   Krishi Bhavan  
   New Delhi 110 001  
   (For the Regional Committee No. IV)

36. Dr S.K. Tripathi  
   Director  
   Central Institute of Fisheries Education  
   7, Bungalow, Versova  
   Bombay (Maharashtra) 400 061  
   (For the Regional Committee No. VII)

37. Dr S.C. Mudgal  
   Vice-Chancellor  
   Govind Ballabh Pant University of Agriculture and Technology  
   Pantnagar (Uttar Pradesh) 263 145  
   (For the Regional Committee Nos I & IV)

38. Dr S. Arya  
   Vice-Chancellor  
   Ch. Charan Singh Haryana Agricultural University  
   Hisar (Haryana) 125 004  
   (For the Regional Committee No. VI)

39. Dr A.S. Khehra  
   Vice-Chancellor  
   Punjab Agricultural University  
   Ludhiana (Punjab) 141 004  
   (For the Regional Committee No. IV)

40. Dr R.K. Patel  
   Vice-Chancellor  
   Rajasthan Agricultural University  
   Bikaner (Rajasthan) 334 001  
   (For the Regional Committee No. VI)

41. Dr M.P. Singh  
   Vice-Chancellor  
   Central Agricultural University  
   for the NEH Region  
   Imphal (Manipur) 795 001  
   (For the Regional Committee No. III)

42. Shri Jayant Das  
   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

43. Dr Aditya Prasad Das  
   Director-Incharge of the  
   Desert Medicine Research Centre  
   Jodhpur (Rajasthan)  
   (For the Regional Committee No. VI)

44. Shri Hari Shankar Singhania  
   President  
   J.K. Organization  
   4, Bahadur Shah Zafar Marg  
   New Delhi  
   (For the Regional Committee No. IV)

45. Shri H.P Nanda  
   President  
   Escorts Limited  
   Scindia House  
   New Delhi  
   (For the Regional Committee No. IV)

46. Shri P.K. Aggarwal  
   President  
   B.D. Steels  
   Jalandhar (Punjab)  
   (For the Regional Committee No. IV)
47. Shri Hiranand Sinha
S/o Kumar Tara Nand Sinha
Village Champa Nagar
Deorhi Distt Purnea (Bihar)
P.O. Banali

(For the Regional Committee No. IV)

48. Shri Mahadev Singh
Ex MLA, Khandela
Sikar (Rajasthan)
(For the Regional Committee No. VI)

49. Shri M.M. Thapar
Joint Managing Director
Ballapur Industries
Thapar House, Janpath
New Delhi
(For the Regional Committee No. IV)

50. Shri Sudhir Sanghi
Company Director
Sanghi Group of Industries
Hyderabad (Andhra Pradesh)
(For the Regional Committee No. V)

51. Shri S. Jayaram Choudhry
Hotel Mayura
Tirupati (Andhra Pradesh)
(For the Regional Committee No. II)

52. Shri R.S. Velan
974, Cross-Cut-Road
Gandhipuram
Coimbatore (Tamil Nadu) 641 012
(For the Regional Committee No. VIII)

53. Shri Rameshwar Rajora
Vice-President
Cong. (I) Sewa Dal
Maur Mandi
Distt Bhatinda (Punjab)
(For the Regional Committee No. IV)

54. Shri K.V. Kuppusamy
Chairman and Managing Trustee
Blakhatvatsalam Memorial Trust
242 B, Trichy Road
Sulur, Coimbatore (Tamil Nadu)
(For the Regional Committee No. VIII)

55. Shri Sher Bahadur Singh
Advocate
Baradeeh Chauraha
Mukhtiar Ganj
Satna (Madhya Pradesh)
(For the Regional Committee Nos V & VII)

56. Shri Rajender Singh Jakhar
Village & P.O. Fatrewala
Teh. Fazilka
Distt Ferozepur (Punjab)
(For the Regional Committee No. IV)

57. Shri P.M. Samentray
IAS (Retd)
P.O. Madhupatan Cuttack (Orissa)
(For the Regional Committee No. V)

58. Shri Praveen Katewa
Village & P.O. Bakhawar Pura
Distt Jhunjhunu (Rajasthan)
(For the Regional Committee No. VI)

59. Shri D.S. Ananth
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)

60. Shri Chengal Reddy
2, Shesh Villa
3-6-293
Hyderguda
Hyderabad (Andhra Pradesh)
(For the Regional Committee No. V)

61. Ms Suniti Wadhwa
S 468-A
Greater Kailash
Part I
New Delhi
(For the Regional Committee No. IV)

62. Shri G.N. Raju Yadav
Guduru, Guduru Mandal
Krishna (Andhra Pradesh) 521 149
(For the Regional Committee No. V)

63. Shri M. Tulasi Das
House No. 14-24
Srinivasapuram Colony
Rammathanpur
Hyderabad (Andhra Pradesh)
(For the Regional Committee No. V)

64. Shri Prem Nath Vij
97, Patel Nagar
Abohar
District Ferozepur (Punjab)
(For the Regional Committee No. IV)

65. Dr D.S. Balain
Director
Indian Veterinary Research Institute
Izatnagar (Uttar Pradesh) 243 122
(For the Regional Committee Nos I & IV)
<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Position/Role</th>
<th>Address/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>66.</td>
<td>Dr. A.K. Basu</td>
<td>Director</td>
<td>Central Institute for Cotton Research</td>
<td>9.4.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post Bag No. 225, GPO Nagpur (Maharashtra) 440 001</td>
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<td></td>
<td>(For the Regional Committee No. I)</td>
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<td></td>
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<td></td>
<td>AB Mushroom Farm Solan (For the Regional Committee No. VII)</td>
<td></td>
</tr>
<tr>
<td>67.</td>
<td>Dr. A.K. Bandopadhyay</td>
<td>Director</td>
<td>Central Agricultural Research Institute for Andaman and Nicobar Group of Islands</td>
<td>9.4.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post Box No. 181 Port Blair (Andamans) 744 101</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>(For the Regional Committee No. III)</td>
<td></td>
</tr>
<tr>
<td>68.</td>
<td>Chairman of the Development Council/Chairman of the Development Council of the region</td>
<td></td>
<td></td>
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<tr>
<td>69.</td>
<td>Directors of the Institutes / National Bureaux/Project Directorates/National Research Centres/Zonal Co-ordinators of the region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70.</td>
<td>Secretaries of Agriculture/Animal Husbandry/Fisheries/Rural Development of the states in the region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71.</td>
<td>Agricultural Production Commissioner of the states in the region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>72.</td>
<td>Directors of the Agriculture/Horticulture/Animal Husbandry and Veterinary/Fisheries/Rural Development of the states in the region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>73.</td>
<td>Engineer-In-Chief/Chief Conservator of Forests of the states in the region</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Chairman of the Development Council or Councils constituted by the Department of Agriculture, Government of India, located in the region**

**Directors of the Institutes of the Council in the region**

**Secretaries of Agriculture/Animal Husbandry/Fisheries/Rural Development of the states in the region**

**Agricultural Production Commissioner of the states in the region**

**Directors of the Agriculture/Horticulture/Animal Husbandry and Veterinary/Fisheries/Rural Development of the states in the region**

**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**

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Position/Role</th>
<th>Address/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>74.</td>
<td>Shri Buta Singh Bajwa</td>
<td>Up to</td>
<td>6, Guru Nanak Nagar Batala (Punjab)</td>
<td>29.12.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(For the Regional Committee No. I)</td>
<td></td>
</tr>
<tr>
<td>75.</td>
<td>Shri Prempal Sandhu</td>
<td>Up to</td>
<td>Sandhu Bhavan</td>
<td>29.12.97</td>
</tr>
<tr>
<td>85.</td>
<td>Shri Nathu Lal Jain</td>
<td>Up to</td>
<td>525, Patwari Building Govind Rajiya Ka Rasta Chandpal Bazar Jaipur (Rajasthan) (For the Regional Committee No. VI)</td>
<td>29.12.97</td>
</tr>
<tr>
<td>86.</td>
<td>Ms Jayantiben Shroff</td>
<td>Up to</td>
<td>Near Vegetable Market At Post Palghar</td>
<td>29.12.97</td>
</tr>
</tbody>
</table>
Distt Thane (Maharashtra)  
(For the Regional Committee No. VII)  

87. Shri Prakash Vyas  Up to  
Nutan Nagar Colony  
Khargon (Madhya Pradesh)  
(For the Regional Committee No. VII)  

88. Shri Lingaraj Patil  Up to  
5th Cross, 1Ind Main  
Sadashiv Nagar  
Belgaum (Karnataka)  
(For the Regional Committee No. VIII)  

89. Shri A.R. Andu Gowde  Up to  
At Post 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  

90. Shri S.K. Ahuja  Up to  
V&PO Panjkosi  
Teh. Abohar  
District Ferozepur (Punjab)  
(For the Regional Committee No. I)  

91. Shri Bhagwant Singh  Up to  
S/o Shri Harbans Singh  
Chhawni Kala  
Hoshiarpur (Punjab)  
(For the Regional Committee No. I)  

92. Prof. S.S. Chakraborty  Up to  
Shri R.K. Mission Ashram  
Narendrapur  
24 Parganas (West Bengal)  
(For the Regional Committee No. II)  

93. Dr A.K. Butta  Up to  
Yug Nirman Yojana  
Shanti Kunj  
Haridwar (Uttar Pradesh)  
(For the Regional Committee No. II)  

94. Dr Aparna Hariparasad  Up to  
Project Director  
Social Work and Research Centre  
West Garo Hills  
Meghalaya  
(For the Regional Committee No. III)  

95. Smt. Annu Mukherjee  Up to  
President  
Tripura Adivasi Mahila Samiti  
Tripura  
(For the Regional Committee No. III)  

96. Shri J.S. Cheema  Up to  
S/o Shri Amrik Singh Cheema  
President  
Farmers’ Youth Forum  
168, Sector 8  
Chandigarh (Punjab)  
(For the Regional Committee No. IV)  

97. Shri Pramod Agarwal  Up to  
B.D. Educational Foundation  
2/5, Patel Road  
Jalandhar Cantt (Punjab)  
(For the Regional Committee No. IV)  

98. Shri K.V. Kuppusamy  Up to  
Chairman and Managing Trustee  
Bhaktavatsalam Memorial Trust  
242 B. Trichy Road  
Sulur, Coimbatore (Tamil Nadu) 641 402  
(For the Regional Committee No. VIII)  

99. Shri Chengal Reddy  Up to  
Peddireddy Thimmareddy  
Farm Foundation Trust  
No. 2, Shesh Villa, 3-6-293 Hyderguda  
Hyderabad (Andhra Pradesh)  
(For the Regional Committee No. V)  

100. Shri Mihir Bhatt  Up to  
Disaster Mitigation Institute  
ASHA 4, Panchsheel Society  
Ahmedabad (Gujarat)  
(For the Regional Committee No. VI)  

101. Shri S.R. Ola  Up to  
Balika Vidyalaya Trust  
Ardawata, PO Chairawa  
Distt Jhunjhunu (Rajasthan)  
(For the Regional Committee No. VI)  

102. Shri Sanjay D. Patil  Up to  
D.Y. Patil Educational Institute  
Kohlapur (Maharahtra)  
(For the Regional Committee No. VII)  

103. Shri S.B. Nayamagounda  Up to  
Krishna Teer Rayat Sangh  
Maitri Gali, Jamakhandi  
Distt Bilapur (Karnataka) 587 301  
(For the Regional Committee No. VII)  

104. Shri B.V. Parameshwara Rao  Up to  
Bhagavatula Charitable Trust  
Yellamanchili  
Visakha Distt (Andhra Pradesh)  
(For the Regional Committee No. VIII)  

105. Shri P.N. Dhawan  Up to  
General Secretary, Punjab  
Association (Regd)  
Lajpatrai Bhavan  
(For the Regional Committee No. III)
P.B. No. 416, Peters Road
Royapettah
Madras (Tamil Nadu)
(For the Regional Committee No. VIII)

Member-Secretary

106. One of the Directors of the ICAR Institutes in the region

Special Invitee

in the respective region

107. 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

108. Director, WAlMIS, Tezpur/Lucknow/Patna/Hyderabad/Bhopal/Cuttack/Anand/Kota/Aurangabad/Dharwad/Trichy

Others

109. Director-General U.P. Council of Agricultural Research, A-11, Nirala Nagar Lucknow (Uttar Pradesh) 226 007
(For the Regional Committee No. IV)

110. Director National Bureau of Soil Survey and Land-Use Planning Shankar Nagar Amaravati Road Nagpur (Maharashtra) 440 010
(For All the Regional Committees)

111. Dean, Home Science Govind Ballabh Pant University of Agriculture and Technology Pantnagar (Uttar Pradesh) 263 145
(For the Regional Committee No. I)

112. Associate Dean Assam Agricultural University Jorhat (Assam)
(For the Regional Committee No. II)

113. Dean Chander Shekhar Azad University of Agriculture and Technology Kanpur (Uttar Pradesh) 208 002
(For the Regional Committee No. IV)

114. Dean, Home Science Punjab Agricultural University Ludhiana (Punjab) 141004
(For the Regional Committee No. IV)

115. Dean, Home Science Andhra Pradesh Agricultural University Rajendranagar Hyderabad (Andhra Pradesh) 500 030
(For the Regional Committee No. V)

116. Dean, Home Science Rajasthan Agricultural University Udaipur (Rajasthan)
(For the Regional Committee No. VI)

117. Associate Dean Marathwada Agricultural University Parbhani (Maharashtra) 431 402
(For the Regional Committee No. VII)

118. College of Home Science Tamil Nadu Agricultural University Madurai (Tamil Nadu)
(For the Regional Committee No. VIII)
<table>
<thead>
<tr>
<th>Regions/States</th>
<th>ICAR Institutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Himachal Pradesh, Jammu and Kashmir, Hill Region of Uttar Pradesh</td>
<td>CPRI, Shimla; CSWCR &amp; TI, Dehra Dun; VPKAS, Almora</td>
</tr>
<tr>
<td>II. Assam and West Bengal</td>
<td>JTRL, Calcutta; CRIJAF, CICFRI, Barrackpore</td>
</tr>
<tr>
<td>III. Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Meghalaya, Tripura, Manipur, and Nicobar Islands</td>
<td>ICAR Research Complex for NEH Region, Shillong; CARI, Port Blair</td>
</tr>
<tr>
<td>IV. Bihar, Punjab, Plains of Uttar Pradesh, and Union Territory of Delhi</td>
<td>IARI, NBPGR, IASRI, New Delhi; IVRI, CARI, Izatnagar; IGFRI, Jhansi; IISR, CIIHF, CITH, Lucknow; CIPHET, Ludhiana; CIRG, Mukhdoom; ILRI, Ranchi</td>
</tr>
<tr>
<td>V. Orissa, Andhra Pradesh and Eastern Madhya Pradesh</td>
<td>CRRI, Cuttack; CIFA, Bhubaneswar; NAARM, CRIDA, Hyderabad; IISS, CIAE, Bhopal; CTRI, Rajahmundry</td>
</tr>
<tr>
<td>VI. Haryana, Rajasthan, Gujarat, and Union Territory of Dadra and Nagar Haveli, Daman and Diu</td>
<td>CAZRI, Jodhpur; CSWRI, Avikanagar; NDRI, NBAGR, NIAG, CSSRI, Karnal; CIRB, Hisar</td>
</tr>
<tr>
<td>VII. Maharashtra, Western and Central Madhya Pradesh, Goa</td>
<td>CIRCOT, CTRL, CIFE, Bombay; CICR, NBSSLUP, Nagpur; ICAR Research Complex for Goa</td>
</tr>
<tr>
<td>VIII. Kerala, Karnataka, Tamil Nadu, Union Territory of Pondicherry and Lakshadweep Islands</td>
<td>CIFT, CMFRI, Kochi; NIANP, IIHR, Bangalore; SBI, Coimbatore; CPCRI, Kasaragod; CTCRI, Thiruvananthapuram; CIBA, Madras</td>
</tr>
</tbody>
</table>
APPENDIX 6
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
   w.e.f. 22.6.93

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)     w.e.f. 6.6.94
7. Dr.K.L. Chadha (Horticulture)
8. Dr J.P. Abrol (Soils, Agronomy and Agroforestry)
9. Dr D.S. Balain (Animal Sciences)  w.e.f. 22.11.94
10. Dr P.V. Dehadrai (Fisheries)
11. Dr Gajendra Singh (Agricultural Engineering)  w.e.f. 12.12.94
12. Dr A. Ahmad (Education)          up to 31.1.95
13. Dr Puranjan Das (Agricultural Extension)  w.e.f. 15.3.95

Directors

14. Shri S.S. Rana (Personnel)
15. Smt S. Basu (Finance)          up to 23.1.95
16. Dr R.D. Sharma (Acting)       (Publications and Information)
17. Shri J.S. Yadav (Works)

Assistant Directors-General

18. Dr S.P. Ghosh (Horticulture)     w.e.f. 4.7.94
19. Dr J.P. Tandon (Acting) (Food and Forage Crops)
20. Dr B.K. Tripathi (Commercial Crops)
21. Dr P. Rethinam (Plantation Crops)
22. Dr A.K. Raheja (Entomology and Biological Control)
23. Dr Mangala Rai (P)
24. Dr T.N. Chaudhary (Integrated Water Management)
25. Dr R.N. Prasad (Acting) (Agroforestry)  w.e.f. 16.5.94
26. Dr P.C. Bhatia (Agronomy)        w.e.f. 16.12.94
27. Dr B.N. Choudhary (Lab-to-Land Programmes)
28. Dr A.N. Shukla (Krishi Vigyan Kendras)
29. Dr P.B. Mathur (UNDP)
30. Dr O.N. Kunzru (Animal Science Education)  w.e.f. 7.9.94
31. Dr A.P. Saxena (NARP)
32. Dr K.N. Singh (NARP II)
33. Dr G. Singh (Agricultural Engineering)
34. Dr Kiran Singh (Animal Nutrition and Physiology)
35. Dr B.S. Hansra (Agricultural Extension)
36. Dr V.K. Taneja (Animal Production and Breeding)
37. Dr M.Y. Kamal (Inland Fisheries)
38. Dr K. Radhakrishna (Marine Fisheries)
39. Dr R.C. Maheshwara (Centre-State-Co-ordination,
   Technical Co-ordination)
40. Dr D.P. Singh (Vegetables)
41. Dr Mruthyunjaya (Economics, Statistics and Marketing)
42. Dr R.P. Kachru (Post-harvest Technology)  w.e.f. 16.6.94
43. Dr (Mrs) Tej Verma (Home Science)     w.e.f. 5.7.94
44. Dr D.P. Singh (OP)
45. Dr R.K. Gupta (Acting) (Soils)         w.e.f. 20.2.95

Deputy Secretaries

46. Shri K.K. Bajpai (Education and NARP)
47. Shri Devinder Singh (Administration and
    General Administration and Co-ordination)
48. Shri A.K. Chaturvedi (Animal Sciences)
49. Shri Gaya Prasad

Principal Scientists

50. R.N. Pal (Horticulture)
51. Dr S.R. Singh (Agronomy)
52. Dr P.S. Bhatnagar (Plant Breeding)
53. Dr D.P. Singh (Plant Breeding)
54. Dr G.D. Diwakar (NARP)
55. Dr G. Appa Rao (Agricultural Extension)
56. Dr Shankar Manji (Education)
57. Dr A.K. Sinha (Soil Science)
58. Dr Arun Verma (NARP)
59. Dr P.S.R.C. Murti (Livestock Health)
60. Dr (Mrs) Usha Anand (Agricultural Extension)

ICAR ANNUAL REPORT 1994-95
61. Dr S.D. Rai (Agricultural Extension)
62. Dr S.C. Chopra (Animal Production and Breeding)
63. Dr D.K. Chaturvedi (Poultry Nutrition)
64. Dr O.P. Dubey (Agricultural Entomology)
65. Dr G.C. Tiwari (Agricultural Entomology)
66. Dr M. Velayutham (Soil Science)
67. Dr Y.P. Nanda (Veterinary Science)

**Others**

68. Captain R.K. Marwaha
   Secretary
   Agricultural Scientists' Recruitment Board

69. Shri T.A. Sriram
    Senior Technical Officer

70. Dr P.N. Bhat
    Officer on Special Duty

71. Dr R.D. Sharma
    Chief Editor (Hindi)

72. Shri R.R. Lokeshwar
    Editor (English)

73. Shri R.S. Gupta
    Editor (English)

74. Shri Rajinder Singh
    Editor (English)

75. Shri J.B. Mehra
    Chief Production Officer

76. Shri Aravinda Chakravarty
    Chief Artist

77. Shri Rajinder Mohan
    Deputy Chief Artist

78. Shri B.S. Panwar
    Chief Publicity and Public Relations Officer
APPENDIX 7

ICAR INSTITUTES

1. Dr R.B. Singh
   Director
   Indian Agricultural Research Institute
   Pusa Complex
   New Delhi 110 012

2. Dr K.C. Mathur
   Director
   Central Rice Research Institute
   Cuttack (Orissa) 753 006

3. Dr S.N. Pandey
   Central Research Institute for Jute and Allied Fibres
   24 Paraganas
   Barrackpore (West Bengal) 743 101

4. Dr M.S. Chari
   Director
   Central Tobacco Research Institute
   Rajahmundry (Andhra Pradesh) 533 105

5. Dr R.P. Singh
   Director (Acting)
   Indian Grassland and Fodder Research Institute
   Pahuj Dam, Gwalior Road
   Jhansi (Uttar Pradesh) 284 003

6. Dr M.S. Mishra
   Director
   Indian Institute of Sugarcane Research
   PO Dilkusha
   Lucknow (Uttar Pradesh) 226 002

7. Dr K.C. Alexander
   Director
   Sugarcane Breeding Institute
   Coimbatore (Tamil Nadu) 641 007

8. Dr K.D. Koranne
   Director (Acting)
   Central Institute for Cotton Research
   Post Box No. 225
   GPO, Nagpur (Maharashtra) 440 001

9. Dr S.D. Dubey
   Director
   Vivekananda Parvatiya Krishi Anusandhan Shala
   Almora (Uttar Pradesh) 263 601

10. Dr G.S. Shekhawat
    Director
    Central Potato Research Institute
    Shimla (Himachal Pradesh) 171 001

11. Dr G.T. Kurup
    Director
    Central Tuber Crops Research Institute
    Sreekariyam
    Thiruvananthapuram (Kerala) 695 017

12. Dr I.S. Yadav
    Director
    Indian Institute of Horticultural Research
    Hessaraghatta Lake Post
    Bangalore (Karnataka) 560 089

13. Dr M.K. Nair
    Director
    Central Plantation Crops Research Institute
    Kasaragod (Kerala) 670 124

14. Dr S.S. Negi
    Director
    Central Institute for Subtropical Horticulture
    Rai Bareli Road, PO Dilkusha
    Lucknow (Uttar Pradesh) 226 016

15. Dr D.G. Dhandar
    Director (Acting)
    ICAR Research Complex for Goa
    Ela Old
    Goa 403 402

16. Dr U.C. Sharma
    Director
    ICAR Research Complex for NEH Region
    Umroli Road
    Barapani (Meghalaya) 793 103

17. Dr A.S. Faroda
    Director
    Central Arid Zone Research Institute
    Jodhpur (Rajasthan) 342 003

18. Dr J.S. Samra
    Director
    Central Soil and Water Conservation Research and Training Institute
    218, Kaulagarh Road
    Dehra Dun (Uttar Pradesh) 248 195
39. Dr B.C. Mitra
   Director
   Jute Technological Research Laboratories
   12, Regent Park
   Calcutta (West Bengal) 700 040

40. Dr K.R. Krishan Iyer
   Director
   Central Institute for Research on Cotton Technology
   Post Box No. 16640, Adenwala Road
   Matunga, Bombay (Maharashtra) 400 019

41. Dr K.V. Peter
   Director
   Indian Institute of Spices Research
   P.B.No. 1701, Marikunnu PO
   Calicut (Kerala) 673 012

42. Dr N.S. L. Srivastava
   Director
   Central Institute of Agricultural Engineering
   Berasia Road
   Nabi Bagh
   Bhopal (Madhya Pradesh) 462 018

43. Dr Jai Singh
   Officer on Special Duty
   Central Institute of Post-harvest Engineering and Technology
   PAU Campus
   Ludhiana (Punjab) 141 004

44. Dr J.C. Kalla
   Director
   National Academy of Agricultural Research and Management
   Rajendranagar
   Hyderabad (Andhra Pradesh) 500 030

45. Dr A.S. Asthana
   Director
   Indian Institute of Pulses Research
   Kanpur (Uttar Pradesh) 208 024

46. Dr A.A. Sofi
   Director
   Central Institute for Temperate Horticulture
   Iqbal Colony
   Zainakote PO HMT
   Srinagar (Jammu and Kashmir) 190 012
APPENDIX 8

NATIONAL BUREAUX

1. Dr K.P.S. Chandel
   Director (Acting)
   National Bureau of Plant Genetic Resources
   FCI Building, Pusa
   New Delhi 110 012

2. Dr J.L. Sehgal
   Director
   National Bureau of Soil Survey and Land-use Planning
   Post Box No. 426
   Shankar Nagar, Amravati Road
   Nagpur (Maharashtra) 440 010

3. Dr R. Sahai
   Director (Acting)
   National Bureau of Animal Genetic Resources
   NDRI Campus
   Karnal (Haryana) 132 001

4. Dr P. Das
   Director
   National Bureau of Fish Genetic Resources
   Radhaswami Bhavan
   351/28, Dariya Pur
   Talkatora Road, PO Rajendranagar
   Lucknow (Uttar Pradesh) 226 002
APPENDIX 9

PROJECT DIRECTORATES

1. Dr G. Kalloo
   Project Director
   Project Directorate on Vegetables
   No. 1 Gandhinagar
   Sunderpur (Nasic)
   Varanasi
   (Uttar Pradesh) 221 005

2. Dr P.S. Reddy
   Project Director
   Directorate of Oilseed Research
   Rajendranagar
   Hyderabad
   (Andhra Pradesh) 500 030

3. Dr R.L. Yadav
   Project Director
   Directorate of Cropping Systems Research
   Modipuram, Meerut
   (Uttar Pradesh) 250 110

4. Dr R.K. Rajput
   Project Director
   Directorate of Water Management
   Mahatma Phule Krishi Vidyapeeth Campus
   Rahuri
   Ahmednagar (Maharashtra) 413 722

5. Dr K. Krishnalah
   Project Director (Acting)
   Directorate of Rice Research
   Rajendranagar
   Hyderabad (Andhra Pradesh) 500 030

6. Dr S.P. Singh
   Officer on Special Duty
   Project Directorate of Biological Control
   Bellary Road
   Post Box No. 2491
   HA Farm Post
   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 S. Nagarajan
   Project Director
   Directorate of Wheat Research
   Post Box No. 158, Kunjpura Road
   Karnal (Haryana) 132 001

9. Dr' Ayyagiri
   Project Director (Acting)
   Project Directorate on Poultry
   Andhra Pradesh Agricultural University Campus
   Rajendranagar
   Hyderabad (Andhra Pradesh) 500 030

10. Dr C.L. Arora
    Project Director (Acting)
    Project Directorate on Cattle
    PH-7, Pallavpuram
    Phase II, Modipuram
    Meerut (Uttar Pradesh) 250 110
APPENDIX 10

NATIONAL RESEARCH CENTRES

1. Dr M.S. Basu
   Director
   National Research Centre for Groundnut
   Timbawadi, Ivanagar Road, PB No.5
   Junagadh (Gujarat) 362 001

2. Dr P.S. Bhatnagar
   Director
   National Research Centre on Soybean
   Bhawerkua Farm, Khandwa Road
   Indore (Madhya Pradesh) 452 001

3. Dr R.P. Sharma
   Project Director
   National Research Centre on Plant Biotechnology
   Indian Agricultural Research Institute
   New Delhi 110 012

4. Dr B.S. Rana
   Director
   National Research Centre for Sorghum
   Rajendranagar
   Hyderabad (Andhra Pradesh) 500 030

5. Dr N.B. Singh
   Director (Acting)
   National Research Centre for Rapeseed and Mustard
   Post Box No. 41
   Bharatpur (Rajasthan) 321 001

6. Dr R.N. Verma
   Director
   National Centre for Mushroom Research and Training
   Chambaghpat
   Solan (Himachal Pradesh) 173 213

7. Dr Harcharan Das
   Director
   National Research Centre for Citrus
   Seminary Hills
   Nagpur (Maharashtra) 440 006

8. Dr E.V.V. Bhaskar Rao
   National Research Centre for Cashew
   Kamminje
   Puttur (Karnataka) 574 202

9. Dr G.B. Raturi
   Officer-Incharge
   National Research Centre for Onion and Garlic
   MF 37, Sundarvan Colony, Near Lekha Nagar
   Nasik (Maharashtra) 422 009

10. Dr O.P. Pareek
    Director (Acting)
    National Research Centre for Arid Horticulture
    C-35, Sadulganj
    Bikaner (Rajasthan) 334 003

11. Dr N.D. Verma
    Director
    National Research Centre on Mithun
    ICAR Research Complex
    Jharnapani
    District Kohima (Nagaland) 797 106

12. Dr H.P. Singh
    Officer-Incharge
    National Research Centre for Banana
    No. 4, Ramalingam Nagar, Veluyur Road
    Tiruchirapalli (Tamil Nadu) 639 103

13. Dr K.C. Dalal
    Director
    National Research Centre for Medicinal and Aromatic Plants
    Boriavi Seed Farm
    Boriavi
    Anand (Gujarat) 387 310

14. Dr S.D. Shikamany
    Officer on Special Duty
    National Research Centre for Grapes
    C/o IIHR, Hesaraghatta, Lake Post
    Bangalore (Karnataka) 560 089

15. Dr P. Rethinam
    Director
    National Research Centre for Oilpalm
    Tenali Ramakrishnanah Street
    Ashok Nagar
    Eluru (Andhra Pradesh) 534 002

16. Dr R.C. Upadhyaya
    Officer Incharge
    National Research Centre for Orchids
    C/o Jt Director, ICAR Complex for NEH Region
    Regional Station, Tadong
    Gangtok (Sikkim) 737 102
17. Director  
National Research Centre for Women in Agriculture  
Bhubaneswar (Orissa) 751 001

18. Dr Dayanatha Jha  
Director  
National Centre for Agricultural Economics and Policy Research  
IASRI Campus  
New Delhi 110 012

19. Dr S.N. Puri  
Director  
National Centre for Integrated Pest Management  
Lal Bahadur Shastri Centre for Biotechnology  
IARI, Hillside Road, Pusa  
New Delhi 110 012

20. Dr R.N. Pal  
Director  
National Research Centre on Yak  
West Kemeng  
Dirang (Arunachal Pradesh) 790 101

21. Dr M.P. Yadav  
Director  
National Research Centre for Equines  
Sirsa Road  
Hisar (Haryana) 125 001

22. Dr N.D. Khanna  
Project Director  
National Research Centre on Camel  
Jorbeer, P. Box No. 07  
Bikaner (Rajasthan) 334 001

23. Director  
National Biotechnology Centre for Animal Health  
Izatnagar (Uttar Pradesh) 243 122

24. Dr G.C. Mohanty  
Director (Acting)  
National Research Centre on Meat  
Indian Veterinary Research Institute Campus  
Izatnagar (Uttar Pradesh) 243 122

25. Director  
National Embryo Biotechnology Centre for Animal Production  
National Dairy Research Institute  
Karnal (Haryana) 132 001

26. Dr Harbhajan Singh  
Project Director (Acting)  
National Research Centre on Coldwater Fisheries  
Shilwa Hills Nursery, P. Box No. 28, Roop Nagar  
Haldwani (Uttar Pradesh) 263 139

27. Dr A.S. Gill  
Director (Acting)  
National Research Centre for Agroforestry  
IGFRI Campus  
Pahuj Dam  
Gwallor-Jhansi Road  
Jhansi (Uttar Pradesh) 284 003

28. Dr V.M. Bhan  
Director  
National Research Centre for Weed Science  
215, Ravindra Nagar  
C/o Department of Agronomy, JNKVV  
Izatnagar (Uttar Pradesh) 243 122

29. Dr S.R. Singh  
Project Director  
National Research Centre for Water Technology  
Eastern Region  
VII-H/176-180, Sallashree Vihar  
Bhubaneswar (Orissa) 751 016
APPENDIX 11

ALL-INDIA CO-ORDINATED RESEARCH PROJECTS

1. Dr R. Lakshminarayana
   Project Co-ordinator (Tobacco)
   Gujarat Agricultural University
   Anand (Gujarat) 388 110

2. Dr S.R. Misra
   Project Co-ordinator (Sugarcane)
   Indian Institute of Sugarcane Research
   Lucknow (Uttar Pradesh) 226 002

3. Dr H.M. Srivastava
   Project Co-ordinator (Network on Sugarbeet)
   Indian Institute of Sugarcane Research
   Lucknow (Uttar Pradesh) 226 002

4. Dr K. Venugopal
   Project Co-ordinator (Cotton)
   Regional Research Station (CICR)
   PO Lawley Road
   Coimbatore
   (Tamil Nadu) 641 003

5. Dr V.N. Saraswat
   Project Co-ordinator (Jute and Allied Fibres)
   Central Research Institute for Jute and Allied Fibres
   PO Barrackpore
   24 Paraganas
   (West Bengal) 743 101

6. Dr P.S. Bhatnagar
   Project Co-ordinator (Soybean)
   National Research Centre for Soybean
   Khandwa Road
   Indore (Madhya Pradesh) 452 001

7. Dr K.S. Randhawa
   Project Co-ordinator (Barley)
   Regional Station (IARI)
   Karnal (Haryana) 132 001

8. Dr A.V. Tendulkar
   Project Co-ordinator (Pearl Millet)
   College of Agriculture Campus
   Shivaji Nagar
   Pune (Maharashtra) 411 005

9. Dr B.S. Dabas
   Project Co-ordinator (Guar)
   NBPG, Pusa Campus, IARI
   New Delhi 110 012

10. 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

11. Dr A. Seetharam
    Project Co-ordinator (Minor Millets)
    University of Agricultural Sciences
    GKVK Campus
    Bangalore (Karnataka) 560 065

12. Dr B.S. Rana
    Project Co-ordinator (Sorghum)
    NRC for Sorghum
    Rajendranagar
    Hyderabad (Andhra Pradesh) 500 030

13. Dr Bhagmal
    Project Co-ordinator (Underutilized and Under-exploited Plants)
    NBPG, FCI Building
    New Delhi 110 012

14. Dr P. Shyam Sunder Rao
    Project Co-ordinator (Network on Economic Ornithology)
    APAU Veterinary College Campus
    Rajendranagar
    Hyderabad (Andhra Pradesh) 500 030

15. Dr B.D. Rana
    Project Co-ordinator (Rodent Control)
    Central Arid Zone Research Institute
    Jodhpur (Rajasthan) 342 003

16. Dr S.K. Handa
    Project Co-ordinator (Pesticide Residues)
    Division of Agricultural Chemicals
    Indian Agricultural Research Institute
    New Delhi 110 012

APPENDICES
17. Dr S.K. Midha  
Project Co-ordinator (Nematodes)  
Division of Nematology  
Indian Agricultural Research Institute  
New Delhi 110 012

18. Dr M.R. Siddiqui  
Project Co-ordinator (Seed-borne Diseases)  
Division of Seed Science and Technology  
Indian Agricultural Research Institute  
New Delhi 110 012

19. Dr S. Maity  
Project Co-ordinator (Betelvine)  
Indian Institute of Horticultural Research  
Bangalore (Karnataka) 560 089

20. Dr B. Mallick  
Acting Project Co-ordinator (Acarology)  
University of Agricultural Sciences  
Bangalore (Karnataka) 560 024

21. Dr V.K. Gupta  
Project Co-ordinator (Apple Scab)  
Dr Y.S. Parmar University of Horticulture and Forestry  
Solan (Himachal Pradesh) 173 230

22. Dr R.C. Misra  
Project Co-ordinator (Honeybees)  
Division of Zoology (Entomology)  
Ch. Charan Singh Haryana Agricultural University  
Hisar (Haryana) 125 004

23. Dr C.P.S. Yadav  
Project Co-ordinator (Whitegrubs)  
Agricultural Experiment Station  
Sukhadi University  
Durgapur  
Jaipur (Rajasthan) 392 018

24. Dr T. Vishnumurthy  
Project Co-ordinator (Dryland Agriculture)  
CRIDA, Santoshnagar, PO Saidabad  
Hyderabad (Andhra Pradesh) 500 659

25. Dr O.S. Tomar  
Project Co-ordinator (Use of Salt-affected Soils and Saline Water)  
Central Soil Salinity Research Institute  
Karnal (Haryana) 132 001

26. Dr M.V. Singh  
Project Co-ordinator  
(Micro Nutrients and Secondary Nutrients and Pollutant Elements)  
Indian Institute of Soil Science  
Z-6 Zone, Maharana Pratap Nagar  
Bhopal (Madhya Pradesh) 462 011

27. Dr K.K.R. Bhardwaj  
Project Co-ordinator (Microbiological Decomposition)  
Himachal Pradesh Krishi Vishwa Vidyalaya  
Palampur (Himachal Pradesh) 176 062

28. Dr S.L. Gulati  
Project Co-ordinator (Biological Nitrogen Fixation)  
Division of Microbiology  
Indian Agricultural Research Institute  
New Delhi 110 012

29. Dr R.P. Gupta  
Project Co-ordinator (Soil Physical Conditions)  
Division of Agricultural Physics  
Indian Agricultural Research Institute  
New Delhi 110 012

30. Dr K.C.K. Reddy  
Project Co-ordinator (Soil Tests and Crop Response)  
Central Research Institute for Dryland Agriculture  
Santoshnagar, PO Saidabad  
Hyderabad (Andhra Pradesh) 500 659

31. Dr R.N. Prasad  
Assistant Director-General and Project Co-ordinator (Agroforestry)  
Indian Council of Agricultural Research  
Krishi Bhavan  
New Delhi 110 001

32. Dr H.P. Singh  
Project Co-ordinator (Tropical Fruits)  
Indian Institute of Horticultural Research  
Bangalore (Karnataka) 560 089

33. Dr D.S. Rathore  
Project Co-ordinator (Subtropical Fruits)  
Central Institute of Horticulture for Northern Plains  
B-217, Indira Nagar  
Ramsagar Mishra Nagar  
Lucknow (Uttar Pradesh) 226 016
34. Dr O.P. Pareek  
Project Co-ordinator (Arid Fruits)  
National Research Centre for Arid Horticulture  
C 35, Sadulganj  
Bikaner  
(Rajasthan) 334 003

35. Dr S.M. Paul Khurana  
Project Co-ordinator (Potato)  
Central Potato Research Institute  
Shimla  
(Himachal Pradesh) 171 001

36. Dr P.G. Rajendran  
Project Co-ordinator (Tuber Crops)  
Regional Station of the Central Tuber Crops Research Institute  
Thiruvananthapuram  
(Kerala) 695 017

37. Dr R.N. Verma  
Project Director and Project Co-ordinator (Mushrooms)  
Chambaghat  
Solan  
(Himachal Pradesh) 173 213

38. Dr S.P.S. Raghava  
Project Co-ordinator (Floriculture)  
Division of Floriculture and Landscaping  
Indian Agricultural Research Institute  
New Delhi 110 012

39. Dr S.K. Pareek  
Project Co-ordinator (Medicinal and Aromatic Plants)  
National Bureau of Plant Genetic Resources  
Indian Agricultural Research Institute  
New Delhi 110 012

40. Dr E.V.V. Bhaskar Rao  
Project Co-ordinator (Palms)  
Central Plantation Crops Research Institute  
Kasaragod (Kerala) 670 124

41. Dr S. Edison  
Project Co-ordinator (Spices)  
National Research Centre for Spices  
Post Box No. 170, Marikunnanu  
Calicut (Kerala) 673 012

42. Dr M.K. Nair  
Project Co-ordinator (Cashew)  
Puttur (Karnataka) 574 202

43. Dr Susanta K. Roy  
Project Co-ordinator (Post-harvest Technology)  
Division of Fruits and Horticultural Technology  
Indian Agricultural Research Institute  
New Delhi 110 012

44. Dr R.P. Singh  
Project Co-ordinator (Tillage Management of Indian Soils)  
Division of Soil Science  
Indian Agricultural Research Institute  
Pusa  
New Delhi 110 012

45. Dr K.K.M. Nambiar  
Project Co-ordinator (Long-term Fertilizer Experiments)  
Division of Soil Science and Agricultural Chemistry  
Indian Agricultural Research Institute  
New Delhi 110 012

46. Dr B. Gangwar  
Project Co-ordinator (Diara Lands)  
Project Directorate of Cropping Systems Research  
Modipuram  
Meerut (Uttar Pradesh) 250 011

47. Dr Ramakrishna Rao  
Project Co-ordinator (Agricultural Meteorology)  
CRIDA, Dryland Building  
Santoshnagar, PO Saidabad  
Hyderabad  
(Andhra Pradesh) 500 659

48. Dr J.S. Mishra  
Project Co-ordinator (Weed Control)  
National Research Centre for Weed Science  
JNKVV, Adhartal  
Jabalpur (Madhya Pradesh) 482 001

49. Dr B.U. Khan  
Project Co-ordinator (Goat)  
Central Institute for Research on Goats  
Farah, Mathura  
Makhdoom  
(Uttar Pradesh) 281 122

50. Dr S.S Bhatia  
Project Co-ordinator (Pigs)  
Indian Veterinary Research Institute

APPENDICES

217
51. Dr R.N. Singh  
Project Co-ordinator (Sheep Breeding)  
Central Sheep and Wool Research Institute, Arid Region Campus  
Bikaner (Rajasthan) 334 002

52. Dr S.N. Kaushik  
Project Co-ordinator (Buffalo Breeding)  
Central Institute for Research on Buffaloes  
Hisar (Haryana) 125 001

53. Dr (Mrs.) Tej Verma  
Assistant Director-General (Home Science)  
Indian Council of Agricultural Research  
Krishi Anusandhan Bhavan  
New Delhi 110 012

54. Dr M.L. Punj  
Project Co-ordinator (Agricultural Byproducts)  
Department of Animal Nutrition  
Ch. Charan Singh Haryana Agricultural University  
Hisar (Haryana) 125 004

55. Dr A.K. Mukhopadhyay  
Project Co-ordinator (Foot-and-mouth Disease)  
Division of Epidemiology  
Indian Veterinary Research Institute  
Izatnagar (Uttar Pradesh) 243 122

56. Dr M. Rajshekhar  
Project Co-ordinator (Surveillance of Animal Diseases)  
Institute of Animal Health and Veterinary Biology  
Hebbal  
Bangalore (Karnataka) 560 004

57. Dr Y. Bhattacharyulu  
Project Co-ordinator (Haemoprotista Diseases)  
College of Veterinary Science  
Ch. Charan Singh Haryana Agricultural University  
Hisar (Haryana) 125 004

58. Dr K.L. Mazumdar  
Project Co-ordinator (Farm implements and Machinery Scheme)  
Central Institute of Agricultural Engineering  
Berasia Road, Nabi Bagh  
Bhopal (Madhya Pradesh) 462 018

59. Dr Jai Singh  
Project Co-ordinator (Post-harvest Technology)  
Punjab Agricultural University Campus  
Ludhiana (Punjab) 141 004

60. Dr M. Shyam  
Project Co-ordinator (Renewable Energy Sources)  
Central Institute of Agricultural Engineering  
Berasia Road, Nabi Bagh  
Bhopal (Madhya Pradesh) 462 018

61. Shri A.C. Varshney  
Project Co-ordinator (Power Tillers)  
Central Institute of Agricultural Engineering  
Berasia Road, Nabi Bagh  
Bhopal (Madhya Pradesh) 462 018

62. Dr B.R. Sharma  
Project Co-ordinator (Wells and Pumps)  
Water Technology Centre  
Indian Agricultural Research Institute  
New Delhi 110 012

63. Dr A.K. Bhattacharya  
Project Co-ordinator (Agricultural Drainage)  
Water Technology Centre  
Indian Agricultural Research Institute  
New Delhi 110 012

64. Dr N.S.L. Srivastava  
Project Co-ordinator (Utilization of Animal Energy)  
Central Institute of Agricultural Engineering  
Berasia Road, Nabi Bagh  
Bhopal (Madhya Pradesh) 462 018

65. Project Co-ordinator (Plastics in Agriculture)  
Central Institute of Agricultural Engineering  
Berasia Road, Nabi Bagh  
Bhopal (Madhya Pradesh) 462 018

66. Dr Jaswant Singh  
Project Co-ordinator (Processing, Handling and Storage of Jaggery and Khandsari)  
Indian Institute of Sugarcane Research  
Lucknow  
(Uttar Pradesh) 226 002
67. Dr P.R. Kumar
   Project Co-ordinator (Rapeseed and Mustard)
   Sewar Farm
   District Bharatpur
   (Rajasthan)

68. Dr M.S. Basu
   Project Co-ordinator (Groundnut)
   C/o NRC on Groundnut Timbavadi, Ivanagar Road
   Post Box No.5 Junagadh
   (Gujarat) 362 005

69. Dr Shankar Lal
   Project Co-ordinator (Chickpea)
   Indian Institute of Pulses Research
   Kalyanpur
   Kanpur
   (Uttar Pradesh) 208 024

70. Dr Shankar Lal
   Project Co-ordinator (Pigeonpea)
   Indian Institute of Pulses Research
   Kalyanpur
   Kanpur
   (Uttar Pradesh) 208 024

71. Project Co-ordinator (MULLARP)
   Indian Institute of Pulses Research
   Kalyanpur
   Kanpur
   (Uttar Pradesh) 208 024

72. Project Co-ordinator (Human Engineering and Safety Studies)
   Central Institute of Agricultural Engineering
   Berasia Road, Nabi Bagh
   Bhopal
   (Madhya Pradesh) 462 018

73. Dr Dipankar De
   Project Co-ordinator (Energy Requirement in Agricultural Sector)
   Central Institute of Agricultural Engineering
   Berasia Road, Nabi Bagh

74. Project Co-ordinator (Management of Acid Soils)
   Indian Council of Agricultural Research
   Krishi Bhavan
   New Delhi 110 001

75. Project Co-ordinator (ORP on Processing and Utilization of Organic Waste for Aquaculture)
   Indian Council of Agricultural Research
   Krishi Bhavan
   New Delhi 110 001

76. Project Co-ordinator (Network on Embryo Transfer)
   Indian Council of Agricultural Research
   Krishi Bhavan
   New Delhi 110 001

77. Project Co-ordinator (R&D Support for Products of Indigenous Milk)
   National Dairy Research Institute
   Karnal (Haryana) 132 001

78. Project Co-ordinator (Network on Micronutrients)
   Indian Council of Agricultural Research
   Krishi Bhavan
   New Delhi 110 001

79. Project Co-ordinator (Network on Animal Genetic Resources)
   National Bureau of Animal Genetic Resources
   Post Box No. 129
   Karnal (Haryana) 132 001

80. Project Co-ordinator (Network on Crop-based Animal Production System)
   Indian Grassland and Fodder Research Institute
   Pahuj Dam, Jhansi-Gwalior Road
   Jhansi (Uttar Pradesh) 284 003
## APPENDIX 12

### ON-GOING PL-480/US-INDIA FUND (USIF) RESEARCH PROJECTS

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Title</th>
<th>Institution</th>
<th>Amount (Rs)</th>
<th>Date of commencement</th>
<th>Date of termination</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Gene manipulation in rice through plant tissue and cell culture</td>
<td>Osmania University Hyderabad</td>
<td>1,812,186</td>
<td>1.9.89</td>
<td>28.2.95</td>
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<tr>
<td>2.</td>
<td>Integrated project for soil conservation and watershed management (Co-ordinating Unit)</td>
<td>CS&amp;WCR&amp;TI, Dehra Dun</td>
<td>561,800</td>
<td>26.2.90</td>
<td>25.2.96</td>
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<tr>
<td>3.</td>
<td>Integrated project for soil conservation and watershed management (Dehra Dun Centre)</td>
<td>CS&amp;WCR&amp;TI, Dehra Dun</td>
<td>2,500,000</td>
<td>26.2.90</td>
<td>25.2.96</td>
</tr>
<tr>
<td>4.</td>
<td>Integrated project for soil conservation and watershed management for alluvial soils and ravine region (Agra Centre)</td>
<td>Research Centre CS&amp;WCR&amp;TI, Agra</td>
<td>1,645,000</td>
<td>26.2.90</td>
<td>25.2.95</td>
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<td>5.</td>
<td>Integrated project for soil conservation and watershed management : Soil conservation and watershed management (Bellary Centre)</td>
<td>Research Centre CS&amp;WCR&amp;TI, Bellary</td>
<td>2,205,200</td>
<td>26.2.90</td>
<td>25.2.95</td>
</tr>
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<td>6.</td>
<td>Integrated project for soil conservation and watershed management (Bangalore Centre)</td>
<td>UAS, Bangalore</td>
<td>1,648,500</td>
<td>1.4.90</td>
<td>31.3.95</td>
</tr>
<tr>
<td>7.</td>
<td>Integrated project for soil conservation and watershed management (Indore Centre)</td>
<td>College of Agriculture (JNKVV), Indore</td>
<td>1,645,000</td>
<td>2.2.90</td>
<td>1.2.95</td>
</tr>
<tr>
<td>8.</td>
<td>Enhancing fertilizer-use efficiency in conjunction with residue management in dryland crops and cropping systems (Co-ordinating Unit)</td>
<td>CAZRI, Jodhpur</td>
<td>877,381</td>
<td>1.4.90</td>
<td>31.12.97</td>
</tr>
<tr>
<td>9.</td>
<td>Enhancing fertilizer-use efficiency in conjunction with residue management in dryland crops of very low rainfall arid region (Jodhpur Centre)</td>
<td>CAZRI, Jodhpur</td>
<td>2,985,899</td>
<td>1.4.90</td>
<td>31.12.97</td>
</tr>
<tr>
<td>10.</td>
<td>Enhancing fertilizer-use efficiency in conjunction with residue management in dryland crops and cropping systems (Hyderabad Centre)</td>
<td>CRIDA, Hyderabad</td>
<td>3,561,560</td>
<td>1.4.90</td>
<td>31.12.97</td>
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<td>11. Enhancing fertilizer-use efficiency in conjunction with residue management in dryland crops and cropping systems : Soil water nitrogen interaction and crop yields as affected by residue management (Punjab Centre)</td>
<td>PAU, Ludhiana</td>
<td>3,263,560</td>
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<td>12. Germplasm enhancement for drought tolerance and reclamation of wastelands (Co-ordinating Unit)</td>
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<td>13. Germplasm enhancement for drought tolerance and reclamation of wastelands : Physiological evaluation of selected crops and varieties under arid conditions with emphasis on yield stabilization under drought (Jodhpur Centre)</td>
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<td>14. Germplasm enhancement for drought tolerance and reclamation of wastelands : Rehabilitation of mined wastelands (Jodhpur Centre)</td>
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<td>15. Germplasm enhancement for drought tolerance and reclamation of wastelands : Evaluation of castor genotypes for drought tolerance and yield (Hyderabad Centre)</td>
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<td>16. Germplasm enhancement for drought tolerance and reclamation of wastelands : Evaluation of genotypic variability in legumes under drought for N-fixation, partitioning and use efficiency in relation to grain yield (Hyderabad Centre)</td>
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<td>1,807,682</td>
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<td>17. Germplasm enhancement for drought tolerance and reclamation of wastelands : Screening and breeding rabi sorghum for drought tolerance, moisture, storage and fertility management to improve production over 'M 35-1' (Solapur Centre)</td>
<td>AICRP for Dryland Agriculture (MPKV) Solapur</td>
<td>2,087,500</td>
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<td>18. Germplasm enhancement for drought tolerance and reclamation of wastelands : Germplasm enhancement for drought tolerance and yield stability (Bijapur Centre)</td>
<td>AICRP for Dryland Agriculture Research Station (UAS, Dharwad)</td>
<td>1,922,500</td>
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<td>19. Development of models to simulate field-water balance and water-use and crop yield relations to optimize production in arid and semi-arid regions of India (Co-ordinating Unit)</td>
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<td>190,000</td>
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<td>20.</td>
<td>Development of models to simulate field-water balance and water-use and crop yield relations to optimize production in arid and semi-arid regions of India: Modelling field water-use and crop yields in maize-wheat system in northern India (Ludhiana Centre)</td>
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<td>Development/testing of models to simulate field-water balance and water-use and yield relations in the Indian arid zone (Jodhpur Centre)</td>
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<td>22.</td>
<td>Development of models to simulate field-water balance and water-use and crop yield relations to optimize production in arid and semi-arid regions of India: Crop simulation modelling in drylands (Hyderabad Centre)</td>
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<td>24.</td>
<td>Research on mechanization of dryland agriculture (Junagadh Centre)</td>
<td>Research Testing Centre (GAU), Thargadia, Gujarat</td>
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<td>Research on mechanization of dryland agriculture (Bangalore Centre)</td>
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<td>27.</td>
<td>Research on mechanization of dryland agriculture (Raichur Centre)</td>
<td>College of Agricultural Engineering (UAS, Dharwad)</td>
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<td>28.</td>
<td>Research on mechanization of dryland agriculture: Design, development, evaluation and testing of tools, equipments and implements for mechanization of dryland agriculture (Hyderabad Centre)</td>
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<td>29.</td>
<td>Research on mechanization of dryland agriculture: Development and testing of improved agricultural implements for Rewa region (Rewa Centre)</td>
<td>College of Agriculture (JNKVV), Rewa</td>
<td>790,000</td>
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<td>30.</td>
<td>Cataloguing and pre-breeding of wheat genetic resources</td>
<td>PAU, Ludhiana</td>
<td>1,977,000</td>
<td>6.12.89</td>
<td>5.12.94</td>
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<td>31.</td>
<td>Research on mechanization of dryland agriculture: Identification, evaluation and modification of suitable agricultural tools/implements/machinery for rainfed areas of Jammu region, keeping in view soil, socio-economic and other agronomic factors of the region</td>
<td>Sher-e- Kashmir University of Agricultural Sciences and Technology, Srinagar</td>
<td>790,000</td>
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<td>32.</td>
<td>Breeding carrots for improvement in nutritional value, yield, quality and resistance to diseases and pests</td>
<td>IIHR, Bangalore</td>
<td>1,563,600</td>
<td>1.192</td>
<td>31.1294</td>
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<td>33.</td>
<td>Regulation of CO₂ assimilation in pod walls of <em>Brassica campestris</em> L.</td>
<td>CCS HAU, Hisar</td>
<td>1,402,000</td>
<td>1.990</td>
<td>31.895</td>
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<td>34.</td>
<td>Characterization of rock-phosphates for direct use in different cropping sequences</td>
<td>OUAT, Bhubaneswar</td>
<td>1,678,600</td>
<td>1.691</td>
<td>30.1195</td>
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<td>35.</td>
<td>Nitrogen-use efficiency studied in relation to resource conservation and quality of the environment</td>
<td>OUAT, Bhubaneswar</td>
<td>1,595,142</td>
<td>1.491</td>
<td>31.395</td>
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<td>36.</td>
<td>An ecological study of soil arthropods and annelids in relation to biological conditioning of different pseudocesosystems of Uttar Pradesh</td>
<td>BHU, Varanasi</td>
<td>1,834,300</td>
<td>1.392</td>
<td>28.295</td>
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<td>37.</td>
<td>Exploiting irrigation potential of poor quality waters for cropping and salinity control</td>
<td>CSSRI, Karnal</td>
<td>1,420,500</td>
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<td>2.994</td>
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<td>38.</td>
<td>Role of minerals in fish reproduction: Trace mineral nutrients in the regulation of seasonal reproductive cyclicity</td>
<td>Punjab University Chandigarh</td>
<td>1,400,800</td>
<td>22.491</td>
<td>21.494</td>
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<td>39.</td>
<td>To evaluate <em>Prosopis</em> sp. for biofuel production in arid, semi-arid and salt-affected soils of India</td>
<td>CAZRI, Jodhpur</td>
<td>1,817,870</td>
<td>1.791</td>
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<td>40.</td>
<td>Collection, maintenance and evaluation of indigenous temperate fruit species</td>
<td>Regional Station, NBPGR, Phagli, Shimla</td>
<td>1,241,000</td>
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<td>41.</td>
<td>Etiology and pathobiology of the carcinoma of the mucosa of the ethemoid in domestic animals</td>
<td>College of Veterinary and Animal Sciences, KAU Mannuthy</td>
<td>2,418,461</td>
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<td>42.</td>
<td>Taxonomic revision of Indian tenthredinidae (Hymenoptera : Symphyta)</td>
<td>Punjabi University Patiala</td>
<td>1,403,184</td>
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<td>43.</td>
<td>Studies on the mineral nutrition of fruit crops in Haryana through tissue analysis</td>
<td>CCS HAU, Hisar</td>
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<td>44.</td>
<td>Microbial control of plant parasitic nematodes</td>
<td>PAU, Ludhiana</td>
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<td>Allelopathic interactions of crops</td>
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<td>46</td>
<td>Gaseous losses of nitrogen through denitrification from soil under different cropping systems</td>
<td>PAU, Ludhiana</td>
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<td>47</td>
<td>Concurrent multiple poultry infections: The complexity</td>
<td>National Avian Health Lab., Gurgaon</td>
<td>1,559,000</td>
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<td>48</td>
<td>Application of molecular biological techniques in diagnosis, persistence and variation of rinderpest virus</td>
<td>IVRI, Mukteswar</td>
<td>1,684,000</td>
<td>30.792</td>
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<td>49</td>
<td>Insect-pest management in vegetable crops utilizing threshold and statistical models</td>
<td>IIHR, Bangalore</td>
<td>624,000</td>
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<td>50</td>
<td>Persistence and mobility of herbicides in soils in southern Karnataka</td>
<td>University of Agricultural Sciences, GKVK, Bangalore</td>
<td>998,400</td>
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<td>51</td>
<td>UVβ-radiation and CO₂ enrichment effects on crop growth</td>
<td>IARI, New Delhi</td>
<td>1,640,400</td>
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<td>52</td>
<td>Studies on epidemiology and immunobiology of bluetongue virus</td>
<td>CCS HAU, Hisar</td>
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<td>53</td>
<td>Studies on the integrated management of root-knot nematodes (Meloidogyne spp.) in vegetable crops</td>
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<td>54</td>
<td>Characterization of various interleukins from cattle</td>
<td>IVRI, Izatnagar</td>
<td>2,396,100</td>
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<td>55</td>
<td>Self-Inhibitors, lipid, protein and mineral metabolism during germination in smut spores of Neovossia indica</td>
<td>PAU, Ludhiana</td>
<td>1,552,000</td>
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<td>56</td>
<td>Project for standardization of seed production, processing and storage technology for tree seeds</td>
<td>TNAU, Coimbatore</td>
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<td>57</td>
<td>Characterization of certain crop plant viruses and biochemistry and physiology of lipids during disease development in groundnut</td>
<td>Sri Venkateswara University Tirupati</td>
<td>2,535,070</td>
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<td>58</td>
<td>Genetic studies on marine penaeid prawns</td>
<td>CMFRI, Kochi</td>
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<td>59</td>
<td>Physiological investigations on grain and green amaranths (Amaranthus spp.) in relation to productivity under mid-hill conditions of Himachal Pradesh</td>
<td>HPKVV, Palampur</td>
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<td>60.</td>
<td>Epidemiology and immuno-diagnosis of <em>Chlamydia psittaci</em> infection in sheep and goats</td>
<td>HPKVV, Palampur</td>
<td>2,976,926</td>
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<td>61.</td>
<td>Identification of cotton germplasm for improved levels of unsaturated fatty acids</td>
<td>Central Institute for Cotton Research, Nagpur</td>
<td>1,372,996</td>
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<td>62.</td>
<td>Studies on the utilization of domestic and urban sewage and sludge and industrial wastes for increasing crop production</td>
<td>TNAU, Coimbatore</td>
<td>1,752,400</td>
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<td>63.</td>
<td>Assessment of immunostimulation by Tuftsin/Immunogenic RNA in poultry</td>
<td>Madras Veterinary College, Tamil Nadu Veterinary and Animal Sciences University Madras</td>
<td>1,971,000</td>
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<td>19.496</td>
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<td>64.</td>
<td>Light utilization and canopy and nitrogen-use efficiency of component crops in some selected agroforestry systems</td>
<td>KAU, Thrissur</td>
<td>906,800</td>
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<td>65.</td>
<td>Biological control of burrowing nematode on palms and black pepper</td>
<td>CPCRI, Regional Station Kayangulum, Krishnapuram, Kerala</td>
<td>1,362,400</td>
<td>30.1193</td>
<td>29.1196</td>
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<td>66.</td>
<td>Mitigating hazardous effects of poor quality irrigation water on soil, crop and ground water: Computer simulation approach</td>
<td>CCS HAU, Hisar</td>
<td>1,376,250</td>
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## APPENDIX 13

### NATIONAL AGRICULTURAL RESEARCH PROJECT

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<tr>
<th>Sl No.</th>
<th>State Agricultural University</th>
<th>Subproject sanctioned as on 31.3.95</th>
<th>Outlay sanctioned as on 31.3.95 (Rs in Lakh)</th>
<th>Date of completion</th>
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<tbody>
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<td>1</td>
<td>CCSHAU (Haryana)</td>
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<td>5. Sirsa (18.8.82)</td>
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<td>6. Karnal - Kaul (19.8.82)</td>
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<td>Substation at Rohtak (12.4.88)</td>
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<td>(c) Livestock biotechnology</td>
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2. APAU (Andhra Pradesh)

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Subtotal | 754.82 |

10. Supplementary subprojects

A. Krishna-Godawari Zone (1.4.90)
   a. Vijavarai  b. Kakinada  126.20  31.3.94
   c. Gorkapedu  d. Challapall  31.9.94
   e. Maruteru  f. Darsi  31.9.94
   g. Lam

B. North Coastal Zone (1.4.90)
   a. Ragolu  b. Yelamanchilli  21.43  31.9.94

C. Southern Zone (1.4.90)
   a. Utukur  b. Tirupati  35.22  31.9.94
   c. Kavali  d. Anantarakupetta  31.9.94

D. North Telengana Zone (1.4.90)
   c. Mudhal  d. Warangal  31.9.94
   e. Rudur  f. Adilabad  31.9.94

E. Scarce Rainfall Zone (1.4.90)
   a. Nandyal  b. Karimnagar  17.98  31.9.94
   c. Anantnagar  31.9.94

F. Southern Telengana Zone (1.4.90)
   a. Palem  b. Tendur  38.43  31.9.94
   c. Sangar  31.9.94

G. High Altitude Zone (1.4.90)
   a. Seetampeta  5.43  31.9.94

11. Mallapalli (28.12.89)  40.00  27.12.93
12. Additional funds for civil works  35.16
13. Additional works funds for library  14.00
14. Funds for improvement of library  17.00
15. PCs for ADRs and ZRS  36.84
16. AP cyclone proofing  450.00
17. Additional equipment for modernizing laboratory  58.18
18. Supplementary funds for POL  1.96
19. Additional funds for ARIS  64.00
20. Supplementary funds for replacement of vehicles  21.00
21. Supplementary funds for replacement of vehicles under Director of Research  3.00
22. Additional funds for library facility  0.50

Subtotal | 1,022.70 |
Total | 1,777.52 |

3. GAU (Gujarat)
   1. Armej (4.12.79)  94.73  31.12.84
   2. Targadia (1.12.79) civil works (CW) (30.9.85)  72.00  30.11.84
   3. Director of Research (1.12.79)  12.14  30.11.84
   4. Dantiwada (10.12.80)  143.41  9.12.85
   5. Navasari (15.3.82)  79.36  14.3.87
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Subtotal: 563.85

8. Supplementary subproject (9.1.90)
   A. South Gujarat Heavy Rainfall one
      ZRS Navasari
      ARSParia
   B. South Gujarat Zone Medium Rainfall Zone
      ARS Acchalia
   C. Middle Gujarat Zone
      ZRS Anand
   D. North Gujarat Zone
      ZRS Sardarkrishi Nagar
   E. North-West Gujarat Zone
      ZRS Bachau
      ARS Mundra
   F. North Saurashtra Zone
      ZRS Targadia
   E. South Saurashtra Zone
      ZRS Junagadh, Jonpur
   9.  Chharodi (4.9.89)                       |                       | 30.02 | 2.12.93|
   10. Additional funds for civil works      |                       | 29.70 |       |
   11. Additional funds for library          |                       | 16.00 |       |
   12. Funds for improvement of library      |                       | 17.00 |       |
   13. PCs for ADRs and ZRS                  |                       | 37.78 |       |
   14. Vehicle                               |                       | 10.49 |       |
   15. Modernization of laboratory           |                       | 78.90 |       |
   16. Additional funds for ARIS             |                       | 71.00 |       |
   17. Additional funds for replacement of vehicles |       | 24.00 |       |
   18. Additional funds for replacement of vehicles under Director of Research |       | 3.00 |       |
   19. Additional funds for library facility |                       | 0.50 |       |

Subtotal: 454.12

Total: 1,017.97

4. UAS (Bangalore)
   1. Bijapur (22.5.80)
      civil works (CW) (31.7.85) | 88.58 | 21.5.85 |
   2. Director of Research (20.8.80) | 15.08 | 19.8.85 |
   3. Bidar-Raichur (28.5.81) CW (30.9.86) | 40.84 | 27.5.86 |
   4. Brahamavar (28.5.81) CW (26.11.86) | 125.79 | 27.5.86 |
   5. Mudigere (20.5.81) CW (22.5.87) | 68.74 | 27.5.86 |
   6. Shimoga (25.8.82) CW (24.3.87) | 48.62 | 24.3.87 |
   7. Nagamangla (23.2.83) CW (30.9.86) | 52.18 | 22.2.88 |

Subtotal: 439.83

8. Bidarmangudi (13.10.88) | 193.32 | 12.10.93 |
9. Supplementary subprojects (17.4.89)
   A. Eastern Dry Zone
      Chintamani
   B. Southern Dry Zone
      Mandya, Nagenhelgera, Mudigere

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Subtotal: 582.08

Total: 784.44

7. TNAU (Tamil Nadu)

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Subtotal: 514.78

9. Supplementary subproject (1.11.88)

A. North-Eastern Zone civil work

Kattupakkam

B. North-Western Zone CW (30.6.93)

Patyur, Pettanerl, Memkal

C. Cauvery Delta Zone CW (31.3.93)

Aduthurai-Trichy, Kattuchetan Srigumant

D. Western Zone

Bhavanisagar, Mettupalayam, Perikulam CW (31.12.92)

E. South Zone (31.12.92) CW (30.6.94)

Aruppukottal, Puttukketal Shrivilliputhur, Killikulam

F. Hilly and Tribal Zone CW (30.6.94)

10. Supplementary Pachiparai (1.11.89) CW (30.6.94)

11. Additional funds for civil works

12. Additional funds for library

13. Funds for improvement of library

14. PCs for ADRs and ZRS

15. Resource characterization of rainfed farming systems (30.9.92)

16. Additional equipment for modernizing laboratories for SAU

17. Supplementary funds for POL

18. Additional funds for ARIS

19. Additional funds for replacement of vehicles

Subtotal: 514.78

Total: 784.44
20. Additional funds for replacement of vehicles under Director of Research 3.00
21. Additional funds for library facility 0.50

Subtotal 1,006.40
Total 1,521.18

8. OUAT (Bhubaneswar)

1. Director of Research [5.6.81] 9.73 4.686
2. Udaigiri [8.2.83] CW [31.6.90] 75.02 7.288
7. Supplementary subprojects [16.9.89]
   A. North-Western Plateau Zone
      Kerai, Sundergarh 62.08 15.993
   B. North Plateau Zone
      RRS, Keonjihar 23.70 15.993
   C. South-Eastern Coastal Zone
      RRS, Ranital 22.58 15.993
   D. East and South-Eastern Coastal Zone
      Mayagarh Sugarcane Station 48.73 15.993
   E. North-Eastern Ghat Zone
      G. Udaigir 22.02 15.993
   F. Eastern Ghat High Land
      Semiliguda, Umerkote, Kalimela, Pottangi 74.28 15.995
   G. Western Undulating Zone
      Bhawanipatana 24.40 15.993
   H. Western Central Tableland Zone
      RRS, Chipilma 10.04 15.993
   I. Mid Central Tableland Zone
      Mahasapet 27.71 15.993
8. Additional funds for civil works 24.01
9. Additional funds for library 20.01
10. Funds for improvement of library 17.00
11. PCs for ADRs and ZRS 41.44
12. Funds for vehicles 5.55
13. Modernizing laboratory 80.20
14. Additional funds for ARIS 85.00
15. Additional funds for replacement of vehicles 30.00
16. Additional funds for replacement of vehicles under Director of Research 3.00
17. Additional funds for library facility 0.50

Subtotal 622.24
Total 981.05

9. HPKVV (Himachal Pradesh)

1. Director of Research [2.3.82] 12.70 1.387
2. Bajaura [2.2.83] 142.36 1.288
3. Dhaulakuan [9.11.83] 123.29 8.1188
4. Mashobra [Chamba] [17.5.85] 34.70 16.590

Subtotal 313.05

6. Supplementary subproject of Dhaulakuan, Bajaura and Agro-zones I and IV [29.11.88] 151.26 28.1192
7. Additional funds for civil works 31.11

Subtotal 313.05
Total 981.05

APPENDICES
## YSPUH & F  
**Himachal Pradesh**

1. Mashobra and Kotkhai (30.9.86)  
   CW (29.3.92)  
   **Total 85.00**  
   **29.9.91**

2. Kukumseri (Sharbo and Tabo)  
   (29.9.86) CW (31.5.92)  
   **Total 123.72**  
   **28.9.91**

3. Director of Research (1.8.88)  
   **Total 16.27**  
   **31.7.93**

4. **Supplementary subprojects of Zones I, II, III (19.12.88) CW (30.6.93)**  
   **Total 242.32**  
   **18.12.92**

5. Supplementary subproject  
   Randaqhat (27.11.89)  
   **Total 34.51**  
   **26.5.93**

6. Additional funds for library  
   **Total 4.00**

7. Additional funds civil works  
   **Total 13.67**

8. Funds for improvement of library  
   **Total 17.00**

9. PCs for ADRs and ZRS  
   **Total 10.78**

    **Total 61.00**  
    **29.9.95**

11. Additional equipment for modernizing laboratories  
    **Total 65.00**

12. Supplementary fund for POL  
    **Total 0.56**

13. Additional funds for completion of civil works  
    **Total 22.14**

14. Additional funds for ARIS  
    **Total 29.00**

15. Additional funds for replacement of vehicles  
    **Total 6.00**

16. Additional funds for replacement of vehicles under Director of Research  
    **Total 3.00**

17. Additional funds for library facilities  
    **Total 0.50**

**Subtotal 649.47**

**Total 734.47**

## CSAUAT  
**Uttar Pradesh**

1. Director of Research (29.3.82)  
   **Total 10.40**  
   **28.3.87**

2. Bharari (12.8.83)  
   **Total 89.17**  
   **11.8.88**

3. Madhurikhind (24.9.84)  
   **Total 93.96**  
   **23.9.89**

**Subtotal 193.53**

## A. Additional Subprojects (1.10.89)

### South-Western Zone

1. Madhurikhind, Nazarapur, Kalai  
   **Total 77.94**  
   **30.9.93**

### Bundelkhand, Belatal and Tundwari

2. **Total 35.47**  
   **30.9.93**

## B. Daleepnagar/Saini (13.3.88)

3. **Total 98.87**  
   **12.3.93**

## Additional Subprojects (30.9.92)

4. **Total 19.05**  
   **29.9.95**

5. **Total 14.39**

6. **Total 4.00**

7. **Total 17.00**

8. **Total 10.50**

9. **Total 0.84**

10. **Total 36.00**

11. **Total 9.00**

**Subtotal 232**

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12. **GBPUAT**  
(Uttar Pradesh)  

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13. **MPKV**  
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**Subtotal** 1,210.70

**Total** 1,717.96

*Include the one time expenditure for training centre at College of Agriculture, Indore*
## Northern Hill Zone

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**Total**: 268.18

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## KAU (Kerala)

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**Subtotal**: 468.46

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## Supplementary projects (20.4.88)

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**Subtotal**: 545.50

**Total**: 1,013.96

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## RAU (Rajasthan)

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**Total**: 31.12.86

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**Subtotal** **528.77**

| 8. | Jalore-Sumerpur (13.3.88) | 142.62 | 12.3.93 |
| 9. | Kota-Aklora (3.3.88) | 144.33 | 2.3.93 |
| 10. | Udaipur/Vallabhnagar, Arjia | 130.53 | 28.11.93 |
|   | (29.11.88) |         |         |
| 11. | Mandore/Chandan/Kadendesar | 174.35 | 28.11.93 |
|   | (29.11.88) |         |         |
|   | Partapgarh (29.12.89) |         |         |
| 13. | Supplementary subprojects (7.12.89) |         |         |
| A. | *Irrigated North-Western Plain Zone* I B | 30.22 | 6.12.93 |
|   | Sriganganagar, Nohar |         |         |
| B. | *Transition Plain of Inland Drainage Zone III A* | 50.51 | 6.12.93 |
|   | Fatehpur, Goglagaon, Dalaji |         |         |
| C. | *Flood-prone Eastern Plain Zone III B* | 42.41 | 6.12.93 |
|   | Kumber, Bharatpur |         |         |
| D. | *Semi-Arid Eastern Plain Zone III A* | 33.17 | 6.12.93 |
|   | Durgapur, Digg, Tabji |         |         |
| E. | *Humid Southern Plain Zone IV B* | 8.38 | 6.12.93 |
|   | Banswara |         |         |
| F. | *Humid South-eastern Plain Zone V* | 17.34 | 6.12.93 |
|   | Kota, Umedganj |         |         |

14. Additional funds for civil works | 53.09 |
15. Additional funds for library | 18.00 |
16. Funds for improvement of library | 17.00 |
17. PCs for ADRs and ZRS | 42.28 |
18. Supplementary funds for POL | 2.52 |
19. Funds for modernization of laboratories | 89.55 |
20. Additional funds for ARIS | 78.00 |
21. Additional funds for replacement of vehicles | 27.00 |
22. Additional funds for replacement of vehicles under Director of Research | 3.00 |
23. Additional funds for library facility | 0.50 |

**Subtotal** **1,133.42**

**Total** **1,662.19**

20. **AAU (Assam)**

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**Subtotal** **350.28**

8. Supplementary subprojects

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9. Additional funds for civil works | 41.92 |
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Subtotal | 444.98 |

Total | 795.26 |

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Subtotal | 183.13 |

| 5. | Supplementary subprojects (14.12.89) | 29.66 | 13.12.93 |
| A. | North-West Alluvial Plain Zone I | 29.66 | 13.12.93 |
| B. | North-East Alluvial Plain Zone II | 8.16 | 13.12.92 |
| C. | South Alluvial Plain Zone III | 27.30 |   |
| 6. | Additional funds for civil works | 22.87 |   |
| 7. | Additional funds for library | 6.00 |   |
| 8. | Funds for improvement of library | 17.00 |   |
| 9. | PCs for ADRs and ZRS | 15.28 |   |
| 10. | Rice-wheat cropping system | 22.55 |   |
| 11. | Supplementary funds for POL | 0.84 |   |
| 12. | Funds for modernization of laboratory | 28.18 |   |
| 13. | Additional funds for ARIS | 36.00 |   |
| 14. | Additional funds for replacement of vehicles | 9.00 |   |
| 15. | Additional funds for replacement of vehicles under Director of Research | 3.00 |   |
| 16. | Additional funds for laboratory facility | 0.50 |   |

Subtotal | 421.53 |

Total | 604.66 |

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Subtotal | 219.37 |

<p>| 5. | Supplementary subproject | 30.83 | 28.12.93 |
| Chianki, Darisai (29.12.89) |   |   |
| 6. | Additional funds for civil works | 42.09 |   |
| 7. | Additional funds for library | 6.00 |   |
| 8. | Funds for improvement of library | 17.00 |   |
| 9. | Supplementary funds for POL | 0.84 |   |
| 10. | Funds for modernization of laboratory | 28.53 |   |
| 11. | PCs for ADRs and ZRS | 14.39 |   |
| 12. | Additional funds for ARIS | 36.00 |   |
| 13. | Additional funds for replacement of vehicles | 9.00 |   |</p>
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23. NDUAT (Uttar Pradesh)

| 1. | Director of Research (29.3.82) | 10.03 |
| 2. | Goghraghat (22.9.84) CW (30.6.91) | 52.73 |
| **Subtotal** | **62.76** |

| 3. | Kumarganj/Masadha/Ghazipur (2.11.88) CW (30.6.95) | 174.36 |
| 4. | Basauli/Gorakhpur (1.7.89) CW (30.6.95) | 136.96 |
| 5. | Tissuhi (Mirzapur) (30.8.89) CW (30.6.95) | 98.06 |
| 6. | Additional funds for civil works | 59.91 |
| 7. | *Funds for improvement of library* | 17.00 |
| 8. | Additional funds for library | 8.00 |
| 9. | Rice-wheat cropping system | 49.55 |
| 10. | PCs for ADRs and ZRS | 13.50 |
| 11. | Funds for vehicles | 6.34 |
| 12. | Additional funds for ARIS | 36.00 |
| 13. | Additional funds for replacement of vehicles | 9.00 |
| 14. | Additional funds for replacement of vehicles under Director of Research | 3.00 |
| 15. | Additional funds for library facility | 0.50 |
| **Subtotal** | **612.18** |
| **Total** | **674.94** |

24. KKV (Maharashtra)

| 1. | Director of Research (Dapoli) (25.4.82) CW (30.9.90) | 10.97 |
| 2. | Vengurla (2.12.78) CW (30.9.90) | 82.56 |
| 3. | Karjat (7.10.84) CW (21.10.90) | 89.42 |
| **Subtotal** | **182.95** |

| 4. | Supplementary Vengurla (11.12.89) | 43.72 |
| 5. | Additional funds for civil works | 13.54 |
| 6. | Additional funds for library | 4.00 |
| 7. | Funds for improvement of library | 17.00 |
| 8. | PCs for ADRs and ZRS | 9.89 |
| 9. | Additional equipment for modernizing laboratories for SAUs | 20.00 |
| 10. | Supplementary funds for POL | 0.56 |
| 11. | Additional funds for civil works | 18.86 |
| 12. | Additional funds for ARIS | 29.00 |
| 13. | Additional funds for replacement of vehicles | 6.00 |
| 14. | Additional funds for replacement of vehicles under Director of Research | 3.00 |
| 15. | Additional funds for library facility | 0.50 |
| **Subtotal** | **166.07** |
| **Total** | **349.02** |

25. BCKVV (West Bengal)

| 1. | Director of Research (23.6.87) | 14.51 |
| 2. | Kalimpong (Pedong) (17.10.90) | 141.82 |
| 3. | Jhargram (29.6.87) | 212.82 |
| 4. | Pundibari, Khambari (28.3.89) | 175.79 |
| **Subtotal** | **166.07** |
| **Total** | **349.02** |

APPENDICES 239
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**Total** 1,031.49

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**Total** 1,066.47

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**Total** 240 ICAR ANNUAL REPORT 1994-95
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| 27| Rice-Wheat Cropping System    |       |         |
| 28| Hamdard University Livestock Biotechnology | 50.00 | 29.9.95 |
| 29| TERI-Brassica Cell and Molecular Biology, New Delhi | 54.00 | 29.9.95 |
| 30| ISNAR                         | 1,200.00 |         |
| 31| Training FAO                  | 400.00 |         |
| 32| Project Unit                  | 210.00 |         |

Total Outlay for 122 Research subprojects, Basic Research Subprojects, 26 Administrative Subprojects, 6 Special Subprojects, Personal Computers for ADRs and ZRS, 10 Basic Research Projects, ISNAR, Training FAO, 2 training projects, Suppl. subprojects

Grand Total 28,475.91
## APPENDIX 14

### EMERITUS SCIENTISTS, NATIONAL FELLOWS AND NATIONAL PROFESSORS

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<tr>
<td>3</td>
<td>Dr B. Baldev</td>
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<tr>
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<td>Dr B.A. Kulkarni</td>
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<tr>
<td>5</td>
<td>Dr Y.C. Panchal</td>
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<td>6</td>
<td>Dr A.S. Arya</td>
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<td>7</td>
<td>Dr P.B. Kundu</td>
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<td>Dr S.P. Aggarwal</td>
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<td>Dr B.C. Joshi</td>
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<td>Dr G.V. Raghvan</td>
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<td>Dr R.C. Joshi</td>
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<td>Dr S. Bharti</td>
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<td>Dr B.S. Mathur</td>
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<td>15</td>
<td>Dr T.V. Moorti</td>
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<td>Dr H.B. Joshi</td>
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<td>Dr Satguru Saran</td>
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<td>Dr N.M. Nair</td>
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<td>Dr G.K. Veeresh</td>
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<td>Dr S.R. Anand</td>
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<td>Dr C.C.P. Rao</td>
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<td>Dr U.B. Singh</td>
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<td>Dr D.S. Misra</td>
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<td>Dr K.K. Paniker</td>
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### National Fellows

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ICAR ANNUAL REPORT 1994-95
# APPENDIX 15

## SUMMER INSTITUTES

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<td>Advances in Crop Improvement (Plant Breeding)</td>
<td>Dr L.N. Chaudhary Professor</td>
<td>Deptt. of Plant Breeding, Rajendra Agricultural University, Pusa (Bihar)</td>
<td>During May for 20 days</td>
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<td>2</td>
<td>Recent Advances in Agronomy with Special Reference to On-Farm-Water Management</td>
<td>Dr K.K. Khade Prof. &amp; Head</td>
<td>Deptt. of Agronomy, Mahatma Phule Krish Vidyapeeth, Rahuri (Maharashtra 413 722)</td>
<td>18 April to 7 May 1994</td>
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<td>3</td>
<td>Recent Advances in Entomology</td>
<td>Dr O.P. Lal Head</td>
<td>Division of Entomology, IARI New Delhi 110 012</td>
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<td>4</td>
<td>Advances in Soils with Special Reference to Water and Nutrient Management</td>
<td>Dr V.S. Tomar Prof. &amp; Head</td>
<td>Deptt of Soil Sciences and Agricultural Chemistry, JNKVV, Jabalpur (Madhya Pradesh) 482 004</td>
<td>23 May to 11 June 1994</td>
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<td>5</td>
<td>Advances in Production Technology of Temperate Fruits</td>
<td>Dr R.P. Awasthi Prof. &amp; Head</td>
<td>Dept of Fruit Culture and Orchard Management, Dr Y.S. Parmar University of Horticulture and Forestry, Solan (Himachal Pradesh) 173 230</td>
<td>18 July to 4 August 1994</td>
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<td>6</td>
<td>Advances in Agricultural Economics with Special Reference to Natural Resources and Environmental Economics</td>
<td>Dr S.R Subramaniam Prof. &amp; Head</td>
<td>Dept of Agricultural Economics, Centre for Agriculture and Rural Development Studies, Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu)</td>
<td>9 May to 28 May 1994</td>
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<td>7</td>
<td>Advances of Agricultural Statistics with Special Reference to General Linear Models and Applied Regression Analysis</td>
<td>Dr R.K. Pandey Director</td>
<td>Indian Agricultural Statistics Research Institute, Library Avenue, New Delhi 110 012</td>
<td>16 May to 4 June 1994</td>
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<td>8</td>
<td>Modern Technique in Farm Machinery and Power Management</td>
<td>Dr K.N. Singh Prof. &amp; Head</td>
<td>Deptt of Farm Machinery and Power Engg College of Technology, GBPUAT, Pantnagar (Uttar Pradesh) 263 145</td>
<td>6 June to 25 June 1994</td>
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<td>9</td>
<td>Cell Technology and Genetic Engineering for Crop Improvement</td>
<td>Dr S.R. Sree Rangasamy Director</td>
<td>Centre for Plant Molecular Biology, Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu) 684 003</td>
<td>19 April to 8 May 1994</td>
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<td>Advances in Agricultural Education Technology</td>
<td>Dr A. Gopalam</td>
<td>National Academy of Agricultural Research Management, Rajendranagar, Hyderabad (Andhra Pradesh) 500 030</td>
<td>2 May to 20 May 1994</td>
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<td>Advances in Agroforestry and its Role for Sustainable Agriculture and Environment</td>
<td>Dr R. Deb Roy</td>
<td>National Research Centre for Agroforestry near Pahuj Dam Jhanshi, Gwalior (Uttar Pradesh) 284 003</td>
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<td>Advances in Agricultural Extension Education</td>
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<td>Division of Agricultural Extension, IARI New Delhi 110 012</td>
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<td>13.</td>
<td>Advances in Animal Reproduction and Gynaecology</td>
<td>Dr A.S. Nanda</td>
<td>Deptt. of Gynaecology and Obstetrics College of Vety Sci., Punjab Agricultural University, Ludhiana (Punjab) 141 004</td>
<td>1 August to 20 August 1994</td>
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<td>Prof. &amp; Head</td>
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<td>14.</td>
<td>Recent Advances in Animal Nutrition with Special Reference to Rumen Manipulation to Improve Nutrient Utilization and Reduce Environment Pollution by Decreased Methano genesis</td>
<td>Dr N.N. Pathak</td>
<td>Animal Nutrition Devision, IVRI Izatnagar (Uttar Pradesh) 243 122</td>
<td>23 May to 11 June 1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scientist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Recent Advances in Surgical Techniques and their Application in Farm and Pet Animals</td>
<td>Dr N.N. Balasubramaniam</td>
<td>Deptt. of Surgery. Madras Vety College Tamil Nadu Veterinary and Animal Sciences University, Madras (Tamil Nadu) 600 007</td>
<td>1 May to 20 May 1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prof. &amp; Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Advances in Veterinary Pathology and Disease Diagnosis</td>
<td>Dr A. Rajan</td>
<td>Centre of Excellence in Pathology. College of Vety and Animal Sciences Mannuthy, Thrissur (Kerala) 681 051</td>
<td>23 May to 11 June 1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Director</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Meat Species Identification and Quality Control of Meat and Meat Products</td>
<td>Dr A.M. Shanmugam</td>
<td>Deptt. of Meat Science and Technology. Madras Vety College, Tamil Nadu Veterinary and Animal Sciences University Madras (Tamil Nadu) 600 007</td>
<td>6 May to 25 May 1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prof. &amp; Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Advances in Agril. Microbiology with Special Reference to Mycorrizal Symbiosis and their role in Crop Productivity</td>
<td>Dr. D.J. Bagyarak</td>
<td>Deptt. of Agril. Microbiology, UAS, GKVK Campus, Bangalore</td>
<td>29 August to 17 September 1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prof. &amp; Head</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 16

STATE AGRICULTURAL UNIVERSITIES

Vice-Chancellors

1. Dr M.V. Rao
   Vice-Chancellor
   Andhra Pradesh Agricultural University
   Rajendranagar
   Hyderabad (Andhra Pradesh) 500 030

2. Dr U.C. Upadhyay
   Vice-Chancellor
   Assam Agricultural University
   Jorhat (Assam) 785 013

3. Dr K.S. Chauhan
   Vice-Chancellor
   Rajendra Agricultural University
   Pusa, Samastipur (Bihar) 848 125

4. Dr R. Kerketta
   Vice-Chancellor
   Birsa Agricultural University
   Kanke, Ranchi (Bihar) 834 006

5. Dr S. Arya
   Vice-Chancellor
   Haryana Agricultural University
   Hisar (Haryana) 125 004

6. Dr R.P.S. Tyagi
   Vice-Chancellor
   Himachal Pradesh Krishi Vishwa Vidyalaya
   Palampur (Himachal Pradesh) 176 062

7. Dr B.R. Sharma
   Vice-Chancellor
   Dr Y.S. Parmar University of Horticulture and Forestry
   Solan (Himachal Pradesh) 173 230

8. Dr K.V. Devraj
   Vice-Chancellor
   University of Agricultural Sciences
   Post Bag No.2477
   Bangalore (Karnataka) 560 065

9. Dr M. Mahadevappa
   Vice-Chancellor
   University of Agricultural Sciences
   Dharwad (Karnataka) 580 005

10. Dr Govindbhai Shekhada
    Vice-Chancellor
    Gujarat Agricultural University
    Sardar Krushinagar
    Banaskantha (Gujarat) 385 506

11. Dr K.S. Johar
    Vice-Chancellor
    Jawaharlal Nehru Krishi Vishwa Vidyalaya
    Jabalpur (Madhya Pradesh) 482 004

12. Dr Hirvi Singh
    Vice-Chancellor
    Indira Gandhi Krishi Viswa Vidyalaya
    Krishinagar
    Raipur (Madhya Pradesh) 492 012

13. Dr A.M. Michael
    Vice-Chancellor
    Kerala Agricultural University
    Vellanikkara
    Thrissur (Kerala) 680 654

14. Dr A.G. Sawant
    Vice-Chancellor
    Konkan Krishi Vidyapeeth
    Dapoli (Maharashtra) 415 712

15. Dr S.K. Dorge
    Vice-Chancellor
    Mahatma Phule Krishi Vidyapeeth
    Rahuri (Maharashtra) 413 722

16. Dr V.K. Patil
    Vice-Chancellor
    Marathwada Agricultural University
    Parbhani (Maharashtra) 431 402

17. Professor B.G. Bathkal
    Vice-Chancellor
    Dr Punjabrao Deshmukh Krishi Vidyapeeth
    Krishinagar
    Akola (Maharashtra) 444 104

18. Dr K. Pradhan
    Vice-Chancellor
    Orissa University of Agriculture and Technology
    Bhubaneswar (Orissa) 751 003
19. Dr A.S. Khehra  
Vice-Chancellor  
Punjab Agricultural University  
Ludhiana  
(Punjab) 141 004

20. Dr R.K. Patel  
Vice-Chancellor  
Rajasthan Agricultural University  
Bikaner  
(Rajasthan) 334 002

21. Dr S. Sankaran  
Vice-Chancellor  
Tamil Nadu Agricultural University  
Coimbatore  
(Tamil Nadu) 641 003

22. Dr Indira Pal Singh Yadav  
Vice-Chancellor  
Chandra Shekhar Azad University of  
Agriculture and Technology  
Kanpur  
(Uttar Pradesh) 208 002

23. Dr S.C. Modgal  
Vice-Chancellor  
Govind Ballabh Pant University of  
Agriculture and Technology  
Pantnagar (Uttar Pradesh) 263 145

24. Dr S.S. Khanna  
Narendra Deva University of Agriculture  
and Technology  
Faizabad (Uttar Pradesh) 224 001

25. Dr M.G. Som  
Vice-Chancellor  
Bidhan Chandra Krishi Vishwa Vidyalaya  
PO Krishi Viswa Vidyalaya  
Mohanpur, Nadia (West Bengal) 741 252

During Winter (November to April)

26. Dr M.A. Dar  
Vice-Chancellor  
Sher-e-Kashmir University of  
Agricultural Sciences and Technology  
Railway Road  
Jammu Tawi (Jammu and Kashmir) 180 004

During Summer (May to October)

Dr M.A. Dar  
Vice-Chancellor  
Sher-e-Kashmir University of Agricultural  
Sciences and Technology  
Shalimar Campus, Post Box 262  
Srinagar (Jammu and Kashmir) 190 001

27. Dr V. Gyanaprakasm  
Vice-Chancellor  
Tamil Nadu Veterinary and  
Animal Sciences University  
Madras (Tamil Nadu) 600 007

Central University

28. Dr M.P. Singh  
Vice-Chancellor  
Central Agricultural University  
Imphal (Manipur) 795 001
## APPENDIX 17

### EMPLOYEES IN THE ICAR AND ITS RESEARCH INSTITUTES AND THE NUMBER OF SCHEDULED CASTES AND SCHEDULED TRIBES

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Class of posts</th>
<th>Total No. of posts sanctioned</th>
<th>Total No. of employees in position</th>
<th>Total No. of scheduled castes among them</th>
<th>Percentage to total employees</th>
<th>Total No. of scheduled tribes among them</th>
<th>Percentage to total employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Scientific Post</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Experimental Scientist</td>
<td>96</td>
<td>41</td>
<td>6</td>
<td>14.6</td>
<td>1</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>Scientist</td>
<td>3,477</td>
<td>1,736</td>
<td>117</td>
<td>6.73</td>
<td>15</td>
<td>0.86</td>
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<td></td>
<td>Senior Scientist</td>
<td>1,631</td>
<td>1,855</td>
<td>114</td>
<td>6.14</td>
<td>11</td>
<td>0.59</td>
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<tr>
<td></td>
<td>Principal Scientist</td>
<td>804</td>
<td>773</td>
<td>38</td>
<td>4.91</td>
<td>-</td>
<td>-</td>
</tr>
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<td></td>
<td>RMP Scientist</td>
<td>102</td>
<td>73</td>
<td>5</td>
<td>6.84</td>
<td>1</td>
<td>1.3</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td>6,110</td>
<td>4,478</td>
<td>280</td>
<td>6.25</td>
<td>28</td>
<td>0.6</td>
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<td>2.</td>
<td><strong>Technical Posts</strong></td>
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<td></td>
<td>Category I</td>
<td>4,396</td>
<td>3,882</td>
<td>770</td>
<td>19.8</td>
<td>240</td>
<td>6.1</td>
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<tr>
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<td>Category II</td>
<td>3,457</td>
<td>2,917</td>
<td>463</td>
<td>15.8</td>
<td>108</td>
<td>3.7</td>
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<tr>
<td></td>
<td>Category III</td>
<td>618</td>
<td>412</td>
<td>58</td>
<td>14.07</td>
<td>16</td>
<td>3.8</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td>8,471</td>
<td>7,211</td>
<td>1,291</td>
<td>17.90</td>
<td>364</td>
<td>5.04</td>
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<td>3.</td>
<td><strong>Administration Posts</strong></td>
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<tr>
<td></td>
<td>(a) Under Secretary, Senior Accounts</td>
<td>190</td>
<td>150</td>
<td>32</td>
<td>21.3</td>
<td>9</td>
<td>6.0</td>
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<td></td>
<td>Office/Finance &amp; Accounts Officers</td>
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<td></td>
<td>(b) Assistant Finance &amp; Accounts Officer/Section Officer/ Hindi Officer/Desk Officer/ Superintendent/Public Relations Officer etc.</td>
<td>639</td>
<td>518</td>
<td>86</td>
<td>16.6</td>
<td>26</td>
<td>5.0</td>
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<tr>
<td></td>
<td>(c) Assistant</td>
<td>1,063</td>
<td>945</td>
<td>175</td>
<td>18.5</td>
<td>57</td>
<td>6.0</td>
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<tr>
<td></td>
<td>(d) Stenographer</td>
<td>1,023</td>
<td>816</td>
<td>86</td>
<td>10.5</td>
<td>41</td>
<td>5.0</td>
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<td></td>
<td>(e) UDC/Senior Clerk</td>
<td>1,260</td>
<td>1,254</td>
<td>202</td>
<td>16.1</td>
<td>72</td>
<td>5.7</td>
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<tr>
<td></td>
<td>(f) LDC/Junior Clerk</td>
<td>1,907</td>
<td>1,452</td>
<td>300</td>
<td>20.6</td>
<td>87</td>
<td>5.9</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td>5,059</td>
<td>5,135</td>
<td>881</td>
<td>1.7</td>
<td>292</td>
<td>5.6</td>
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<td>4.</td>
<td><strong>Supporting Staff</strong></td>
<td></td>
<td></td>
<td></td>
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<td>Grade I</td>
<td>7,311</td>
<td>6,756</td>
<td>1,608</td>
<td>23.8</td>
<td>290</td>
<td>4.2</td>
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<td>Grade II</td>
<td>2,172</td>
<td>2,068</td>
<td>530</td>
<td>25.6</td>
<td>137</td>
<td>6.6</td>
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<tr>
<td></td>
<td>Grade III</td>
<td>1,428</td>
<td>1,367</td>
<td>366</td>
<td>26.7</td>
<td>80</td>
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<td></td>
<td>Grade IV</td>
<td>1,461</td>
<td>1,360</td>
<td>409</td>
<td>30.07</td>
<td>61</td>
<td>4.4</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td>12,372</td>
<td>11,551</td>
<td>2,913</td>
<td>25.2</td>
<td>568</td>
<td>4.9</td>
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<td>5.</td>
<td><strong>Supporting Staff (Safaiwala)</strong></td>
<td>641</td>
<td>632</td>
<td>593</td>
<td>93.8</td>
<td>6</td>
<td>0.9</td>
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<td>6.</td>
<td><strong>Auxiliary Posts</strong></td>
<td>1,612</td>
<td>1,279</td>
<td>289</td>
<td>0.14</td>
<td>84</td>
<td>6.5</td>
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</tbody>
</table>
## APPENDIX 18

### KRISHI VIGYAN KENDRAS (KVKS) AND TRAINERS' TRAINING CENTRES (TTCs)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Designation of the head and address of KVKS/TTCs</th>
<th>Designation of host with address</th>
<th>Year of sanction</th>
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<tbody>
<tr>
<td>1</td>
<td>Training Organizer Krishi Vigyan Kendra Sadalpur, Hisar</td>
<td>Vice-Chancellor Ch. Charan Singh Haryana Agricultural University Hisar 125 004</td>
<td>1989</td>
</tr>
<tr>
<td>2</td>
<td>Training Organizer Krishi Vigyan Kendra Devigarh, Kaithal</td>
<td>Vice-Chancellor Ch. Charan Singh Haryana Agricultural University Hisar 125 004</td>
<td>1992</td>
</tr>
<tr>
<td>3</td>
<td>Training Organizer Krishi Vigyan Kendra District Jind</td>
<td>Vice-Chancellor Ch. Charan Singh Haryana Agricultural University Hisar 125 004</td>
<td>1992</td>
</tr>
<tr>
<td>4</td>
<td>Training Organizer Krishi Vigyan Kendra 430/13, Urban Estate District Kurukshetra</td>
<td>Vice-Chancellor Ch. Charan Singh Haryana Agricultural University Hisar 125 004</td>
<td>1992</td>
</tr>
<tr>
<td>5</td>
<td>Training Organizer Krishi Vigyan Kendra Rai Farm District Sonipat</td>
<td>Vice-Chancellor Ch. Charan Singh Haryana Agricultural University Hisar 125 004</td>
<td>1992</td>
</tr>
<tr>
<td>6</td>
<td>Training Organizer Krishi Vigyan Kendra Bharpani Farm District Faridabad</td>
<td>Vice-Chancellor Ch. Charan Singh Haryana Agricultural University Hisar 125 004</td>
<td>1992</td>
</tr>
<tr>
<td>7</td>
<td>Training Organizer Krishi Vigyan Kendra Village Damla Block Jagadhari District Yamunanagar</td>
<td>Vice-Chancellor Ch. Charan Singh Haryana Agricultural University Hisar 125 004</td>
<td>1992</td>
</tr>
<tr>
<td>8</td>
<td>Training Organizer Krishi Vigyan Kendra Rampura District Rewari</td>
<td>Secretary Bhagwat Bhakti Ashram Rampura District Rewari 132 152</td>
<td>1983</td>
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**ZONE I**
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<tbody>
<tr>
<td>9.</td>
<td>Training Organizer</td>
<td>Director</td>
<td>1983</td>
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<tr>
<td></td>
<td>Krishi Vigyan Kendra</td>
<td>Indian Agricultural Research Institute</td>
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</tr>
<tr>
<td></td>
<td>Shikhopur</td>
<td>New Delhi 110 012</td>
<td></td>
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<td></td>
<td>District Gurgaon</td>
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<tr>
<td>10.</td>
<td>Training Organizer</td>
<td>Director</td>
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<td>Krishi Vigyan Kendra</td>
<td>National Dairy Research Institute</td>
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<tr>
<td></td>
<td>National Dairy Research Institute</td>
<td>Karnal 132 001</td>
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</tr>
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<td></td>
<td>District Karnal</td>
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<td></td>
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</tbody>
</table>

**Himachal Pradesh**

| 11. | Training Organizer                     | Vice-Chancellor                        | 1982 |
|     | Krishi Vigyan Kendra                   | Himachal Pradesh Krishi Vishwa         |    |
|     | Dhaulakuan                              | Vidyalaya, Palampur 176 062            |    |
|     | District Sirmur                         |                                        |    |
| 12. | Training Organizer                     | Vice-Chancellor                        | 1985 |
|     | Krishi Vigyan Kendra                   | Dr Y.S. Parmar University of Horticulture and Forestry |    |
|     | Bara Hamirpur                           | Solan 173 230                          |    |
|     | District Hamirpur                       |                                        |    |
| 13. | Training Organizer                     | Vice-Chancellor                        | 1986 |
|     | Krishi Vigyan Kendra                   | Himachal Pradesh Krishi Vishwa         |    |
|     | Agricultural Research Station          | Vidyalaya                              |    |
|     | Bajaura, District Kulu                  | Palampur 176 062                       |    |
| 14. | Training Organizer                     | Vice-Chancellor                        | 1992 |
|     | Krishi Vigyan Kendra                   | Dr Y.S. Parmar University of Horticulture and Forestry |    |
|     | Baloo                                   | Solan 173 230                          |    |
|     | District Chamba                         |                                        |    |

**Jammu and Kashmir**

| 15. | Training Organizer                     | Vice-Chancellor                        | 1983 |
|     | Krishi Vigyan Kendra                   | Sher-e-Kashmir University of Agricultural Sciences and Technology |    |
|     | Malangpur                               | Dalgate (Srinagar) 190 001              |    |
|     | District Anantnag                       |                                        |    |
| 16. | Training Organizer                     | Vice-Chancellor                        | 1992 |
|     | Krishi Vigyan Kendra                   | Sher-e-Kashmir University of Agricultural Sciences and Technology |    |
|     | R.S. Pura, Jammu                        | 45-D, Gandhinagar, P.O. No. 37          |    |
|     | District Jammu                          | Railway Road, Camp Office              |    |
|     |                                        | Jammu 180 004                          |    |

**Punjab**

<p>| 17. | Training Organizer                     | Vice-Chancellor                        | 1982 |
|     | Krishi Vigyan Kendra                   | Punjab Agricultural University         |    |
|     | Gurdaspur                               | Ludhiana 141 004                       |    |
| 18. | Training Organizer                     | Vice-Chancellor                        | 1988 |
|     | Krishi Vigyan Kendra                   | Punjab Agricultural University         |    |
|     | Malwal, Ferozepur                       | Ludhiana 141 004                       |    |</p>
<table>
<thead>
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<tr>
<td>19.</td>
<td>Training Organizer</td>
<td>Vice-Chancellor</td>
<td>1989</td>
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<td>Krishi Vigyan Kendra</td>
<td>Punjab Agricultural University</td>
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<td>Research Station</td>
<td>Ludhiana 141 004</td>
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<tr>
<td></td>
<td>Dabwali Road</td>
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<td></td>
</tr>
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<td>District Bhatinda</td>
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<td>20.</td>
<td>Training Organizer</td>
<td>Vice-Chancellor</td>
<td>1989</td>
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<td>Krishi Vigyan Kendra</td>
<td>Punjab Agricultural University</td>
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<td></td>
<td>Bahowal, Hoshiarpur</td>
<td>Ludhiana 141 004</td>
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<td>21.</td>
<td>Training Organizer</td>
<td>Vice-Chancellor</td>
<td>1989</td>
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<td>Krishi Vigyan Kendra</td>
<td>Punjab Agricultural University</td>
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<tr>
<td></td>
<td>Bhubendhra Regional Rice</td>
<td>Ludhiana 141 004</td>
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<td></td>
<td>Research Station, Rauni</td>
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<td>Patiala</td>
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<td>22.</td>
<td>Training Organizer</td>
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<td>Punjab Agricultural University</td>
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<td>Kapurthala</td>
<td>Ludhiana 141 004</td>
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<tr>
<td>23.</td>
<td>Training Organizer</td>
<td>Director</td>
<td>1992</td>
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<td>Krishi Vigyan Kendra</td>
<td>Central Institute of Post-harvest</td>
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<td>Abohar</td>
<td>Engineering and Technology</td>
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<td>Ludhiana 141 004</td>
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**ZONE II**

**Bihar**

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Director
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NEH Region
Umroi Road
Barapani (Meghalaya) 793 103

Nagaland

50. Training Organizer
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   ICAR Research Complex
   for NEH Region
   Medziphema
   Jharnapani, District Kohima

Director
ICAR Research Complex for
NEH Region
Umroi Road
Barapani (Meghalaya) 793 103

Sikkim

51. Training Organizer
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   District Gangtok 737 135

Director
ICAR Research Complex for
NEH Region
Umroi Road
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Mizoram

52. Training Organizer
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Director of Agriculture
Government of Mizoram
Aizwal

53. Training Organizer
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Secretary
Department of Agriculture
Government of Mizoram

Meghalaya

54. Training Organizer
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   Meghalaya 794 905

Director
ICAR Research Complex for
NEH Region, Umroi Road
Barapani 793 103

Tripura

55. Training Organizer
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Director
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**Goa**

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**Pondicherry**

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**Tamil Nadu**

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# NEW KRISHI VIGYAN KENDRAS SANCTIONED DURING 1992-95

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<td>Chief Training Organizer Trainers' Training Centre CIAE, Shri Guru Teg Bahadur Complex TT Nagar Bhopal 462 003</td>
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<td>Chief Training Organizer Trainers' Training Centre ICAR Research Complex for NEH Region Jharnapani, Mediziphema</td>
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<td>Chief Training Organizer Trainers' Training Centre CIFA, Kausalyaganga District Bhubaneshwar 751 002</td>
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## APPENDIX 19

### AWARDS

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<th>Sl No.</th>
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<tr>
<td>1</td>
<td><strong>Rafi Ahmed Kidwai Memorial Prizes for Agricultural Research 1990-92</strong></td>
<td>11 March 1995 at Mavalankar Hall New Delhi</td>
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<tr>
<th>I.</th>
<th><strong>Crop Improvement and Crop Protection</strong></th>
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<td>1</td>
<td>Dr Randhir Singh and Dr I.S. Sheoran, CCSHAU, Hisar</td>
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<td>Dr V. Arunachalam, Division of Genetics, IARI, New Delhi</td>
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<td>Dr O.P. Meelu, Dr Yadvider Singh and Dr Bijay Singh, PAU, Ludhiana</td>
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<td>Dr Lakshman Lal, CPRI, Shillong</td>
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<td>Dr Amrik Singh Sidhu and Dr M.L. Chadha, PAU, Ludhiana</td>
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<td>1</td>
<td>Dr Guntur Butchiah, IVRI, Izatnagar</td>
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<td>Dr M.L. Madan, Dr B.S. Prakash and Dr S.K. Singh</td>
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<th>V.</th>
<th><strong>Fisheries and Aquatic Sciences</strong></th>
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<td>Dr K. Janki Ram, CIFA, Bhubaneswar</td>
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VI. Social Life Sciences and Home Science

1. Dr S.L. Intodia
   Dr Rekha Upadhyay and
   Dr L.S. Bareth
   RAU, Udaipur

2. Fakhruddin Ali Ahmed Awards 1990-91

   1. Animal Sciences

      1. Dr N. Balaraman
         and
         Dr M.M. Golay
         ICAR Research Complex for
         NEH Region, Sikkim, Gangtok

3. Hari Om Ashram Trust Award for the Biennium
   1991-92

   1. Crop Sciences

      1. Dr K. Mani Bhushan Rao
         University of Madras

4. Jawaharlal Nehru Awards for Outstanding
   Post-graduate Agricultural Research 1990

   1. Plant Breeding, Genetics and Botany

      Dr(Mrs) Daisy Anand
      Dr(Miss) Sabita Bala Pradhan
      {Jointly

   2. Plant Physiology, Horticulture and
      Biochemistry

      Dr Kiran P. Raverkar
      Dr(Mrs) Sujata Vasudev
      {Jointly

   3. Soil Science and Agricultural Chemistry
      Agricultural Physics and Microbiology

      Dr Manbir Singh Sachdev

   4. Agronomy and Agricultural Engineering

      Dr C.V. Raghaviah
      Dr C.K. Teckchandani

   5. Plant Pathology, Entomology and
      Nematology

      Dr A. Nazir Ahmed Khan
      Dr S. Mallikarjunappa

APPENDICES
VI. Agricultural Economics and Statistics and Agricultural Extension

Dr K.B. Umesh
Dr N. Nagaraja Jointly

VII. Veterinary Bacteriology and Virology
Veterinary Pathology and Veterinary Physiology

Dr (Mrs) Sheela Tiwari

VIII. Animal Genetics and Breeding
Livestock Products and Technology, Poultry Science

Dr Gurvinder Singh

IX. Fisheries

Dr Rina Chakrabarti

5. Jawaharlal Nehru Awards for Post-graduate Agricultural Research 1991

I. Crop Improvement

1. Dr Bakheru Yadav
2. Dr Munna Singh Jointly
   Dr U.N. Joshi

II. Crop Protection

1. Dr Sukhdeo Panchbhai

III. Soil Science, Natural Resource Management and Agronomy

1. Dr V. Velu

IV. Horticulture

1. Dr (Miss) K. Usha

V. Engineering and Technology

1. Dr V.N. Sharde
2. Dr P.K. Mishra Jointly
   Dr M.M. Pandey

VI. Animal Sciences

1. Dr (Mrs) Deepa Pande
2. Dr Bhartander Rattan
3. Dr Ishwar Dayal Gupta Jointly
   Dr Tilak Raj Dhinan
VII. Fisheries

1. Dr K. Sunil Kumar Mohammed

VIII. Social Sciences including
Home Science

1. Dr S. Mahaboob Shareef
2. Dr K. Nagi Reddy

6. **Jawaharlal Nehru Awards for Post-graduate Agricultural Research 1992**

11 March 1995
at Mavalankar Hall
New Delhi

I. Crop Improvement

1. Dr Rajender Singh Chauhan
2. Dr Rakesh Kumar Kapila

II. Crop Protection

1. Dr P. Sundara Raj
2. Dr A.K. Choudhary

III. Soil Science, Natural Resource Management and Agronomy

1. Dr Ravinder Kaur
2. Dr Ashish Kumar Biswas

IV. Horticulture

1. Dr V. Thamizharasi

V. Animal Sciences

1. Dr Veer Singh

VI. Social Science including
Home Science

1. Dr (Mrs) G. Ramathilagam

7. **Jawaharlal Nehru Awards for Post-graduate Agricultural Research 1993**

11 March 1995
at Mavalankar Hall
New Delhi

I. Crop Improvement

1. Dr M. Kunnimalaivam
2. Dr A. Vishnuvardhan Reddy

II. Crop Protection

1. Dr Apurba Kumar Chaudhary
2. Dr Channa Rayappa
III. Soil Science, Natural Resource Management and Agronomy
   1. Dr G.R. Korwar
   2. Dr S.N. Panda

IV. Horticulture
   1. Dr K. Manorama

V. Engineering and Technology
   1. Dr H.M. Jayaprakasha

VI. Animal Sciences
   Dr Asitbaran Mandal

VII. Fisheries
   1. Dr S. Bijoy Nandan

VIII. Social Science including Home Science
   1. Dr Anil Rai
   2. Dr Jai Singh

8. Jawaharlal Nehru Awards for Post-graduate Agricultural Research 1994

I. Crop Improvement
   1. Dr Jauhar Ali
   2. Dr Rajeshwari Ramanan

II. Crop Protection
   1. Dr S. Mohan
   2. Dr K.P. Jayanth

III. Social Science, Natural Resource Management and Agronomy
   1. Dr S. Ramasamy
   2. Dr T.V. Ramachandra Prasad

IV. Engineering and Technology
   1. Dr Rajendra Singh
   2. Dr Sadachari Singh Tomar

V. Animal Sciences
   1. Dr P.K. Kapoor
   2. Dr N.S. Randhawa
   3. Dr Satyendra Kumar

11 March 1995
at Mavalankar Hall
New Delhi
VI Fisheries

1. Dr R. Sathiadhas

VII Social Science including Home Science

1. Dr S. M. Mundinamani
2. Dr Krishna Srinath

9. Dr Rajendra Prasad Puraskar 1991-93

1. Dr P.K. Gupta
2. Dr Ram Dev Misra
3. Dr Arvind Kumar
4. Dr R.K. Pathak
5. Dr A.M. Michael
   Dr T.P. Ojha \{ Jointly
6. Dr K.M.S. Pathak

11 March 1995
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