DARE/ICAR Annual Report 1999-2000

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

Indian Council of Agricultural Research
New Delhi

Indian Council of Agricultural Research

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Foreword

Indian Agriculture has made commendable progress since independence. Application of science to generate cost-effective technologies and well developed system to transfer technologies to the farmers ensured that country becomes free from food import.

Today the production of foodgrains has reached 202.5 million tonnes, oilseeds 26 million tonnes, milk 78 million tonnes and fish 5.38 million tonnes. The Indian National Agricultural Research System under the aegis of the ICAR has made this transformation of agricultural sector possible.

As we enter into the new millennium, we find that several important issues need to be addressed on sustainability of production/productivity, environment, resource management, poverty alleviation, household food and nutritional security, system efficiency, globalization of agriculture, liberalization of world trade, IPR regime in technology generation etc. The Prime Minister has also given a call to double the food production in the next 10 years. Our agricultural research system is seized of these issues and is moving ahead in the required direction.

The research institutes of the Council and the State Agricultural Universities have successfully released more than 75 high-yielding and diseased-resistant varieties/hybrids of various crops during the year. A total of 2,302.48 tonnes of breeder seed was also produced. Several other technologies on production and post-production management have also been developed in the system during the year. The Council has taken/initiated some bold O&M reforms to improve the overall efficiency of the system to take the Indian agriculture to its commanding heights in the new millennium.

It gives me immense pleasure to present *DARE/ICAR Annual Report 1999-2000,* first Annual Report of this millennium, in which multiple activities of agricultural research and education are highlighted. It is hoped that the report would be useful for the policy-makers, planners and development agencies.

(Nitish Kumar)
President
ICAR Society

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भाकृअनुप
ICAR

The Mandate of the Indian Council of Agricultural Research

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

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

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

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

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

1. Overview

Agricultural research is a vital input for planned growth and sustainable development of agriculture in the country. India had for the first time a record production of 202.5 million tonnes during 1998-99. The production of rice and wheat was 84.7 and 71.0 million tonnes respectively. With these production levels, India has emerged as the second largest producer of wheat and rice in the world. Production of pulses, oilseeds, potato, milk, egg and fish has also been very high placing India amongst frontrunners in their production. Generation, testing and adoption of improved technologies have played major role in enhancing the production and productivity.

The Indian Council of Agricultural Research (ICAR), being an apex scientific organization in agriculture at national level, plays a crucial role in promoting and augmenting agricultural research, education and demonstration of new technologies as frontline extension activities. Its objectives for the current plan are to enhance productivity, profitability, stability and sustainability of the agricultural system, so that the quality of life among every segment of current and future generations could be improved. This will lay a strong foundation for evergreen revolution in Indian agriculture. The salient achievements of the Council during the year are given in different chapters in this report.

In tune with the recognition of the role of science and technology in overall national perspective by the Hon'ble Prime Minister of India, 21 Jai Vigyan National Science and Technology Missions have been initiated during 1999 in the country for the development of all sectors of Indian society. The ICAR has taken up two of these missions, one on Conservation of Agro-biodiversity and the other on Household Food and Nutritional Security through enhancement of production and productivity of life support enterprises of tribal, backward and hilly areas.

Under the **Crop Improvement and Management**, in rice three resistant/tolerant varieties [Pooja (blast and gall-midge), CSR 13 (blast) and VL Dhan 81 (leaf and neckblast, stem-borer and low temperature)] at Central level, 32 high-yielding varieties at State level and four hybrids (CORH 2, ADTRH 1, Pantshankar Dhan 1 and Narendra Sankardhan 2); in wheat seven varieties (Shresth, UP 2425, Malviya Wheat 468, Malav Shakti, UP 2384, Abha and HI 1418); in maize Vivek Hybrid 4, Composite Gaurav, Jawahar Composite Makka 12 and CoBC 1 (baby corn); in barley huskless variety HBL 276; in sorghum seven varieties/hybrids (CSH 17, JKSH 22, PSH 1, GJ 41, Jawahar Jowar 1041 for grain, and Safed Moti (multi-cut) and CO 27 for fodder); in pearl millet, five varieties/hybrids (Pusa 605, Pusa 415, Nandi 32, Nandi 8 and MLBH 44) and two open-pollinated varieties (Pusa Composite 334 and JBV 2); in small millets, one variety each of foxtail millet (PS 4) and kodo millet (KK 1); Vikrant of faba-bean; in cowpea UPC 9202 for forage; in oilseeds, four varieties of groundnut (CSMG 884, HNG 10, LGN 2 and ALR 3), JS 90-41 of soybean, and dual-purpose LCK 9216 and for seed LMH 62 of linseed; in pulses, 10 varieties of chickpea (Pusa 1003, BGD 72, GCP 1001, JG 11, Surya, CO 3, CO 4, K 551, JGG 1 and JG 322), two of pigeonpea (Durga and Amar), HUM 1 in mungbean, TU 94-2 of urdbean; in arid legumes, one variety of mothbean (RMO 257), two varieties each of guar (RGC 1003 and HGS 563), cowpea (V 585 and GC 3) and horsegram (AK 21 and PHG 9); in commercial crops, two varieties (MCU 12 and G.Cot. 18) of cotton and two (JRC 698 and JRO 8432) of jute were released for cultivation in different agro-climatic regions. Besides, several varieties/hybrids, viz. NSS 104 as the first sweet sorghum hybrid, DCH 177 of castor, PCSH 243 as sunflower hybrid, safflower PH 3 hybrid, two hybrids (AKH Til 5 and RTH 1) of sesame, and five varieties (CoS 91269, CoS 91230, Co 89029, Co P 89181 and Co 91010) of sugarcane were found promising for different qualitative and/or quantitative traits.

To maintain our agro-biodiversity and broadening the genetic base through improved varieties for increasing productivity, the National Bureau of Plant Genetic Resources (NBPGR) has undertaken various plant explorations at different stations, viz. Ranchi, Bhowali, Thrissur, Cuttack, Shimla, Meghalaya, Arunachal Pradesh and Sikkim. A total of 61,015 samples of diverse germplasm including inputs for trials of rice, maize, triticale, lentil, and chickpea were procured from 63 countries including institutes. Germplasm (87,999) were also examined and processed for quarantine clearance. Of the 14,425 accessions received, 12,418 were qualified for long-term conservation in National Gene Bank. A total of 46,255 accessions of different agri-horticultural crops were evaluated/ maintained in the fields.

A total of 2,302.48 tonnes breeder seed of oilseed, pulse,

fibre and forage crops was produced. Rice tungro virus diagnostic kit showed promise in differentiating resistant and susceptible lines in glass-house. Fungicide Raxil was found most effective in controlling loose smut of wheat. Bio-intensive integrated pest management module showed higher benefit : cost ratio than farmer's practice in Andhra Pradesh. CLIMEX software was used to assess threat to Indian crops from exotic pests and diseases. Encouraging results were also obtained in honeybee research, rodent control, agricultural acarology, pesticide residue, agricultural ornithology, white-grub management and nematode management.

In **Improvement and Management of Horticultural Crops**, Guava Lalit for table and processing purposes; two hybrids (BRS 1 and BRS 2) of banana for Kerala; in potato five varieties (Kufri Pukhraj, Kufri Chipsona 1, Kufri Chipsona 2, Kufri Giriraj and Kufri Anand); and in floriculture, two varieties (Shagun and Shringarika) of gladiolus, and Diana of chrysanthemum were released for commercial cultivation. Besides, three hybrids in vegetables, viz. MHW 6 in watermelon, Sun 496 in tomato and PBOG 1 in bottlegourd; two top cross hybrids of cassava and two clones of sweet potato; hybrid 87-17-1 in chrysanthemum and four varieties (Kamini, Poornima, Phule Ganesh Pink and Phule Ganesh Violet) in China aster were identified or recommended for release. Several other promising varieties of different crops were also identified. In medicinal and aromatic plants, newly developed Mandsaur Isabgol (MI) 21, and palmarosa (CI 80-68) and vetiver (IC 78670) accessions were found promising.

DNA-based finger-printing technology has been developed for all released potato varieties. A number of transgenic potato lines resistant to tuber moth and *Helicoverpa* have also been developed. In north-western plains, groundnut-potato-onion and blackgram-potato-radish cropping systems were found remunerative over traditional rice-potato-sunflower system. In central plains potato-okra-cowpea, potato-Frenchbean-okra and potato-cowpea-okra were most suitable cropping systems.

The development of cassava starch-based bio-degradable plastic was a significant achievement, and has been transferred to its users in India. A technique was standardized for converting sweet potato starch into maltose syrup. A small-scale palm-oil extractor of 200 kg FFB/hr capacity was developed which could cater to the need of oil-palm plantations of 10-30 ha.

Rejuvenation technology has been developed for old and unproductive mango trees (40 years and above) in which fourth-order pruning severity resulted in highest yield of mango (330.92 kg/tree). Post-harvest treatment of hot water (48 ± 1°C) for 1 hr gave 100% fruitfly infestation-free fruits. Kallipati and PKM 1 varieties of sapota at 312 plants/ha (8 m × 4 m) gave higher yield (5.46 tonnes/ha)/unit area. In ber, 500 g N and 500 g P/plant/year resulted in maximum yield (60.6 kg/plant) with better-quality fruits. Significant achievements were made under crop production and crop protection of spices.

About 40 mushroom strains were collected from Himachal Pradesh and Uttar Pradesh. Of them, four were new additions. The *Lentinula lateritia* and a wild strain of *Agaricus bisporus* were successfully cultivated under controlled conditions. In post-harvest management, comb-type sapota harvester (capacity 30 kg/hr) was developed, fruit grader for sweet orange modified and foldable solar drier was standardized. Alphonso mango could now be stored for 30 days under controlled conditions.

In the area of **Natural Resource Management**, soil database of at least one district in each state is being generated. Soil and land form conditions were mapped for different states and land resource atlas of North-Eastern region was prepared. The soil resource map of Madhya Pradesh was released, and the maps of the salt-affected soils of Maharashtra and Madhya Pradesh were prepared. Sorghum, soybean and cotton in a watershed showed positive water balance using CROPWAT programme. Biofertilizers formulations based on new strains of *Azotobacter* and *Azospirillum* performed successfully at farmers' fields. Dual inoculation, a new technology of inoculant, gave about 25% higher yield in cereal, pulse and oilseed crops. The *Parthenium* weed can be used as a green-manure to substitute requirement of farmyard manure in rice-wheat system in Vertisols, as it saved fertilizer N. In Punjab manganese application increased the grain yield by 2.65-2.73 times in durum and 2.60-3.99 times in bread wheat in Mn-deficient soil of Ludhiana. An application of 11 kg P/ha to rice and 5.5 kg P/ha to maize was found necessary for maintaining sustained yield and P-fertility status of the coastal soils of Sunderbans, along with regular N. Microbial growth and population in cadmium- and lead-contaminated sick soil was improved by the addition of straw or organic matter.

Cost-free surge irrigation, an alternate to lift irrigation, was found promising in maize, sunflower and sorghum. And it also holds promise for furrow-irrigated crops. At Pantnagar, under shallow water-table condition, only three irrigations to wheat resulted in optimum yield (4.17 tonnes/ha) with recommended dose of fertilizer. In a village of coastal Orissa, reclamation of waterlogged area through construction of pond and raising of surrounding fields as a model with diversified agriculture resulted in higher productivity of rainy-season and winter crops and fish in pond. In an ICAR-MOWR collaborative pilot study, at two selected outlets of Mohindergarh canal, cropping intensity increased from 70% before irrigation to 150% after installation of tube-well in the command area.

Technologies were developed for improving water-use efficiency of various crops. In rainfed agriculture, adoption of improved varieties of sorghum, pigeonpea and soybean increased the productivity. Crop sequences, rice-pea (Rs 12,832/ha) in Assam, groundnut-wheat (Rs 24,659/ha) in Bihar, rice-radish-potato (Rs 42,712) under irrigated conditions and maize-*gobhi sarson* + *toria* (Rs 25,899/ha) in Himachal Pradesh and groundnut-wheat (Rs 15,153) in Maharashtra were found remunerative under rainfed conditions.

The technology of growing groundnut in broad bed and furrow method (90.5% yield increase) and in flat bed method (95.0% yield increase) of polythene mulching has high potential over non-mulching in coastal ecosystem.

In Tamil Nadu rainwater harvesting in farm ponds to provide supplemental irrigation proved profitable in getting higher yield.

Paulowinia fortunei, an important agroforestry tree of China, has been successfully introduced and its propagation is being standardized. Adoption of the technology developed for increased production of gum arabic would improve the economic condition of the farmers of Lohawat (Rajasthan) and nearby areas. Henna, a popular cosmetic dye-stuff, is the leaf-based product of *Lawsonia inermis*. Its planting at 0.074 million plants/ha in Pali district (Rajasthan) could lead to greater stability in production.

Promising results were also obtained under agri-silviculture and agri-horticulture systems.

Under **Livestock and Poultry Development**, livestock census database was updated for 1992, and distribution maps and photographs were also added. A fully operational information system in animal genetic resources was developed. For evaluation and characterization of breeds hometracts were surveyed to collect the information on status of livestock and poultry in India. Databanks of gene maps of buffalo and cattle were updated. Polymorphism was observed in Garole sheep. Polymorphism in poultry breeds revealed that native poultry breeds are genetically more closer. Dalhem Red breed has high immune status. The national milch breed Frieswal gave 2,837.4 kg first lactation milk yield in 300 days and less, and by fourth lactation the yield reached 3,240.7± 165.0 kg. Some native breeds were surveyed in the native tract under Associated Herd Progeny Testing Programme. Fifth set of buffalo bulls was introduced for breeding. Avikalin × Airmaans sheep produced 1.597 kg annual greasy wool. Selection and breeding improved the performance of Jamunapari and Barbari goats. Rabbit broiler weighed 1,599.17 g at 12 weeks of age. Selection in birds resulted in 10-20 days early maturity, 20-30 more eggs up to 280 days of age, and improved the egg production and egg weight at 40 weeks of age. Specialized egg and meat lines were developed in quail. Guinea fowl is being developed as alternative poultry germplasm. The dietary supplementation of branched fatty acid proved beneficial in ruminants. A cheap concentrate, which was able to sustain 3.76 kg milk/day, was developed for dairy cows in some parts of Orissa. Formaldehyde-treated mustard-cake was found to be a better by-pass protein and reduced decline in lactation curve.

Animals showing delayed estrus, were fed daily with mineral mixture in their diets. They came into heat and conceived within 2-4 weeks of mineral supplementation. The animals fed with forage diet had higher rumen volume than those fed with concentrate. Mimosine degradation was found more with the mixed rumen population of sheep and goats. The performance of goat kids under intensive system was better than that under semi-intensive system. Goat kids showed better daily weight gain when fed 2.58 g yeast bolus/ kid/day. In rabbits feeding of soyflakes improved the wool production. Inclusion of locally available energy sources in diet of rabbit was found very economical. Mulberry leaves up to 15% only in rabbit diet had no adverse effect. Anaerobic degradation of poultry droppings with dry grass checked the pollution as well as left a biomass of high manurial value. Mechanical methods of preantral follicle isolation proved better than enzymatic method in buffalo. Progesterone-impregnated vaginal sponge in combination with PMSG was found best for estrous synchronization in sheep. In Bharat Merino 100% embryo recovery was observed by double puncture technique. Addition of bromocryptin in poultry diet improved the egg production. Commercial dairy products like *makhana, khir* mix, *burfi*, *kunda* were developed. Nanofiltration membrane system improved the quality of cow-milk products. Transverse jet-mixer reactor was developed at the National Dairy Research Institute (NDRI), Karnal. Bacteriocin, a bio-preservator, was developed and proved very effective in preservation of food products. Methods of preparing spent goat meat croquettes and roasted turkey breast chops were standardized. Preparation methodology for egg-crust pizza was developed. Coarse-quality wool was used for developing handmade felts.

A repository was created on antigenic characterization of *Theileria annulata*. Rapid genetic correlation of FMD field isolates is now possible. Retrospective simulated disease forecasting study is in progress. An information on ethno-veterinary medicine was compiled. Bark of *arjuna*, leaves of henna plant etc. were found useful in different diseases. Pathotyping of Newcastle disease is now possible. Diagnostic kits and vaccines including the IBD virus vaccine, were developed for many diseases.

In case of **Fish Production and Processing** the estimation of marine fish production was 2.67 million tonnes.

The landing increased by about 11,000 tonnes over the previous year along the north-east coast. In Inland sector the data on different parameters were structured to develop geographical information system (GIS), and a GIS map of the river Kosi was prepared to know the habitat of different life stages of endangered mahseer. The plankton group Chlorophyceae occurs throughout the river course of Godavari, indicating the fitness of environment. The average yield of fishery resources (94 species of fish and shell fish) of Kerala backwaters was 246-2,747 kg/ha. Under culture fisheries, freshwater aquaculture showed significant results in large-scale seed production of freshwater shark, short-term carp culture, fish-health management, and control of argulosis. Under cold water fisheries, the mature brooders of snow trout were artificially fecundated in farms and the formulated feed showed better performance in golden mahseer. In brackish-water aquaculture, 0.27 million hatchlings were obtained which were fed with live rotifers and *Artemia nauplii*. In mariculture breakthrough was in breeding of spineless cuttle-fish (*Sepilla inermis*). The larval rearing technology was perfected in clownfish (*Amphiprion chrysogaster*). An artificially impregnated female of *Penaeus monodon* spawned 12 times in 102 days and produced 3.5 million of healthy nauplii. Results of fish-processing technology showed development of a machine design for production of value-added fish product and standardization of procedure for ready-to-eat mackerel packed in retortable pouch, and design and fabrication of PVC solar drier. The available data on fish biodiversity were updated by incorporating 800 synonyms, and 10 and 11 endangered species of *Labeo dussumieri* and *Schizothorax richardsonii* were added in the mini gene bank of the National Bureau Fish Genetic Resources.

Significant achievements of **Agricultural Engineering and Technology** include development of tractor-mounted hydraulically controlled wetland leveller (saves 30% operation cost over animal-drawn implements) for puddled bed preparation of rice, tractor-mounted till planter (saves 20% operation cost over conventional method), tractor-mounted multi-crop planter (field capacity 3.15 ha/day), self-propelled boom sprayer (field capacity 0.6 ha/hr), rear-mounted tractor-operated groundnut harvester windrower (field capacity 0.2 ha/hr), power-tiller operated axial flow pump, heavy-duty auger digger, 2-stage evaporative cooler made of aluminium and mild steel for fruits and vegetables, seed extractor for dry chilli which can be owned and operated by small-scale entre-preneurs and seed agencies, mechanical grader for weight-based grading of round fruits, tamarind seed extractor and sheeter (processing capacity 50 kg fruits/hr). Other accomplishments are development of process for production of soy sauce from soy residue and for making jaggery chocolate; chemi-mechanical process of jute stick biopulping, development of jute-based ratine yarn; superior shellac-based drying baking-type insulating varnish suitable for coating electric motor and transformers; superiority of no-till drill system of wheat to conventional method; development of biogas plant for anaerobic digestion of agro-residues; standardization of inexpensive and ecofriendly method of degumming ramie fibres under anaerobic conditions and of an inexpensive method for treating raw materials for seeding oyster mushrooms; superiority of geo-jute non-wovens in reducing soil loss and enhancing *in-situ* conservation of rainwater; and usage of shellac (non-toxic) as hot-melt adhesive for food packaging for the first-time. Self-propelled riding-type 8-row mechanical transplanter was successfully adopted by farmers. The yield increase was about 15%. Under Agricultural Research Information System (ARIS) additional assistance was provided to 174 colleges of SAUs, 50 ICAR Institutes, 9 Project Directorates, 30 National Research Centres and ICAR headquarters. The ICAR and CABI International, UK, signed MoU in the field of Information System Development for the development of national databases, automation of libraries, electronic publication and repatriation of data on micro-organisms of Indian origin.

Under **Social Sciences and Policies**, a study on rice-wheat system in Karnal and Kaithal districts of Haryana revealed that rice blast tops the list of biotic factors, constraining production of rice. Technology, feed-fodder availability and health services proved to be the main determinants of growth in livestock production in Karnataka. Farmers responded strongly to productivity of crop than to price of crop because they experienced the productivity change while price change was only perceived. Only assured output market attracted farmers towards cultivation of fruits and vegetables. Since farmers continue to be the best source of information on advances in agriculture, their involvement in testing promising material is important. State Department of Agriculture continues to be the most important source of information for farmers. Public Sector investment in agriculture is declining but it has to be reversed to check its adverse impact on agricultural output. Potential impact of trade liberalization on Indian agriculture revealed that maize producers will have high benefits. Important information on socio-economic status of farming community in the country will help in future planning. Statistical model was developed for forecasting production and yield of rice crop.

The World Bank Supervision Mission appreciated the progress made by the **Agricultural Human Resource Development Project** in improving agricultural education in the country. The National Information System on Agriculture Education was developed for systematic planning. Achievements under capacity development include specialized training in advanced studies in animal nutrition, animal biotechnology and animal physiology at 3 centres of the Indian

Veterinary Research Institute, Izatngar; and installation of VSAT/INTERNET server, extension of E-mail/internet facility and provision of SYSAT/WINDOWS at the NDRI, Karnal. State Agricultural Universities (SAUs) have achieved uniformity in academic regulations in all degree programmes and introduced new departments, subjects and post-graduate courses in animal nutrition, pharmacology and toxicology, computer science, agri-business management, and electrical engineering, fishery science etc. In the Central Agricultural University (CAU), Imphal, the construction work has started at Imphal (Manipur), Seleish (Mizoram) and Lembuchhera (Tripura). Manpower development includes participation of 87 deans in management training, and overseas training to 43 faculty members. The Accreditation Board has revised course curriculae for 16 post-graduate courses. The Horticultural College and Research Institute, Periyakulam (under TNAU, Coimbatore), was the first to undergo the new process of accreditation. The AHRD has also rendered education through need-based training to over 200 scientists of 25 foreign countries. Centres of Advanced Studies have trained 1,252 scientists/teachers of SAUs and Deemed-to-be Universities (DUs) under 75 training programmes. To promote excellence in teaching, Best Teacher Award Scheme was implemented. The award carries a cash award of Rs 10,000 along with citation, and was given away to 8 teachers of SAUs, CAU and DUs. To encourage preparation of good textbooks in agriculture, veterinary and animal sciences, home science, fisheries and agricultural engineering,35 university-level textbooks have been finalized in Deans' Committees, followed by the Brain-storming Workshop of authors for the finalization of the contents of the book. Significant results were observed under the scheme National Professors/National Fellows. Achievements in Home Science included generation of database for 13,500 rural women, and value-addition of agro- and animal-based fibres. The All-India Co-ordinated Project on Home Science has formulated strategic plan to provide nutritional security and reduce drudgery of farm women, and has identified indigenous technologies for scientific validation, empowerment of women for economic ventures.

As a part of collaboration between the National Academy of Agricultural Research Management (NAARM) and International Service for National Agricultural Research, distance training for agricultural research management was initiated to increase contribution of National Agricultural Research System for sustainable rural development.

Under **Technology Assessment, Refinement and Transfer**, Agricultural Technology Information Centres (40) are in the process of establishment in the ICAR Institutes/ SAUs, and these will provide 'Single Window' delivery system for technology products, services, and information available in the institutions to the farmers. The Krishi Vigyan Kendras (KVKs) organized 8,842 training courses in 8 zones benefiting 191,812 farmers and farm-women including 52,536 SC/ST farmers, and 963 programmes for in-service personnel. Vocational trainings (2,076) were organized for unemployed rural youth in various fields of agriculture. Networking covered 108 KVKs under ARIS. Extension literature was prepared and distributed to the farmers. Newsletters in local languages were also brought out by the KVKs. Frontline demonstrations showed maximum potential of new production technologies in given farming systems and resulted in improvement in yields of oilseeds and pulses. Trainers' Training Centres organized 138 training courses for in-service officials, benefiting 1,823 participants. Since Institution-Village Linkage Programme (IVLP) proved highly successful, it was further strengthened under the NATP. The National Research Centre for Women in Agriculture organized training programme on technological empowerment of farm women in rice production and post-harvest operation. A joint project of Division of Crop Sciences and Division of Agricultural Extension initiated a programme of multi-locational trials across various production ecologies in the country to identify the high-yielding varieties.

In **Research for Tribal and Hill Regions**, salient achievements of the ICAR Research Complex for NEH Region, Umaim, had been the growing of tree bean (*Parkia roxburghii*), a multipurpose tree species in Meghalaya, standardization of protocol for micro-grafting of khasi mandarin on rootstock and graft-union histology, development of bacterial wilt-resistant brinjal and processing-type tomato, and successful introduction of profitable poultry ration for rural poultry production. Major findings of the Central Agricultural Research Institute, Port Blair, include development of high-yielding, Pokkali rice somaclone BTS 24 having higher potential in saline agriculture; successful induction of *in-vitro* flowering in maize; first-time success achievement in breeding and larval rearing of freshwater prawn in Andaman; and development of a vaccine for protection against infectious bursal disease. The research conducted at the Vivekanand Parvatiya Krishi Anusandhan Shala, Almora, led to release of awnless VL Dhan 81 rice for irrigated, transplanted condition of valley and hills of Uttar Pradesh, Himachal Pradesh and Meghalaya and of high-yielding, disease-resistant Vivek Hybrid 4 for rainfed areas of Gujarat, Madhya Pradesh and Rajasthan; production of 10.3 tonnes breeder seed of 24 improved varieties; and higher production of green forage of *Pennisetum purpureum* on field terrace risers and marshy lands.

The **National Agricultural Technology Project** (NATP) was jointly implemented by the ICAR and Department of Agriculture and Co-operation with the World Bank support. It has made major strides towards full implementation of diverse activities of the project under 3 major components, viz. Agro-ecosystem Research (Rs 4,400 million; 56.4%), innovations

in Technology Dissemination (Rs 1,481.4 million; 18.9%), and Organization and Management System (Rs 1,926.4 million; 24.7%). Progress made under the first component includes approval of research programmes in Teams of Excellence (22 out of total 26), Mission Mode (18 out of 38) and Production System Research and TAR (130 including IVLP/TAR out of 230 listed), deputation of 12 scientists abroad, etc. In the second component, Zonal Research Stations of the ICAR were selected in 53 districts to play the additional role of KVKs, where KVKs do not exist. The Agricultural Technology Information Centres are also being established, linking various units of research institutions in the ICAR/SAUs. In the third component, steps for developing strategic plans for the ICAR, developing training plan, re-orientation of senior management of the ICAR, through brainstorming sessions and workshops, consultancies, developing public and private partnerships have been taken.

Taking cognizance of changes taking place in agriculture sector in general and agricultural research in particular, the ICAR has initiated a reform process under the **Organization and Management**. In its endeavour to revamp the system to make it more responsive, responsible and efficient, the ICAR has completed the revision of guidelines for functioning of the Quinquennial Review Teams. *The ICAR Vision 2020* document has been finalized. Training programmes, both in India and abroad, for all categories of the ICAR staff have started as per approved plan. The ICAR has given away 54 awards under different categories, honouring 46 scientists and their 11 associates, four extension workers, one innovative farmer and three institutes.

In **Partnership and Linkages**, the DARE and ICAR have been operating partnership and linkages at national as well as international level through the Memoranda of Understanding (MoUs)/Work Plans. The ICAR has signed 3 MoUs/Work Plan with the Ohio State University, USA; RAAS, Russia; and Government of Cuba. International linkages include Agricultural Human Resources Development Project, ACIAR Collaborative Projects, UNDP Project, FAO/IAEA Projects, NATP, Indo-German Project, Indo-Hungarian Project, and Indo-Global Environmental Facility, Washington Project. DARE/ICAR have arranged trainings and admissions to foreign nationals under Nepal Aid Fund (6), Cultural Exchange Programme (3), Aid to Bhutan Scheme of External Affairs (4), ITEC Programme of Ministry of External Affairs (2), FAO (8) etc. During 1 January-31 October 1999, 55 scientists and technical staff were sent abroad on deputation for international courses/trainings/studies etc. Foreign delegations (18) visited India and Indian delegations (20) visited foreign countries. Since April 1999, the ICAR has approved 274 cases of deputation abroad for participation in various international conferences/seminars or on consultancy.

Publications and Information Division brought out 30 publications and seven periodicals *The Indian Journal of Agricultural Sciences* (Monthly), *The Indian Journal of Animal Sciences* (Monthly), *Indian Farming* (Monthly), *Indian Horticulture* (Quarterly), *ICAR News* (Quarterly), *ICAR Reporter* (Quarterly) and *ARIS News* (Quarterly) in English, and 4 books and three periodicals (*Kheti, Phal Phool* and *Krishi Chayanika*) in Hindi. The *Indian Farming* brought out three special issues, and the *Indian Horticulture* an accent number, *Kheti* 4 special numbers, and *Phal Phool* and *Krishi Chayanika*, each brought out one special number. The Agricultural Research Information Centre (ARIC) brought out *Directory of Conferences, Seminars, Symposia and Workshops in Agriculture and Allied Sciences* and *ICAR Telephone Directory 1999-2000* for use of scientists and technicals of the ICAR system. The DIPA, ICAR, India, and the CABI, UK, jointly organized a 4-day workshop for development of an outline of the business plan for the DIPA, covering financial performance at the macro-level.

(R S Paroda)