Overview

The year 2003–2004 received normal monsoon in over 90% of the country. Fortunately, during the year there was no major incidence of drought, disease or insect pests. As a result of favourable weather conditions and timely and adequate availability of inputs such as seeds, fertilizers, pesticides, feeds, vaccines, medicines etc., our foodgrains production is estimated to be 210.78 million tonnes.

The Indian Council of Agricultural Research, as the national apex organization for agricultural research and education, is strongly emphasizing the role of collective and synergistic efforts to increase the food production, through enhancements of productivity and input use efficiency, in view of our rising population and mounting concern to safeguard the natural resources. An overview of the Council's achievements in agricultural research, education and frontline extension during 2003–2004 and the initiatives taken to sustain the enhanced agricultural productivity and profitability is presented here.

Under *Crop Improvement and Management* germplasm being basic and essential, 11,889 accessions of crops and their wild relatives were collected through 186 explorations in different parts of the country. Besides, 33,092 accessions of diverse crops from various countries including 25 of transgenic crops, were introduced. Accessions numbering 45,093 were processed for quarantine clearance. The National Seed Genebank has been enriched with 20,453 accessions and over 200 phyto-sanitary certificates have been issued for export material. More than 600 varieties and elite germplasm lines of 15 crops have been fingerprinted. Also, marker has been identified to determine rate of ripening in tomato.

During the year, 19 varieties and one hybrid in rice, seven varieties in wheat, one variety in barley, 11 cultivars in maize, two hybrids in sorghum, three open-pollinated varieties and one hybrid in pearl millet have been released for their commercial cultivation in food crops for various agro-ecologies. Rice variety Nidhi was found suitable for direct seeding under puddle conditions. Besides, 10 varieties of wheat, two varieties of barley, five hybrids of pearl millet and one variety of proso millet have been identified for release. One variety of foxtail millet has been notified for cultivation in Rajasthan. In forage crops, five varieties, one each in cowpea, tall fescue grass, setaria grass, pearl millet and berseem have been released for cultivation.

Among pulses three varieties of pigeonpea, two varieties each of chickpea and urdbean and one variety each of fieldpea and lentil have been released/identified for cultivation. Two varieties of arid legumes could be identified for pre-release seed multiplication. In oilseeds, two varieties each of groundnut and rapeseed-mustard, four of sesame, and one variety each of niger, soybean, sunflower, safflower and linseed have been released/identified for cultivation. A stem-rot-resistant groundnut genotype (CS 19) of interspecific origin was developed for the first time. In commercial crops, six varieties/hybrids of cotton and five varieties of sugarcane have been released/notified/identified for commercial cultivation. One variety of tobacco has also been recommended for release.

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The national test guidelines were framed for Distinctness, Uniformity and Stability (DUS) testing for all major crops. An atlas was prepared for quality parameters of wheat. Other major achievements in the crop sector include: production of 3,067 tonnes of breeder seed of different crops, popularization of rice–chickpea system over rice–wheat system for higher economical returns, effective control of Karnal bunt on wheat with two foliar sprays of *Trichoderma viride,* standardization of simplified growth-room screening technique for studying *Botrytis* grey-rot in detached spike of castor and development of Expert System BIORICE for biocontrol of rice pest.

In *Improvement and Management of Horticultural Crops*, 15 accessions of guava and seven wine varieties and four natural mutants of grape were added to gene bank. The traps consisting of ethyl alcohol, methyl eugenol and malathion in a 6 : 4 : 1 ratio soaked in plywood could manage fruit-fly effectively in mango. In banana, a novel technique to feed bunches through distal end has been developed to increase bunch weight. Packaging technology for banana was standardized for export purpose. Two hybrids of rough lemon × Troyer Citrange were found promising rootstocks for *Phytophthora* resistance. Embryo-rescue technique was standardized in grape. During one year production cycle Metwin 2 software could save 11 sprays in disease management in grape cultivation. Besides, improvement in shelf-life of grapes was noted with pre-harvest treatment of chitosan alone or in combination with *Trichoderma*. In papaya, adoption of plant density of 555 trees/ha resulted in 48% more yield. Litchi Rose Scented gave high yield with good-fruit quality.

In arid zone fruits, major accomplishments include collection of 12 new frost-resistant genotypes of *aonla* from mid-hills region of Himachal Pradesh, introduction of six varieties of pomegranate and three varieties of fig, and recommendation of two varieties (Kaithali and Gola) of *ber* and one variety (APK 1) of pomegranate for commercial cultivation in rainfed Vertisols in Arupukkotai region. Collection of apricot selection Suka, having red cheeks, was a major finding in temperate fruits.

In vegetable crops, one variety and two hybrids of tomato and two varieties of garlic have been released for cultivation. One variety and one hybrid of chilli; one variety each of cowpea, pea and French bean; two varieties of okra; one hybrid each of tomato, capsicum, bitter-gourd and cauliflower; and two hybrids of brinjal were identified for release. Eight new varieties of vegetables have been released by the Delhi State Variety Release Committee. Other major accomplishments include: standardization of technology producing quality tomato and capsicum and discovery of a new species of begomo virus causing leaf curl in tomato. In potato, four hybrids have been recommended for release and 20 accessions added to germplasm. In tropical tuber crops, 65 new accessions/collections have been added to germplasm.

In cassava, two triploid clones with higher extractable starch have been identified for industrial use. In mushroom, 21 new wild mushroom species have been collected. Oyster mushroom could be successfully grown on wheat straw, rice straw and on leaves and stalk of maize. A cryoperservation technique for preservation of *Volvariella* and *Morchella* cultures has been developed.

Six varieties of rose and five of gladiolus have been released. About 450 species belonging to 93 genera of orchids have been collected. The concerted research efforts resulted in release of two high-yielding and high-quality ginger varieties (IISR Mahima and IISR Rejatha) and one nutmeg clonal selection (IISR Viswashree) for cultivation in Kerala and addition of accessions of ginger, cardamom, turmeric, *Garcinia, Cinnamomum* and of nine seed spices to germplasm.

In *Natural Resource Management,* soil resource

atlases of 24 districts for sustainable land use, and soil erosion maps of Rajasthan, Madhya Pradesh and Chhattisgarh have been brought out, besides identification of important benchmark soil series in four districts of Assam. Sustainable cropping system in rice fallows of Brahmaputra valley of Jorhat, Assam, and critical areas for prioritized land treatments in watersheds have been identified. Mixed biofertilizer formulations consisting of nitrogen-fixing organisms and phosphate-solubilizing bacteria (PSB) proved superior to individual inoculants.

The water resource development proved beneficial for cyclone-affected farmers of coastal Orissa. Other salient achievements under water management had been improvement in yield and quality of banana under drip irrigation and usefulness of fish pond-cum-reservoir for economized and multiple uses of water. The research conducted in saline coastal soils led to the maintenance of rice and wheat yields even at 50% NPK when used in conjunction with farmyard manure (FYM) or green manuring, development of technologies for skimming and recharging freshwater in saline groundwater regions, identification of causes and remedial measures for resodification of reclaimed soils in Uttar Pradesh, development of organic practices for rice-based cropping systems in saline coastal soils and reclamation of alkali Vertisols under rainfed condition.

Conservation furrow plots could store 4–37% additional soil moisture and resulted in higher bean and seed yield of castor and pigeonpea. Tolerance of sorghum to biotic stress could be enhanced through genetic manipulation. Development of a new technique of growing mat-type nursery for rice transplanters, improvement in nitrogen and phosphorus-use efficiency through inclusion of forage cowpea in rice–wheat system and enhancement in yield, soil organic carbon and available P and K with soil application of ferrous sulphate, zinc sulphate and urea along with *Aspergillus awamorae* and *Trichoderma viride* in rice–wheat system are the salient features of crop production research.

A low-cost passive cool chamber has been developed for short-duration preservation of vegetables and fruits. Spraying 2,4-D @ 1.5–2.0 kg/ha, glyphosate @ 1.5 kg/ha on actively growing plants or new shoots of *Ipomoea carnea*, the most problematic weed, proved effective in its control. An integrated management package for lantana has been developed. In agroforestry research, 80% success with *in-situ* veneer grafting in August–September and 25% success with chip budding in August was recorded when these were done on 2 or 3 years old plants of *chironjee*. High survival, increased tree height, canopy diameter, dry leaf fodder and fuel wood of *Albizia procera* were noticed during seventh year in natural grassland. In neem, 276 accessions were collected from eight states. On-line computerized database was also developed for system of agroforestry in India. A website named 'Crop-Weather Outlook' has been developed under AICRPAM and operates from the Central Research Institute for Dryland Agriculture, Hyderabad. The site provides useful information on crop-weather conditions in the country.

Under *Livestock and Poultry Improvement and Management,* database on Indian livestock resources, infrastructure, animal production, products and utilization has been made available in a single user-friendly package. Polymorphism of growth hormone gene in Karan Fries cattle and Murrah buffalo was revealed for the first time in developing a strategy for genetic selection of dairy bulls. Immune competence of purelines of poultry was profiled, primarily for breeding purposes. Buffalo ovary-released protein was identified as a marker for oestrous and pregnancy detection. Genetic distance measures revealed that Nali and Chokla sheep are genetically closer, while Garole sheep is a distinct population. Since Nicobari and

Kashmir Favorolla poultry populations showed recent genetic bottleneck, these require their special conservation efforts. For the first time, neighbour-joining tree of Indian goat breeds with wild goats could be constructed.

Aseel and Kadakanath poultry breeds were utilized to develop CARI-Nirbheek and CARI-Shyama for backyard poultry. A preliminary attempt was made to grow embryonic stem cells in buffalo. Double window embryo culture system for production of turkey embryos was developed for first time in the world. This technique could be used for transgenesis, production of chimeric birds and production of pharmaceutical proteins with egg gene promoters. The technique will help in conserving rare and endangered poultry species.

The Frieswal cows recorded 3,570 kg milk yield in 300 days with peak yield of 14.27 kg and lactation length 315 days. Average milk yield of Murrah buffaloes was 2,928 kg. Genetic improvement studies are in progress in Hariana, Gir, Ongole and Tharparker breeds. In sheep, Chokla, Marwari and Magra are being studied for carpet wool production and Madras Red, Ganjam, Muzaffarnagari, Nellore and Deccani for mutton production. In Barbari and Jamunapari goats, genetic improvement and sire evaluation are in progress. The National Research Centre on Pigs was established at Rain, Guwahati, Assam. The Caribro-Tropicana birds ranked third in 19th Random Sample Poultry Performance Test (RSPPT), Gurgaon, showing 1,750 g body weight by 7 weeks of age. The CARI layer bird strain achieved top position in hen-housed egg production at 31st RSPPT, Hessaraghatta, Bangalore. The CARIBRO-Dhanraj birds could achieve 1,875 g body weight at 7 weeks of age.

Complete nucleotide (nt) sequence of foot-and-mouth disease virus Asia 1 vaccine strain (IND 491/97) was determined. The National Animal Disease Referral Expert System was evolved for monitoring and forecasting animal diseases. Immunized kids showed reduction in growth of *Theileria annulata*. Molecular techniques could be developed to unravel mysteries of disease outbreak in natural conditions. Low volume saponified *hemorrhagic septicemia* vaccine for cattle and buffalo was prepared and is under trial in a large number of cattle. Primer for identification of gastro-intestinal parasites was developed for the first time. In pigs, diagnostic test was developed for porcine reproductive and respiratory syndrome (PRSS). An indigenous killed vaccine using EHV-1 strain was developed, showing better immune response than commercially available vaccine. PCR-ELISA was developed for differential diagnosis of capri-pox virus. PCR was found to be the test of choice in surveillance and monitoring of camel surra or trypanosomiasis. Non-isotropic DNA probe was developed for detection of swine fever. A primer pair was synthesized for using in duck plague virus detection by PCR. Diagnostic kits were developed for rinderpest and peste des petits ruminants (PPR) and live attenuated vaccine for PPR. Recombinant antigen-based diagnostics could be developed for detection of bovine viral diarrhoea virus.

The potential dry-matter availability of animal feed resources increased in Karnataka. Grain : straw ratio was found useful in determining dry fodder availability. Cellulase gene from *Ruminococus albus* could be cloned in *Escherichia coli*. Feeding of chaffed maize improved the body weight in crossbred calves. *Orphinomyces* sp.(C 14) proved a better ruminal fungal isolate in improving nutritive value of wheat straw-based diet. Ragi straw was found to be a better source of dry matter, crude protein and fibre than paddy straw. A technology was developed for preparation of chelate minerals. Nutritional remedies were suggested for sustainable cattle milk production.

Citric acid and neem bark powders were used to prevent fungal infestation of stored feeds. Substitution of barley by *Prosopis juliflora* in sheep diet proved satisfactory. Feed pellets for feeding

goats were prepared using leaves of *subabul*, neem, *ber*, *peepul*, siris, mulberry and *desi babul*. Milk replacer containing 24% crude protein was found economical than mother's milk for finisher goat kids. Approximately 15 species of rumen ciliates have been identified in mithun.

The nutrient requirement was updated for various avian species. Methionine-supplemented red sorghum diet improved the growth in birds. Feed supplement zeosil plus could counter the adverse effects of aflatoxin. The measured feeding of metabolizable energy in grower phase regulated body weight gain and helped in achieving optimum performance. Krishibro chicks performed normal even with low lysine diets. Dietary supplementation of natural agents minimized production losses due to aflatoxin in feeds and improved cellular immune response, dressing yields and liver fat content. Recommendation of reduced Ca and P in birds' diet resulted in decreased feed cost without affecting the growth or bone mineralization. Sesame and sunflower protein-meal resulted in lean broiler meat.

A laboratory procedure was evolved to accurately predict fertility of bulls in making selection procedure more effective. Improvement in cryopreservation method of semen could reduce rejection rate of ejaculates by 20%. Milk progesterone profile successfully demonstrated the reproduction status in buffalo and it was utilized for timely remedy of reproductive disorder in animal. Estrus synchronization in Malpura ewes resulted in 75% ovulation. The scientific management practices resulted in reduced calf mortality in loose housing system. Artificial insemination (AI) and pregnancy diagnosis could be perfected in equines. Yaks were successfully induced into heat. Enzyme immuno assay was evolved for determination of growth hormone in mithun. Antibiotics reduced the bacterial count in foam of quails. Birds immunized against vaso active intestinal peptide showed higher egg production.

Whey-based *jaljeera* drink was standardized and its dried form was also developed. Inulin @ 3% resulted in better growth and acid production in symbiotic yogurt preparation. Immuno-modulatory property of *dahi* stimulates immune system and protects against enteric infection. Twin-screw plasticizer was developed for production of ghee-based butter. A model was evolved for pore membrane formation by class IIa bacteriocins from gram-positive lactic acid bacteria. Low fat/sugar-free frozen dessert could be developed for diabetic patients. Energy auditing was done for identifying potential for improvement in energy efficiency in model dairy plant. Assays were standardized for detection of antibiotic residues in milk. A process was standardized for soft cheese preparation from camel milk. Customer response to chevon pickle indicated that it has good market potential.

In *Fish Production and Processing,* marine fish landings improved by 13.5% over previous year. Under inland sector, a multimatrix index of fish assemblages has been developed for fish species in river Hooghly. Hilsa continued to be a major component, contributing 10.4% of total yield from Hooghly estuary. The GIS was developed on water bodies for eight districts of Bihar and a digital map was prepared for six districts of Rajasthan.

In culture fisheries, important research achievements during the year have been seed production in *Macrobrachium rosenbergii* using underground saline water with necessary ionic amendments at Rohtak, Haryana, breeding of *Labeo fimbriatus* using a portable hatchery at Bangalore and *in-vitro* cell culture of freshwater pearl mussel. Research efforts in the field of coldwater fisheries led to development of natural lake as conservation site for the threatened mahseer species *Tor putitora*, evolvement of eye ova of rainbow trout under warmer conditions for the first time, and advancement in maturing period of grass and silver carps with harmone treatment and raising water temperature at high altitude. The work conducted under brackishwater aquaculture led to

successful testing of shrimp feed in a farmer's pond, development of a latex agglutination kit for the detection of white spot virus in shrimps and preparation of immune index to assess the health status of tiger shrimp.

In mariculture, natural spawning of groupers *Epinephelus tauvina* and *E. polyphekadion* could be observed under captive conditions. In five species of damsel fishes, viz. filamentous tail black damsel, yellow tail damsel, blue damsel, peacock damsel and Indian dascyllus, broodstocks were successfully developed. Identification of molecular markers and natural genetic variation in important fish species, karyological characterization of fish species endemic to Western Ghats, development of sperm cryopreservation protocols for *Ompok malabricus*, and diagnostic capability of PCR in detecting exotic pathogens for fish quarantine are some salient accomplishments in fish genetic resources.

In *Agricultural Engineering and Technology*, a number of implements such as lug-wheel puddler, seven-row till-plant machine, pneumatic planter for vegetables, two-row vegetable transplanter, zero-till seed-cum-fertilizer drill for wheat, MPKV multi-crop planter, semi-automatic potato planter and flail-type forage harvester-cum-chopper were developed as tractor-operated machines. Zero-till drill machine, orchard sprayer, OUAT groundnut digger and chipper shredder for cotton-stalks and other agricultural waste were the implements fabricated under power-tiller-operated machinery. In case of self-propelled machinery, two-row cultivator for *biasi* operation, riding type (10-row) rice seeder and power weeders were developed. Likewise, CIAE planter for groundnut, maize, pigeonpea, sorghum and other oilseed and pulse crops under animal-drawn machinery, and indigenous seed counter, high-capacity pigeonpea thresher, maize dehusker-cum-sheller and ANGRAU sugarcane leaf stripper under stationery machinery were developed.

A strength measurement set-up for agricultural workers and anti-vibration devices for comfort of power-tiller and tractor operators were evolved. A low-cost and energy-saving fruit and vegetable preservator has been fabricated that increases shelf-life by 7–12 days and reduces handling damages. In post-harvest engineering technology, prototype of cleaner to arrest dust emission in *dal* mills, process for making fermented banana beverage, double stage filtration system for sugarcane juice and electronic thermometer for striking point in jaggery making have been developed. The technology of making ginger- and vanilla- flavoured chips of coconut has been transferred to coconut entrepreneurs.

The work carried out under cotton technology led to the development of light-weight cotton-gin which can be operated by remote as well. For the first time, coir-cotton composite yarn has been developed through friction spinning technology for industrial uses. In lac technology, successful propagation of *Flemingia semialata* – a recently identified potential bushy host, identification of rare variants of *Butea monosperma* and development of water-thinnable coating compositions for cementitious surfaces were the important findings. Salient achievements in jute technology include successful blending of coir with jute and of sisal with jute, besides the development of bagasse-based gasifier, improved cook stove for low pollution and roof integrated unglazed solar-air heater and solar refrigerator. Pantnagar adjustable collar harness and Allahabad harness have been modified to provide comfort to the animals during work. Technologies of soy-processing, manu-facturing package for serrated sickle etc. have been transferred to users. For commercialization, 31 technologies have been assigned by the ICAR to the National Research Development Corporation.

Under *Agricultural Human Resource Develop-ment*, Model Course Curricula and Syllabi of 8 UG and 44 PG programmes were developed and provided to all agricultural universities along with academic regulations, and majority of SAUs

and Deemed Universities (DUs) have implemented these courses.

During the year, 127 students from 22 foreign countries were admitted in various degree programmes in ICAR-DUs/SAUs. In Centres of Advanced Studies and Summer/Winter Schools/ Short Courses, 4,250 scientists/faculty members were trained in diverse subjects of agricultural and allied fields. For the award of National Talent Scholarships (NTS), 218 candidates were recommended on the basis of their merit. Junior Research Fellowships were awarded to 438 candidates and Senior Research Fellowships to 202 candidates.

The women and rural girls were trained in scientific child-care and also to undertake activities such as candle preparation, mushroom cultivation etc. As a part of its HRD activities, the National Academy of Agricultural Research and Management organized 36 programmes through which 828 scientists were trained with respect to agricultural research and education management.

In *Social Sciences and Policies*, a study has shown that the demand for livestock products has increased with improved rural income, indicating a need for faster growth in production of livestock products. Coping mechanism was evolved to reduce the impact of climate-induced natural disasters. Integrated technology package was prepared for food security in tribal, backward and hilly areas and initial impacts were assessed. A new mechanism - deficiency price payment - was suggested, and it has to be developed to protect farmers' income. Dissemination of available technology needs more attention in future, as farmers are realizing significant economic benefits by adopting them and support to the extension system will yield heavy returns.

Technology Assessment, Refinement and Transfer is accomplished through Krishi Vigyan Kendras (KVKs), Institution-Village Linkage Programme (IVLP) and Agricultural Technology Information Centres (ATICs). There are 376 KVKs, 70 IVLP Centres, and 44 ATICs. The ATICs provided technological products, diagnostic services and technology information to farmers and end-users. During the year, 19,880 training programmes were organized benefiting 470,000 farmers and farm women, 110,000 rural youth and 60,911 participants. *Kisan melas, gosthies* (discussion forum), advisory services, film shows, diagnostic services, etc. were arranged to accelerate the process of dissemination of technologies.

The production potential of newly released technologies in oilseeds, pulses and other crops were demonstrated through front-line demonstrations. The KVKs identified more than 330 technologies for on-farm testing to assess their impact on location-specific basis in different farming systems. Also quality seed/planting material of cereals, pulses, oilseeds, vegetables, fruits and spices, and livestock strains were produced by KVKs and provided to farmers.

The TTCs organized 216 training courses, benefiting more than 4,100 participants. From the inception of Mission Mode Project, more than 4,000 ITKs have been documented and three publications have been brought out in the form of *Inventory of ITK in Agriculture*. Validation and promotion of IPM technologies were carried out in selected crops in different agro-ecological regions.

Eight projects have been initiated nearly on all aspects of role of *Women in Agriculture*. The Krishi Vigyan Kendras trained nearly 200,000 farm women, girls and women extension workers. Innovative marketing outlets were developed for self-help groups. Cafeteria for women in agriculture was developed and offered to states to guide the development of new programmes for women in agriculture. Five components of the *All-India Co-ordinated Research Project on Home Science* moved towards empowerment of rural women and their main achievements are : mobilization of self-help groups and creation of learning environment,

strengthening empowerment process, and assessment of empowerment gains for women.

In agricultural research planned especially for *Tribal and Hill Regions*, nine varieties (wheat 2, barley 1, maize 1, pea 2, toria 1, tomato 1 and okra 1) of crops were released and one variety each of wheat, finger millet and amaranth identified at the Vivekananda Parvatiya Krishi Anusandhan Shala, Almora, for release in North-western/ Uttaranchal hills. Identification of eight rice genotypes for multiple-disease tolerance, isolation of a new strain of bacterium (*Yersinia* sp.) from infected white-grub larvae and development of Vivek thresher-cum-pearler for *mandua* and *madira* had been the other significant findings.

The work conducted at the ICAR Research Complex for NEH Region, Umiam, led to development of 10 guava hybrids for cultivation in mid-hills of North-eastern hills region. Rich contents of vitamins and minerals were found in young shoots of edible bamboo. A methodology was developed for boar semen preservation. Dies and fixtures were developed for fabrication of wheel hand hoe, octagonal maize sheller and other tools.

At the Central Agricultural Research Institute, Port Blair, a protocol was developed in rice varieties compatible for other *indica* varieties for developing transgenic plants with economically important genes. Five varieties of rice could be identified for large-scale cultivation under humid tropics of Bay Islands. Cultivation of capsicum, beans and tomato was found economically viable under protected conditions. Other achievements were the successful control of mastitis, enteritis and hump sore in cattles development of synthetic layer suitable for backyard farming in Bay Islands, standardization of dairy calves management for hot and humid climate, successful breeding of clawn fish (*Amphiprion percula*) in captivity and first time breeding of *A. sandarocinos* on formulated feed.

In organization and management of the *National Agricultural Technology Project*, major thrust has been put now by the Council for commercialization of technologies. The National Centre for Agricultural Economics and Policy Planning (NCAP) in consultation with PIU has selected 14 technologies of national significance for impact assessment. A software *Nitriguide* has been developed for assessing the food intake in the Indian context. The National Academy of Agricultural Research and Management(NAARM) has launched a web site *http://naarm.ernet.in* for getting information on Indian agriculture.

Research on production systems resulted in 40–50% additional yield of oilseed crops owing to water-harvesting and drought-mitigation technologies and 75–90% increase in income of tribal farmers by crop diversification. Further, new *arboreum* cotton varieties were identified for dryland areas under rainfed agro-ecosystem. The research conducted under irrigated agro-ecosystem led to the release of multi-cut sorghum hybrid and variety with enhanced nutritional quality, increase in income through zero-tillage technology in wheat, development of direct sensitive micro-filter plate enzyme-immuno-assay method for the first time for estimation of oxytocin, LH, GH, FSH and PGFM and 3–4 times increase in productivity and production of fish reservoir with proper stocking of bigger-size fingerlings. In case of coastal agro-ecosystem, the major findings were popularization of backyard poultry for landless and marginal farmers, development of technology for tissue-cultured pearls that can manipulate colour, hue and luster, process for manufacturing of shell-bead nucleus using indigenous materials and machinery and sero-diagnostic kit for early diagnosis of basal stem rot pathogen of coconut. Control of *khejri* drying and development of skin fibroblast cell technology for livestock germplasm conservation under arid agro-ecosystem and development of cost-effective technology for treatment of choes (rainy-season torrents) under hill and mountain ecosystem were the other achievements.

In mission mode research, five special explorations were made in different inaccessible areas and areas not surveyed earlier. Standard descriptors were prepared for fruit and medicinal and aromatic plants. Quality seeds of crops and planting material of fruit and vegetable crops, improved sheep, poultry, pigs, quality seeds for freshwater aquaculture were supplied to farmers in tribal, backward and hilly areas in 15 states. Thirty-seven hybrids of crops having improved quality, yield and disease resistance were released. Commercialization of technology for pouch processing for fish curry preparation, prototype fabrication of 44 agricultural implements, development of equipment and technology for direct sprouted rice seeding that could save 70–75% in labour, 85–90% in operational energy and 80–85% in operation cost and empowerment of women in tribal, backward and hilly areas with implements to reduce drudgeries in farm operations, were the other accomplishments.

Under Team of Excellence (ToE), 30 genes of eight groups of viruses and citrus viroid were cloned, sequenced and deposited in genebank. Transgenic to tomato leaf curl virus incorporating *Rep* gene of virus was generated. Immunity was developed in buffaloes using antibodies against bursal diseases and infectious bronchitis. Other achievements under ToE include development of royal jelly extractor, mapping of pearl mussel resources in different agro-ecological regions of the country, preparation of a holistic quality management programme for production and processing of wholesome meat and establishment of three Referral Laboratories for quality assurance of plant, animal and fishery products.

In competitive grants programme, novel abiotic stress-responsive genes were identified and characterized in rice. Rare and high-valued medicinal plant species in north-eastern India were propagated on large scale using tissue-culture technology. Molecular markers for natural disease resistance in Nicobari fowl were identified. Technologies were developed for aquaculture, breeding and hatchery production of marine ornamental fishes. The other significant findings were standardization of techniques for off-season chrysanthemum flowering in plastic greenhouse-cum-rain shelter, preparation of computer models for optimal allocation of water and water-table management in the existing irrigation projects, and standardization of process for product development, value-addition and waste utilization in banana and plantains.

To improve working environment and to make research effective, efficient and relevant, the ICAR has taken several initiatives under *Organization* and *Management*. Significant progress was made in adjustment of outstanding advances, compliance of Audit paras, Reconciliation of Bank Account and Maintenance of Asset Registers at ICAR institutes. The Budget Estimates (BE) and Revised Estimates (RE) of the DARE and ICAR (Plan and Non-Plan) for 2002–2003 were Rs 14,988 million and Rs 14,488 million respectively. The BE for 2003–2004 (Plan and Non-Plan) is Rs 15,109.2 million.

The ICAR announced 44 awards in 12 categories to honour 33 scientists and their nine associates, four extension workers, innovative farmers, agricultural journalists, and three institutions, during the year. Financial assistance was also provided to 47 scientific societies and academic universities for publication of journals and for seminars/symposia/conferences.

The DARE and ICAR have been operating *Partnership and Linkages* in agricultural research and education at the national and international level through the Memoranda of Understanding (MoUs)/Work Plans/Projects/Training Courses/Exchange Visits etc. One MoU and three Work Plans were signed between the ICAR and France and Sri Lanka, Cuba and Iran for scientific and technical co-operation in field of agriculture and education. Under International linkages nine

projects have been approved/initiated. A number of delegations led by Presidents of Republic of Mozambique, Republic of Guyana, and Prime Ministers of Laos, People's Democratic Republic and Lesotho visited India. An Indo-French seminar 'To identify priority areas for collaborative research, germplasm exchange, study visits, training' was also held at New Delhi.

The Directorate of Information and Publications of Agriculture (DIPA) brought out 50 publications in English and 10 in Hindi besides regular research monthly journals/magazines. Special issues/accent numbers of periodicals were also brought out on the occasions/themes of World Food Day, ICAR Foundation Day, etc. Recently, the DIPA has entered into e-publishing and developed five CDs - DARE/ ICAR Annual Report 2002–2003, All-India Co-ordinated Research Project Database, ICAR Telephone Directory, Terminated ICAR Ad-hoc Research Projects and ICAR Institutes' Research Project Information. The DIPA earned Rs 4.78 million through sale of its publications, advertisements etc., and participated in various exhibitions and displayed its publications.

In tune with recognition of the role of science and technology in overall national perspective, the ICAR established a National Agricultural Science Museum. This will be opened to farmers, scientists and the general public very soon.

Publicity and Public Relations Unit issued materials of current importance to various newspapers, agricultural and current affairs magazines and electronic media to cover the achievements of the Council in agricultural research, extension and education at national and regional levels. The video films prepared on the activities and achievements of the Council are being distributed to ICAR institutes, KVKs, Extension Directorates of SAUs and others for wider dissemination of information for technology led growth in agriculture and allied sectors.

(Mangala Rai)
Secretary (DARE) & DG, ICAR