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Overview

The rainfall during the year 2008 (1 June to 30 September 2008) was 98% of its long period average (LPA) and a cumulative seasonal rainfall for the country as a whole was near normal. Monsoon covered the entire country on 10 July against its normal date of 15 July. Of the 36 meteorological subdivisions, 32 received excess/normal rainfall and the remaining 8% received deficient rainfall during the season. During the year country harvested a record 230 million tonnes of foodgrains and estimations for the year ahead are even higher. The production of rice, wheat and maize was highest so far. The fish production was 6.87 million tonnes and the milk production was over 100 million tonnes. The floods and outbreak of avian influenza in the eastern and NE parts of the country remained a cause of concern.

The Indian Council of Agricultural Research marched ahead in generating technologies towards sustainable advancements in agriculture and allied sectors, improving quality of higher agricultural education, institutional capacity building, fostering international linkages for co-operation in agricultural research etc. The research and development activities during the year covered wide areas, ranging from optimizing resources' use, improved cultivation techniques, development of improved varieties/breeds, excellence in agricultural education and frontline extension of technologies, providing improved planting materials, imparting training especially to rural women and youth and various stakeholders through the chain of Krishi Vigyan Kendras as a knowledge hub. In our efforts to improve the system's efficiency and to make the research and education programme more relevant in the present context, organization and management (O&M) reforms were put in place. Human resource development (HRD) programmes and talent search in agricultural sciences continued to meet the future needs of agricultural research, education and extension.

The Council has taken decision to reorient the functioning of some National Research Centres to work in Directorate mode such as Groundnut; Rapeseed-Mustard; Soybean; Sorghum; Coldwater Fisheries; Women in Agriculture; Oil Palm; Cashew; Medicinal and Aromatic Plants; Mushroom; Onion and Garlic; Floriculture; and Water Management. The National Bureau of Agriculturally Important Insects (NBAII) is established by reorienting the Project Directorate of Biological Control. In order to protect agriculture from the increasing abiotic stresses through technological intervention, a state-of-the-art National Institute of Abiotic Stress Management is contemplated.

The number of projects under the Basic and Strategic Research has gone up to 49 during the year. Some of the potential impact making areas under the scheme are controlling arsenic in food chain, genetic engineering for fixation of heterosis, developing wireless sensor for effective animal management, C_4 photosynthetic system in rice, stem cell research in cattle and buffaloes, nano-technology for higher utilization of native phosphorus in arid soils etc. Similarly, there are now 21 projects in network mode to address issues of climate change, control of diseases and pests in crops and livestock etc. Besides the research, continued efforts are on to develop competent Human Resources in frontier areas of science as well as in the IPRs. In order to improve the efficiency of system various measures were taken in the important areas of administration and finance management.

An Overview of the Council's initiatives and achievements during the year under report is presented here.

Soil and water productivity

Soil-erosion maps of districts like Kota

(Rajasthan) and Pauri Garhwal (Uttarakhand) were prepared for resource-conservation planning. Cost-effective bio-engineering structures were developed and locally adaptive flow-resistant vegetative species identified for training the river flow, bank-erosion control and protection of the agricultural land and other property along the banks. Assessment of rainwater harvesting potential across the major rainfed growing districts showed that about 39 million ha area under coarse cereals, rice, cotton, oilseeds and pulses could generate about 114 billion m^3 surplus water capable of providing supplemental irrigation in major part of rainfed areas. Field kits were developed for ascertaining soil sodicity and quality of bofertilizers. Liquid formulations were developed for enhancing the shelf-life of biofertilizers, viz. *Rhizobium, Azospirillum* and phosphate-solubilizing bacteria.

A molecular protocol developed for early and rapid detection of heavy metal pollution in open water can be used to assess the impact of pollution on freshwater fishes. Decision support software developed for shrimp aquaculture will help state governments and other regulatory organizations to regulate the level of shrimp farming activity for each receiving water body and in framing future guidelines and policies for sustainable development of shrimp farming.

Genetic resources

During the year, 33 explorations were undertaken and 2,203 accessions including 784 of wild species were collected. In the National Herbarium of Cultivated Plants, 371 herbarium specimens, 121 seed samples and 21 economic products were added. A total of 25,456 diverse crop accessions were introduced from various countries, and 15,000 accessions, including germplasm from the ICRISAT, were exported to 19 countries. About 13,850 accessions of orthodox seed species were added to the National Genebank.

Twenty accessions of fruit crops, 17 of bulb and tuber crops, five of medicinal and aromatic plants and three of spices were added to the *in-vitro* Genebank. In all, 1,991 accessions (nearly 32,000 cultures) belonging to 52 genera and 158 species of vegetatively propagated crops and medicinal and aromatic and threatened species were conserved. Accessions of fruits and nuts (214), spices (9), industrial crops (136) and medicinal and aromatic plants (72) were cryo-stored.

The community-level physiological profiling of soil microbes using BIOLOG showed significant shift in C-utilization pattern of effluent irrigated soils over the control soil. Forty-five fast-growing actinomycetes strains isolated from the effluent-contaminated sites were characterized at the molecular level. From salt lake of Sambhar, Rajasthan, unique bacterial isolates capable of growing at 20% NaCl and at pH 12 were isolated.

Development of a computational methodology based on genetic algorithm to solve the individual assignment problem using microsatellite data; phenotypic characterization of Bargur cattle, Malnad Gidda cattle, Balangir sheep, Surti goat, and Busra chicken; genotyping of Calpastatin gene, responsible for meat tenderness, in Deccani, Nellore, Sonadi, Malpura, Nali, Ganjam, Chokla and Garole sheep breeds; consistent superiority of naked neck birds to normal birds for broiler traits; and better genetic resistance in SDL-IC broilers than Aseel and Kadaknath against H5N1 infection, are the significant achievements in animals and poultry.

Development of microsatellite markers in *Macrobrachium rosenbergii*; initiation of marker to marker linkage study in rohu; revelation of captive breeding and milt cryopreservation techniques for Indian catfish *Horabagrus nigricollaris*, which was categorized as critically endangered; preparation of DNA barcodes for 180 fish species; and standardization of DNA based-diagnostic technique for species-specific identification of the trematode, *Gyrodactylus elegans*, a first attempt in the country, towards molecular detection of parasites, are some of the major accomplishments in the field of fish genetic resources.

Crop improvement

Seventy-six varieties/hybrids of major food crops including rice, wheat, barley, maize, pearl millet, and pulses and oilseeds have been released/identified for different agro-climatic regions of country.

Significant crop improvement research includes registration of 10 new genetic stocks of wheat, resistance of 78 wheat genotypes to stem rust Ug99, identification of dual-purpose hybrid sorghum CSH 25 for cultivation in *kharif* in Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh and Gujarat. Jute variety JRO 2003 H was recommended for entire tossa-growing belt of country. Sangami variety of tobacco was released for cultivation.

A coloured regular bearing hybrid Arunika of mango, having good fruit qualities, was released. Potato varieties Kufri Khayati and Kufri Sadabahar for plains and Kufri Girdhari (good for processing) for hills were released.

Three varieties of coconut Kalpa Pratibha, Kalpa Mitra and Kalpa Dhenu were released for commercial cultivation. A new high-yielding coconut variety Kalparaksha was recommended for release. A high-yielding and root (wilt)-resistant variety Gauthami Ganga with sweet nut water and high potassium was released for Andhra

Pradesh, Tamil Nadu and Maharashtra.

HH 67 (ew) sorghum bred using DNA markers for downy mildew resistance has significantly arrested spread of disease. A significant breakthrough is development of first public sector transgenic Bt cotton variety Bikaneri Narma (BN Bt) for commercial cultivation, and farmers can reuse seeds of this variety year after year.

Breeders seeds 7,162.4 tonnes of centrally released varieties and 2,788.1 tonnes of state-released varieties of field crops were produced. In fish, 1,502.5 lakh spawn of carps, 504.94 lakh fry + fingerlings of carps, 5.1 lakh fry and spawn of catfish, 22.03 lakh larvae of sweet-water prawn, 185.97 lakh larvae of marine prawn, 12.17 lakh seed of ornamental fishes, 12.7 lakh brackishwater fish fry and 848.87 lakh seed of other marine fishes were produced.

Livestock improvement

The XI set of 14 genetically superior Murrah breeding bulls was selected from the participating centres, and test mating was initiated from July 2008. Herds of elite Jaffarabadi buffaloes were established at the JAU, Junagarh, of elite Pandharpuri buffaloes at the MPKV, Kolhapur, and of elite Surti buffaloes at the MPUAT, Vallabhnagar. Under the programme for enhancing mutton production, the twining rate of 37.61% and triplets of 4.27% were achieved in Garole × Malpura sheep.

A demo microarray (biochip) was developed for the detection of economically important viral pathogens white spot syndrome virus (WSSV), monodon baculovirus (MVV) affecting shrimp and Koi herpes virus. *Lactobacillus* spp. inhibited four strains of *Listeria monocytogenes* and showed desirable characteristics for use as a biocontrol (competitive exclusion) culture. Silver barb, *Puntius sarana,* can be used for biological control of insects. Breakthrough in early carp breeding would enable the farmers to have fingerlings by May for stocking and utilize at least five more months as the growing period. Besides, this opens up the possibility of breeding and seed production of carps round the year. *Osteobrama belangeri,* an endemic species of Loktak lake, Manipur, that fetches high price in local market, was successfully bred under controlled conditions. Shrimp *Penaeus semisulcatus* and crab *Portunus pelagicus* seeds were produced in hatchery and sea ranched. Spawning, hatching and larval rearing of crucifix crab *Charybdis feriatus* was achieved for the first time.

Crop management

Groundnut-wheat-greengram cropping system recorded maximum productivity and improved soil nitrogen and organic-carbon. Sesbania as a green-manure crop preceding mustard recorded significantly higher mustard seed yield in the north-eastern Rajasthan and Haryana. An intercropping of pigeonpea and sorghum in 2:1 row ratio on the raised bed planting gave higher yield than flat bed planting.

Modified central leader system of training gave maximum yield in mango orchards at Pantnagar and Pusa. Saba, Karpuravalli and Ney Poovan banana showed normal finger development and fruit filling under salt-affected field (EC 1:2.5 = 3.34) and Nendran and Robusta recorded small and ill-filled fingers. Okra-gladiolus was found best intercropping in litchi (young) orchard, giving net returns of Rs 97,847/ha annually.

In mango, hot-water treatment of fruits at 48±1°C for 1 hour controlled all stages of fruit fly, *Bactrocera zonata* in Dashehari, Langra, Chausa, Amrapali and Mallika. At Gandevi, for sapota a trap named "NAUROH-STONEHOUSE FRUIT FLY TRAP" was designed and produced commercially for orchardists.

Livestock management

For enhancing the fibre digestibility of poor quality crop residues, cellulase gene obtained from the best fibre degrading fungi, was cloned to *Streptococccus bovis,* a predominant bacteria in rumen of crossbred cattle. A mixture of three plant species reduced methane emission by 12% in crossbred calves, showing that there is a potential in using tree leaves for reducing methane production from enteric fermentation. Dual-staining technique that saved time and chemicals, was standardized for testing viability and acrosomal integrity in frozen and fresh semen. The semen production was high in the intensively reared Jamunapari bucks.

A status of freedom from contagious bovine pleuropneumonia infection in cattle and buffalo was obtained from Office International des Epizooties (OIE). The Indian Veterinary Research Institute, Izatnagar, developed an effective PK-15 cell line-based live attenuated freeze-dried vaccine. To improve the diagnosis of foot-and-mouth disease (FMD) in suspected clinical samples, a multiplex PCR (m-PCR) was developed and by using it 42% of the outbreaks that went undiagnosed using ELISA, were identified. A large databank on the livestock diseases of the country, based on reports submitted to the Government of India by various state governments, was developed at the PD_ADMAS. A web-based interactive expert system on animal diseases of the country was developed, and it can be accessed at www.nadres.res.in.

Molecular diagnosis of brucellosis was standardized that helped in differential diagnosis

of *Brucella abortus* and *B. suis*. Molecular epidemiological studies are being standardized to diagnose and differentiate the brucellosis of cattle, ovine, caprine and humans. Molecular studies on BHV-1 were carried out. Occurrence of zoonotic bacterial pathogens from the livestock and livestock products was studied. A computer interface based BHV-1 whole antigen AB-ELISA developed, as per the standards of the International Atomic Energy Agency (IAEA), was standardized and validated. Serum Bank facility at PD_ADMAS has more than 170,000 serum samples from all over the country, which is being used for long-term national surveys on various diseases of economic importance.

Fish production improved by over 60% in reservoirs Dahod in Madhya Pradesh and Pahuj in Uttar Pradesh, through stocking of fish seed and improvement of institutional arrangements for fish catch and marketing. The compatibility of *Labeo gonius* with other major carps revealed that silver carp has higher overall species survival. A low fish meal shrimp feed was developed which could be successfully used for culturing tiger shrimp at low cost of production. The study on prevalence levels of white spot syndrome virus in crabs indicated that they do not pose any additional WSSV risks. Coconut wood of more than 50 years old was used for constructing a low-cost plank built type of canoe for gillnetting in backwaters. The price of coconut wood is less than half of the conventional boat building timber.

Post-harvest management and value-addition

A process was standardized to make osmotically dehydrated slices from papaya variety Taiwan Red Lady. Bittergourd chips were prepared and popularized among rural and urban areas as snack foods. A solar PV mobile unit was designed and developed to provide a complete self-sustained mobile power unit for domestic, small agricultural and other rural applications in isolated cluster of houses (*dhanis*) of arid region. Several sulphur dyes free from banned amines and safe from ecological considerations were used for dyeing jute fabric.

An immuno-diffusion test for detection of adulteration of soymilk in milk was developed. Whey-based oral rehydrating solution (ORS) was developed. A process was developed for manufacturing Quarg, a milk protein paste, from the milk of buffalo. Quarg cheese is of high nutritional value owing to high concentration of proteins and a carrier for probiotic micro-organisms.

Production of heavier broilers has indicated benefits of producing primal cuts, deboned meat and valuable protein at lower cost to benefit producers and consumers. The felts of less than 4-mm thickness were converted into value-added products like jackets and women ruffles. These products are in great demand and can create employment opportunity in rural/unorganized sector.

A method was developed for the preparation of Maricream, essentially a ready-to-eat and highly nutritious product, containing deodorized fish protein. Fish-enriched noodles were prepared to improve nutritional value (protein, calcium and phosphorus) and taste of the market noodles. Sandwich paste was prepared from Sciaenid fish and fortified with EPA and DHA in retortable pouch.

Agricultural engineering and energy management

Tractor-operated machinery developed includes rotary nozzles for mango orchard, chopper-type tynes for power tiller rotavator for sugarcane trash shredding, vegetable transplanter for brinjal, cauliflower and tomato, rotary weeder, farmyard manure spreader; and tractor-mounted includes onion harvester-cum-elevator. Controlled traffic rotary no-till slit drill was developed for sowing of soybean under wheat crop residue.

A manually-operated tool for desuckering and another equipment for desuckering and clump removal for hill banana were developed and well accepted by farmers. Drainage technologies were revelated for the crops sensitive to waterlogging in Vertisols. Parameters were optimized for utilization of paddy straw, kinnow pulp and pea pods for production of cellulases, ethanol and feed supplements. Paddy straw-based bio-methanation system was commissioned.

Agricultural human resource development

For maintaining and upgrading the standards and quality of higher agricultural education in the country, the ICAR continuously providing the professional and financial support to the Agricultural Universities (AUs). Admission of 1,687 students (up to 15% of total seats) in under-graduate (UG) and 1,875 students (up to 25%) seats in post-graduate (PG) programmes were made through central entrance tests to reduce inbreeding and foster national integration.

Besides organizing 61 trainings and capacity building programmes, the National Academy of Agricultural Research Management, Hyderabad, has embarked upon becoming an academic unit and has started two post-graduate diploma programmes, viz information technology management, and IP management.

The IV Deans Committee Report on reforms

in agricultural education has been implemented. The accreditation of 14 Agricultural Universities for assured quality of education was done. For skill development 138 Units were established in 43 universities for Experiential Learning. An ICAR net has been put in place for connecting the libraries of 35 State Agricultural Universities (SAUs), 69 ICAR institutes and 182 off-campus colleges. In order to further enhance capabilities of Deemed Universities and Agricultural Universities, the ICAR has launched a programme to promote Niche Area of Excellence in these institutions. Some important Niche Areas of Excellence include Hi-tech horticulture, Molecular diagnostics of avian diseases, Resource conservation technology, Soil and water management, Biofuels, Buffalo genomics, Arsenic management in soils, Fin-fish farming, Immunodiagnostics, Tropical home gardens and Agro-based nutraceuticals. Besides with the involvement of 180 academicians for over an year, PG course curricula was revised and is expected to be implemented in all the universities w.e.f July 2009.

A new activity on overseas fellowships is put under the continuing HRD programme to develop competent human resources that are trained in the best laboratories in the world (for Indian candidates) and expose overseas candidates to the best of the Indian Agricultural Universities for facilitating future co-operation with these countries. For ensuring quality research technology and human resource development, Rs 421 crore was allocated for modernization of the research farm of the universities. Scientists are being provided training in advanced laboratories in India and abroad to develop core competencies in select areas. Sixty scientists were trained and over 500 are to be trained abroad in 21 frontier areas during XI Plan and about 1,000 scientists are to be trained in the country. With a massive recruitment drive about 500 scientists have joined the ICAR and another over 500 will be joining during 2009 as per the recruitment programme already set in motion.

The model qualifications for various scientific positions under the ICAR were finalized and the number of disciplines for entry level ARS/NET Examination was reduced from 69 to 38 and notified.

Information, communication technology and publicity services

Directorate of Information and Publications of Agriculture has developed on-line scrolling day-to-day news, in addition to regular uploading the issues of *ICAR Reporter* and *ICAR News* on the ICAR web page. World-wide more than 753,039 visitors have browsed ICAR Web page during 2008. Two projects have been approved by the National Agricultural Innovation Project (NAIP): (i) E-publishing and Knowledge System in Agricultural Research – development of on-line electronic publishing and hosting of ICAR publications integrated with e-commerce, and (ii) Agro web – digital dissemination system for Indian Agricultural Research. Some new initiatives were also taken. English and Hindi Editorial Units have brought out 100 publications. E-library facility has been started at the ICAR(Hq). It is using latest information and communication technologies. The ICAR Library has been modernized with information kiosks, internet surfing, on-line catalogue etc. using latest ICT tools.

Technology assessment, refinement and transfer

A total of 520 technologies in various crops, livestock, fisheries, entrepreneurship and family health and nutrition were taken up for 20,002 on-farm trials with network of 562 Krishi Vigyan Kendras (KVKs). The Krishi Vigyan Kendras conducted 18,949 demonstrations on oilseeds spread over 6,379 ha, and 17,301 demonstrations on pulses in 5,433 ha, showing 33.17 and 41.14% more yield than farmers' practice respectively. Besides, demonstrations were conducted on cotton, covering an area of 8,347 ha, benefiting 4,211 and 5,628 farmers directly from demonstrations on production technology and farm implements, respectively, in 1,754 and 5,173 ha. The KVK also conducted 22,334 demonstrations, covering 6,295 ha on other crops, besides 2,168 on livestock and fishery, and 109 on other enterprises.

A total of 35,533 training programmes were organized on various technologies, benefiting 966,142 lakh farmers and farmwomen. Skill-oriented trainings were imparted in different areas of agriculture, benefiting 187,304 rural youth. A total of 3,487 training programmes were organized for 90,398 extension personnel to upgrade their knowledge and skills in frontier areas of agriculture technology. Besides, 6,099 sponsored training programmes were conducted for 232,951 lakh participants from government and non-government organizations.

The Government has recently approved conversion of existing 8 Zonal Co-ordinating Units to Zonal Project Directorates. Further, 28 KVKs in newly created districts and one additional KVK in 50 larger districts for wider coverage of KVK activities have been approved. Provision has been made for e-linkage of KVKs; establishment of facilities, namely the mobile diagnostic-cum-exhibition units; the soil- and water-testing labs; rain-water harvesting structures; the basic plant health diagnostics; minimal processing ; portable carp hatchery; integrated farming system ; and

support to Directorate of Extension of SAUs for knowledge empowerment of KVKs.

National Agricultural Innovation Project

The National Agricultural Innovation Project (NAIP) has made good progress in approving 112 subprojects at a total outlay of Rs 658 crore. Under the project, 28 value-chain models were approved covering niche agro-produce like millets, cotton, pelagic and freshwater fishes, coconut, seed spices, potato, banana fibre, carps and prawns, flowers, pork, maize etc., and 26 rural sustainable livelihood security models were approved covering 82 most backward districts directly benefiting about 83,000 households. Forty-nine Basic and Strategic Research (BSR) subprojects are pursued covering some of the most potential impact making areas like controlling the deadly arsenic problem in food chain, genetic engineering for fixation of heterosis; and 21 projects are in operation under National Fund for Basic and Strategic Research (NFBSRA) since February 2006.

Organization and management

The Budget Estimates (BE) and Revised Estimates (RE) of DARE and ICAR (Plan and Non-Plan) for 2007-2008 are Rs 2,460 crores and Rs 2,337 crores, respectively, and BE for 2008-09 (Plan and Non-Plan) is Rs 2,680 crores. Patents were granted to the ICAR in 11 fields of invention. The world patent search for ICAR as the applicant (at the European free search facility http://ep.espacenet.com), revealed 35 patent records. Policy issues were decided for Guidelines for management of ICAR services and contracts, IPR clearance of collaborative research projects, and Business Planning and Development.

One hundred eleven awardees under twelve different categories were conferred awards. These comprised four Institutions, 103 scientists, 3 farmers and one journalist. Out of 103 scientists there were 13 women scientists.

Partnership and linkages

Work plans were signed with the Islamic Republic of Iran, the Republic of Ecuador for co-operation in agricultural research and education. A total of 208 foreign nationals of 20 countries have completed post-graduate degree programme in ICAR Institutes and State Agricultural Universities. The ICAR in November 2008 also organized an extra-ordinary meeting of SAARC Agriculture Ministers in New Delhi wherein SAARC Declaration on UG 99 was made for addressing the problem jointly. The ICAR hosted a Global Agro-Industries Forum 2008 and about 500 senior delegates and professionals from 111 countries participated and shared world experience in promoting agro-industries for greater profitability of agriculture. A notable feature of the conference was the active participation of Central Ministries of Agriculture, Commerce and Industries, and Food Processing Industries and Directors-General of FAO, UNIDO and President, IFAD of UN. The ICAR has initiated a major programme on agricultural knowledge empowerment of African countries.

The Council is marching ahead to ensure sustainable development of agriculture through technological developments and in this endeavour timely completion of 11th Plan EFC/SFC meetings for all the schemes under ICAR is expected to provide impetus. This will certainly help us in effective implementation of the research and educational programmes and other activities envisaged.

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