Overview

Efforts of the Indian Council of Agricultural Research are aimed at making an increasingly intensified knowledge-based agriculture so that an all-round success is possible in the country. Realizing this urgent requirement several result-oriented initiatives were taken in desired direction. A number of useful techniques and technologies were developed to improve the productivity and quality of the farm produce. Steps were also taken towards institutional capacity building to improve the quality of education being imparted in our State Agricultural Universities (SAUs). An overview of the salient achievements is presented here and the detailed accounts of activities/achievements are presented in the specific sections devoted to each thematic area.

In July 2006, National Agricultural Innovation Project (NAIP) with a total outlay of US $ 250 million was launched. The main features of the project include research on production to consumption system, sustainable livelihood security in disadvantaged areas and basic and strategic research at the frontiers of science. This is considered as the next step towards attaining excellence in science, using science for enhancing rural livelihood security and making agriculture a profitable commercial venture through integration of technology with agricultural economy. The innovativeness of the project lies in its emphasis on holism, integration of basic, strategic, applied and anticipatory research, social re-engineering in terms of consortia mode of operation, and management and combining social, economic, ecological and participatory governance features. We are confident that in conjunction with the intensified on-going research efforts and with the continued co-operation and support of all the stakeholders, the project will prove to be a worthy initiative in transforming Indian agriculture into a commercial venture with enhanced on- and off-farm employment, profitability and livelihood security.

An India-US Knowledge Initiative to explore and work on mutually reinforcing priority areas of agricultural education, research, service and commercial linkage was launched with initial focus on education; food processing, use of byproducts and biofuels; biotechnology; and water management. Work plan was signed in February 2006 and 15 young scientists under Borlaug Fellowship Programme from the ICAR institutes/State Agricultural Universities (SAUs) were deputed to different universities in the United States. Six joint research projects are formulated

and put to implementation.

A National Fund for Basic and Strategic Research in Agricultural Sciences under the chairmanship of Dr C.N.R. Rao with eminent scientists as members has been launched. The initiatives aims to serve as an apex body for providing overall policy framework and priorities for promoting and supporting basic research, building strength in chosen emerging areas of Science and Technology (S&T) and to co-ordinate various scientific departments/agencies for evolving a focused approach and avoid overlapping areas of research and funding. Under the scheme 14 projects have been approved.

The ICAR implemented the Guidelines for Intellectual Property Management and Commercialization of Technologies in the ICAR system with effect from 2 October 2006. This system will facilitate enhanced institutional partnerships in agricultural research and transfer of Intellectual Property Rights (IPR) enabled technologies; protection of IP through patents, plant variety protection and other forms of IPR; safeguarding the animal/fish genetic resources; and allow scientist entrepreneurship in a responsible manner with liberalized incentives. The ICAR has now delegated powers to Directors of the ICAR institutes to file patent applications under the Intellectual Property Rights. Thirty-eight new patent applications have been filed.

The ICAR had the privilege to host three major international events to promote research collaboration and partnerships among countries/organizations in different parts of the world. These were 2nd International Rice Congress, inaugurated by Hon'ble Prime Minister; The Third Triennial Conference of Global Forum on Agricultural Research (GFAR) inaugurated by His Excellency, the President of India, and Asia Pacific Association of Agricultural Research Institutions (APAARI) Expert Consultation on Linking Farmers to markets inaugurated by Hon'ble Agriculture Minister. The events witnessed participation of nearly 2,000 delegates representing nearly 100 countries and several International Agricultural Research Organizations/Institutions. Besides, the Council signed MoUs with several countries including China during 2006 for co-operation in agricultural research.

The ICAR not only enhanced its resource generation substantially but also received Rs 46 crore as Matching Grant from the Ministry of Finance towards the resources internally generated. A system of electronic remittance of funds has been operationalized in 56 institutes reducing the time lag from 5–10 days to 1 day. Eighty per cent of the audit paras pertaining to the period 1985–86 to 2004–05 have been settled during the year 2005–06 as a result of a concerted drive. About one-third of our institutes are free from any audit para. The reform process is on.

Crop sciences: Collection and conservation of germplasm is essential for improvement of crop. During the year 2,607 accessions of crops and their wild relatives have been collected through 34 explorations, and 25,847 accessions were introduced. Besides, 579 accessions of fruits and nuts and industrial crops have been cryopreserved. During this year, over 45 improved varieties of cereals and forage crops have been released. In commercial crops, two hybrids of cotton and four varieties of tobacco have been released. Two hybrids of castor, DCH 519 and Sagarshakti, having high oil content and enhanced resistance to biotic stresses have been released. Four varieties of soybean (PS 1347, DS 98-14, JS 95-60 and PRS 1), two hybrids of safflower (NARI-H 15 and JSF 99), two varieties each of niger (JNC 1 and JNS 9) and linseed (Sharda and LMS 9-2 K), six varieties of sesame and a sunflower hybrid (DRSH 1) were released during the year. Besides, the first CMS-based hybrid MRSA 521 of safflower has been identified for release. Drought tolerance was enhanced in greengram through *in-vitro* shoot regeneration. A protocol was standardized for *in-vitro* micro-propagation of elite provenances of *bhimal* (*Grewia optiva*). New rice variety CSR 36 for salt-affected areas of Haryana and Pondicherry and *raya* variety CS 54 were developed for saline/alkali soils. Test Guidelines for Distinctness, Uniformity and Stability more for economically important crops were developed raising their number to 35. During the year 5,026 tonnes of breeder seeds of major crops have been produced. Designed and developed a polymerase chain reaction (PCR)-based diagnostic kit using *Ustilago scitaminea* specific primer sequences for detection of incipient infection of smut disease of sugarcane. The diagnostic kit is highly sensitive and is useful in production of healthy seed cane and tissue culture-raised plantlets. Validated integrated pest management (IPM) protocols in Pusa Basmati 1, Baghpat (Uttar Pradesh), Taraori Basmati, Panipat (Haryana) and in Dehraduni Basmati, Dehradun (Uttarakhand). IPM technologies for mustard and groundnut crops were validated in Navgaon (Alwar) and Sriganganagar and rendered 17 to 24 per cent higher yields than Farmer Practice.

Horticulture: Software for grape germplasm information and disease forecasting for powdery mildew management in grape were developed. An advanced generation hybrid papaya with high keeping quality was developed. Three potato varieties, viz. Kufri Surya, Kufri Arun and Kufri Chipsona, were released. A highly sensitive PCR technique was developed to detect potato leaf curl. High-yielding triploid hybrids of cassava, Sree Athulya and Sree Apoorva, were recommended for industrial areas of Tamil Nadu. A reproducible protocol for regeneration of plantlets in cassava was standardized. A technology for making light colour chips from tubers was standardized. Geriatric health drinks from cassava and arrowroot starches were made. Aonla beverage was developed in

the form of juice with attractive colour, appealing flavour and smell. Pusa Gaurav rose was found best for cut flower production. Aluminum sulphate along with sucrose was found to increase vase-life of roses. A total of 86 coconut germplasm types were collected. New cashew Bhaskara was released. A protocol for *in-vitro* fleshy root formation in Safed Musli was standardized. Black peppers stored in vacuum showed good quality even after 8 months of storage. Varied levels of curcumin were observed in ginger and turmeric. Sequence analysis has confirmed the identity of virus causing mild chlorotic mottle and streaks on leaves of vanilla. A software package for identification of medicinal and aromatic plants was developed. An eco-friendly strategy for the management of the coconut eriophyid mite involving nutrient management, organic manuring, and botanical pesticides has been developed and popularized among the coconut growers through the state departments of horticulture and agriculture in Karnataka, Tamil Nadu and Kerala.

Natural resource management: Soil resource survey and mapping of 12 districts of 8 states was done for land-use planning, and 254 atlases for 22 districts in Andhra Pradesh were generated. Soil loss maps generated for Andhra Pradesh and Orissa are useful in soil-conservation measures and prioritizing the implementation programme and resource allocation.

Minimum tillage with crop residue treatment proved beneficial in conserving natural resources and increasing productivity under rainfed conditions in Doon Valley. In Western Rajasthan, surface run-off of about 20–22% of cropping seasonal rainfall and soil loss of nearly 1.5–2.0 tonnes/ha due to water erosion could be reduced to 14–16% and 0.7–1.1 tonnes/ha, respectively, with the help of grass barriers (*Veteveria/ Saccharum/ Cenchrus/ Dichanthium*). Resource conservation technologies, viz. double no-till, leaf colour chart and brown manuring, were found effective in increasing profitability of rice-wheat system. Multiple uses of water showed the highest income (374.13%) from fish in dug-out pond and horticulture on dykes, followed by fish in dug-out secondary reservoir (234.53%), compared to rice and wheat with fish refuge in the centre (6.18%). The impact of water harvesting and recharge filters in Antisar Watershed, Vasad (Gujarat), was enormous and resulted in mitigating drought impact, and in improving crop productivity. Bio-drainage species of *Acacia* and *Casuarina* can be grown for reclamation of waterlogged wasteland.

Research in nutrient management led to mitigation of reduced soil carbon stocks in intensified cropping system, correction of boron and sulphur deficiency with a new boron source granular borax and new sulphur source gromor sulphur bentonite, respectively, and sustenance of higher productivity of maize-niger cropping system in acid soils of high altitude.

Profitable winter maize-based diversified cropping systems, agroforestry systems for different agroclimatic regions and fruit crop-based multi-tier cropping systems were identified. Cultivation of amaranth proved a commercially viable proposition and a good source of protein for farmers in arid Kachchh. The vegetative propagation of *Jatropha* through stem cutting has been standardized. Jatropha-forage grass (*Aeluropus logopoides*) was found suitable intercropping system for biosaline agriculture. Drought management software has been developed for Andhra Pradesh.

Animal Sciences: The rapidly upcoming poultry sector in the country received a big setback, as it was struck with bird flu caused by deadly H5N 1 virus. The ICAR accorded high priority to develop a vaccine against the bird flu. As a result of concerted efforts a cost-effective vaccine has been developed using cell culture rather than chick embryos, in a short span of 3 months. The trials of vaccine indicate its superior efficacy over the imported vaccine.

The first mithun calf in India was born through artificial insemination. Elite herds of Nili-Ravi, Surti, Jaffarabadi, Bhadwari, Pandharpuri, Godavari buffalo breeds were established under Network Project on Young Bull Production. Body weight at birth in Garole × Malpura sheep showed 64% improvement. Krishibro broilers has become popular for intensive farming on low input, in areas having demand for colour broiler.

Animal disease surveying revealed that foot-and-mouth disease (FMD) returned to Andaman and Nicobar islands after a lapse of 16 years, and infection has gone from mainland. Polymerase chain reaction (PCR) was developed for determination of lineage of the type Asia 1 field isolates of FMD. At the Project Directorate on Animal Disease Monitoring and Surveillance (PDADMAS), BHV 1 genome was detected in peripheral blood leucocytes, aborted materials etc. A blue tongue virus vaccine was developed, which gave promising results in local and Bharat Merino sheep.

In clinical cases of diarrhoea a herbal medicine was found effective. Various essential oils completely paralyzed *Gastrothylax crumenifer, Haemonchus contortus, Fasciola hepatica* and *Gigantocotyle explantum*. *In-ovo* vaccination in broiler chickens was standardized. Species specific molecular markers were developed for identification of species from remnants of body parts or tissues, which is important for wild life forensic.

Thematic maps depicting district-wise information on feed and livestock resources were prepared. Anifeed supplementation in ration of lactating crossbred cows improved milk yield by 10.16%.Vitamin E-selenium injections improved udder health of cows. Supplementation of 2% activated charcoal in the diet of lactating cattle reduced residual pesticide in milk. *Pleurotus ostreatus* fungi proved

efficient in lignin breakdown of ragi straw. Extracts of *Allium sativum* reduced methanogenesis without affecting *in-vitro* digestibility. Zinc sulphate-treated soybean cake enhanced protein utilization in buffaloes. Byproducts based complete feed was prepared for intensive goat production. Feeding of complete blocks to lactating camels improved their milk yield. Earthworm meal proved an alternative ideal animal protein source for poultry. Formic acid (1%), propionic acid (1%), lactic acid (1%) and fumeric acid (0.5%) in quail diet proved suitable dietary alternate for antibiotic feed supplement.

Isolation and partial purification of buffalo hormones, viz. buFSH, buLH and buPRL, were completed. Embryos of transferable stage were successfully produced using oocytes derived from *in-vitro* grown prenatal follicles—apparently first report in buffaloes. Kids of 5.5 to 7.0 months of age showed fully developed thermoregulatory mechanisms. First yak calf was born through embryo transfer technology.

Methods for preparation of several milk products were standardized. A test was developed for detecting detergent in milk, and it helps in detecting adulteration of milk with synthetic milk. Herbal ghee was prepared; it has sensory response similar to market ghee. Shelf life of mango *lassi* was enhanced. Mozzarella cheese was developed from Jamunapari goat milk using starter culture method. Process was developed for use of chicken neck in value-added meat products. Technology developed for preparation of different products from mithun meat. Black pepper extract proved an effective preservative for chicken gizzard snacks. Different products of very high quality were prepared from mithun leather.

Fisheries: In marine sector, nearly 77 species of non-conventional deep-sea demersal finfishes, shell fishes and other organisms were recorded. Dense and profuse growth of deep-sea glass sponge *Hyalonema* sp. indicated great commercial value, as the bio-silica extracted has wide applications in medicinal field. Besides, eight species of deep-sea shrimps also indicated commercial concentrations. Indian mackerel showed signs of recovery from the progressive decline in catches experienced since 2001.

Under inland sector, different management practices were suggested for each zone in the river Ravi *vis-à-vis* fishery restoration due to the impact of changes in water flow. The other work carried out led to mapping of water bodies for 15 districts of Orissa and all districts of Rajasthan, development of biotic integrity index for reverine ecosystem, standardization of methods for detection of microbes having capacity to degrade trichloroethylene, and evaluation of performance of ascorbic acid in diet containing it as an antidote for pesticide in common carp. In culture fisheries, significant achievements were—the multiple breeding of *Labeo fimbriatus* in peninsular rivers, development of sexual maturity in *Puntius pulchellus*

under captivity, possibility of incorporation of silver barb in grow-out carp culture system, successful breeding and mass seed production of highly relished fish pabda (*Ompok pabda*) in North and Eastern regions, significant breakthrough in upscaling the captive breeding of *Chitala chitala,* artificial propagation of catfish, *Pangasius pangasius* for diversification of aquaculture and effective tagging with visible implant elastomer taggs in juvenile *Macrobrachium rosenbergii* in freshwater aquaculture. Development of formulated feed for grow-out culture of mud crabs and upscaling of seabass seed production were the important findings of brackish water aquaculture.

In mariculture, seed production technology of orange clown, false clown, blue damsel, spot damsel and humbug damsel has been standardized. Mabe pearl production technology was extended to the blacklip pearl oyster *Pinctada margaritifera* at Port Blair. The work in fish harvest and processing technology resulted in : successful erection of eight community fish smoking kilns for benefit of fishermen community, effectiveness of fibre glass reinforced plastic as a physical barrier for chemically treated wood for boat construction in reducing leaching, estimation of presence of bioactive substances having analgesic healing properties in the roots of *Eichhornia crassipes*, development of eco-friendly tunnel fish dryer, preparation of high value products from fish and fish-processing waste, preparation of ready-to-cook freshwater fish streaks from *Labeo rohita* and fabrication of fish meat-bone separator.

In area of fish genetic resources, important achievements have been completion of DNA barcodes of 32 marine fish species for the first time in India, isolation and characterization of more than 36 microsatellite markers from rohu genome, cloning and characterization of vitelogenin cDNA in catla, purification and characterization of a ß-glucan binding protein from *M. rosenbergii*, and PCR-based gender identification of marine mammals.

Agricultural engineering and technology: Many new farm implements and tools were designed and improved upon to achieve higher efficiency of farming operations/processes by making them user friendly. Some of these are lug wheel puddler for high speed shallow puddling of rice, rotary furrower/trencher for crops like sugarcane or for drainage or conveying water, twin auger digger sugarcane planter, garlic planter, flail-type forage harvester-cum-chopper were the implements developed as tractor-operated machinery. Air-assisted seed drill and groundnut digger were fabricated as power tiller-operated machinery. Biasi cultivator was developed by modifying light weight rotary tiller under self-propelled machinery. Prototype feasibility testing was carried out successfully for new machines/implements.

Renewable energy technologies development resulted in fabrication of solar

tunnel dryers, high rate anaerobic treatment system for dairy effluent, floating dome type biogas plant for solid state digestion of cattle dung, biogas burner for community applications and industrial scale solar drying of fruits and vegetables. The gasification of jute caddies briquettes may provide a new avenue for cogeneration of heat and power to meet industrial need by waste recycling and management.

Development of belt and chain conveyer feeding system reduced drudgery of workers during feeding of harvested crop in the high capacity thresher. The work carried in area of post-harvest technology led to development of: cleaner-cum-grader for light seeds, curry leaf stripper, rotary maize cob sheller, hand-operated aonla picking machine, cryofreezer seed pelletizer and HCl gas-based cotton seed delinting plant. Besides, process parameters for hulling of pigeonpea were optimized. Pulse beetle disinfestations of stored pigeonpea, chickpea and greengram could be done using eco-friendly thermal and vacuum techniques.

Agricultural human resource development: A special grant of Rs 200 crore for strengthening infrastructure facilities in SAUs and Rs 100 crore to the Punjab Agricultural University (PAU) was approved. The scheme for Experiential Learning, i.e. setting up of facilities for hands on training in SAUs was launched. The financial amount of National Talent Scholarships for the students admitted against 15% seats at undergraduate level, was enhanced from Rs 700 per month per student to Rs 1,000 per month per student. Similarly, the rates of Junior Research Fellowships (JRFs) and Senior Research Fellowships (SRFs) were enhanced and brought at par with Department of Science and Technology (DST) rates. To improve the quality of education and upgradation of skills, Deans' Committee was constituted, report received, national and international interaction held including brain-storming session in India involving over 30 distinguished professions/ academicians of the USA and Vice-Chancellors of all SAUs to improve our agricultural education further. It is hoped that contemplated improvement would go a long way in providing a cutting-edge in human resource development.

Educational Technology Cell at the ANGARU, Rajendranagar, Hyderabad, first of its kind in the country, was inaugurated. A very positive development was a high percentage of placements of our students from Dairy Technology, Food Technology, Engineering and Technology, Agriculture and Home Science. Agro-industrial Tie Up programme was launched at the TNAU, and students were trained in marketing. A training module for gender sensitization in agriculture was prepared. Skill training needs and interests of women Self-help Groups (SHGs) were identified for their entrepreneurial development. A training programme on Entrepreneurship Development among farmwomen was developed at the National Research Centre for Women in Agriculture (NRCWA),

Bhubaneshwar.

Agricultural extension: Additional new Krishi Vigyan Kendras (KVKs) were sanctioned in rural districts thereby raising their number to 541. A new Framework for Technology Development and Delivery System in agriculture was prepared where the processes right from basic and strategic research to technology generation and transfer to the end users are in a continuum.

The KVKs conducted 4,109 on-farm trials involving 537 technologies on varietal evaluation, nutrient management, insect and pest management, cropping system, weed management, resource conservation, and farm implements and tools. Activities at KVKs organized were—frontline demonstrations on oilseeds, pulses, cotton and other important crops; training programmes for farmers, skill-oriented programmes for rural youth and in-service personnel; creating awareness about improved agricultural technologies; production of seeds of cereals, oilseeds, pulses and vegetables, saplings/seedlings of fruits, vegetables, spices, medicinal plants, ornamental plants, plantation crops and forest species; fingerlings; biofertilizers, biopesticides, baculoviruses, neem oil and bioagents (Cards) for availability to the farmers.

Hill and tribal areas: At the ICAR Research Complex for NEH Region, Umiam, climatic atlas was prepared covering all growing seasons. Plant regeneration and transformation protocol for pigeonpea was developed. Abbot, a kiwi fruit variety, was propagated in Sikkim and Arunachal Pradesh. Raised and sunken bed technology was developed for increasing cropping intensity in marshy lands. Protocol for sex diagnosis of ducks was developed. Captive breeding of chocolate mahseer was achieved.

At Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora, during the year under report nine varieties of different crops were released. At the VPKAS, Almora, a user-friendly low cost (Rs 570) light trap was designed for efficient mass trapping of white grub that causes severe economic loss in crops. At the Central Agricultural Research Institute, Port Blair, the breeding lines and somaclones of Annada developed *in situ* produced 6 and 8 tonnes/ha respectively. Gas exchange parameters were measured in maize cultures Seedtech 22324, VL Makka 16 and X 3342, grown in hill slopes. Molecular characterization of *Dioscorea vexans,* an important endemic medicinal plant species, revealed ample genetic divergence among diverse collections. The developed IPM module for brinjal reduced the damage to the extent of 74.52%. Plant growth promoting *Rhizobacteria* (PGPRs), i.e. *Pseudomonasi* spp. and *Bacillus* spp., were isolated and characterized biochemically. Supplementation of propionate chelated organic trace minerals significantly improved the daily milk production in crossbred cows. Turkey birds were found highly suitable under hot and humid climate of the

Islands ecosystem. Azolla (*Azolla pinnata*) an aquatic fern was found to be good feed supplement for livestock and poultry. Diverse fishery resource of Andaman and Nicobar Islands were documented. Economic status and scope of dairy farming in Andaman and Nicobar Islands was analyzed.

Organization and management: The Council has taken several new initiatives to improve working environment and to make research effective, efficient and relevant. Full powers were delegated to the Directors of the Institutes to sanction foreign deputation cases under approved projects. Towards right-sizing the manpower at the Headquarters, about 20 per cent posts of Assistant Directors-General have been redeployed to the field. A committee is also looking into personnel and promotion policy of scientists. The Council amended the composition of ICAR Society and the Governing Body. Now, Secretary, Department of Biotechnology (DBT) and Director-General, Council of Scientific and Industrial Research are also its members. Scientists in the private sector/international organizations are also being invited as members on Research Advisory Committees of the institutes.

Scholarships were awarded to the meritorious wards of the Council's employees under Staff Welfare Fund Scheme. During this year, 57 awards under 13 different categories have been conferred, honoring nine institutions, 42 scientists and their 57 associates, six farmers and one journalist. Out of 42 scientists, there are 11 women scientists and one farm woman.

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and
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