Overview

The Indian Council of Agricultural Research is surging ahead to provide scientific and technological support for enhancing production and productivity for sustainable agriculture through innovative approaches. Through its research, education and extension programmes, the Council is committed for transforming Indian agriculture primarily from food self-sufficiency to enhancing profitability. Enhanced production coupled with productivity spurts has led the country to witness a record production of foodgrains during the year, with the support of technological interventions and an enabling policy environment.

The research and development programmes during the year has armed the ICAR with the preparedness to meet future challenges, especially the prospective global climate change *vis-à-vis* depleting and degrading natural resources. A 'National Initiative on Climate Resilient Agriculture' is a noteworthy step in this direction which is being initiated in XI Plan. Realising the importance of sharing of knowledge across stakeholders, the Council took several initiatives to harness the potential of Information and Communication Technology (ICT). The programmes on entrepreneurship and skill development have been accorded priority with the objective to catalyse the commercialization of technologies on a larger scale.

Some of the initiatives and salient achievements of the ICAR during the year under report are elucidated.

Soil and water productivity: The GIS-based soil-fertility maps, using soil-test data, were prepared for 500 districts spread over 21 States of India. The data revealed that the soils of most of the districts have low to medium amount of nitrogen and phosphorus and medium to high amount of potassium. Thematic maps were prepared for the areas climatically suitable for raising *kharif* potato in India and growing seed crop in the north-eastern states. A Decision Support System for precise application of nutrients (N) was developed for facilitating location-specific nutrient management. For improving the water productivity, the existing ridge and furrow was modified for *in situ* rain-water harvesting (10% than the earlier 1% of rain) that increased the castor yield by 30%. For north-west states where decline in groundwater levels is alarming, the individual farmer based technologies on groundwater recharge, integrated farming and laser leveling/improved irrigation, have led to improvement in rice and wheat yield by 8-12 % and saving in irrigation water by 18-21%. Soybean seed yield increased with integrated nutrient management option with biofertilizers by 18% over balanced fertilization and 54% over farmers' practice.

Farming system: An Integrated Farming System Component Selection Model was developed, which is useful in taking decision about selection of integrated farming system (IFS) components based on expected profit under the prevailing constraints and also to suggest beneficial IFS components from profit as well as land and water productivity point of view. In Bundelkhand, adoption of integrated watershed-management interventions has almost doubled the fodder production, making the area fodder surplus and thereby achieving enhanced milk productivity from buffalo by 33% and cows by 40%.

Climate change: A new scheme 'National Initiative on Climate Resilient Agriculture' was conceptualized to address the problems related to biotic and abiotic stresses. The elevated CO_2 (550 ± 50 ppm) influenced growth and development, physiological and biochemical aspects in greengram variety K 851. The amount of carbon sequestered by oil palm hybrids ranged from 17.98 to 38.10 tonnes/ha, with hybrids from Papua New Guinea and Ivory Coast sequestering the highest and lowest carbon contents respectively. Studies under the ICAR Network Project on Climate Change revealed that Naked neck birds performed significantly better than the normal birds with respect to thermo-tolerance, growth, feed conversion efficiency and immunity at high temperatures.

Genetic resources: During 32 explorations undertaken in 21 States of India, 1,785 accessions were collected and added to the repository. These included 976 accessions of wild species. Also, 32,617 accessions were imported from 37 countries; including international trial material (6,127) and transgenics (132) for utilization in crop improvement programme. Genetic stocks with promise for inclusion in crop improvement programmes were specifically registered with Bureau; these included barnyard millet (1), *Gossypium arboreum* race *cernuum* (3), wheat (4), soybean (5), maize (20) and sorghum (19).

More than 360 accessions of mango, banana, coconut, cashew and potato were added to the genebank for further utilization in the improvement programme. *Musa textilis*, known for banana fibre, has been introduced for the first time in India. *Solanum verrucosum* was identified to have high yield and resistance to late blight. Over 140 new accessions of cassava, sweet potato, *Alocasia*, *Xanthosoma*, *Colocasia*, yams and minor tuber crops were collected from Jharkhand, Lakshadweep islands and Wayanad in Kerala. Sixteen land races of cassava with good chip-making quality were identified, of which Ci-24 had low cyanogens and was free from symptoms of cassava mosaic disease. Eighty-seven accessions of cassava were evaluated for drought tolerance, of which 34

were found tolerant. In black pepper, 2,595 accessions are being conserved. Fourteen endangered species of medicinal plants were rescued from different parts of the country; these have been planted and characterized for phenotypic and genotypic traits.

The mtDNA-based phylogenetic tree confirmed the unequivocal classification of Manipuri buffaloes as true swamp type. Phenotypic characterization of new breeds/populations, in case of Konkan Kanyal goats, Ramnad White sheep, Chevaad sheep and Bhutia or Bhotia ponies, was completed. Genetic profiling of important indigenous sheep breeds revealed poor resolution of individual breeds in the north-western arid and semi-arid regions but clear separation of the breeds of Eastern and Southern Peninsular region.

Large-scale spat production of green mussel (*Perna viridis)* was achieved for the first time in India. Sixteen polymorphic microsatellites were identified from *Pampus chinensis* to be used in *P. argenteus* and *Parastromateus niger.*The presence of 5S rDNA clusters on more than one pair of chromosomes in *Tor mosal ahanadicus* can be used as a marker for species identification and germplasm conservation.The first report of differential gene expression profiling of white spot syndrome virus infection in *Fenneropenaeus indicus* provided new insight into the shrimp immune system.

Twenty-three surveys for collection of variability in agriculturally important micro-organisms were undertaken in 12 States. Thermophillic micro-organisms were isolated and characterized from hot spring environment, and grown in the temprature range of 40-60^{o}C. Likewise, psychrophillic micro-organisms were isolated and characteraized from extreme cold conditions, and grown in the temprature range of 4-6^{o}C.

Crop improvement: Fifty-two varieties/hybrids of crops including major food crops of rice, wheat, maize, pearl millet and pulses have been released/recommended for cultivation in different agro-climatic regions of country.

Significant results under crop improvement include identification of Karan 5 (mid-late maturing) and Karan 6 (early maturing) varieties of sugarcane for commercial cultivation in Punjab, Haryana, Rajasthan and western Uttar Pradesh. CNHO 12 cotton, spinnable at 20s counts and suitable for manufacturing denim, has been identified for release in irrigated areas of the Central Zone. *Desi* variety CISA 614 of cotton has been notified for commercial cultivation in Punjab, Haryana and Rajasthan. Eleven released varieties of wheat showed resistance to Nilgiri flora of black and brown rusts. Adzuki bean variety HPU 51 was found promising, with 24.5% protein. Nine lines of groundnut showed tolerance to drought. One drought-responsive promoter from sorghum was characterized into tobacco. In case of microbes, 381 bacteria, 35 fungi, 104 cyanobacteria and 28 phytoplanktons were isolated, showing tolerance to a wide range of abiotic stresses such as moisture, cold, heat, salinity and anoxia. During the year, 629 tonnes of nucleus seed, 9,554 tonnes of breeder seed, 7,745 tonnes of foundation seed, 3,471 tonnes of certified seeds and 10,443 tonnes of truthfully labelled seed were produced.

Four varieties, namely Thar Mahi of sword bean, Thar Kartiki and Thar Maghi of Indian bean and Thar Bhadavai of clusterbean, were released for arid area of western India. Potato hybrid, JX 576, was released as Kufri Gaurav for north-western plains.

Saba and Monthan cultivars of *Musa balbisiana* were found as drought tolerant ones. Oregon Spur, Star Krimson, Red Fuji, Red Chief and Silver Spur cultivars of apple recorded higher fruit yield (25-30 tonnes/ha). Among 12 early-maturing apple cultivars evaluated for fruit yield and quality, Mollies Delicious and Vista Bella recorded the highest yield of 21.1 and 17.30 tonnes/ha, respectively, with TSS above 14^{o} Brix and were found very suitable for mid- to high hills. Multiple-disease resistant (LCV, bacterial wilt, early blight, root-knot nematode) line of tomato was found promising. Microsatellites developed for *Piper* species were successfully used to detect polymorphism in its cultivars. Rose cultivars Valentine, Summer Snow Saratoga and Canadian Centenary (floribundas) and Small Virtue and Rise-n-Shine (miniatures) showed flowering during summer months. A male-sterile plant of *ashwagandha* was identified for the first time.

Livestock improvement: The use of superior (crossbred Frieswal) bulls contributed to genetic improvement of field crossbred animals. Under Field Progeny Testing 81,560 semen doses of genetically superior Murrah buffalo bulls were disseminated to farmers and other agencies involved in buffalo development programme in the field. Elite herds of Nili-Ravi, Jaffarabadi, Surti, Bhadawari, Pandarpuri and Swamp buffaloes were established. The F_1 crosses of indigenous pigs Ghungroo and Hampshire ($H_{50}G_{50}$) showed high heterosis for all the production parameters. The newly developed C1 cross could be another promising dual-purpose variety for rural poultry production, with body weight closer to Vanaraja and 72 weeks egg production similar to Gramapriya (233). At 33rd Random Sample Poultry Performance Test, Caribro-Dhanraja bird attained 1.5 and 1.9 kg body weight at 6 and 7 weeks of age with corresponding FCR values of 1.45 and 1.65 respectively.

A protocol for fullsib and halfsib family production of *Macrobrachium rosenbergii* was developed and standardized. In a study, first of its kind, chitosan (CN) and gold-based salmon LHRHa (S LHRHa) hormonal nanoparticles were formulated for effective delivery of the hormone for spawning of a cyprinid fish (common carp), which can serve as an alternative for the commercially available inducing agents. *Cobia (Rachycentron canadum),* a marine fish, was successfully induced bred in captivity for the first time.

Crop management: A soybean *Rhizobium* isolate showed thermo-tolerance with capability to enhance nodulation, proline content and trehalase activity. In

wheat, nine Lr genes (Lr1, 3, 10, 13, 14a, 23, 24, 26, 34) were characterized in 145 lines; 10 Sr genes (Sr2, 5, 7b, 8a, 9b, 9e, 11,13, 24, 31) in 157 lines; and five Yr genes in 74 entries. Pigeonpea genotypes IPA 8F, IPA 16F, IPA 204 and BSMR 736 revealed multiple disease resistance against wilt and sterility mosaic. Lentil genotypes PL 01 and PL 02 also showed multiple disease resistance for wilt and rust over the years.

Eco-friendly bird management practices, at farmers' fields of Nalgonda and Mahaboobnagar districts of Andhra Pradesh, showed that fodder maize as screen around the main crop (maize) gave higher yield (2,025 kg/ha), followed by wrapping method (1,983 kg/ha) compared to the check (1,543 kg/ha). Use of artificial nest boxes of different sizes for cavity nesting birds showed successful breeding of 12 bird species. Barn owl breeding was successfully completed in the specially developed artificial nest boxes in Kerala.

The seedling populations of Almond variety Waris, having poor yield and quality, could be rejuvenated with different pruning intensities, fertilizer doses, water-harvesting structures and grafts of commercial varieties. In arid regions, drip irrigation at 0.75 cumulative pan evaporation (CPE) and micro-sprinkler at 1.00 CPE gave best growth in kinnow and *ber*. In walnut, scion wood taken from middle portion recorded the highest grafting success (90%) in wedge graft under polyhouse done during middle of March; 15th March being the best date for maximum graft success. The low-cost polyhouse or polytrench showed ideal environmental condition for the maximum success owing to better humidity and ideal temperature than open field. An intercropping of ash gourd, pumpkin or amaranth in coconut orchard gave higher yield of coconut (124 nuts/palm/year).

In oil palm, direct embryogenesis without callus phase was obtained from cotyledonary nodes of germinated immature zygotic embroys. The globular embryos with clear suspensor region appeared directly on the explants and multiplied. An intercropping of *Vetiveria zizanioides* in juvenile black pepper garden recorded the maximum net return (Rs 46,225), followed by *Alpinia calcarata* (Rs 44,600) with a benefit : cost ratio of 2.3 and 2.2 respectively. Perennial *Stylosanthes* was found to be a suitable fodder legume under coconut in root (wilt)-affected areas for higher fodder production. Three genotypes of cardamom, namely IC 349591, IC 349537 and IC 349550, were found relatively tolerant to moisture stress. For monitoring health of seeds and plants, a dipstick kit was developed for use by farmers to check the presence of virus.

Incorporation of three co-evolved parasitoid species, namely *Anagyrus loecki, Acerophagus papayae* and *Pseudleptomastix mexicana* from Peurto Rico, is at an advance stage of research for classical biological control of aggressive papaya mealybug (*Paracoccus marginatus*).

Livestock management: Arecanut sheath (having less lignin, silica and more calcium, sulphur and copper) could be an alternative to paddy straw in feeding sheep and dairy animals owing to its better nutritional value. Supplementing curry and bael leaf powder had positive effect in restoration of cyclicity and fertility in acyclic goats and buffaloes. *Pipli* (*Piper longum*), *hing* (*Ferula assafoetida*) and lemongrass (*Cymbopogon citratus*) oil proved potent antifungal herbal compounds against *Aspergillus parasiticus* in poultry feed under *in vitro* condition. Feeding detoxified *karanj* cake to Krishibro chicks improved performance as compared to feeding cake as such. Heat stress in broiler chickens could be ameliorated through supplementation of vitamin C and potassium chloride in the diet.

Polyunsaturated fatty acid feeding reduced the lipid peroxidation and improved the frozen semen fertility in buffalo males. In female buffalo calves, supplementation of higher dietary energy (through bypass fat) showed a positive effect on early and better luteinizing hormone secretion and ovarian follicular activity. One of the five proteins, specific to uterine secretions of pregnant buffalo, could be used as a marker for early pregnancy diagnosis to monitor pregnancy and prevent early embryonic mortality. Successful pregnancy from artificial insemination with extended semen is reported first time in Indian dromedary camels. The first mithun calf was born at farm-gate level through artificial insemination (AI) technique using cryopreserved semen from genetically superior mithun bulls. Semen collection by 'Gloved Hand Method' and AI technique were standardized for pigs, and by using AI technology the highest litter size (15 piglets) at birth was recorded from a Ghungroo sow in a farm.

The current in-use foot-and-mouth disease (FMD) vaccine strain IND R2/75 is still the best and covers all the type O circulating outbreak strains in the country. The Project Directorate on FMD is designated as FAO Regional Reference Laboratory for South Asia. FMD sero-monitoring and sero-surveillance in the South Asian Association for Regional Co-operation (SAARC) region is being initiated through a FAO programme 'Diagnostic Laboratory Network Coordination for FMD Surveillance and Vaccine Evaluation in South Asia'. Indirect-ELISA was standardized for screening porcine brucellosis, one of the most important emerging zoonoses. Chitosan-coated cationic PLG nanoparticles were tested for transfection efficiency and could be safely used for delivery of DNA vaccines. Magnetic nanoparticles were synthesized and evaluated for cellular toxicity in *in vitro* experiments. Genotyping and partial sequencing of rotaviruses from man and pigs revealed human-pig reassortants as well as the presence of novel combinations in India. Use of the potent peste des petitis rumenentis (PPR) vaccine brought down the number of outbreaks of PPR and resulted in 50% reduction in economic losses. The adoption of adequate sanitary measures helped in prompt containment of glanders in equines in the affected States. The updated equine influenza vaccine proved effective in protective immune response in equines.

Cadalmin *Varna* feed, the state-of-the-art in aquatic

feed, forms an important step to speed up growth of high-value marine ornamental fish culture or aquariculture in country, as it will cut down the maintenance cost incurred on feeding. Growth, survival, protein efficiency ratio were significantly higher and feed conversion ratio was significantly lower in shrimps fed with feed supplemented with live cellulolytic bacteria compared to control feed.

An improved diagnostic nested RT-PCR with custom-designed primers targeting RdRp gene of Laem-Singh Virus (LSNV), which has been implicated in monodon slow growth syndrome (MSGS), in shrimp, was developed. During 2009 the contribution of mechanized, motorized and artisanal sectors to capture fisheries was 74%, 22% and 4% respectively. Habitat fingerprinting technique using Otolith was useful in determining nursery area affiliation, population structure, and movement of individual fish.

Post-harvest management and value-addition: A multi-tier rack growing system for tender wheat shoot cultivation and also a pilot plant for production of tender wheat shoot powder were developed to facilitate its availability round the year. The storage life of mango, sapota and custard-apple could be extended without any chilling injury at 8-12°C by modified atmosphere packing with semi-permeable film. A technology was revelated for utilization of waste generated by mango-processing industries at finished pulp stage. A dietary mango fibre (50 mesh size) was extracted from the waste and incorporated in biscuits. These biscuits are low in calories, rich in antioxidants, vitamin C, high in dietary fibre and have shelf-life of more than six months. Oil of high cosmetic value comprising fatty acids, namely plamitic, stearic, oleic, linoleic and myristic acids, was extracted from mango kernel. To utilize the industrial waste like pulps, slicer fines, chips, peel and rejected potatoes, compounded animal feed pellets were developed which are easy to handle.

A handloom was developed with jacquard shedding arrangement to weave jute-based ornamental fabrics as well as traditional cotton *saris* or fabrics from 100% jute yarn as well as jute-blended yarns. A novel jute man-made fibre blended composite structured woven geotextile was developed which is suitable for construction of plain cement concrete road. A cost-effective supply chain mechanism was evolved for collection, cleaning, chipping and transportation of cotton stalks from fields to the factory.

An appropriate technology was developed for the manufacture of good quality feta cheese from buffalo milk with enhanced functional attributes. A technology was also developed for preparation of shelf-stable low calorie artificially sweetened whey lemon beverage which is a highly nutritious dairy product containing lactose, protein, minerals and water-soluble vitamins.

Camel milk powder was prepared by lyophilizing the raw, pasteurized and boiled camel milk. Simple consumer-friendly and commercially viable goat meat *murukku* and *nimkee,* shelf-stable meat snacks, were developed to address the nutritional concerns of snack foods. Functional chicken nuggets with low salt, low fat and high dietary fibre were developed without any adverse effect on sensory and technological attributes.

Agricultural mechanization and energy management: A number of implements were developed/redesigned as power-operated, animal-drawn and self-propelled machinary for carrying out farm operations. A power-operatated, pneumatically controlled bud chipping machine was developed for chipping the buds in sugarcane, having a capacity of 1,200 buds /hr compared to 550 buds/hr in the padal-operated unit. Usage of eight-row power-operated rice transplanter with the covering capacity of 0.2 ha/hr resulted in reduction of 82 labourers/ha and economic saving of 50%. To overcome the drudgery involved in splitting coriander seed and losses in terms of seed damage, a power-operated machine with 60 kg/hr capacity was developed. An animal-drawn engine-operated sprayer was developed, suitable for pigeonpea and cotton, which is an improvement over the traditionally used two-spray gun sprayer. A self-propelled tractor-driven straw reaper with trailor was redesigned, with straw collection container mounted over the reaper itself, to improve field maneuverability and simplify loading and unloading. A sleeve boom intra-canopy spraying system was developed for enhancing efficiency of spray depositing on target plants. High capacity chaff-cutter-cum-blower loader was found suitable for chaffing fodder crops and residue ranging from soft stemmed crops (berseem, cenchrus, napier) to stiffer stemmed crops (maize, sorghum, oats).

Jute nail weeder (with 5-6 nails) could control 80% of weeds in 4-30 days after their emergence. Net benefit of this system was Rs 3,000-5,000/ha over the manual weeding twice. Non-selective application of herbicides between crop rows using herbicide brush reduced the composite weed flora 80% between rows and saved Rs 4,000-5,000/ha compared to manual weeding twice. Only one hand weeding was required to control remaining 20% weed between rows.

Solar tunnel dryer of the single span arc polyhouse type was developed and tested. In the solar tunnel dryer the drying rate of croaker, anchory and ribbon fish varieties with and without salt treatment was higher than under open sun drying. Low density polyethylene-lined small bunds were found quite effective in providing supplemental irrigation to horticultural/ vegetable crops in hilly areas. The supplemental irrigation from such tanks increased the productivity by 14.7-27.8% in different vegetables.

Agricultural human resource development: Twenty-five new Experiential Learning Units were added to the existing 220 Units in 49 universities, to develop entrepreneurship skills amongst students. Niche Area of Excellence was also supported at 30 locations to achieve global competence in agricultural research and education. In order to reduce inbreeding, 1,694 students in Under-graduate and 2,122 students in Post-graduate were admitted through centralized admission by ICAR. Besides continuation of the ICAR

International Fellowships, new India-Africa Fellowship and India-Afghanistan Fellowship programmes were initiated and 43 candidates from 19 countries started their post-graduate education in India.

Agricultural economics and statistics: The concept of Neighbour Balanced Block (NBB) designs was defined and a method of constructing rotatable designs for fitting second-order response surface in the presence of neighbour effects was developed. In Uttar Pradesh, district level weather-based models for forecasting potato yield provided better forecast than zone level, and it is feasible to obtain reliable forecasts about three/four weeks before harvest. A centralized statistical and computational genomics laboratory facility was created for analysis of genomic data. A database on core collection of germplasm for rice, cucumis, lathyrus and mothbean was designed and data are being populated (http://bioinformatics.iasri.res.in/BAMAST/BAM.html).

Information, communication and publicity services: The Council adopted the open access policy for research journals, namely *The Indian Journal of Agricultural Sciences* and *The Indian Journal of Animal Sciences*. These journals were also made on-line under E-PKSAR Project (NAIP) and now there are 4,746 registered users in 47 different countries across the world. The visibility of the ICAR website on internet has increased several folds, attracting on an average more than 150,000 visitors per month with 45% new visits. Visitors from 184 countries (4,746 cities) across the globe browsed the website; its various value-added services, such as news/press releases, video films, photo gallery, newspaper clippings, weather based agro-advisory, virtual tours, recent publications and many other features.

A monthly newsletter *ICAR Mail* in English and *ICAR Chitthi* in Hindi has been started. Besides, *Agribiotech,* a quarterly news, in 13 languages was also launched and being mailed to various stakeholders for creating awareness about biotechnology. The ICAR has developed a tie-up with Prasar Bharati to telecast ICAR films. Under the national knowledge network, nine research institutes/SAUs were connected. Under AGROWEB-Digital Dissimination Systems for Indian Agricultural Research uniformity guidelines were developed for content, look and feel of the Institutes' websites; these have been implemented in eight institutes. The Council participated in 20 national level technology fairs/conferences to showcase its technological strengths and knowledge products.

Technology assessment, refinement and transfer: The ICAR through Krishi Vigyan Kendras assesses, refines and demonstrates the technologies/products developed by its institutions. During the year, 1,819 technological interventions were assessed by conducting 18,013 trials on various crops in 4,501 locations. In case of livestock, 238 technological interventions were assessed in 610 locations at the farmers' fields.

A sum of 86,979 frontline demonstrations, covering an area of about 28,000 ha, were organized for skill development. Mobile advisory services were initiated in 300 KVKs for narrowing down gap between technology generators and end-users. Internet connectivity was provided to 192 KVKs and all eight Zonal Project Directorates to have access to global e-content on agriculture.

Hon'ble President of United States of America, Mr Barack Obama, visited the agricultural EXPO on 6 November 2010, organized jointly by CII and USAID in Mumbai on the theme "Tools and implements for drudgery reduction of farm women workers". He took keen interest and appreciated the women-friendly tools and implements developed by the ICAR.

Research for tribal and hill regions: The Institutes located at Almora, Umiam and Port Blair evolve technologies to meet the needs of tribal and hill farmers. Four varieties, namely two varieties of maize, one variety each of wheat and millet, were released for cultivation. Eighteen accessions of coconut were collected from South Andaman including three dwarfs and a *makapuno* type. Package of practices for table-purpose groundnut in coconut plantation was standardized, which suggested that seed production can be taken in coconut plantations with pruning practices. In two sponges, namely *Crella cyathophora* and *Plakortis* sp., collected from Andamans, more than 75% of the associated bacteria exhibited significant antimicrobial activity against the selected pathogens.

IP portfolio management: Fifty-seven patent applications were filed, 30 published and seven granted to the ICAR. Besides, 11 plant variety title applications were filed, 109 published and 81 granted. Five trademarks were also secured by ICAR institutes to distinguish its products. In the ICAR-Industry Meet organized during 28-29 July 2010, 168 industry participants attended the meet.

Awards and incentives: Under 11 different categories 130 awardees were conferred awards comprising four institutions, 122 scientists and three farmers. Out of 122 scientists who received awards, 10 were women scientists.

Partnership and linkages: The Indian Council of Agricultural Research (ICAR) and Department of Agricultural Research and Education (DARE) signed an MoU with Kansas State University, Manhattan, USA and one Work Plan with International Water Management Institute for Scientific and Technical Co-operation. Besides, one collaborative project was implemented in collaboration with University of Saskatoon, Canada. India will be contributing US $ 0.5 million under Window I and US $ 2.36 million under Window III by the end of the financial year to CG Institutes.

National Agricultural Innovation Project: This Project is bringing various stakeholders together for sustainable development of Indian agriculture. Consortium for e-Resources in Agriculture (CeRA) is providing free online access to more than 2,900 international journals and 124 libraries of the NARS. Ten Business Planning and Development (BPD) units,

five each in ICAR and SAU system, were established for commercialization of technologies. A production technology was developed for *jowar* flakes for nutritional improvement. These flakes are suitable for all age groups, especially people ailing from diabetes and obese conditions owing to the presence of slowly digestible starch in it. A technology was developed for preparation of pearl millet flour-based whey protein-enriched biscuits. A technology was also developed for the manufacture of extruded snack (*kurkure*-like product) that contained 13% protein and 2% fat, compared to commercially available similar products containing about 6% protein and 32% fat. Colours and their combinations from natural sources like flowers, bark, leaves, etc. have been developed for use as natural dye for textile industry and this could reduce the use of chemical dye. Complete genome sequence of an Indian strain of Potato Virus X has been generated for the first time. PUSA-ELISA kit for detection of Groundnut Bud Necrosis Virus (GBNV) has been commercialized.

With the repositioning of its approach towards entrepreneurship and livelihood security, the Council has made a strong commitment for the socio-economic transformation of the Indian rural population. The research programmes, educational initiatives and extension activities have been reoriented to meet the objective. Efforts were made to ensure free flow of knowledge crossing all the barriers in the way. I am pleased to indicate that the Department's performance against the commitments made in the Results-Framework Document (RFD) for 2009-10 had been commendable, as it had achieved the highest composite score among 59 Government of India Departments covered under the first phase of RFD Policy during the year. I wish to record my sincere thanks and regards to Hon'ble Union Minister of Agriculture and Hon'ble Union Minister of State for Agriculture for their constant support, encouragement and participation in various activities of the DARE/ICAR. I acknowledge the cooperation of various ministries, international organizations and stakeholders for their keen interest in the programmes and support to ICAR initiatives for further strengthening agricultural research and development in the region. I hope the steps taken by the Council will steer the Indian agriculture to new level in terms of profitability and value.

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and
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