1. Overview

Indian agriculture saw growth in all its dimensions during the year 2011-12 with a record production of foodgrains, fruits, vegetables, milk, meat, eggs and fish. The agriculture and allied sectors achieved a compound growth rate of 3.3% during the XI Five Year Plan which is higher than the 2.4 per cent registered in the X Five Year Plan. The year 2012 saw intense activity for the Indian National Agricultural Research and Education System (NARES), in terms of completion and consolidation of programmes of the XI Five Year Plan, introspection of the path we travelled and interactions for the way ahead. The year that went by posed challenges, with an erratic monsoon, drought-like situation in some parts of the country as also cyclones impacting agriculture. The technological backstopping by the ICAR institutes helped the farmers in their efforts to overcome the impact of these natural calamities. Some of the salient research achievements and new initiatives of DARE/ICAR during the year are as follows.

The ICAR has commenced establishment of Indian Institute of Agricultural Biotechnology, Ranchi and National Biotic Stress Management Institute, Raipur. The proposal for establishment of a Central Agricultural University for Bundelkhand Region was initiated. Five new Krishi Vigyan Kendras (KVKs), one each in the states of Andhra Pradesh, Odisha, Rajasthan, Karnataka and Maharashtra, were established.

Soil and water productivity

To account for and bring out the variability of land, soil and hydrology agro-ecological subunits in Kerala were delineated within an agro-ecological unit. The maps and reports highlight the potentials and problems of agro-eco unit of each district, that can be used as a base for planning agriculture and allied sectors in the state.

An innovative model of groundwater sharing aimed at enhancing water productivity in the Ranga Reddy district of Andhra Pradesh was evolved. This intervention not only avoided competitive digging of bore wells by the local farmers but also helped improving cropping intensity (150%) and water productivity (1.25-5.4 kg/ha-mm) besides ensuring judicious use of groundwater (achieving higher water productivity per unit groundwater by crop diversification). The NABARD and Department of Rural Development, Government of Andhra Pradesh are mainstreaming this application in the state.

Farming system

An integrated farming system (IFS) model for the resource poor farmers of western Uttar Pradesh was designed, which yielded a net return of ₹1 lakh from 0.70 ha of land (after fulfilling household food and nutritional security requirements). The system components included field crop, horticulture, apiary, dairying and vermicomposting units besides boundary planting of multipurpose trees. Recycling of crop residues and farm wastes accounted for a saving of 4,500 by offsetting the cost of chemical fertilizer application.

A new variety of rice, CSR 43, released for sodic soils of Uttar Pradesh, could withstand sodicity up to pH ~ 9.9 and showed yield potential of 3.5 to 4.0 tonnes/ha in sodic soils, and also saved irrigation water. The direct-seeded rice yielded at par with transplanted rice, saved 20-25% water, 40-50% diesel, 25-30% electricity and 25-30% labour. Rice transplanted with wheat-residue incorporation or transplanted after green-manuring was most remunerative, where irrigation water was not a constraint. An integration of fungal pathogens *Curvularia lunata* and *Alternaria alternata* with insect bioagent *Neochetina bruchi* effectively managed water hyacinth in and around Jabalpur, Madhya Pradesh.

Climate change

Under the National Initiative on Climate Resilient Agriculture (NICRA), technology demonstration was taken up in 100 vulnerable districts of the country. Increasing rainwater-harvesting capability along with crop production-supporting activities brought in new energy into NICRA villages. Land shaping and harvesting rainwater helped successfully reclaim lands affected by sea-water inundation due to Aila cyclone in South 24 Parganas, West Bengal.

Genetic resources

Forty explorations of crop plants were undertaken in 20 states and 2,676 accessions including 371 of wild species were collected. In the National Genebank, 6,550 germplasm accessions of orthodox seed species found place for long-term storage and 26 accessions of non-orthodox species were cryo-stored and 28 were added to *in vitro* culture.

In fruit crops, 55 mango accessions were morphologically characterized as per the International Descriptors. Grape germplasm was strengthened by adding seven new accessions, taking the total number

to 464. In pomegranate, 15 accessions were collected from Maharashtra and Odisha.

Black pepper accessions (236) were collected from Idukki, Sabari Hills and Goodrickal ranges in Kerala including two endangered species, *Piper barberi* and *P. hapnium*. Ninety-five core collections of cardamom germplasm were profiled using 25 ISSR and three microsatellite markers.

Complex genome of potato (*Solanum phureja*) was deciphered by a consortium of 26 international institutes including Central Potato Research Institute, Shimla.

Breed Registration Committee of the ICAR approved nine new populations, viz. Pulikulam cattle, Kosali cattle, Malnad Gidda, Kalahandi buffalo, Konkan Kanyal goat, Berari goat, Ghoongroo pig, Niang Megha pig, Spiti donkey, of indigenous farm animals as breeds. Presently, there are 144 registered indigenous livestock breeds, comprising 37 breeds of cattle, 13 of buffalo, 23 of goat, 39 of sheep, six of horses and ponies, and eight of camel, two of pig, one of donkey, and 15 of chicken.

Mahseer (*Tor tor*) inhabits mountaneous streams to fast-flowing rivers and was first time reported in the plains from Penganga river. A fish, *Pinniwallago bhagirathiensis* sp. nov. and a prawn *Macrobrachium hooghliense* sp. nov., were described and reported as new to science. *Hippocampus kuda*, an endangered fish species, was collected from Kakdwip area, being the first record of sea horse species from the riverine section of Hooghly estuary.

Crop improvement

Over 90 new varieties/hybrids of crops were released for different agro-climatic regions of the country. A six-row malt-barley variety DWRUB 64 was recommended for cultivation in the north-western plains zone (Punjab, Haryana, western Uttar Pradesh, Delhi and Rajasthan) in irrigated late-sown areas. Three new varieties of sugarcane, viz. Co 0403 for peninsular zone, and Co 0237 and Co 05011 for north-west zone of Punjab, Haryana, Rajasthan, Uttarakhand and Uttar Pradesh, were released.

Application of arbuscular mycorrhizal fungus, *Glomus mosseae* enhanced groundnut yield by 13%. Of the newly isolated groundnut rhizobia RH11, RH17 and RH20, inoculation with RH11 was found best in enhancing pod yield of TG 37A. Treatment of Him Alsi 2 linseed with *Bacillus subtilis* during retting resulted in fibre softness, fineness, higher yield and less retting time as compared to conventional retting process.

Multigene cassettes were developed for imparting tolerance against *Botrytis*, a major disease in castor. Soybean seed treatment with *Trichoderma viride* @ 6 g/kg seed was found most effective in increasing the seed germination (15.71%), reducing the seed rot causing pathogens (72.73%) and seedling blight (87.50%). Storage of wheat and paddy seeds in 40% CO_2 environment provided complete protection against *Rhizopertha dominica* up to nine months and against *Sitotroga cerealella* up to six months, respectively.

During the year, 9,838 tonnes of breeder seed, 13,228 tonnes of foundation seed, 20,541 tonnes of certified seed, 14,860 tonnes of truthfully labelled seed and 4,437 tonnes of planting materials were produced to meet the requirement of different States.

Two varieties of chilli, namely Kashi Sinduri for Karnataka, Tamil Nadu and Kerala and Kashi Gaurav for West Bengal and Asom, one hybrid of tomato Kashi Abhimaan for Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Uttar Pradesh and Bihar, were notified by the Central Varietal Release Committee. Three onion varieties, viz. Bhima Shubra for Maharashtra; Bhima Shweta for Delhi, Uttar Pradesh, Haryana, Bihar, Punjab, Madhya Pradesh, Chhattisgarh, Odisha, Maharashtra, Karnataka and Andhra Pradesh; and Bhima Shakti for Delhi, Uttar Pradesh, Haryana, Bihar, Punjab, Rajasthan, Gujarat,Madhya Pradesh, Chhattisgarh, Odisha, Maharashtra, Karnataka and Andhra Pradesh; one garlic variety Bhima Purple for Delhi, Uttar Pradesh, Haryana, Bihar, Punjab, Maharashtra, Karnataka and Andhra Pradesh were released. In pear, two high-yielding sweet and juicy Kashmiri Nakh selections, namely CITH-Nakh 1 and CITH-Nakh 2, were collected and maintained in field gene bank. In palms and nuts, three coconut varieties IND 045S, IND 048S and IND 058S, two arecanut varieties VTL 62-Shriwardhan selection and VTL7 Nalbari, and two selections of cocoa VTLC 1 and VTLC 57, were identified for commercial cultivation.

Livestock improvement

Ovum pick-up technique followed by *in-vitro* fertilization resulted in the birth of first cattle calf (named Holi) through this technique. This technology will be useful for harnessing valuable germplasm from infertile and aged dairy cattle. “Mohan” became the first mithun calf to be born through embryo transfer technology from a cryopreserved embryo. The technology of freezing goat semen for artificial insemination was standardized. Quality embryos were flushed from a superior Sirohi goat and transferred to non-descript goats, resulting in the birth of four kids. These findings demonstrated the potential of multiple ovulation embryo transfer technology (MOET) for fast multiplication of superior germplasm. A Barbari doe produced a record number of 13 kids in three kiddings (including two quintuplets) under field conditions. Introduction of superior genetic resources facilitated conservation of indigenous goats with considerable

enhancement in the income of goat keepers, ensuring better nutritional and livelihood security.

India joined the elite group of countries engaged in satellite tracking of yellow fin tuna (*Thunnusal bacares*), a migratory marine fish. These tags provide fisheries-independent measure of the straight-line distance traveled from the point of tagging. A new working module was developed to enhance the fish production in Dimbhe reservoir, Pune, Maharashtra through community co-management.

Crop management

In Odisha rice-potato-sesame cropping system showed the highest production efficiency and low-lying land utilization efficiency, while rice-maize-cowpea system was found the most economical one. Nitrogen applied just before irrigation resulted in higher wheat yield than its application after irrigation, and application of nitrogen in three splits was better than two splits. To maximize productivity in malt barley, row spacing of 18 cm with seed rate of 100 kg/ha was recommended in normal as well as late-sown conditions of the north-western plains zone.

In groundnut, irrigation at 6-day interval through drip and 15-day interval with check-basin method saved 15.4 and 26.0% water over 4-day interval through drip and 15-day interval under check-basin respectively. Maize-wheat-mungbean and pigeonpea-wheat systems showed a significant increase of 11 and 10% in organic carbon, respectively, and of 10 and 15% in soil microbial biomass carbon compared to maize-wheat system. Under moisture stress, *Mesorhizobium ciceri* strains, 13 and 30 enhanced yield of chickpea cultivar RSG 888 up to 27% and 20% respectively. A talc-based dry formulation of microbial consortium was developed for easy handling and use in farmers' fields and it could ret jute within 13-15 days with fibre strength of 27.8 to 29.9 g/tex.

Sugarcane bud-chip was developed and standardized for quick multiplication of quality seed-cane as well reducing quantity of seed-cane required per unit area. It ensures seed multiplication rate of 1:60 in comparison to 1:10 under the conventional method.

Nucleopolyhedrosis virus (NPV) was isolated for the first time from spotted pod-borer, *Maruca vitrata* in India under natural epizootic conditions in early pigeonpea. Eighteen chickpea lines screened against six races of *Fusarium oxysporum* f. sp. *ciceri* under artificially inoculated sick-tank conditions were found to possess multi-race resistance. Seven variants of *Fusarium udum* were identified and their distribution maps were prepared. The collections from Uttar Pradesh has all the seven variants, followed by Maharashtra, Karnataka (6 each), Madhya Pradesh, Bihar (5 each), Andhra Pradesh, Rajasthan (4 each), Haryana (3), Tamil Nadu, Jharkhand (2 each) and West Bengal (1). *Beauveria bassiana*, introduced as an endophyte in tossa jute (*Corchorus olitorius*), reduced the stem weevil infestation in white jute (*C. capsularis*).

An area-wise pest management in pigeonpea and chickpea was implemented through IPM awareness campaigns in conventional and electronic media and through the establishment of the National Pest Reporting and Alert System, covering more than 35,000 ha in five major pulse-growing states of Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh.

Intercropping of vegetables in eight year-old mango orchard proved beneficial, as it yielded 19.38 tonnes/ha brinjal and 2.88 tonnes/ha of mango; besides yields of bottle gourd (13.54 tonnes/ha), cauliflower (9.23 tonnes/ha) and cabbage (8.50 tonnes/ha), especially during pre-production phase and off-year in mango. This provided additional income to the mango farmers who were doing monocropping of mango previously.

Significantly higher yields of cowpea (11.45 tonnes/ha) and tomato (34.98 tonnes/ha) were achieved with zero tillage on permanent ridges and residue retention, compared to conventional tillage with flat planting and residue removal. Seed-pelleting techniques for onion, tomato and carrot were standardized. Pelleted onion, carrot and tomato seeds could be stored for three months under ambient conditions without reduction in seed germination and vigour. A dual purpose carrier-based microbial product, containing N-fixing, P- and Zn-solubilizing; and plant growth-promoting microbes, was developed and commercialized, where farmers need not apply two different products separately.

An organic farming package was developed for production of black pepper, ginger and turmeric by applying farmyard manure, vermicompost, ash, rockphosphate, *Azospirillum* sp. and phosphobacteria, and *Trichoderma* sp. and *Pseudomonas* sp. as biocontrol agents for disease control.

Decision support systems, namely Plausible Potato Growing Seasons Estimator (PPGSE) and Yield Estimator, developed for spatial and temporal diversification of potato cultivation, provide information on the growing seasons and their durations, climatic features of seasons and estimated yield potential for important locations in India.

Surveys on species composition of mites attacking Nagpur mandarin and bioagents revealed the presence of three species of phytophagous mites, namely *Eutetranychus orientalis, Brevalpus pheonicis* and *Polyphagotarsonemus latus*. The strains endo *Metarhizium anisopliae*-66 caused 76% banana stem weevil mortality and strain endo *Beauveria bassiana*-32 resulted in 54% corm weevil mortality. Two formulations of fungal pathogens, viz. *Metarrhizium*

anisopliae and *Beauveria bassiana*, showed efficacy at par with chemicals like Thiamethoxan and Acephate in effective management of grape thrips. PCR-based diagnosis was developed for quick detection and identification of phytoplasma infecting cucurbitaceous crops, viz. ash gourd, bitter gourd, bottle gourd and cucumber. Invasive mealy bug, *Phenacoccus solenopsis* is emerging as one of the major sucking pests in vegetable crops. The major biological control agents identified for this invasive pest were nymphal endoparasitoids *Aenasius bombawalei* and *Promuscidea unfasciati* and their cumulative parasitization was 22.35%.

Livestock management

The refined livestock feed resources database for cattle and buffaloes was launched. This provides information on large and small ruminant and poultry population and requirement vs availability of dry roughage balance, concentrates, dry roughages and greens in different states. A matrix of 712 feed resources, containing information on composition, mineral topography, rumen degradable and undegradable protein contents and amino acid profile, was developed.

The equation developed for estimating methane production, based on the nutrient composition of feed ingredients, revealed higher per cent methane of the fermented gas in concentrates than straw. Medicinal and aromatic plants such as *Clerodendrum inerme*, *Gymnema sylvestre* and *Sapindus laurifolia* showed the potential to suppress methanogenesis, which would help in development of new additives in ruminant feed formulations.

Artificial lighting in the poultry houses, using longer wavelength light (red spectrum-675 nm), improved the egg production in layers by about 8%. Naked neck broiler CARIBRO-Mritunjai showed better tolerance to heat stress.

India was declared rinderpest-free country. It is a major milestone towards ensuring enhanced livestock productivity, food security and livelihood of livestock owners. Diagnostics were developed for infectious bovine rhinotracheitis (IBR) virus, peste des petits ruminants (PPR) virus, bluetongue, coccidiosis etc.

Unique horn cancer-specific ligand sequences were identified for developing horn cancer-specific peptide nano-delivery vehicle. An analysis of cumulative disease data indicated — gradual decline in the occurrence of anthrax; 4.58% prevalence of PPRV antibody in cattle and buffaloes in different parts of Southern peninsular India; and highest mortality by trypanosomiasis. The complete genome of the Japanese encephalitis virus (JEV) strain JEV/eq/India/H225/2009(H225) was sequenced to decipher the genetic characteristics. The analysis indicated H225 to be a highly virulent strain and the study confirmed that it is associated with clinical cases in equines in India.

The m-KRISHI®-Fisheries mobile service was developed to disseminate potential fishing zone (PFZ) and wind advisories to fishers in local language. Satellite data on thermal and wind speed as well as algal movement were utilized to provide exact location of PFZ areas to reduce excessive fuel consumption in search of fish.

Mechanization and energy management

A two-row tractor-mounted inter-row site-specific herbicide applicator was developed in which laser sensor registers the presence of green weeds. This signal operates a solenoid actuated flow control valve which permits herbicide spray at the points where needed. A power weeder suited for cassava, developed by improvizing a commercial light weight mini roto-tiller, is light in weight (13 kg) and has a field capacity of 0.2 ha/day and weeding efficiency of about 90%.

A hydraulically operated three-wheel self-propelled platform system was developed for harvesting mango, oranges, oil palm, etc. capable of keeping the operator at various heights ranging from 1.8 to 6 m. A tractor-mounted pick positioner having a movable platform fitted on a tractor, with double acting hydraulic cylinder, was developed in which a person can be hoisted to a height of 9.6 m for harvesting fruits and pruning trees. One person could harvest about 120 kg aonla fruits/ hour.

Commercially available Chemperi model climber was modified to provide additional safety by locking the machine to the tree trunk. The attachment provides full safety to the climber during operation and also reduces the fear of height and risk of falling. Patent application has been filed for this device. A pilot scale non-electric pyrolysis unit of 2 kg capacity was developed for conversion of biomass into charcoal.

Post-harvest management and value-addition

A cost-effective and import substitute autoclavable system was evolved for microencapsulation of sensitive functional ingredients, i.e. bacteriocins, enzymes, nutraceuticals, probiotics and prebiotics, for food and feed applications. It can produce microcapsules of particle size of 100-1,000 µm.

Insulated and ventilated freight container suitable for transport of fruits and vegetables over long distance, was designed. The National Horticulture Board tested the design of container for transport of various fruits and vegetables through railways, and the train with these containers is named 'National Horticulture Train'. A fruit and vegetable grader of 2 tonnes/h capacity was developed for grading apple, guava, mango, sapota, citrus, tomato, onion, potato etc. with grading efficiency

of more than 92%. A coconut-fibre segregator was fabricated, with outturn of 50-60 kg/h, for grading coconut fibres into various grades. These graded fibres can be used selectively according to the product need or blended with other fibres for making value-added products. A polyhouse technique was developed for walnut, in which walnut plants were ready for transplanting in field after a year instead of four years.

A new eco-friendly hydrophobic finish for cotton fabrics was developed using zinc oxide nano particles, silicones and organic acid. The treatment was durable up to 20 hand washes with spray rating of 70, indicating good hydrophobic characteristic. The fabric also accorded protection from the harmful effects of ultra-violet rays (UPF rating 50) present in the light.

A sensitive test was developed for detection of detergents in milk, that can detect adulteration in less than five minutes. The low-calorie strawberry polyphenol fortified stirred dahi showed high antioxidant activity and total phenol content and was acceptable up to two weeks when stored at 7–8^{o}C. Dahi proved a good source of lactic acid bacteria in processing of fermented meat. Oat and milk based probiotic fermented product showed potential in rat trials to fight type-II diabetes. Super-chilling and vacuum packaging technology was developed for enhancing quality and shelf-life of buffalo meat steaks.

An edible oyster (*Crassostrea madrasensis*) peptide-based nutraceutical, OPex was developed that has potent antioxidant capabilities to protect cells from lipid peroxidation and deleterious membrane structure changes. Exploration of new sources of secondary metabolites from seaweeds led to the designing and development of green algal extract (GAe), a nutraceutical, to combat inflammatory diseases such as joint pain and arthritic conditions.

Agricultural Human Resource Development

The National Information System on Agricultural Education Network in India (NISAGENET) became operational which provides country/state/university/college level reporting on agricultural education in India (http://nisagenet.iasri.res.in). Under ICAR International Fellowships, which were started to develop competent human resource and showcasing the strengths of Indian ICAR-AUs system, 75 fellowships were given to the African nationals and 115 to students of Afghanistan for pursuing Masters' and Ph.D. programmes in Indian agricultural universities. ICAR International Fellowships were provided to seven Indian candidates for Ph.D. programmes in overseas universities.

Agricultural economics, marketing and statistics

Grain outlook model and oilseed model were developed for generating advance information on medium- and long-term projections on economic variables, viz. likely demand, production, trade and prices of important agricultural commodities. These models are capable of undertaking sensitivity analysis and simulations under alternative policy and technological scenarios. In future, it is targeted to integrate both grains and oilseeds models dynamically, so that each model takes inputs from the other model and gets converged simultaneously.

Pigeonpea microsatellite database (pipemicrodb) based on chromosome- as well as location-wise search of primers, is available at http://cabindb.iasri.res.in/pigeonpea/. This is the first database of pigeonpea marker in the world with 123387 STRs extracted in silico from pigeonpea genome. It will help in selection of desirable traits, such as high yield, resistance to a particular disease and other traits that will benefit the crop in a long run. These markers will be of immense use in marker assisted selection which would help to overcome approximately 50% loss in pigeonpea productivity due to biotic and abiotic stress in India as well as many parts of the world.

For precise comparison of treatment effects in presence of neighbour effects, neighbour balanced designs were developed. The efficiencies of these designs are quite high indicating that these are fairly robust against missing observations and ensure that no treatment is unduly disadvantaged by its neighbour(s).

Technology assessment, refinement and transfer

Five new Krishi Vigyan Kendras (KVKs), one each in Andhra Pradesh, Jammu and Kashmir, Odisha, Maharashtra and Karnataka, were established, raising the total to 631 KVKs across the country. In crops and livestock, 328 technological interventions were refined under different thematic areas in 395 locations. Besides, five women-specific income-generating technologies were also refined in eight locations. As many as 73,175 frontline demonstrations were undertaken on cereals, millets, oilseeds, pulses, and other important crops; 4,710 on improved tools and farm implements; 14,390 on livestock; and 5,991 on other enterprises including gender-specific technologies Under the National Initiative on Climate Resilient Agriculture (NICRA), 26,218 demonstrations were also carried out.

Over 65,000 training programmes were organized for capacity building in which nearly 18 lakh farmers, farm-women, rural youth and extension personnel participated. Over five lakh extension programmes/activities were organized to create awareness about improved technologies and to provide timely advisories to farmers. About 1.47 lakh short text messages were transmitted to 11.14 lakh farmers for timely actions through Kisan Mobile Advisory. Besides, Voice Mail Services to farmers was also attempted by a few KVKs.

Technological information was provided to 3.13 lakh farmers through print and electronic media and 2.60 lakh farmers were given technological products, viz. 88,077 q seed, 13.30 lakh seedlings/saplings, 3.41 lakh livestock, 3.79 lakh poultry birds and 1,172 q bio-products through the Agricultural Technology Information Centres.

Research for tribal and hill regions

New varieties, viz.Vivek Maize Hybrid 39, VL Lahsun 2, VL Mandua 347, VL Tamatar Hybrid 1, VL Shimla Mirch Hybrid 1, VL Cherry Tamatar 1, VL Shimla Mirch 3 and VL Tamatar 5, were notified/ released for various agro-climatic regions of the country. In place of traditional plough, VL Syahi Hal was developed for hilly areas, which is light in weight (<14 kg) and can be used for ploughing as well as leveling the fields. Colocasia-coriander-tomato and colocasia-onion-frenchbean cropping systems were found suitable in the North-Western Himalayas for higher energy-use efficiency and per unit energy productivity respectively.

Geo-referenced soil fertility mapping of macro- and micro-nutrients undertaken in 13 priority districts of Asom can be utilized for optimization of nutrient supply for better crop production and for regularizing supply of nutrients during crop season. A short-duration RCM 13 rice line, having low amylose content (11.70%), was found suitable as contingent variety for pre-*kharif* /early *kharif*/main *kharif* condition and different cropping systems in the Manipur region. Akhanphou, a popular local rice cultivar of Manipur, possessing high resistance to leaf blast under uniform blast nursery, was found to possess four major blast-resistant genes (Pita/Pita2, Pi40, Pi54 and Pi2). It also showed tolerance to low phosphorus conditions. Two candidate genes IPS1 and CAX2 were identified for improving aluminium toxicity tolerance in rice.

Indigenous leafy vegetables, *Mukia maderaspatana* and *Limnophila chinensis*, were identified and 64 species of medicinal and 19 of specialty flowers were collected from Island system and maintained in the gene garden at CARI, Port Blair. Deepika, an improved dual-purpose Nicobari fowl showed higher adult body weight and annual egg production with better survivability. Herbal products, namely Gromune (Tonic) and Morical feed supplement, were prepared from the fruits of *Morinda citrifolia*. Feeding of Gromune @ 15 ml/bird improved immunity and Morical @ 4% in feed supplement enhanced 24% egg production in Japanese quail.

The coral reefs in Andaman were monitored to study the coral recovery and reef fish diversity after the 2010 mass bleaching phenomena. All the sites showed significant increase (11%) in live coral cover. Abundance of *Chaetodontids* and *Pomacentrids* decreased with decrease in coral cover while that of *Acanthurids* and *Scarids* (predominantly algal grazers) increased.

IP portfolio management

Over 200 partnerships were developed by 39 research institutes with 120 public and private organizations, resulting in an earning of over Rs 640 lakh. Concerted efforts made by 30 research institutes led to filing of 96 patent applications during the year, raising the cumulative number to 716. Eight national patent applications were granted, besides two international applications — An Artificially Synthesized Peptide (in collaboration with DBT) and A Process for the Production of Organic Formulation of Bio-Pesticides *Pseudomonas florescens* — granted by United States Patent and Trademark Office (USPTO). Three copyrights were obtained for Monograph Hadamard Matrices, Monograph Q-designs and Expert System for Maize Crop (Maize AGRIdaksh).The cumulative total of varieties granted registration rose to 326. The technologies generated at the ICAR institutes are being transferred/commercialized through Memoranda of Understanding (MoU), licensing agreements, and consultancies/contract research/contract service to various stakeholders, and thus, about 165 such partnerships were developed by 20 research institutes with around 118 public and private organizations.

Awards and incentives

Under 16 different categories, awards were conferred to three Institutions, one All India Coordinated Research Project, nine Krishi Vigyan Kendras, nine farmers, one journalist, four teachers and 56 scientists including 5 women scientists.

Partnership and linkages

The Work Plans between ICAR and International Water Management Institute and International Rice Research Institute were signed during the year. Collaborative projects, viz. Global yield gap and water productivity between Independent Science and Partnership Council of the CGIAR, University of Nebraska, Lincoln and ICAR; New knowledge and innovation food design leading to sustainable development of the Agro-food sector and decreased poverty between Anand Agricultural University, Anand and SASNET Fermented Foods and Hildur Functional Foods Pvt. Ltd., to be funded by Swedish International Development Cooperation Agency, Lund, Sweden; Genetic analyses of Asia seabass populations in Indian peninsular waters using polymorphic DNA markers' between National Bureau of Fish Genetic Resources, Lucknow and Temasek Life Sciences Laboratory, Singapore; Precision farming for enhancing the

livelihood security of farmers between Tamil Nadu Agricultural University, Coimbatore and Nova Scotia Agricultural College, Canada; A global census of rumen microbial diversity between AgResearch, New Zealand and National Dairy Research Institute, Karnal; 'Genetic Engineering of stay green trait for development of drought tolerant wheat' between Indian Agricultural Research Institute, New Delhi and Institute of Experimental Botany, Academy of Science of the Czech Republic, Laboratory of Stress Physiology, Czech Republic were initiated.

Several major international events were organized during the year, Workshop on 'Climate Change, Adaptation and Mitigation in Agriculture in the ASEAN Region and India' at New Delhi during 23-24 August 2012; Meeting of Experts on Agro Products & Food Security of BRICS Countries (Brazil, Russia, India, China and South Africa)/2nd Meeting of Agriculture Experts Working Group at New Delhi during 27-28 August 2012; ICAR-APAARI expert Consultation on Trans-boundary Diseases 10-12 October 2012, and the 2nd ASEAN-India Ministerial Meeting on Agriculture and Forestry, ASEAN - India Agriculture Expo at New Delhi during 17–19 October 2012, and the ASEAN-India Farmers Exchange Programme (19-30 December 2012).

National Fund for Basic, Strategic and Frontier Application Research in Agriculture

Based on experience gained and learning from the execution of the Fund during the XI Plan, the Council has planned to enlarge the NFBSFARA substantially during the XII Plan. In the identified thrust areas for the XII Plan, a total of 29 projects were approved with a budget of Rs 71.69 crore. Some of the salient achievements include: optimized transformation protocol for pigeonpea using *Agrobacterium* strain EHA105 harbouring binary vector pBI121; stem cell culture using pig bone marrow mesenchymal stem cell lines; and design and fabricating indigenous lab-scale atmospheric pressure cold-plasma reactor with and without cooling system for environment friendly treatment of cotton-fabrics for effective dyeing and other qualities.

National Agricultural Innovation Project

The NAIP is supporting 185 sub-projects under four components, viz. ICAR as the Catalyzing Agent for Management of Change in the Indian NARS; Research on Production to Consumption Systems (PCS); Research on Sustainable Rural Livelihood Security (SRLS) and Basic and Strategic Research in the Frontier Areas of Agricultural Sciences (BSR) and has promoted inter institutional and inter organization collaboration. The main achievements were: development of Central Data Centre (CDC) and National Agricultural Bioinformatics Grid (NABG) for hosting different types of ICT applications; 24×7 Rice Knowledge Management Portal; Gender Work Participation Disparity Index (GWPDI); and Decision Support System for Agricultural Commodity Market Outlook based on online database repository called Commodity Market Outlook Statistics (CMOS).

A fuel-efficient propeller, capable of saving 19% fuel was developed. Its intervention in the sector having 1,100 vessels saved diesel worth around Rs 63-78 crore per annum. Foxtail-millet based food was found beneficial to diabetic, obese and heart patients. Under GEF-funded sub-projects, community gene banks were created for distribution of seed of local landraces to farmers that would help in conservation as well as enhancement of income to the beneficiary farmers. An innovative service 'm-Krishi-Fisheries', helped a village having 32 fishing boats to save 70,000 litres diesel/ month and avoided generation of 150,000 kg of CO_2. Allele mining for blast resistance genes *Piz (t), Pita* and *Pi54* was concluded in 268 heterogenous Indian rice landraces. A triple gene fusion construct was developed to build-up broad spectrum diagnostic tools for papaya ring spot virus (PRSV), cucumber mosaic virus (CMV) and groundnut bud necrosis virus (GBNV). Antimicrobial extracts/ fractions/pure molecules were identified from selected weeds against micro-organisms causing septic arthritis and urinary tract infection. Fungal isolates capable of synthesizing the ZnO nanoparticles and extracellular synthesis of Fe nanoparticles, were found. Starch nano-composite film was validated for good sealing-ability of pouches, a major criterion in food packaging.

Finance

The plan and non-plan allocations (RE) to DARE/ ICAR for 2011-12 were Rs 2,850 crore and Rs 2,157 crore respectively. An internal resource of Rs 137.89 crore (including interest and advances, income from revolving fund schemes, recovery of loans and advances and interest on short term deposits) was generated. The plan and non-plan allocations (BE) for 2012-13 are Rs 3,220 crore and Rs 2,172 crore respectively.

The 84th Foundation Day of ICAR Society was organized on 16th July 2012. The chief guest, Bharat Ratna Dr A.P.J. Abdul Kalam, former President of India, while addressing the august gathering suggested research missions for ICAR on efficient farm practices for small and marginal farmers, reviving waste lands and rejuvenating water bodies. He also highlighted the need for capacity building of small and marginal farmers through the intervention of KVKs and promotion of agro-processing through rural cooperatives. These valuable suggestions would guide us in formulation of

research programmes for the XII Plan.

The ICAR continually surged ahead in developing farmer-friendly technologies and assuring quality higher education. The Council, in consultation with all stakeholders, prepared the first ever Policy Framework for Research and Development in Agriculture and Allied Areas. It spells out the key role of the public sector in governance, funding, and execution of agricultural research and education. Human resource development, partnership within and outside the NARS, including private sector and farmers, and commercialization of technology are important dimensions of the R&D policy. This policy has also been recognized in the Science, Technology and Innovation Policy, 2013 unveiled during the 100th session of the Indian Science Congress at Kolkata, by the Hon'ble Prime Minister of India. The R&D policy articulated by the ICAR would be appropriately integrated with the national R&D system and S&T policy. Further, the Knowledge Meet of Directors, Vice Chancellors of State Agricultural Universities and other stakeholders initiated the formulation of Vision 2050 by all institutions.

I wish to place on record our gratitude to the Hon'ble Union Minister of Agriculture and Food Processing Industries and President of the ICAR Society and Hon'ble Union Ministers of State for Agriculture and Food Processing Industries, for their valuable guidance, support and encouragement in all endeavours of the DARE/ICAR. I wish to convey our thanks to various Ministries and Departments of the Government of India, State Agricultural Universities, National and International Organizations and other stakeholders, for their association in formulation and implementation of different programmes of the ICAR. I am confident that the efforts of the Council would enable technological empowerment of farmers to achieve higher levels of input efficiency and productivity to ensure sustainable agricultural growth.

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