# 12. Agricultural Human Resource Development

To upgrade quality of human resource, various activities and programmes have been undertaken by the ICAR for Agricultural Universities (60 AUs), Deemed-to-be-Universities (5 DUs), Central Agricultural Universities (2) and Central Universities (4 CUs) with Agricultural faculties under the National Agricultural Research and Education System (NARES). During this year, four new agricultural universities, viz. Kamdhenu University, Amreli; Sri Karan Narendera Agriculture University, Jobner; Agriculture University, Kota and Agriculture University, Jodhpur have been established by the respective State Governments.

The ICAR assists the AUs to plan, and coordinate agricultural education in the country through the implementation of Scheme-Strengthening and Development of Higher Agricultural Education in India. The scheme aims at enabling these institutions in building excellence in specific strategic areas in education and research through Niche Area of Excellence (NAE), promoting holistic higher agricultural education by blending knowledge, skill and attitude through Experiential Learning Units, infrastructural development, gender mainstreaming and capacity building.

The ICAR continuously strives for upgrading quality and relevance of higher agricultural education through implementation of different schemes and accreditation of AUs. Financial support was provided for Niche Area of Excellence (25), Experiential Learning, besides refurbishing and maintenance of educational structures, providing student and faculty amenities, equipments, course curricula revision/improvement, strengthening libraries with ICT and modernization of teaching with multimedia learning resources. The HRD programmes/activities facilitated promotion and execution of ICAR sponsored schemes that include centralized admissions in UG/PG to reduce inbreeding, infuse merit and promote national integration; award of fellowships to attract talent and promote merit, admission of foreign students for globalization of agricultural education, capacity building of faculty through summer–winter schools and Centre of Advanced Faculty training, National Professorial Chairs and National Fellow Scheme for promotion of excellence, Emeritus Scientist Scheme as a structural method of utilizing skill bank of the outstanding superannuated professionals.

## Infrastructural support

The support for student amenities including renovation and refurbishing university buildings, overall strengthening of infrastructure in AUs, maintenance of major equipment continued during the year. The universities initiated short courses/workshops/special lectures on overall personality development, leadership programmes and fluency in spoken English.

The Council also supported the AUs in developing comprehensive strategy for digital education, effective delivery of course curriculum ensuring enriched learning experience. The support for the curriculum delivery enabled common framework for curriculum management and preparation and implementation of the practical manuals leading to improvement in teaching as well as conducting practical classes. The Council conducted awareness workshops to enable students and teachers to take full benefit of ICAR e-courses. The e-courses were made available online and offline to supplement and complement the classroom teaching. The laboratories for UG and PG teaching and research were modernized and upgraded.

Support was also provided for student health, developing facilities for sports, organization of cultural and sporting events as Agriunifest and Agrisports. It also helped improving amenities in the hostels, including facilities for the disabled. Education Technology Cells were strengthened by publication of booklets, pamphlets and exhibit model products. Substantial support from Council was provided and the universities were encouraged to take up programmes to develop overall personality of students by teaching them self defence, yoga, career development talks by guest faculty, conducting workshops, counselling for exams, etc.

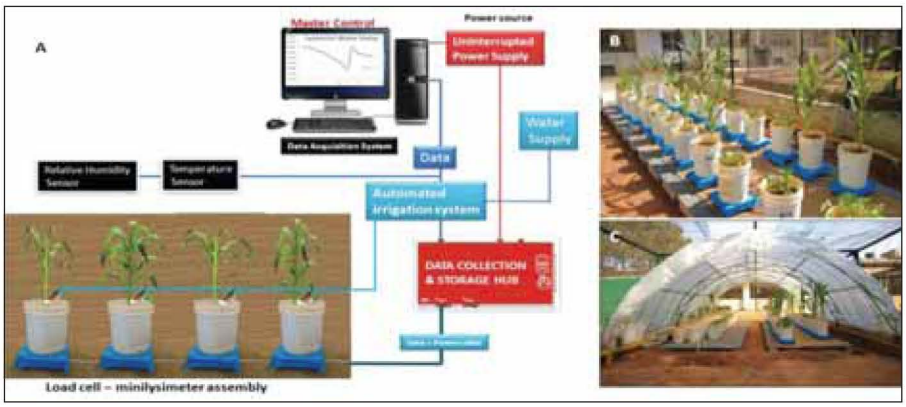
## Niche Area of Excellence

For strengthening capacity building and creating excellence in specific cutting edge areas support of ₹ 20.92 crore to 24 centres of Niche Area of Excellence (NAE) was extended during the year. On 3 June 2014, VIII Annual Review meeting under NAE programme was organized at New Delhi.

Significant achievements under the programme are:

- The area under ravines was estimated by developing land use and crop cover map for Morena and Gwalior districts by remote sensing and GIS. Control measures to prevent further advancement of deep ravines are being devised at Gwalior centre.
- Okra-lentil based cropping system produced 98.15 q/ha okra equivalent yield, with net return of ₹ 146,300 and benefit : cost ratio of 2.93 under organic farming at Palampur.

- A pilot scale, minilysimeter phenotyping facility was established for real time monitoring of the soil moisture status and plant transpiration. This unique facility is capable of imposing specific soil moisture regimes for phenotyping constitutive and adaptive traits in plants.




Minilysimeter phenomics facility
A. Pictorial representation of phenomics facility with an array of minilysimeters and data acquisition system; B. Maize and soybean plants grown in minilysimeters with precise moisture regimes; C. Minilysimeters under rain out shelter

- Three different genotypes of Newcastle Disease Virus (NDV), viz Genotype II, Genotype IV and Genotype VII prevalent in India were adapted to Vero cell line for developing candidate vaccine strains, and LAMP assay for the detection of Infectious bronchitis (IB) virus of poultry.

Vero cells infected with NDV (20×) stained with H&E showing giant cells and intra cytoplasmic inclusion bodies

- Purified recombinant OMP-25 protein was immobilized on SPR sensor chips using EDC/NHS covalent coupling chemistry and label-free biosensor assay for detecting *Brucella* specific antibodies. Surface Plasmon Resonance (SPR) biosensor chip surface was prepared by immobilizing monoclonal as well as polyclonal antibodies and label free assays were developed for detecting *Peste des petits ruminants* (PPR) virus by the IVRI centre.
- The studies on bovine reproduction elucidated the role of histamine $H_1$ receptors in buffalo uterus and down-stream calcium signalling pathway(s) involved in histamine-induced myometrial contractions mediated by oxytocin and $PGF_2\alpha$.
- New high value species like brackishwater shrimp (*Litopaeneus vannamei*) in inland salt affected waterlogged areas, cat fish, (*Pangasius*), Murrel, (*Channa striatus*) in freshwater were introduced successfully under programme at GADVASU, Ludhiana. The work motivated the farmers and over 100 acres of salt affected waterlogged waste-land was brought under fish farming.
- The centre on surveillance of diseases of aquaculture finfish and shell fish established that colonization of the antagonistic bacterium *Pseudomonas aeruginosa* P72 on fish *Labeo rohita* reduced both the attachment of pathogenic *Aeromonas hydrophila* and development of infection and disease outbreaks.
- A new bacterial disease caused by *Flectobacillus roseus* was also observed in *Labeo rohita.*
- Power operated Biasi implement was designed and developed in the programme on Farm Mechanization at IGKVV, Raipur. Manual thresher for minor millets with the threshing and cleaning efficiency of 69.25 and 82.5%, respectively was developed and performance evaluation of modified seed cum fertilizer drill was tested for wheat–gram and wheat–mustard intercrop.

Biasi plough

Seed-cum-fertilizer drill for intercropping

- Different centres under NAE organized seven short duration training programmes which attracted 655 faculty members from different AUs. A total of 59 awareness workshops/camps were held for rural agricultural extension workers, veterinary officers of State Animal Husbandry Departments. Farmers meet/demonstrations imparted knowledge and trained 2,856 farmers and about 250 other stakeholders for adopting the new technologies generated. Specific training programmes for specific groups like forensic entomology, stored product insects, vectors, common insects for hobbyists were also conducted. The NAE facilities are also utilized by students for their thesis work in various emerging areas of research.

## Entrepreneurship development

Experiential Learning (EL) modules were implemented to give experience and skill oriented training to the undergraduate students to promote entrepreneurship through different modules having end to end approach. Twenty-one new modules were established during this year in various profitable areas, like hi-tech horticulture, processing of fruits and vegetables for value-addition, product designing, biofertilizer production, broiler and layer production, critical care units for livestock, seed production and processing of milk and milk products.

EL modules helped in training the students in addressing field related problems and producing key inputs as given below.

- The EL module on seed production helped students to acquire experience on hybrid seed production in various field crops.
- Construction of polyhouses and growing vegetables round the year. Production and marketing of cut flowers.
- Large scale production of bio-inputs like bio-fertilizers, bio-agents and vermicompost which are key inputs for organic farming. Mass production and marketing of various biocontrol agents like *Beuveria, Metarizium, Trichoderma,* and fluorescent *Pseudomonas.*
- Processing of milk and milk products trained the students including detection of adulteration. Production and marketing of value added milk products and establishment of dairy units as entrepreneurs.
- Processing and marketing of vegetables, fruits and fish etc. along with packaging practices.
- Production and marketing of prepared table and culinary products like, chips, spice powders, tomato ketchup, puree, jams and other fruit preserves and shrimp pickle.
- Establishing small scale enterprise for broiler production.
- Handling of technologically advanced machines and textile designing software.
- Designing and production of printed materials such as charts, posters, leaflets, folders, extension bulletins etc. for dissemination of agricultural technology.
- Management of bakery units for production and marketing of bakery and confectionery items like, cakes, biscuits, buns, pizzas, breads and dinner rolls.

### Rural Agricultural Work Experience (RAWE)

Providing real life experience and opportunity to work with farmers and identify production, protection and marketing constraints, industrial attachment, in-plant training etc. as per the prescribed programme has been the aim of RAWE. The students were given orientation and familiarization on various issues expected on farmers' field to gain competence and confidence for solving them effectively. The activities focus on intensive observations/analysis of socio-economic and technological profile of the farm families in rural areas, participatory extension approach and acquaintance with farming situations, farm practices and interaction with progressive farmers. The students also gain first hand information on agro industries during attachment with identified agro based industries.

### Library strengthening

University libraries meet the educational, research and training needs of faculty and students. A total of 143 libraries are provided online access to more than 3,000 research journals in consortium mode. Library facilities were further enriched and strengthened by adding new titles (print copy) to the existing collection to ensure procurement of additional need based journals not covered under CeRA. Online resources (FSTA, CAB and open access) improved the quality of teaching, research and dissertation of students by providing window to latest journals, articles and tutorials. Digitization of theses and books also enhanced the access to the literature ensuring equity and availability of learning resources in the main campus as well as off campus colleges. Book banks for the underprivileged students were established in some AUs.WiFi service was also initiated in some AUs.

### National Information System on Agricultural Education (NISAGENET)

NISAGENET is an online software system developed for the record keeping, monitoring, management, and showcasing the activities of Agricultural Universities (AUs). It is operational for all the participating universities and their respective constituent/affiliated colleges. For regular data uploads from participating organizations, the NISAGENET has been strengthened with additional band width at the central server located at IASRI, New Delhi. The information on infrastructural facilities, budget provisions, manpower, research and development activities of university and its constituent colleges are being collected, compiled and uploaded. Three sensitization-cum-training, workshops for the nodal officers of the NISAGENET were organized at OUAT, Bhubaneshwar; UAS, Bengaluru; and MPKV, Rahuri, during the year to senitize and expedite data management. The additional function of allowing faculty to update their profile is being tested and when available will enable all the faculty members to maintain and update their information on web.

### Support under Tribal Sub-Plan

The Tribal Sub-Plan covering 48 districts in 9 states with financial support of ₹ 25 crore was implemented through 13 State Agricultural Universities. Trainings were organized on farm mechanization, integrated farming system, vegetable and cereal production, value addition, resource conservation, seed production, backyard poultry, sustainable livestock production system, backyard poultry, dairy, quality milk production, udder health etc. ensuring livelihood security and employment generation for the tribals. These programmes covered the capacity building of 14,912 tribals through 153 trainings in all. One hundred and three demonstrations conducted at various locations benefited 12,221 tribals. The support improved the infrastructure and led to establishment and demonstration of computing and training facilities, audio visual aids, poly houses, modern farm implements in targeted TSP districts.

## Manpower development

- **All-India Entrance Examination for Admission to UG**: The 19th Undergraduate Examination for admission to 15% seats of degree programme in agriculture and allied subjects, except veterinary sciences, was conducted on 12 April 2014. The examination attracted a record 129,116 applications, out of which 116,453 candidates appeared and 1,860 candidates were finally recommended for admission in 70 AUs through counselling. All the candidates, who joined a university outside their State of domicile, were awarded National Talent Scholarship of ₹ 1,000/ month.
- **All-India Entrance Examination for Admission to PG**: The examination was conducted on 13 April 2014 for admission to 25% seats in PG programme at 70 AUs, including award of ICAR Junior Research Fellowship (JRF). A total of 24,813 candidates appeared in the examination, out of 26,972 applicants, and 2,653 candidates were finally recommended for admissions. In all, 474 students were awarded JRF in 20 major subject groups.
- **All-India Competitive Examination for Senior Research Fellowship for PhD**: The examination was held on 13 April 2014 at 17 centres across the country. A total of 183 Senior Research Fellowships were awarded and 607 candidates qualified for PhD admission without fellowship in 16 major subject groups and 56 sub-subjects.
- **Globalization of agricultural education:** Two hundred three students from 29 countries like Afghanistan, Bangladesh, Belize, Bhutan, Cambodia, Egypt, Eritrea, Ethiopia, Fiji, Guyana, Ghana, Indonesia, Iraq, Iran, Kenya, Liberia, Libya, Mauritius, Madagascar, Malawi, Malaysia, Mozambique, Namibia, Nepal, Niger, Rawanda, Sudan, Sri Lanka, Syria, Seychelles, Swaziland, Tanzania, Vietnam and Uganda, exercised their preference to join various agricultural universities under different fellowships or as self-financed candidates.

## Capacity building

**Summer/Winter Schools and Short Courses:** Summer and Winter Schools (SWS) and Short Courses (47 SWS of 21 days and 40 Short Courses for 10 days) were organized at ICAR Institutes and State Agricultural Universities in key areas of agriculture and allied sciences like Food quality and safety, technological advancements in the seed production of marine finfish and shellfish, empowerment of fish farmers and entrepreneurship development, protected cultivation, waste recycling and resource management through rapid composting techniques, advances in livestock transgenes, recent advances in temperate fruit production, recent advances in educational technology, renewable energy sources for mitigating climate change, micro-irrigation systems and fertigation, decision support systems, plant breeding for stress tolerance, advances in social science research, management, novel genomic tools for crop improvement, wildlife conservation vis-á-vis human and agriculture interface, seafood safety, enhancement of teaching competency through innovative methods, livelihood security, bio-fortification of food crops, agri-business management in reference to hills, biofuels and bioenergy.

**Centres of Advanced Faculty Training:** Thirty-one Centres of Advanced Faculty Training provided training to 886 scientists/faculty members from the NARES through 46 training programs in cutting edge areas of agricultural and allied sciences. All the training programmes were monitored through workflow based online management system. A single platform "Vortal" was developed to provide information on all training programmes, submission of training proposal submission of application by candidates, availability of e-books/ lecture notes of a specific training program and generating reports for all categories of users and many other features.

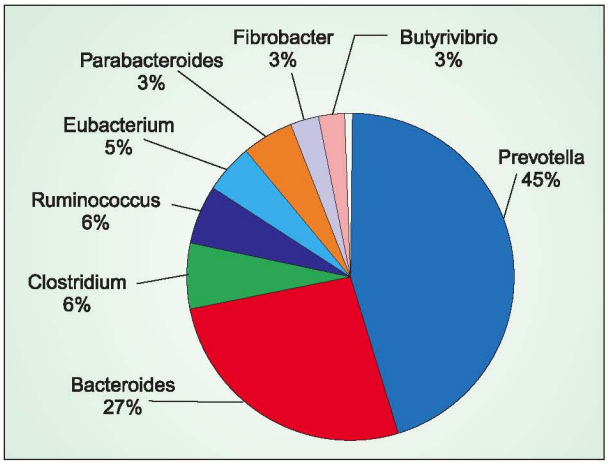
## Promotion of excellence

**ICAR National Professor Scheme**: For promoting excellence and creating a culture of basic research at national level, ten positions of National Professors have been created. Major achievements of ongoing ICAR National Professorial scheme were:

- *Carbon sequestration in agricultural soils:* Temperature sensitivity of soil organic matter decomposition is important in determining soil's feedback to climate change. Decomposition temperature response of physically isolated soil organic matter fractions showed that the coarse particulate organic matter is more sensitive to temperature than the stable mineral associated organic matter suggesting that the global warming will primarily influence decomposition of a small labile fraction of organic matter. The effect of warming on organic matter decomposition was greater at temperatures below 25°C. Evaluation of ashes from agro-industrial wastes for carbon sequestration potential showed that application of bagasse ash leads to carbon accrual in soil by favorably impacting labile and recalcitrant pools of soil organic matter.
- *Broadening the genetic base of Indian mustard:* Gene for determinacy (Sdt1) to chromosome 15 (5B) of *Brassica juncea* was mapped. Constructed SSR based linkage map and identified QTLs for glucosinolates, tocopherols, secondary metabolites and antioxidants. Identified O-Methyl Transferase gene that has a defensive response against sclerotinia stem rot.
- *Allele mining for agronomically important genes in wild rice germplasm:* Expeditions were made to four states namely, Asom, Gujarat, Goa and Chhattisgarh in the reporting year, taking the tally

of wild rice accessions to 367, from the 248 collected till the previous year. Along with the seed samples, complete geographical location information, passport data and photographs of the samples and habitat were recorded for these accessions. A web portal database has been created (nksingh.nationalprof.in) for the entire 426 accessions of wild rice. These accessions were evaluated for 46 phenotypic traits and characterized with 26 p-SINE markers, 24 SSR markers and a set of 48-plex Illumina GoldenGate genome-wide SNP assay. All the accessions were screened for abiotic stress including salinity, drought, and flooding stress.

- *Development of chromosome segment substitution lines (CSSL) of rice:* Development of CSSLs was initiated by crossing seven high yielding popular Indian rice varieties as recurrent parents and three wild accessions with high photosynthetic use efficiency as donor parents to produce F1s. The true F1s from 13 crosses were backcrossed to obtain BC1F1. The 70–80 genomewide SSRs were polymorphic in parents of two crosses using Swarna, MTU1010 and *O. rufipogon* for developing CSSLs. Also, two highest yielding Swarna × *O. nivara* BILs were selected based on yield and physiological traits in two seasons during 2013–14 to identify major yield enhancing QTLs.
- *DNA chips for virus identification and differentiation:* The microarray chip designed for identifying animal viruses reported from India was independently validated. A new chip has also been designed for enteric viruses. This chip contains 8272 probes for 168 viruses and is under testing. Methionine-tRNA synthetase gene of *Salmonella* Typhimurium was partially recoded. The recoded *Salmonella* Typhimurium showed 1.5 log10 less pathogenecity in mice. Expression of met-tRNA synthetase also declined by 50% in recoded *Salmonella* Typhimurium.
- *Metagenomic analysis and manipulation of buffalo rumen ecosystem:* Meta transcriptomic studies on buffalo rumen microbes indicated more than 50 genera of bacteria. *Prevotella, Bacteroides, Clostridium, Ruminococcus, Eubacterium, Parabacteroides, Fibrobacter* and *Butyrivibrio* were most prevalent. CAZyme (carbohydrate active enzymes) database analysis indicated that buffalo rumen microbiome represented 89 CAZy families including 22 from carbohydrate binding module, 11 from carbohydrate esterases, 52 from glycoside hydrolases and 4 from polysaccharide lyases. The abundance of glycoside hydrolases was more on normal diet while that of carbohydrate esterase was higher on high roughage diet, indicating that ester bond cleavage was better in animals fed high roughage diet.

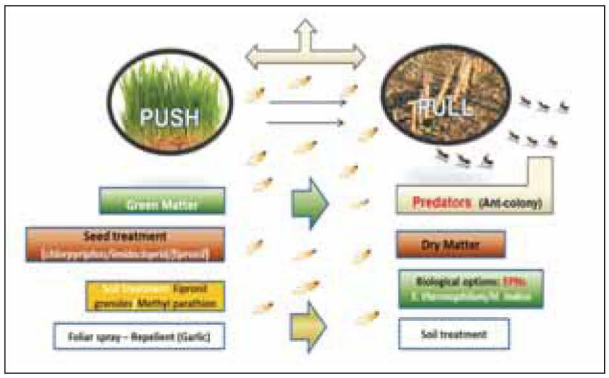



Distribution of 8 most abundant bacteria in the rumen of buffaloes fed roughage based diet

- *Deep placement of fertilizers (P and K) and micro-nutrients:* An innovative 'All-in-One Machine' named as 'Pant-ICAR Controlled Field Traffic Tiller-cum-Multicrop Ferti-Seeder' was developed and is under extensive field evaluation. The machine prepared the seedbed as well as rootbed without soil inversion, and drilled a variety of seeds mainly rice, wheat, barley, greengram, gram, pea, cowpea, soybean, pigeonpea and others. The most significant feature is especially designed winged chisel type 'Jet Openers' for band placement of fertilizers at 10 to 15 cm depth exactly below seeds placed at 5–6 cm depth with openers mounted behind jet openers. The 'New Agronomy' with this machine is being investigated for different crops.
- *Designs for single factor and multi-factor experiments and their applications in agricultural systems research:* A procedure of obtaining w-efficient main-effects and two-factor interactions block designs with block size 2 and row-column designs in 2 rows for n-factor mixed level factorial experiments based on baseline parameterization were developed. Cook statistic and AP-statistic were developed for identifying outliers in designed experiments with correlated errors both in the absence and presence of masking. AR(1) correlation structure was assumed for developing these statistics. Sample survey resources server provided with online software for small area estimation using Fay-Harriot model and also provided bibliography on combinatorics in survey sampling and controlled selection. The manuscript for book on *"Statistical Analysis of Agricultural Experiments"* was prepared.
- *Opportunities for diversification towards high value commodities:* Diversification of Urban and Peri-urban Agriculture (UPA) should be part of urban planning as vast scope exists for expanding UPA to meet the demand of the urban poor. Contract farming helped farmers to improve the income levels by adopting intensified agriculture, improving access to markets and reducing the transaction costs.

***ICAR National Fellow Scheme:*** With an objective to provide support and develop strong centers of research and education around outstanding scientists, 25 ICAR National Fellow positions have been provided in National Agricultural Research System. Highlights of the ongoing projects are:

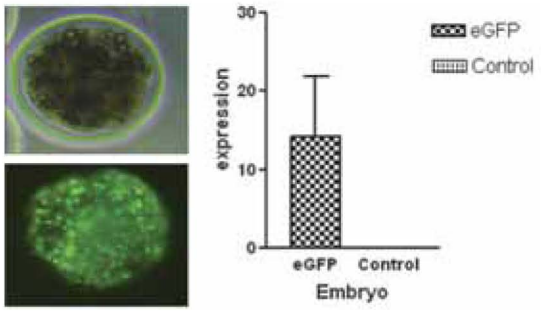
- *Development of soil quality index:* The soil quality studies indicated that the management practices comprising minimum tillage and residue application/retention improved soil quality index, organic carbon in aggregates, reduced the surface soil temperature and enhanced energy use efficiency. The effect on graded levels of sorghum residue was also studied. The application of sorghum stover @ 6 tonnes/ha recorded significantly higher soil quality index of 9.58 which was at par with sorghum stover application @ 4 tonnes/ha (9.28). It was also observed that in 0.5mm and 2mm sized aggregates, organic C was significantly higher with 6 tonnes/ha and 4 tonnes/ha residue levels which was 88.6% and 66.3% higher, respectively compared to no residue application after 9 years.
- *Sustainability of watersheds in rainfed agro-eco-sub-regions of peninsular India:* Post-Facto Evaluation Methodology for Assessment of Watershed Projects using GIS and Remote Sensing Tools have been developed and six critical monitoring indicators and six critical evaluation indicators have been identified for evaluating five aspects of agricultural sustainability namely, agricultural productivity, livelihood security, economic viability, environmental protection and social acceptability at three spatial levels, viz. household (HH), field (FL) and watershed level (WL) in watershed project villages in rainfed AESR in peninsular India. The methodology enables empirical and spatial evaluation using Geo-informatics. Study indicated a positive but marginal impact of watershed projects. A DSS is being developed using Open-source GIS, Java, R statistical package, Postgre SQL and remote sensing.
- *Precision nutrient management using GIS-based spatial variability mapping:* Spatial variability of soil organic carbon (SOC) predicted using exponential ordinary Kriging model indicated that most of the soils of Upper Gangetic Plains (UGP) fall under medium (0.5% to 0.6%) SOC content (43.7% area) and Bhabar and Tarai Zone (BTZ) had maximum SOC content, followed by Central Plain Zone (CPZ), Mid-western Plain Zone (MWPZ), Western Plain Zone (WPZ) and South Western Plain Zone (SWPZ). The SOC stock above optimum threshold, i.e. > 12.5 Mg C/ha was 97.8%, 57.6% and 46.4%, respectively in the soils of BTZ, CPZ and MWPZ, whereas only 9.8% and 0.4% fields of WPZ and SWPZ, respectively had SOC stock above threshold value. The variation in SOC stock was mainly attributed to geo-physical characteristics, cropping systems, land use efficiency, crop residue management, nutrient use and tillage practices.
- *Improvement of Chaetomium globosum: C. globosum* strain Cg2 was genetically transformed by adopting Agrobacterium mediated transformation protocol using Ds-red as reporter gene. Putative transformants were PCR screened using Dsred express gene specific primers DsRed-F (5'-CGTCATCAAGGAGTTCATGC-3') and DsRed-R (5'-GCTCCACGATGGTGTAGTCC-3'). Transformants were confirmed through sequencing and confocal microscopy. The mycelium and spores collected from the transformants showed intense fluorescent signals, which was not found in wild type strain. After transfer on PDA without hygromycin, the fluorescence of these transformants remained stable.
- *Identification and quantification of phosphatase hydrolysable organic P sources:* Mycorrhizal application to *Chlorophytum borivillanium* increased the leaf biomass, the total phenolics, flavonoids and saponin concentrations and these secondary metabolites resulted in increased free radical scavenging activity of the roots. These changes enhanced the resistance of roots against pathogens and also raised the market value of *Chlorophytum borivillanium* owing to its enhanced antioxidant activity. Among the secondary metabolites the contribution of saponins in free radical scavenging activity was found to be less as compared to flavonoids.
- *Insect-plant interactions of major horticulture pests:* Computational reverse chemical ecology, a unique methodology was developed for rapid screening and predicting behaviorally active semiochemicals. A female attractant (ArkaDorsolure F), for *Bactrocera dorsalis,* was discovered from mango to develop a female lure on which the field trials are underway.
- *Environmentally sustainable termite control:* Validation of push-pull-strategy for termite management in wheat–maize agro-ecosystem was attained with the crop residues (pull-site, maize




Push-pull-strategy use a combination of behaviour-modifhying stimuli to manipulate the distribution and abundance of pest and/or beneficial insects for pest management

stubbles) and main/target crop (push-site, wheat-rows). Push-pull-concept was found to be quite effective for the first two years, and is the first report of its kind. In third year, the technology was demonstrated successfully to the farmers at Agro-technology Transfer Information Centre, IARI, New Delhi. Termiticides used in target-crops (wheat, barley, gram and lentil – *rabi* maize – *kharif* crop), were analysed for residues in the harvested commodities; residues were found below detectable level implying safety aspects of termiticides recommended (imidacloprid 17.6% SL, chlorpyriphos 20% EC, and fipronil 0.3% G: in targeted *rabi* crops; and fipronil, methyl parathion @25 kg/ha, imidacloprid 0.5 ml/L spray to root zone, in maize).

- *Comprehensive screening of organic contaminants in fruits and vegetables by GC-MS and LC-MS:* An LC-QTOFMS based screening method was successfully developed and applied for targeted and non-targeted analysis of agrochemical residues in fruits, vegetables, and their processed products. A generic method of sample preparation was developed for simultaneous analysis of various classes of contaminants at 10 ppb and lower levels. A precise and sensitive residue analysis method was validated for the estimation of dithiocarbamate fungicides in fruit and vegetable matrices. Dissipation studies on imidacloprid, carbendazim, kresoxim methyl, flubendiamide, buprofezin and hexaconazole were carried out in okra and their pre-harvest intervals (PHI) estimated. A fast and sensitive method of analysis for pesticide residues in wine was also developed using GC-MS selective reaction monitoring.
- *Development of transgenic goat using sperm-mediated gene transfer method:* Validated the optimized lectroporation parameters for sperm mediated gene transfer (SMGT) using *in vitro* fertilization (IVF). Developed an efficient protocol for electroporation aided testes-mediated gene transfer (TMGT) and validated using *in vitro* fertilization (IVF).




Assessment of fertilizing ability of the sperms from the buck with electroporated testes. (a) Panel showing fertilized embryo with expression of GFP demonstrating the integration of the reporter gene by TMGT and the fertilizing ability of the electroporated sperm. (b) Quantitative Real time PCR showing the presence of eGFP mRNA in the fertilized embryo

- *DIVA marker vaccines against H5N1 avian influenza viruses in chickens*: The protective efficacy of the inactivated rgH5N2 vaccine, developed through reverse genetics, was shown to be 100% against high dose challenge with HPAI virus (109 $EID_{50}$/bird) in vaccinated chickens with single vaccination (0.5 ml/bird) on 28th day post-vaccination. The vaccinated birds showed high level of H5 antibody response estimated by HI test (>210). Challenge virus shedding, via oro-pharynx of the vaccinated chickens, was found to be at minimal detectable level on 1st and 3rd day post challenge. Single dose vaccinated chickens showed high HI titres (>210) which was maintained without booster vaccination, at least till 5 months. The work established India's self-sufficiency to generate re-assortant influenza viruses through use of reverse genetics for making DIVA marker avian influenza vaccines and to carry out other important studies on avian influenza virus.
- *Molecular basis of thermotolerance in native cattle and buffaloes:* Cellular proliferation rate and heat shock protein levels at high thermal stress indicated superior thermotolerant ability of Sahiwal cows. An attempt was made to undertake comparative evaluation of cell proliferation and heat shock protein levels as indicators of thermotolerance at varying temperature-humidity index (THI) across Sahiwal cows (*Bos indicus*), Karan Fries cows (crossbred), Holstein Friesian cows (*Bos taurus*) and Murrah buffaloes (*Bubalus bubalis*). Higher cell proliferation rate and lower serum concentration of HSP 27, 90 and 70 in Sahiwal cows and Murrah buffaloes indicated their better cellular tolerance ability at higher THIs.
- *Molecular diagnostic assays for detection of* Trypanosoma evansi *infection in animals:* Out of 12 microsatellite loci, 10 were successfully genotyped in six *T. evansi* isolates collected from different livestock hosts (horse, donkey, camel and cattle) inhabiting different geographical locations, and six of them were found polymorphic. At six microsatellite loci (TB8/11, TB11/29, TB10/1, TB1/8, TB3/3 and TB4/2), observed number of alleles per locus ranged from 3 (TB8/11) to 6 (TB4/2) with a mean value of 4.83±1.75 and effective number of alleles ranged from 2.11 (TB8/1) to 5 (TB4/2) with a mean value of 3.32±1.16. Polymorphism information content (PIC) value, ranged from 0.34 (TB8/1) to 0.77 (TB4/2), indicating that TB11/29, TB10/1, TB1/8, TB3/3 and TB4/2 microsatellite loci were highly informative (PIC>0.5). Neighbour-Joining (NJ) tree analysis indicated different clustering of isolates based on allelic sharing.
- *Functional genomics for improving productivity in poultry:*The open reading frame of IGF1 and GHR genes were cloned in INSTA cloning vector

and characterized with presence of 12 haplotypes (IGF1) and 8 haplotypes (GHR) in chicken. The haplogroups had significant effect on daily body weight gain between 4 to 6 weeks of age.

- The whole genome sequence of Aseel, an indigenous chicken breed of India, was explored for the first time through Next generation sequencing indicating presence of approximately 23,000 genes, 6,145,838 SNPs and 670,992 Indels in the genome. The epigenetic study showed cytosine methylation in promoters of myostatin and IGF-1 genes showing negative correlation with respective gene expression.
- *Nanotechnology for fish health management and water remediation:* Different laboratory synthesized metal nanoparticles, i.e. gold, selenium, sulfur, Iron oxide and MgO showed broad spectrum antibacterial, antifungal, antialgal activities and wound healing activities against a wide range of bacterial, fungal and algal pathogens. Coating of CuO, ZnO and multiwall carbon nanotubes to glass/plastic/cement aquarium and tanks reduced microbial load, ammonia level, and enhanced hatchability, survival of fish larvae and fry. Dietary supplementation of iron and selenium nanoparticles increased muscle iron and selenium content and haemoglobin concentration in fish, *Labeo rohita* H.
- *Novel immuno-potentiator molecules from fish host:* The recombinant peptides, hepcidin and apolipoprotein A1 were expressed in bacterial system, purified and found to be having broad spectrum antibacterial role against wide range of Gram positive and Gram negative pathogens. One novel peptide was detected in Argulus parasite and its potential role as candidate vaccine in rohu to protect against argulosis is quite promising and it is under further study. Besides, the differential species susceptibility among carps were looked into under an experimental challenge study. The most susceptible rohu carp and most resistant grass carp innate immune molecules were looked into at the gene expression level indicating possible role of multiple genes in modulating the susceptible pattern of one species to Argulus.
- *Evolution of textile articles through processing of wool with silk waste and cotton:* Application of aroma therapeutic finish through microencapsulation technique and evaluation of its durability on textiles was done successfully. Microcapsules were formed with two gums, i.e. gum acacia and sodium alginate and two oils, i.e. citronella oil and lemon grass on four fabric, specimens (Lyocell, Rambouillet, Eri and Muga) with two different techniques of micro-encapsulation. Ergonomic study of handloom weavers and modifications in handloom was done. Loom was modified according to the weaver's physical needs. Weaving became more comfortable for weavers who were using modified loom, and production was increased. Two groups of rural trained women have been linked with marketing agencies for better returns to them.
- *Nutritionally balanced functional foods for children:* Nutritionally, functionally rich biscuits, extruded snacks and Nutribar using sprouted legumes, malted millets and fruits were developed. Composite flours (CF) using wheat, peanuts, oats, jowar, malted ragi, sprouted soybean and green gram and papaya/spinach were used for preparing multi-nutrient biscuits. Both products had high organoleptic acceptability and were rich in protein, fibre, iron, calcium, phenolics and anti-oxidants. Patent was applied for the process of development of the multi-nutrient mix and the product was commercialized. Nutritional trials on school children in MP showed that the products improved the nutritional status of school children significantly and can be used in mid-day meal programs.
- *Development of weaning food based on underutilized crops of Uttarakhand*: Integrated Malting Unit, comprising soaking chamber, drying chamber, main frame, sieve stands, valve, electric motor and blower were developed for the purpose of soaking, germination, and kilning. Weaning

Integrated malting unit

mix based on lesser known crops using fermentation technology was formulated. Process for production of beer using 68 : 32 blend ratio (barley : finger millet), was developed in *Saccharomyces cerevisae*.

## Emeritus Scientist Scheme

The ICAR Emeritus Scientist Scheme is a structural method of utilizing the outstanding superannuated professionals of NARES. Some of the major findings of the projects under this scheme are:

- The vector pANDA–lpaRNAi (lpa gene involved in accumulation of phytic acid) was transformed into *Agrobacterium* strain EHA 105 and confirmed by screening with rifampicin + kanamycin medium and PCR analysis for pANDA.
- Three low amylose B line derivatives and five high amylopectin restorer lines were developed. One fertile from B line population scored grain

mold resistance on par with the resistant check.

- A field survey in the villages of Mumtajpur and Lokera, Block Pataudi, Dist. Gurgaon, Haryana was done in August 2014. The rice varieties PB 1121, PRH 10 and PB 1509 showed heavy infestation of *Meloidogyne graminicola* with typical symptom of root knot gall.
- Nanosilver was prepared using pea peal. The particle size varied from 16 to 23 nanometer. The nanosilver successfully degraded a persistent organophosphorus pesticide chlorpyrifos, present in water.
- 'Autoregressive-Stochastic Volatility with Threshold' nonlinear time-series model was developed for forecasting volatile time-series data and illustrated the methodology on All-India monthly spices data.
- The seed drill for sowing onion was designed with variable circular opening and flexible circular rubber sheet agitator for seed metering. Seed metering opening of 4.3 mm is suitable for export variety Arka Bindu with 12 to 20 seeds per meter of row. Seed metering opening of 5.2 mm is suitable for other varieties with 6 to 16 seeds per meter of row.
- A total of 30 bacterial and 12 fungal strains were isolated from rhizospheric soil of Nendran and Udhayam plants. Six bacterial and three fungal isolates showed effective nematicidal properties on the young juveniles of root-knot nematode (*Meloidogyne incognita*), burrowing nematode (*Radopholus similis*) and root-lesion nematode (*Pratylenchus coffeae*). The isolates exhibited 100% mortality of all the nematodes at 50% concentration when exposed for 24 h.
- Fungicide treated rough lemon leaf discs placed in soil slurry from citrus orchards were an efficient detection method for metalaxyl resistant isolates of *Phytophthora parasitica*. Three RAPD primers showed distinct 100 bp band in resistant isolates of *P. parasitica* and *P. infestans*.
- Grow-out culture of banana shrimp *Fenneropenaeus merguiensis* for improving its production was done.The shrimps attained average size of 19.7 g in 150 days of culture. The data on unused shrimp farms in Gujarat was collected and it was found that recurring white spot disease is the major reason for not taking up culture by the farmers. Due to recurring viral diseases and delay in getting permission for vannamei culture, nearly 538 ha was unused during 2013–14 in Gujarat.
- Improved quality kraft paper was prepared from blended pulp of cotton stalk and banana fibre waste in 50 : 50 proportions. Corrugated boxes suitable for packaging of fruits like mangoes and oranges were prepared. Boxes conformed to BIS specifications and are cost effective.

## Quality assurance and reforms

**Accreditation:** Quality assurance in higher agricultural education is being pursued through accreditation of agricultural universities along with their constituent colleges and degree programmes. During the period four agricultural universities namely, Punjab Agricultural University (Ludhiana), Kerala Agricultural Universities (Thrissur), University of Horticultural Sciences (Bagalkot) and Swami Keshwanand Rajasthan Agricultural University (Bikaner) were accredited. Three ICAR institutes namely, Central Institute of Agriculture Engineering (Bhopal), Indian Institute of Horticultural Research (Bengaluru) and Central Soil and Water Conservation Research and Training Institute (Dehradun) were also upgraded as outreach programmes of Indian Agricultural Research Institute, New Delhi for awarding Masters' Degree in agricultural disciplines with respect to their specialization.

The Peer Review process for accreditation of eight agricultural universities namely, Acharya N.G. Ranga Agricultural University (Hyderabad), Tamil Nadu University of Veterinary and Animal Sciences (Chennai), Dr Yashwnt Singh Parmar University of Horticulture and Forestry (Solan), Govind Ballabh Pant University of Agriculture and Technology (Pantnagar), Mahatma Phule Krishi Vidyapeeth (Rahuri), Dr Y S R Reddy Horticultural University (West Godavari), UP Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan (Mathura) and Jawaharlal Nehru Krishi Vishwavidyalaya (Jabalpur) were also completed during the period.

**ICAR International Fellowships:** With the objectives to develop competent human resource and showcasing the strengths of NARES, ICAR International Fellowships were introduced in 2009–10, for pursuing Ph D programme at Indian agricultural universities and overseas universities for overseas and Indian candidates, respectively.

For the current year, based on the priority areas of study related to plant sciences, animal sciences, social sciences, fisheries, agricultural engineering, food processing and natural resource management, 30 candidates were selected for their Ph D study including 27 Indian candidates at internationally recognized foreign universities in USA, UK, Belgium, Norway, Canada, Germany, Spain, Netherlands, Thailand, Australia and Malaysia and remaining three candidates from Nigeria and Sri Lanka at Indian SAUs/ICAR DUs.

Out of 57 candidates selected during 2009–10 to 2013–14, eight Indian candidates have completed Ph D study at Overseas universities. Currently, 46 candidates including 43 Indian and three candidates from abroad are pursuing PhD under the ICAR International Fellowships.

## Constitution of Fifth Deans Committee

To revisit the curricula in view of the changing demand of agricultural education in the country, the

Fifth Deans' Committee was constituted for 11 disciplines under the Chairmanship of Dr R B Singh. Conveners and Co-conveners for all 11 disciplines have been nominated.

### National Agricultural Education Project

An *Aide-Memoire* has been prepared by the Project Preparation Mission constituted by the World Bank. Expression of interests has been invited from the Agricultural Universities for participation in Component I and II of the Project. In a Tri-Partite Review Meeting (TPRM) organized by Department of Economic Affairs, Ministry of Finance held in August 2014, the implementation of NAEP has been scheduled in the next Financial Year.

### India-Afghanistan Fellowship Programme

India-Afghanistan Fellowship Programme was initiated during academic year 2010–11 with the aim of providing fellowships every year to Afghan candidates for attaining higher education through varied degree programmes in Indian Agricultural Universities. Under the programme, so far 158 Afghan students (98 for MSc; and 60 for Bachelor's degree, have availed fellowship.

### India-Africa Fellowship programme

India-Africa Fellowship programme was started in the year 2010–11 to support the agricultural human resource development in Africa through formal education of African scientists/faculty/students in India. Under the programme, 75 fellowships are being offered each year for a period of four years to the nationals of African continent for pursuing Master's and PhD programmes in agriculture and allied sciences from Indian agricultural universities (AUs). A total of 187 (113 MSc and 74 PhD) African candidates from 27 countries have joined so far, out of which 75 (57 MSc and 18 PhD) candidates have completed their programmes successfully.

### ICAR-National Academy of Agricultural Research Management (NAARM)

The National Academy of Agricultural Research Management (NAARM) strives for the capacity development of individuals and institutions for promoting leadership, governance and innovation capacities of the NARES. The Academy adopts strategies to enhance capacity for leadership and governance, mobilize science and technology for innovation and sustainable development, manage information and communication for promoting innovation and governance, manage extension systems in a market-driven environment, enhance faculty excellence and teaching-learning performance and manage agribusiness for inclusive growth.

**Capacity building programmes:** During 2013–14, the Academy organized 77 mandatory and need-based capacity strengthening programmes through which 2,272 professionals of National Agricultural Research System (NARS) participated. The Foundation Course for ARS (FOCARS), the flagship programme of the Academy, was successfully implemented in the newly-designed format which has been designed and approved after intensive discussions at various platforms of ICAR. Currently, the FOCARS programme of seven months duration, is organized in three phases, with the first phase of three months at the Academy, followed by one month orientation at the institute of posting and the last phase of three months training in the relevant state-of-the-art laboratories. The first module of the training at the Academy focuses on orientation and capacity building; the second module exposes the participants to the problems of stakeholders through an on-site Field Experience Training (FET), and the third module focuses essentially on multidisciplinary perspectives. During 2013–14, two programmes of FOCARS were organized. The first programme was organized during July 1 to September 30, 2013 and the second was organized during January 1 to March 31, 2014, wherein 228 scientist-probationers were trained and are now in phase II and III of the Course. In the context of 3-month training component at the Academy, the first and third modules of component were organized at the Academy, the second module was organized at various centres across the country in collaboration with technology transfer wings of ICAR institutes, SAUs, KVKs and NGOs. The first module covered issues pertaining to research system management, information and communication management, human resource management and extension system management apart from administrative and financial rules. The second module focused on real-time understanding the technology dissemination and technology utilization components of extension systems towards addressing the issues of such systems. The third module oriented the trainees to writing research proposal, scientific reports, research publications and use of tools like SAS, etc. in research using their learnings from first two modules.

**International programmes:** Two international programmes were organized during the year. A training programme on Information Technology Application in Agricultural Extension was organized for extension professionals of ASEAN countries wherein 14 participants from eight ASEAN member countries participated. The programme enabled the participants to gain insights into various IT applications in Agricultural Extension enhanced for use of e-extension for value-added extension advisories. An international workshop on emerging practices of open educational resources in higher education was jointly organized by NAARM and Commonwealth of Learning (COL), Canada. The purpose was to deliberate on emerging practices of open educational resources in higher education and training and arrive-at pragmatic policy strategies.

**Cloud framework for online evaluation:** An ICSSR sponsored study on impact of agri-clinics and agri-business centres (ACABC) in extending broad-based

services to farming community in Andhra Pradesh conducted during the year indicated that the fostering entrepreneurship in agriculture for supplementing the extension services of public extension system resulted in positive impact. The results also indicated the role of producer companies for augmenting agri-entrepreurship in the country. Several studies in area of e-learning and information management were undertaken during the year with an objective to use ICT tools for better delivery of training and governance. Preliminary effort through an in-house project on web-based learning ecosystem based on cloud computing framework indicated that cloud computing could be effectively employed in training and education applications of agriculture. The training preparation time for conducting training programmes of varied nature could be substantially reduced and led to improving of the IT resources utilization.

**Post-graduate education:** The Academy continued its efforts in imparting postgraduate education in the niche areas of Agribusiness Management (PGDMA) and Technology Management in Agriculture (PGDTMA). A total of 51 students passed out from these programmes. The placement process of the students witnessed participation of 15 companies cutting across the major sectors of agribusiness, retail, input, commodity exchange, exports (International Business Development), services (Market Research consultancies) and finance. The participation of agri-industry in the education programme has led to enhancing the PPP model into practice through industry based research projects and demand-driven consultancies for the Academy.

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