11.

Agricultural Human Resource Development

The Agricultural Human Resource Development continued to strive for maintaining and upgrading quality and relevance of higher agricultural education. Financial and monitoring support provided for Niche Area of Excellence (28), Experiential Learning (21 new), besides refurbishing and maintenance of educational structures, student and faculty amenities, course curricula revision/improvement, strengthening libraries with ICT and modernization of teaching with multimedia learning resources, etc. 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 and distribution of fellowships to attract talent and promote merit, admission of foreign students for globalization of agriculture 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. Quality assurance of AUs was ensured through accreditation.

Activities for strengthening and quality assurance of State Agricultural Universities (62 SAUs) was taken up by the Agricultural Education Division of the ICAR, Deemed-to-be-Universities (5 DUs) and Central Universities (4 CUs) with Agricultural faculties under the National Agricultural Research System (NARS) to address the challenges of agricultural growth and upgrading quality of higher agricultural education. The Division, through the implementation of scheme-strengthening and Development of Higher Agricultural Education in India, assists the AUs to plan, undertake, aid, promote and coordinate agricultural education in the country. The scheme has enabled 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, RAWE, and related aspects concerning infrastructural development, gender mainstreaming and capacity building of the students with the total outlay of ₹ 358.00 crore.

Infrastructural Support

The support for minor repair/ renovation and refurbishing of structures, overall strengthening of infrastructure in AUs, maintenance of major equipments, student and faculty amenities, etc. continued during the year. With the support from the Council, the AUs initiated short courses/workshops/lectures on overall personality development, leadership programmes as well as spoken English.

Smart classrooms, supported by the Council provided comprehensive strategy for digital education, effective delivery of course curriculum enabling it to be student centric and ensuring enriched learning experience. The support for the curriculum delivery enabled common framework for curriculum management and effective implementation and preparation of the practical manuals leading to improvement in teaching as well as conducting practical classes. Teaching, learning support, guidance, mentorship, collaborative learning, feedback and assessment, personal development planning and tutoring, skills development and practice, and access to resources are encompassed in 'curriculum delivery' making it dynamic.The laboratories for UG & PG teaching and research were modernized and upgraded.

Support provided for student and faculty amenities/ tours/capacity building encouraged their participation in seminars, symposia, workshops etc. Support was also provided for student health, developing facilities for sports, organization of cultural and sporting events as Agriunifest and Agrisports. The support also helped improve amenities in the hostels and other services in the campus, including facilities for disabled. Placement cells helped students obtain placement or advice on careers. 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 develop overall personality of students by teaching them self-defence, yoga, career development talks by guest faculty, conducting workshops, counselling for exams, etc.

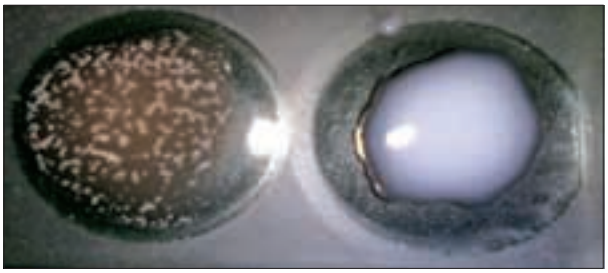
Niche Area of Excellence

For strengthening capacity building and creating excellence in specific cutting edge areas, support of ₹ 20.94 crore to 22 ongoing and five new centres of Niche Area of Excellence (NAE) on "Fish safety and quality assurance at TNFU, Thoothukudi; "Spore based sensor for monitoring pesticides residues in Milk", NDRI, Karnal; "Nutrition and Gut Health: Probiotics, Prebiotics and Phytogenics as Functional Foods to Augment Gut Health of Dogs", IVRI, Izzatnagar; "Molecular Breeding and genetic manipulation of rice and pigeonpea", ANGRAU, Hyderabad and Centre for Zoonosis", MAFSU, Nagpur, was extended during the year. Presently, ten programmes under animal science, three in fishery sciences, two in agricultural engineering, four

in plant sciences, four in natural resource management, two in plant protection and one each in horticulture and agriculture education are being supported. The IX Annual review meeting to fine tune the programmes was organized at New Delhi on May 25, 2014.

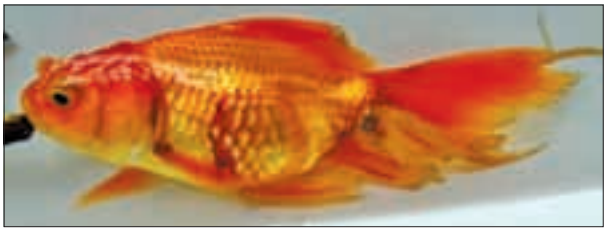
Significant achievements under the programmes were:

- Metatranscriptome sequencing runs of 48 samples for Kankarej, Gir, Jaffarabadi breeds has been done at the centre at AAU, Anand.
- A transformed canine cell line, i.e. MDCK-dSLAM ((heterozygote diploid-based synthetic lethality constitutively expressing canine SLAM molecule was developed for isolation and culture of canine distemper virus (CDV) field strains.
- Recombinant proteins of *Brucella* [P-17, OMP-25 and OMP-28] were up-scaled, purified and immobilized separately on SPR sensor surfaces.
- Label-free biosensor assays for detection of PPR virus and autoantibody signatures (biomarkers) in cases of canine mammary tumour in dogs were developed at IVRI centre.
- For monitoring pesticide residues in milk, the pesticide inhibition assay on paper strip was standardized.



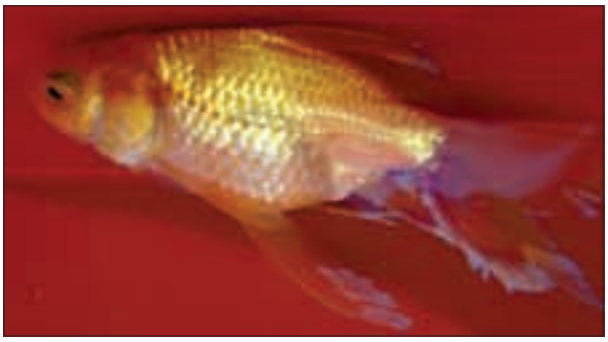
Latex agglutination test using recombinant antigen of DPV Positive serum (*left*) Negative serum (*right*)

- Bio-technological tools for diagnosis of EEHV in Asiatic elephants were validated by the wildlife and forensic health centre.
- Sensitive and specific diagnostic assay for Duck Plague Virus (DPV) was developed using recombinant antigen at TANUVAS, Chennai.
- Incidence of cyprinid herpes virus 3 and cyprinid herpes virus 2 in ornamental fish *Carassius auratus* from India was reported for the first time by the centre on "Surveillance of diseases of aqua cultured finfish and shellfish" at WBUFAS, Kolkata.



Cyprinid herpes virus 3 infected *Carassius auratus*

- Brackish water fish – *Lates calcarifer* (sea bass) reared and tested in salt affected waterlogged waste lands in Fazilka district in Punjab.



Disease free *Carassius auratus*

- Enrichment and fortification of composts and liquid manures and package of practices *w.r.t.* nutrients, insect pests and disease management for the targeted crops developed under organic farming at Palampur.
- The product based on pearl millet and semolina was developed through extrusion processing at the IARI centre.
- Designed and developed power operated single row paddy weeder and power operated planter for dry and wet field conditions for rice.

Light weight single row power weeder

- High resolution soil maps of available nitrogen, phosphorous and potassium created for Nainital district and spectral soil library of different soils series of Pantnagar region was created.
- The concept of adoption of mono and two-tier systems of rain water management in saline tract of Purna river valley on 30,000 ha area through the network of 5,500 farm ponds was promoted with the participation of 12,000 farmers.
- Low cost, innovative method for checking ravine development comprising of silvi-pastoral and crop production system helped in *in-situ* water conservation.
- Five species of pollinators were identified and nesting habitats for wild pollinators in apple

Wooden bee blocks installed in apple orchards (*Megachile* spp. isolated) 70% success rate

orchards were successfully established by the centre at SKUAST-K.

- Manuals with pictorial keys prepared for easy learning of identification methods of insects and mites. The collection of the insects in the region have been strengthened.

Hypsauchenia spp.
(New species)

Apoderus spp.
(New record in South India)

- High grain weight trait transferred from *Aegilops tauschii* to bread wheat and is being validated in the backcross progenies.
- For sustaining rice productivity, the amphiploids (PR122/*O. punctata* IRGC105137) were generated and backcrossed with the cultivars to harness and transfer the productivity traits of *O. punctata*.
- Improved root biomass and WUE efficiency traits introgressed in IR-64 background through multi parent marker assisted back-crossing.

KMP-175—A promising trait introgressed line with yield advantage (aerobic) identified

The centres organized ninety-six long (>10 days) and short (2-10 days) duration training programmes leading to capacity building of 297 faculty. About 11 awareness workshops / camps /workshops for rural agricultural extension workers, veterinary officers of State Animal Husbandry Departments/ farmers meet / demonstrations imparted knowledge and trained 300 farmers and about 75 other stakeholders for adopting the technologies generated. During the year, 58 students completed degrees and 142 students are pursuing research for MSc/MVSc/ MTech/ PhD utilizing the facilities developed under NAE programmes.The support has resulted in 113 publications in peer reviewed journals, including 51 papers in journals assigned NAAS rating of 5 and above. As a result of the workshops and awareness camps conducted under the programme some of the trainees took up entrepreneurship. Two people (entrepreneur) were engaged in fabrication of machines/tools, 108 farmers in fisheries and 5 in beekeeping and other as pollinizers for apple orchards.

Entrepreneurship Development

To instil confidence, provide hands on training and to encourage UG students to take up entrepreneurship, support was extended for experiential learning modules. These were aimed at giving experience –based and skill oriented training to the undergraduate students to promote entrepreneurship, knowledge as well as marketing skills through practical end–to-end approach in product development. Twenty new modules were established during this year and one module viz. “Mushroom production” at BHU, Varanasi was upgraded with modern equipments. New modules were supported in various profitable areas, like processing of fruits, vegetables, milk etc. for value addition, protected cultivation of high value horticultural crops, biofertilizer production, pet care units, seed production and product designing etc. in 12 AUs. Students learned marketing strategies in various programmes. The salient outcomes were:

- ELP on seed production helped students acquire experience on hybrid seed production in various crops, including sunflower.
- Value added products were produced from the horticultural products and were marketed by students under fruit and vegetable processing modules. The ELP on processing of milk and milk products trained the students in procurement and checking for adulteration in milk. Value added milk products were developed and marketed by students.
- The students under agriculture information produced four documentaries on relevant topics and conducted an exhibition related to biodiversity.
- ELP on protected cultivation of high value crops enabled the students to learn construction of polyhouses and growing vegetables with the knowledge about best package of practices. They also developed skills for plant propagation and nursery management.
- Large scale production of bio-inputs like bio-

fertilizers were mass produced, packaged and sold.

- Trainings have been imparted for effective management of insect pests and issuing plant protection advisory to the farmers.
- The ELP on custom hiring farm machinery and fabrication of need based small implements created awareness among students regarding various implements, their repair and maintenance and industrial training. The students were made aware of the advantages of setting up such an enterprise in their areas for the benefit of the community.
- In apparel production modules, skill of handling technologically advanced machines and textile designing software were acquired. Designing and preparation of facilitating materials such as charts, posters, leaflets, folders, extension bulletins etc. for dissemination of agricultural technology was undertaken in ELP on product design.

Rural Agricultural Work Experience (RAWE)

The students under RAWE were exposed to natural setting of the village situations, worked with the farm families, identified their problems and made use of various extension tools for transferring the latest agricultural technologies. The students also got opportunity to study the various on-going schemes related to agriculture and rural development and participate in their implementation. The students were given rigorous orientation and familiarization on various issues and problems expected on farmers' field and hence gain competence and confidence for solving problems related to agriculture and allied sciences. It has been implemented in adopted villages under the supervision of scientists. Activities focused 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 gained first hand information on industries during attachment with identified agro based industries. Eight thousand and six hundred students benefited under RAWE through Council's support.Soil testing has become the integral part of RAWE. This is offered in the last semester of the UG programme and helps orient the agricultural graduates for participation in various rural developmental programme.

Library Strengthening

Central libraries in AUs play pivotal role in providing scientific and technical information to the students as well as faculty. The support from the Council enriched and strengthened the libraries at AUs by adding new titles to the existing collection with the financial support of ₹ 25.00 crore. The addition of latest literature in agriculture and allied subjects helped strengthen the academic programme and ensured procurement of additional need based journals not covered under CeRA. The SAUs libraries have created their own database of thesis. The academic environment and quality of teaching and research has been enhanced through the use of e-resources. Digitization and online access to the literature ensured equity and availability of learning resources in the main campus as well as off campuses colleges. Online demonstration of several instruments /machineries enhanced the conceptual information to students about the application of agricultural engineering technologies in real field situations. Book banks for the underprivileged students were established in some AUs.

Information System on Agricultural Education (NISAGENET)

The single window data retrieval system, NISAGENET portal, for universities was maintained as a regular ongoing activity of the Council at IASRI, New Delhi. All the agricultural universities provided the data as per requirements of this system. The information on infrastructural facilities, budget provisions, manpower, research and development activities of university and its constituent colleges are being collected, compiled and uploaded. The NISAGENET operational architecture which is a three tier web architecture makes it possible to directly enter/update data not only from university but also from the respective constituent/affiliated/college(s).

Five sensitization-cum-training workshops for the nodal officers of the NISAGENET were also organized during the year to sensitize and expedite data management.

Tribal Sub-Plan

Financial support of ₹ 25.00 crore was provided in ten states during the year under Tribal Sub-Plan covering 66 districts. The programmes were implemented through 15 State Agricultural Universities. The capacity building programmes on value addition and post harvest management of agri horticultural crops were initiated, improved agricultural and animal husbandry practices, apiculture, goat breeding etc. The tribal population was also trained in the areas of starch extraction from Tikhur rhizomes, cashew and apple processing production of quality planting material, backyard poultry, sustainable livestock production system etc. ensuring livelihood security and income generation for the tribals. Demonstrations and camps were held for creating awareness about recent technologies. These programmes were executed by conducting 53 training programmes and about 199 demonstrations leading to the capacity building of 8206 tribals. The support helped in installing micro-irrigation system in 13 villages and setting up of vermicomposting, biogas and packing units in 26 villages of targeted TSP districts.

Manpower Development

- **All-India Entrance Examination for Admission to UG**: The 20th Undergraduate Examination for admission to 15% seats of degree programme in agriculture and allied subjects, other than veterinary sciences, including the award of National Talent Scholarship (NTS) was conducted on April 11, 2015. The examination attracted a

record 1,22,122 applications, out of which 1,10,600 candidates appeared and 2,205 candidates were finally recommended for admission in 65 AUs through counselling. All the candidates, who joined a university outside their state of domicile, were awarded NTS of 1000/month.

- **All-India Entrance Examination for Admission to PG**: The examination was conducted on April 12, 2015 for admission to 25% seats in PG programme at 72 AUs, including award of ICAR Junior Research Fellowship (JRF). A total of 27,862 candidates appeared in the examination, out of 30,035 applicants, and 2,765 candidates were finally recommended for admissions. In all, 474 students were awarded JRF in 20 major subject groups.
- **All-India Competitive Examination for Ph.D. admission and award of Senior Research Fellowship**: The examination was held on April 12, 2015 at 17 centres across the country. A total of 4797 candidates appeared in the examination, out of 5628 applicants, and 494 candidates were finally admitted for Ph.D. admissions in 67AUs. Based on the merit, a total of 182 Senior Research Fellowships were awarded in 16 major subject groups.
- **Globalization of agricultural education:** Two hundred and 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 of 10 to 21 days duration (**56** SWS of 21 days and **47** Short Courses for 10 days) were organized at ICAR Institutes and State Agricultural Universities in key areas of agriculture and allied sciences like Micro-irrigation and fertigation; Concepts and techniques in development of health foods; Processing value addition and waste utilization technologies; Engineering Interventions in Conservation Agriculture; Climate Change Mitigation; Technopreneurship Opportunities; Quantitative Genetics and Statistical Genomics; Participatory Extension Research and Management; Extension Methodologies for Agricultural Development; Extension Strategy for Entrepreneurship Development; Management in Agro Processing and Value Addition; Gender Mainstreaming for Resilient Agriculture; Technical Textiles and Functional Clothing; Nutrition Security; Cross Sectoral Disaster Risk Reduction Strategies in Livestock Sector; Functional Genomic Concepts; Quality Ruminant and Poultry Production; Farmers' Empowerment and Entrepreneurial Development; Disease Diagnosis and Management; Value addition and Challenges in Quality Control; Molecular Techniques in Gene Regulation and Functional Genomics; Molecular Breeding Approaches for Genetic Enhancement; Integrated Pest and Disease Management; Biotechnological Approaches for Adaptation to Climate Change; Forecast Modelling; Agro Ecosystem; Resource Conservation; Management Practices and Bio-security; Hi-Tech Intervention; Preservation and Processing Technologies; Sustainable Production; Protected Cultivation; Biofuels-Current Innovations and Future Trends; Food Safety Management Systems; Educational Methodology and Instructional Technology, etc.

Centres of Advanced Faculty Training: The 31 Centers of Advanced Faculty Training provided training to about 1000 scientists/faculty members from the National Agricultural Research System through **46** training programs in cutting edge areas of agriculture and allied sciences. All the training programs sponsored by Agricultural Education Division were monitored through workflow based online management system. A Capacity Building Program Portal was developed to provide information on all training programmes, training proposal submission and evaluation, submission of application by a trainee, availability of e-books/lecture notes of a training and reports for all categories of users and several other features.

Promotion of Excellence and HRD

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 are:

- *Designs for single factor and multi-factor experiments and their applications in agricultural systems research:* An algorithm has been developed to obtain A-optimal Balanced Treatment Incomplete Block designs for comparing several treatments with a control treatment. Methods of construction of efficient block and row-column designs for factorial experiments with baseline parameterization have been developed. A manuscript entitled "Significance of Experimental Designs in Agricultural Research" has been published with the purpose to disseminate among the stakeholders modern, appropriate and efficient designs recommended and already used by the agricultural researchers in conducting experiments along with introduction to some web resources for generation of designs and analysis of data from designed experiments. A monograph entitled "Weighting and Calibration in Sample Survey Estimation" has been published combining developments in the subject from initial times to recent times. A book chapter on "Distance Balanced Sampling Plans: An Overview" in a book "Statistical and

Mathematical Sciences and their Applications" has been written. An electronic document on "History of Statistics on Timeline" has been uploaded at Sample Survey Resources Server.

- *Assessment, prediction and enhancement of biotic carbon sequestration in agricultural soils:* Land-use and management effects on soil organic matter in central and south-western alluvial sub-regions of Punjab were enumerated through physical, chemical and biological fractionation techniques. It was found that majority of organic carbon in the two sub-regions occurred in active pool pointing towards its possible loss as a consequence of soil mismanagement. Rice-wheat and fodder-based cropping systems were characterized by relatively decomposable carbon (C) than the soils under cotton-wheat, which exhibited abundance of recalcitrant C. Different chemical fractionation methods were evaluated for enumerating soil organic matter responses to land-use and management; water soluble C emerged as the most sensitive indicator. Carbon sequestration potential of zero tillage in direct seeded rice was quantified. Zero tillage improved C sequestration by 274 kg/ha/y and the accrued C was mainly stored as particulate organic C. Carbon emissions from farm operations were estimated to identify best management practices and cropping sequence for minimizing agriculture-induced emissions of carbon dioxide.
- *Broadening the genetic base of Indian mustard (Brassica juncea) through alien introgressions and germplasm enhancement:*Released India's first Canola mustard variety RLC 3 for commercial cultivation in Punjab.Identified genetic bottlenecks in domestication related genes associated with pod shatter resistance. Cloned and sequenced the gene associated with determinacy in *B.juncea.*
- *Changing consumption pattern in India: Opportunities for diversification towards high value commodities through production and marketing linkages:* The determinants of diversification towards high value commodities (HVC) provided the empirical evidence that changing consumption pattern is distinctly driving production diversification in India. The structural changes in terms of infrastructure, technology and growing income levels have also positively influenced agricultural diversification. The share of Indian coffee exports to total global coffee exports has reached stagnation due to our inability to meet the growing consumer recognition and demand for certified and specialty coffees at the global market outlining the need to move from conventional coffee production to certified coffee production to capture high value markets.
- *Metagenomic analysis and manipulation of buffalo rumen ecosystem to improve fibre utilization and reduce methane production:* There was a significant inhibition (P=0.015) in methane emission by 20 and 24% in buffaloes fed concentrate: roughage feeds in 50:50 and 70:30 ratio, supplemented with a feed additive (0.5% garlic + 0.001% clove of dry matter intake and 15% nitrogen requirement met through nitrate feeding). There was no effect of treatment on dry matter digestibility and average daily body weight gain. The rumen microbial counts (bacteria, fungi, methanogenic archaea, ciliate protozoa, *Fibrobacter succinogenes*, *Ruminococcus flavefaciens*, *R. albus* and *Butyrivibrio fibrisolves* were not affected on 21 days of feeding, but after 120 days, all the microbes decreased significantly as compared to control animals. The feed additive appears to have a potential to explore further to mitigate methane emission by buffaloes.
- *Development of chromosome segment substitution lines (CSSL) of rice from elite × wild crosses to map QTLs/genes for yield traits:* F1s were obtained from 21 elite × wild crosses, BC1F1 from 7 crosses and BC2F1 from 5 crosses. BC1F1 from MTU1010 × *O. rufipogon* and Swarna × *O. rufipogon* were genotyped using 70 polymorphic core set SSR markers. From the previous 94 BILs from Swarna × *O.nivara*, 81848 were field evaluated during *kharif* 2014 and genotyped using 79 polymorphic SSR markers to identify a set of 50 CSSLs and 12 major QTLs for yield traits were identified. Likewise, 90 BILs from Swarna × *O. nivara* 81832 were genotyped to identify a set of 42 CSSLs, and 7 major QTLs for yield traits identified. Two high yielding stable BILs were selected after phenotypic evaluation for three seasons and intercrossed to get F1 and new F2 mapping populations.

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 molecular platforms for point-of-care detection of major enteric viruses responsible for neonatal mortality in animals:* Molecular epidemiological investigation in an epidemic of diarrhea in piglets from north eastern state (Asom) confirmed detection of rotavirus along with concomitant existence of emerging and opportunistic picobirnavirus in 39.8% (43/108) cases. Sequence based bioinformatic analysis showed higher genomic relatedness of porcine virus isolates with humans. The work is underway on identification of immunogenic regions in rotavirus structural capsid proteins for overexpression of virus specific recombinant protein with an aim to develop rapid and economic indigenous biologicals for rotavirus detection in

animals.

- *Assessment of sustainability of treated / developed watersheds in rainfed agro-eco-sub-regions of peninsular India using GIS and remote sensing:* Based on the methodology developed for measuring agricultural sustainability through implementation of watershed program in rainfed agro-eco -sub-regions in Peninsular India, selected watersheds were monitored and evaluated based on temporal change in land use-land cover. It was seen that in Pamana watersheds in Rangareddy district, over 45% of agricultural area in a watershed of 132 ha, had achieved fairly sustainable agricultural development. On the other hand in Gollapalli watersheds in Nalgonda district with 70% land under agriculture in a watershed of 91 ha, only 4% area was assessed as fairly sustainable and 29% was measured as moderately sustainable. Awareness of watershed programme and land management practices adopted by Pamana farmers had led to sustainable agricultural development. Poor adoption of improved land management practices by farmers in Gollapalli and land conversion were the major causes for unsustainable agricultural development in the region. A DSS is being developed for monitoring and evaluation of watershed projects in an attempt to standardize the procedure.
- *Development of food biopolymer based micro and nano scale delivery systems for bioactive ingredients in functional foods:* The process for preparation of nano emulsion of fish oil and lecithin in water using high pressure homogenizer was standardized. Alginate, with either skim milk powder or whey protein concentrate powder, was explored as delivery matrix to further stabilize the nano emulsion of fish oil for incorporation in functional foods. Fish oil emulsion was oozing out in beads of alginate with skim milk powder. Alginate with whey proteins yielded beads with an encapsulation efficiency of 89% and without any oozing fish oil emulsion. These beads were coated with vanilla flavored high melting fat to fully mask the smell of fish oil.
- *Biomodulation of Marine Biopolymers for the Preparation of Biomaterials of Healthcare Importance:* Vanillic acid and coumaric acid grafted chitosan derivatives improved grafting ratio and potential application in functional food. Thiamine and pyridoxine loaded ferulic acid grafted chitosan microspheres for dietary supplementation were developed. Experimental protocols and methodologies were standardized for the extraction and purification of bioactive and biocompatible collagen from air bladder of *Pangasius hypophthalmus* and skin of *Katsuwonus pelamis* (Skipjack tuna). It is noticed that fish collagen can be used as a bio-functional wall material in different encapsulation processes.
- *Robust and Efficient Small Area Estimation Methods for Agricultural and Socio-Economic Surveys and their Application in Indo-Gangetic Plain:* Many variables of interest in agricultural, environmental and ecological surveys are semi-continuous in nature, i.e. they either take a single fixed value (typically zero) or they have a continuous, often skewed, distribution on the positive real line. Standard methods for small area estimation (SAE) based on the use of linear mixed models can be inefficient for such variables. SAE techniques were developed for semi-continuous variables under a two part random effects model that allows for the presence of excess zeros as well as the skewed nature of the non-zero values of the response variable. In particular, the excess zeros are first modelled via a generalized linear mixed model fitted to the probability of a non-zero, i.e. strictly positive, value being observed, and then model the response, given that it is strictly positive, using a linear mixed model fitted on the logarithmic scale. Empirical results show that the developed SAE method leads to efficient small area estimates for semi-continuous data.
- *Nanotechnology in aquaculture: an alternative approach for fish health management and water remediation:* Zinc oxide nanoparticles showed algicidal and anti-algal properties. These nanoparticles significantly inhibited algal growth by pore formation and disruption of plasma membrane, efflux of intracellular components, cell structure alternation and reduced the chlorophyll contents. In the laboratory study, ZnO nanoparticles were found to control unwanted algal growth in aquaculture environment. Further work is in progress. A national level training programme on “Application of nanotechnology in aquaculture and fisheries” was conducted on September 24-28, 2015 at ICAR-Central Institute of Freshwater Aquaculture, Bhubaneshwar. A total of 16 participants including researchers, entrepreneurs, farmers and students from different states took part in the programme.
- *Development of soy and multigrain based nutritionally balanced functional foods for children:* Developed nutritionally and functionally rich laddoos, nachos, eggless cake and gluten-free eggless cakes using sprouted legumes, malted millets and fruits. Eggless cakes were developed using composite flour (CF) of wheat, malted finger-millet, sprouted soy and amaranth with banana as an egg replacer. Gluten free cakes did not contain any wheat in the CF. The 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 gluten-free eggless cakes. Nutritional trials on school children in MP revealed that the products improved the nutritional

status of school children significantly and can be used in mid-day meal programs.

- *Precision nutrient management using GIS-based spatial variability mapping under Upper and Middle Gangetic Plain Zones of India:* In order to develop precision nutrient prescription, homogeneous fertility management zones were prepared for North Eastern Plain Zone using GIS. Spatial variability in soil organic carbon stock in Upper Gangetic Plain was assessed and relationship between agro-ecological characteristics and crop management practices was established. Calibration of Green Seeker based NDVI for real time N prescription was made in maize crop. Optimized fertilizer N, P, K prescription for targeted rice and wheat yields using reciprocal internal efficiencies for rice and wheat, contribution of indigenous nutrient supplying capacity was developed.
- *Development of Commercially Viable Process Technologies for Weaning Food based on Underutilized Crops of Uttarakhand:* Fingermillet Dehuller-cum-Pearler was designed and developed for dehulling and pearling of fingermillet grain having 8kg/h capacity and 83.68% dehulling efficiency. Process protocols standardized and optimized for underutilized crops based Probiotic weaning mix using 70:30 blend ratio (fingermillet + barnyard: black soybean), 25 h fermentation time and 2.9% *L. plantarum*.
- *Functional Genomics, Epigenetics and Gene Silencing Technology for Improving Productivity in Poultry:* BMP3 (Bone morphogenetic protein 3) gene, a negative regulator of osteogenesis was polymorphic with presence of 5 haplotypes in control broiler line where h3 was the most frequent and h2 was the least frequent haplotype in the line. This gene was also polymorphic in control layer line having 4 haplotypes of which h2 was the most predominant and h1 was the least frequent haplotype in the line. BMP4 (Bone morphogenetic protein 4) gene involved in osteogenesis was polymorphic with presence of 4 haplotypes of which h4 haplotype was predominant in both control broiler and control layer lines, and h2 and h3 were the least frequent in control broiler and control layer lines, respectively. The haplogroups of both genes had significant association with body weight at 4 and 6 weeks of age, and growth rate between 4 to 6 weeks. In second experiment, myostatin (A negative growth regulator) IgG treatment on D7 embryos showed significant effect on body weight at 4 and 6 weeks of age where 26 kDa and 52 kDa IgG had higher body weight at both 4 and 6 wks. In another experiment, whole mitochondrial genome of 6 Indian native chicken (Aseel, Ghagus, Kadaknath, Nicobari, Haringhata black and Tellichery) was found to be 16775 bp in length with 37 genes (13 proteins, 2 rRNAs and 22 tRNAs) and showed SNPs, insertion as well as deletions. All indigenous breeds except Tellichery were very close together and close to the lineage of Red Jungle fowl. A total of five shRNA molecules for myostatin gene were designed, synthesized and cloned in DEST vector of which molecule 1, 3 and 5 showed significant silencing effect on myostatin gene in myoblast primary cell culture.
- *Studies on phyto-semiochemicals involved in Insect-Plant interactions of major horticulture pests:* Symbiotic bacteria influence many aspects of an organism's evolution. The influence of endosymbionts on the evolution of sexual selection is largely unknown. It was discovered that the endosymbiont *Klebsiella oxytoca* aid females choose fit females. It was also found that *K. oxytoca* produced specific volatile compound that attract males to females. It was also found that *K. oxytoca* was involved in ovary development in females. This work is the first report about an endosymbiont influencing sexual selection in higher organisms.
- *Molecular epidemiology and surveillance of Rhabdoviral Infections in farmed exotic trout:*Work was undertaken on the development of a method for detecting the presence of any virus signal in clinical samples of fish. Interferon stimulated genes (ISG) play a vital role in controlling viral infection as Interferon mediated cell signalling leads to the expression of Mx, an indicator of viral infection. Therefore, conditions for amplification of Mx gene from Indian snow trout (*Schizothorax richardsonii*) have been standardized using PCR. Amplicons of expected size were obtained for Mx gene. This will be helpful to detect the expression of Mx upon treatment of fish cells with virus analogue poly I:C.
- *Genome data mining to unravel molecular basis of thermotolerance and adaptation to diverse environment in native cattle and buffaloes:* The transcriptome profile of buffalo PBMCs in Sahiwal (*Bos indicus*), Holstein Friesian (*Bos taurus*) and Murrah buffaloes during summer stress was generated. This study was designed to provide comparative baseline data to understand the underlying alterations in cellular tolerance towards heat stress during hot summers in dairy animals. The responsiveness of PBMCs summer stress in the present study clearly suggested unique transcriptome signature buffalo, Sahiwal and Holstein Friesian PBMCs in response to environmental heat load. The study has identified several genes from different functional classes and biological pathways associated with summer stress that could be utilized in future research.
- *Development of sensitive and specific diagnostic assays for detection of Trypanosoma evansi infection in animals using modern molecular*

tools: Monoclonal antibodies were developed against surface glycoproteins of *Trypanosoma evansi*. A monoclonal antibody based ELISA was optimised for detection of antigen bound in immune-complexes in serum of *T. evansi* experimentally infected donkeys. The serum samples from 0-192 days post infection (d.p.i.) were analysed. The assay could detect antigen successfully in serum sample 14th d.p.i. onwards obtained from experimentally infected donkeys. Validation of the assay on field samples is in progress.

- *Development of novel immuno-potentiator molecules from fish host and pathogens for broad spectrum disease control in freshwater aquaculture:* The *in-vitro* screened recombinant peptides, hepcidin and apolipoprotein A1 were tested for their efficacy in fish to protect from bacterial infections. *In vivo* trials with recombinant hepcidin and apolipoprotein A1 at 100 µg/rohu juvenile rendered 80% and 75% survival, respectively, against *Aeromonashydrophila* challenge (LD75 dose), thus opening up scope for their field applications to protect from bacterial infections. Response of three classes of immunoglobulins (IgM, IgZ and IgD) was evaluated in *Labe orohita* in response to *Argulussiamensis* infection. Parasitic infection triggers expression of all three classes of Igs during infection process. Appearance of high level of expression of IgZ and IgD in skin and mucus might pave the way for vaccine development against ectoparasite*A. siamensis*.
- *Environmentally sustainable termite control: integrative* and *inclusive approach of frontier and indigenous technologies:*A comprehensive review of farmers' ITKs across the country has been made on termites. Termite pest mapping - pest prevalence mapping was done for 4-major termite-pests viz. Odontotermes, Microtermes, Heterotermes and Coptotermes species. Identification of alates of subterranean termites by molecular characterization facilitated study of swarming. Major Indian termites' mitochondrial genes were isolated, characterized, and acquired accession numbers from NCBI. Some new records of fungi associated with termite mounds (fungal combs) are documented, acquired accession numbers as well. Soil functional diversity analysis as affected by termite infestation inside the maize stubbles was studied via viable Phospho-lipid fatty acid analysis.Push-pull-strategy for termite management in wheat-maize agro-ecosystem was demonstrated successfully to farmers. Some noteworthy mass campaign measures on Termite R&D were taken at Pusa Krishi Vigyan Mela, New Delhi and Pusa Horticulture Show & Exhibition, New Delhi, Krishi Mela, IARI Regional Station, Pusa (Bihar).

Emeritus Scientist Scheme

The ICAR continued to operate Emeritus Scientist Scheme as a structural method of utilizing Skill Bank of the outstanding superannuated professionals of NARS. Some of the major findings of the projects under this scheme are:

- The reproductive biological parameters of a high value marine finfish the Malabar trevally (*Carangoides malabaricus*) was assessed. It was observed that the species is gonochoristic, ovary maturation is asynchronous, is a batch spawner, several spawnings can be obtained in a year, the size at first maturity is around 250mm and broodstock development period is comparatively less. All the above reproductive parameters and strategies are suited for captive breeding and hence the species is recommended for broodstock development, breeding and seed production for mariculture.
- Silver nanoparticles (15-30 nm) prepared by using pea (*Pisum sativum*) peel were successful in degrading the pesticide chlorpyrifos from water at room temperature without exposure to UV. Unlike chlorpyrifos, etofenprox degraded better in toluene than in water. Zinc Oxide in toluene and edible alkali in water were found better than other reagents tested to degrade this lipophilic insecticide.
- An instruction manual in Statistical Computing with SAS/MS-Excel has been developed for the benefit of Research Scholars/Scientists working in the fields of Animal Science and Dairy Research.
- The open sea cage culture technology of lobster has been successfully demonstrated and transferred to fisherfolk of Kanyakumari coast.The trained fisherfolk of Chennamuttam, Kadiapattnam and Muttom villages are currently adopting open sea Lobster culture in cages in a profitable and sustainable level .The spread effect is also visible as fishermen of adjoining and nearby villages are also quickly adopting the same as a livelihood enterprise.

Accreditation of Agricultural Universities

The following agricultural universities have been accredited during the year on the recommendations of National Agricultural Education Board (NAEAB) in its meeting held on 16 March 2015:

- Pandit Deen Dayal Upadyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan, Mathura
- Dr Y.S. Parmar University of Horticulture and Forestry, Solan
- Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur
- Tamil Nadu Veterinary and Animal Sciences University, Chennai

- Bihar Agricultural University, Sabour
- ICAR-Indian Agricultural Research Institute, New Delhi

During the period, the Peer Review of six agricultural universities, namely, MPUAT, Udaipur; CIFE, Mumbai; RAU, Pusa (Samastipur); RVSKVV, Gwalior; OUAT, Bhubaneshwar and SKUAST, Srinagar has also been conducted.

Netaji Subhas-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 (AUs) and overseas universities for overseas and Indian candidates, respectively. In order to pay the tribute to the great leader of the country, the name of the scheme was modified as "Netaji Subhas-ICAR International Fellowships".

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, 29 candidates were selected for their Ph.D. study including 17 Indian candidates at internationally recognized foreign universities in the countries viz. USA, Germany, Belgium, Norway, Thailand and Austria and remaining 12 candidates from Nepal, Bangladesh, Sri Lanka, Nigeria, Ethiopia, Rwanda, Sierra Leone and Syria at Indian SAUs/ICAR DUs.

During this year, 27 candidates have joined their overseas laboratories for pursuing Ph.D. and the following 12 candidates including two Egyptians have completed their degree programme.

Name of the Fellow	Research Topic	Host University
Ms Kshipra Chandrashekhar	Understanding *Campylobacter jejuni* colonization and stress survival mechanism: Role of Transducer like proteins (Tlips) and Polyphosphate kinases (ppks)	Ohio State University, USA
Mr R Krishnamoorthy	Exploring the Biodiversity of Arbuscular Mycorrhizal Fungi and Associated Endobacteria to Improve Maize Growth under Salt Stress Conditions	Chungbuk National University, South Korea
Ms Archana Kumari	Molecular mechanisms that link stress and repression of cell proliferation in plants	Osaka University, Japan.
Mr N Muralidharan	Properties and applications of nano-biocomposite film based on fish gelatin	Prince of Songkla University, Thailand
Mr Sudeepta K. Panda	Establishment of mouse disease by using sequence-specific nucleases	Technical University, Munich, Germany
Mr Jagadish Hiremath	Development and Evaluation of PLGA-Nanoparticle Entrapped Influenza Virus Peptides Vaccine and Effect on Molecular Phenotype of Alveolar Macrophages with reference to DAP12 Signaling Pathway in Pigs	Ohio State University, USA.
Mr Ahmed Fawzy Abdel-Naby-Abdel-Naby El-Kot,	Marker Assisted Transfer of Novel Powdery Mildew Resistance Gene (s) from Diploid wheat *Triticum boeoricum* (Boiss) to hexploid wheat *Triticum aestivum* (L)	PAU, Ludhiana
Mr Moamen Mohamed Hamed El-Kady	Nano-science and Remote Sensing Appraisal of Pedogenic Impetus on Constituents in Desert Soils of Punjab	PAU, Ludhiana
Ms Kalavathy Rajan	Characterization of Cellulose Enzyme Inhibitors formed during the Chemical Pretreatments of Rice Straw	University of Arkansas USA
Mr Thirumala R. Talluri	Approaches for the derivation of induced pluripotent stem cells from cattle	University of Veterinary Medicine Hannover, Germany
Mr Pradeep Kumar	Grafting and application of mycorrhiza for improving tolerance to heavy Metal Stress in Tomato	University of Tuscia, Viterbo, Italy.
Ms R. Priyadharsini	Identification of Molecular role of Pelota Protein (PELO) in proliferation and differentiation of male germ stem cells (SSC) by analysis of conditional knockout mice	University of Gottingen, Germany

Netaji Subhas-ICAR International Fellowships

India-Africa Fellowship Programme

India-Africa Fellowship Programme has been implemented by Government of India. As per the programme, placements for 300 fellowships (viz. 75 per year, i.e. 50 Master's and 25 Ph.D.) are provided for students/faculty/professionals of African continent. Under the programme, a total of **195** candidates (119 Master's and 76 Ph.D.) have joined in **35** Indian Agricultural Universities. Out of which **115** candidates (78 Master's and 27 Ph.D.) have successfully completed their programmes.

India-Afghanistan Fellowship Programme

India-Afghanistan Fellowship Programme has been implemented by Government of India for providing 614 fellowships to Afghan nationals for attaining higher education in Agriculture and allied sciences in identified Indian Agricultural Universities (AUs). A total of **182** candidates (67 Bachelor's; 115 Master's) have joined in **38** Indian AUs. Out of which, **29** candidates of Master's programme have completed their programme successfully. During 2015-16, a total of **64** Afghan candidates (51 Master's and 13 Bachelor's) have been recommended for admission in Indian AUs. Eleven candidates (3 Bachelor's; Master's 8) of session 2015-16 have joined the programme, so far. To attain maximum enrolments of Afghan candidate, the tenure of programme is extended over a period of 2012-13 to 2020-2021 under the available slots of 614 fellowships for Bachelor's 50%, Master's 30% and Ph.D. 20%.

New Initiatives

Student READY

The Students READY (Rural Entrepreneurship Awareness and Development Yojana) programme was launched by the Hon'ble Prime Minister on 25 July 2015 and it will be implemented from the next academic year 2016-17. Under this programme, the fellowship of ₹ 3000 per month will be provided for a period of six months to all the under-graduate students of agricultural science. The programme aims to provide rural awareness, entrepreneurship development and practical hand-on experience in agriculture and allied sciences.