Foreword

Deficient monsoon posed various challenges on the front of food security. Responding to the situation, Indian Council of Agricultural Research (ICAR) formulated a technology- driven contingency crop plan to mitigate the drought effect in *kharif* and to compensate the *kharif* crop losses during *rabi* season. The country-wide network of 97 ICAR research institutes, 44 state agricultural universities and 569 Krishi Vigyan Kendras (KVKs) was geared up to deliver the appropriate technologies at farms, and mass media was effectively used for dissemination of proven production and protection technology.

On the research front, in the national herbarium of cultivated plants, 294 specimens were added, whereas in the national repository, 109 red onion, 57 white onion and 46 garlic collections were included. A new mite christened *Mangalaus* with a new species, yet to be named, was discovered. This eriophyid is one of the smallest of the arthropods of the size of 200 microns.

The *Pseudomonas* strain *putida* 'GAP-P 45' induced synthesis of novel proteins in the plants conferring tolerance to drought stress. The Council has released/ identified over 130 varieties/hybrids of major field and horticultural crops suitable for different agro-climatic regions of the country. A total of 7,340 tonnes of breeder seed and 63,415 tonnes of quality seed of field crops were produced. The participatory seed production programme at farmers' field resulted in production of 31,900 tonnes of quality seed.

Advanced hand guided cloning technique in buffalo was standardized for the first time in the world. The calf "Garima" produced through this technique is developing normally with good health status. As an effort to manage the Foot-and-Mouth disease in South Asia, an international Foot-and-Mouth Disease Reference Laboratory was established in Bhubaneshwar.

Bagasse was proved to be a successful bio-stimulator for the removal of ammonia and nitrate in shrimp aquaculture. Shrimps produced using organic components showed improvement in size with better food conversion ratio. Biosecured zero-water exchange system is ready for on-farm demonstration. Micro-feed for nursery technologies is ready for commercial scale production. *Puntius pulchellus,* a threatened shrimp species, was induced bred for the first time.

The KVKs have assessed and refined appropriate technologies by conducting 26,028 trials across the country. For empowerment of rural women, KVKs have assessed 105 technologies pertaining to drudgery reduction, health and nutrition. A total of 86,285 frontline demonstrations in an area of 51,101 ha were conducted. A total number of 56,819 training programmes were organized with the participation of 15.40 lakh farmers including rural youth, and in-service extension personnel. As many as 12,978 skill-oriented training programmes were organized for 3.10 lakh rural youths. A total of 1.58 lakh samples of soil, water, plant material, manure and others were analyzed from 1.40 lakh farmers belonging to 30,330 villages.

To upgrade and maintain the standards and quality of higher agricultural education in the country, the two-year post graduate diploma programme on management (Agriculture) has been started and 31 state agricultural universities were accredited. For the promotion of Excellence under the ICAR National Professor Scheme, a "Norman Borlaug Chair in Agricultural Biotechnology for crop

improvement" has been instituted. The National Agricultural Innovation Project (NAIP) has approved and grounded 75 sub-projects on the cutting-edge agricultural and allied technologies. IT-enabled information and communication, expert systems and database management developed by the Council are being operationlised by the various institutes. Fifty-five personnel including farmers and journalists were honoured for their outstanding services in accelerating agricultural growth and development.

I compliment the Indian Council of Agricultural Research for the commitment and dedicated efforts to develop the strategy and suitable technological interventions to meet the emerging challenges. I believe that *DARE / ICAR Annual Report 2009-2010* will prove a knowledge resource for various stakeholders of Indian agriculture.

(SHARAD PAWAR)
President
ICAR Society

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Indian Council of agricultural research

President, ICAR Society and Union Minister of Agriculture	:	**Shri Sharad Pawar**
Minister of State for Agriculture	:	**Shri Kanti Lal Bhuria (up to 22.5.2009)**
	:	**Prof. K V Thomas (since 1.6.2009)**
Secretary (DARE) and Director-General (ICAR)	:	**Dr Mangala Rai**
Special Secretary (DARE) and Secretary (ICAR)	:	**Shri A K Upadhyay (up to 3.11.2009)**
Additional Secretary (DARE) and Secretary (ICAR)	:	**Shri Rajiv Mehrishi (since 20.11.2009)**
Additional Secretary (DARE) and Financial Adviser (ICAR)	:	**Shri Chaman Kumar**

The Mandate of the Indian Council of Agricultural Research

(i) To plan, undertake, aid, promote and coordinate education, research and its application in agriculture, agroforestry, animal husbandry, fisheries, home science and allied sciences.

(ii) To act as a clearing house of research and general information relating to agriculture, animal husbandry, home science and allied sciences, and fisheries through its publications and information system; and instituting and promoting transfer of technology programmes.

(iii) To provide, undertake and promote consultancy services in the fields of education, research, training and dissemination of information in agriculture, agroforestry, animal husbandry, fisheries, home science and allied sciences.

(iv) To look into the problems relating to broader areas of rural development concerning agriculture, including post-harvest technology by developing co-operative programmes with other organizations such as the Indian Council of Social Science Research, Council of Scientific and Industrial Research, Bhabha Atomic Research Centre and the universities.

(v) To do other things considered necessary to attain the objectives of the Society.

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Overview

With about 60% of the cultivated area as rainfed, our agricultural production is strongly influenced by the movement of South-west monsoon. The rainfall for the period, June-September 2009, was 77% of its long period average (LPA). The monsoon set in over Kerala on 23rd May, one week before its normal date of 1st June, it advanced rapidly and covered the entire country by 3rd July, compared to its normal date of 15th July. Out of 526 meteorological districts for which data are available, 215 districts (41%) of the meteorological districts received excess/normal rainfall and the remaining 311 districts (59%) received deficient/scanty rainfall during the season that reflected adversely on the overall production of *kharif* crops especially, rice and the coarse grains. Responding to the situation, the Council formulated and helped in implementation of the technology-driven contingency crop plan to mitigate the effects of drought like situation following erratic monsoon and to compensate the *kharif* crop losses during the *rabi* season. Crop-weather advisories were disseminated through the country-wide network of the ICAR research institutes, state agricultural universities and Krishi Vigyan Kendras (KVKs). An area of 36,675 ha with the participation of 56,719 farmers was brought under demonstrations on resource conservation technologies in districts facing drought. The drought like situation followed by floods in several parts of the country was a cause of concern and more so because we are witnessing this phenomena with increasing frequency.

The Indian Council of Agricultural Research continued to move forward in generating technologies towards sustainable scientific and knowledge-based advancements in agriculture and allied sectors, improving quality of higher agricultural education, institutional capacity building, and establishing linkages/partnerships with other national/international agricultural research and development organizations/systems. The research and development programmes undertaken during the year addressed areas of optimizing resources' use, improved cultivation techniques, development of improved varieties/breeds, excellence in agricultural education by implementing the reforms and frontline extension of technologies, providing improved planting materials, imparting training for skill development/enhancement especially to rural women and youth and various stakeholders. Human Resource Development (HRD) programmes and talent search in agricultural sciences to meet the future needs of agricultural research, education and extension received priority attention.

For cutting edge research across disciplines and commodities, a National Institute on Abiotic Stress Management, with deemed-to-university status, has been established in Maharashtra and is already operational. The National Institute on Biotic Stress Management and National Institute on Biotechnology have also been approved in principle. A DNA bank has been established, cutting across plant and animal kingdom, so that desirable traits could be incorporated while evolving new varieties, hybrids, breeds etc. For value-addition and efficient utilization of genetic resources and to check biopiracy, special thrust is being given on gene prospecting and allele mining; phenomics, functional genomics and bioinformatics. The ICAR has embarked upon an ambitious multidisciplinary programme 'Bioprospecting of Genes and Allele Mining for Abiotic Stress Tolerance' to meet the challenges due to climate change. Thirty-five institutes are involved in this project. This will also broaden the window of optimal growth conditions for cultivated crops under adverse climate, thereby increasing yield and reaping

enhanced stabilized production under changed climatic conditions.

To safeguard the livestock production, a high security animal disease lab with P-4 measures was established. It played a pivotal role in providing diagnostic services for avian influenza besides developing vaccine. "Garima" a cloned buffalo calf was born through a new and advanced 'Hand-guided cloning technique', at the NDRI, Karnal on 6 June 2009. The growth of the calf is normal and has good health status. For the first time a Mithun calf was born through Artificial insemination.

Some of the Council's initiatives and salient achievements during the year under report are presented here.

Soil and water: Among the *Pseudomonas* strains isolated from rainfed regions of India, *P. putida* 'GAP-P 45' was able to induce synthesis of novel proteins in the plants conferring tolerance to drought stress. Bagasse proved a successful bio-stimulator for the removal of ammonia and nitrate in shrimp aquaculture. This technology is available for adoption by farmers.

Farming system: Gmelina-turmeric based agroforestry was found suitable for Humid and Sub-Humid regions. Gmelina with turmeric, sapota, teak-based agroforestry system proved useful for adoption in transitional and hilly zone with medium/deep soils under irrigated condition in Karnataka.

A pond-based farming technology (deep water rice in *kharif* + watermelon, okra, spinach, chili in winter + on-dyke vegetables-fruits + fish inside pond) in a representative deep waterlogged areas (1.0-2.5 m water depth) of Puri district, Orissa enhanced the net water productivity to Rs 7.21/ m^3 and net returns (Rs 22,100) in rice. Rainwater harvesting system was designed and agricultural diversification model (on-dyke horticulture, fisheries, cultivation of diversified field crops, short-term fruits like papaya, banana, floriculture like marigold, tuberose etc.) with harvested rainwater was developed for small and marginal farmers with multiple use of water. The technology has been recommended for inclusion in the 'National Rural Employment Guarantee Act' (NREGA) for implementation in watersheds of eastern Indian states. Water requirement of animals fed on cactus + grass/straw feed was considerably reduced, making the cactus a feed admixture of choice in the regions facing water-scarcity. A network of 47 model watersheds has been developed that provides a basis for undertaking projects as part of the natural watershed development programme.

Climate change: The studies under controlled environment conditions (free air CO_2 enrichment, open top chambers) and modeling showed that a rise in atmospheric carbon dioxide up to 550 ppm enhanced the yields of wheat, chickpea, greengram, pigeonpea, soybean, tomato and potato between 14% and 27%. In coconut, arecanut and cocoa, increased CO_2 led to higher biomass production. A study on Sahiwal and Holstein Friesian crossbred (Karan-Fries) heifers revealed that HSP72 protein level increased due to thermal exposures, relatively higher in Karan-Fries (106%) than Sahiwal (22.4%). Resource conserving technology was the most cost-effective strategy to reduce N loss and GHG emission, whereas integrated N management costs high for mitigating greenhouse gases (GHG) emission.

Genetic resources: During the year, 38 explorations were undertaken and 2,892 accessions including 784 of wild species were collected. In the National Herbarium of Cultivated Plants, 294 specimens were added. A total of 32,260 accessions including 5,373 international trial material were introduced from 45 countries. As many as 720 germplasm lines have so far been registered. About 9,530 accessions of orthodox seed species were added to the National Gene Bank. Sixteen Phyto-sanitary Certificates were issued for export of 1,120 samples.

Among fruit crops, 78 accessions and 16 superior clones of mango, 122 accessions of guava, 4 of litchi, 24 of banana, 9 of citrus, 14 of grape, 25 of pomegranate and 8 of *ber* were collected. In the field gene bank, 5 distinct coconut, 23 oil palm and 14 cashew accessions were added. Late blight- and early blight-resistant source JX90 of potato was registered with the National Bureau of Plant Genetic Resources (NBPGR), whereas 30 indigenous and 29 exotic collections of sweet potato were collected from Meghalaya. In the national repository, 109 red onion, 57 white onion and 46 garlic collections got the place. Forty-one distinct strains of *Pleurotus* species were characterized. A total of 33 clove, 122 nutmeg, 42 cinnamon and 10 cassia germplasm lines were collected. Eight new accessions of rose, 89 endangered and rare species of orchid were collected from North-Eastern region. The new collections of medicinal and aromatic plants consisting of 42 of *ashoka*, 31 of *ashwagandha* and 43 of *giloe* were added in the repository.
The National Bureau of Agriculturally Important Microorganisms repository has now more than 2,000 collections of culture fungi, 500 bacteria, 30 actinomycetes and 20 yeasts. Bacterial inoculants, developed to alleviate the harmful effect of salinity for enhanced growth and yield of wheat in saline soils, were identified through sequencing of 16S rDNA. A *Catalogue of Microbial Cultures* was also brought out.

The role of A1 and A2 beta casein milk variants in human health is a matter of concern for scientific investigations. The ß-casein A1/A2 frequency data indicated predominance of A2 variant (0.987) in zebu cattle breeds, while buffaloes showed only A2 milk type. The results point towards the origin of A2 variant in *Bos indicus* cattle. This is the first report of A1/A2 milk variant in majority of Indian zebu cattle and riverine buffalo breeds. An association study showed higher adult body weight of the individuals carrying the allele in yak. This marker information could be incorporated in marker-assisted selection for higher adult body weight in yak, as the body weight determines draught and pack ability and quantity of meat production.

Chemo-litho-autotrophic bacteria, which can be used for bioremediation of shrimp-farm discharge, were identified. A molecular tool was developed for the detection of these bacteria and is being offered to private entrepreneurs for its commercialization. Barcoding of five species of tuna was carried out and deposited with the gene bank of the National Centre for Biotechnology Information (*http://www.ncbi.nlm.nih.gov/taxonomy*). Forensic investigations using DNA barcoding helped in identification of whale shark (*Rhyncodon typus)* meat designated as endangered species. And it can be used effectively in curtailing illegal trade.

Crop improvement: One hundred and thirty-one varieties/hybrids of major food crops including rice, wheat, barley, maize, pearl millet, and pulses and oilseeds have been released/identified for different agro-climate regions of the country.

Significant crop improvement research includes development of rice varieties, namely Improved Pusa Basmati and Improved Samba Mahsuri, identification of 17 high-yielding varieties of pulses, six varieties of groundnut, one variety of soybean and two hybrids of sunflower for release in different agro-ecologies and production of 7,339.7 tonnes of breeder seed of centrally released field crop varieties. Gene sources for resistance to Ug99 rust with new genes have been developed and race-specific and adult plant resistance to Ug99 and its cool temperature derivatives have been successfully introgressed in Indian wheat breeding materials.

In coconut, accession IND 125 S was recommended for cultivation in Karnataka, Tamil Nadu and Kerala, and hybrid IND 376 for Asom and Kerala. Two varieties, namely Kufri Nilima and Kufri Frysona, of potato were released for cultivation in Nilgiris hills of Tamil Nadu and Indo-Gangetic plains respectively. In spices, one variety each of ginger (Subhada) and cumin (RZ 345) was recommended for release.

Hybrid 1084 of dwarf stature mango with regular bearing was found promising. In banana, embryo rescue was standardized for wild species and hybrids involving wild species. Fingerprints of 44 grapes accessions were developed. Bhima Red variety of onion, developed through bulb to row selection method, possesses attractive red colour with yield around 30 tonnes/ha in *rabi* and yield potential of 50 tonnes/ha in late *kharif*.

The bud chip technology emerged as one of the most viable and economical alternatives in reducing the cost of sugarcane production, besides other advantages. Bacterial inoculants developed to alleviate harmful effect of salinity for enhanced growth and yield of wheat in saline soils were identified through sequencing of 16S rDNA. Leaf powders of *Vitex nigundi*- and *Polygonum*-treated food recorded least preference by *Rattus rattus* in laboratory, indicating their anti-rodent properties.

The double hedge row system of planting in guava, aonla and litchi proved best method for realizing high fruit yield.

Under salinity stress, Thompson Seedless grape when grafted on B2-56 rootstock exhibited high level of stress tolerance. Wedge grafting in walnut practiced under polytrench recorded high success rate. In arecanut, mined cropping with pepper, banana and citrus was suitable for North-eastern region. The intercropping systems involving ginger, tapioca, coleus, amorphophallus for black pepper; sweet potato + red gram; elephant foot yam with mango/sapota, potato + garlic have been identified for continuous and high yield. Release of bio-control agents, namely *Mallada boninesis* and *Tamarixia radiata*, in citrus orchards resulted in 31-33, 47-49 and 26-30% reduction of blackfly, psyla and leaf miner populations respectively. By releasing parasitoids, infestation on coconut leaf by leaf-eating caterpillar could be suppressed effectively. Soft rot of ginger could be managed by bio-fumigation using cabbage and mustard plant refuses. Marigold and yam bean were found to be effective barrier crops for sweet potato weevil. The problem of fruit cracking in pomegranate could be reduced with application of boron and zinc.

Livestock improvement: The average age at first calving of Frieswal cows was 979.56 days. The breeding value of Hariana sires for milk yield and draught ability confirmed that these 2 traits are of different nature. The introduction of *FecB* gene from Garole into Malpura and backcrossing of GM with Malpura increased body weights of their lambs, and GMM ewes produced 40.0% twins in the flock. Layer poultry variety Gramapriya was widely accepted by the farmers of Kashmir valley.

Puntius pulchellus locally called *Haragi Meenu*

in Karnataka, a threatened species of peninsular carp endemic to the Krishna river basin, was induced bred for the first time. A technology for round-the-year seed production of Asian seabass was developed. Electron beam irradiation method could be devised to reduce anti-nutritional factors in plant-based aquafeed ingredients.

To achieve targeted growth rate of 6% in livestock output, progress in livestock infrastructure, institutional efforts and availability of livestock feed is required to be accelerated by about 50%. Supplementation of zinc and copper from organic sources was more effective in inducing estrus and anoestrus crossbred cows. Methane emission from fresh dung on dry-matter basis was lower in zebu cattle than crossbred cattle. Green fodder feeding increased milk conjugated linoleic acid (CLA) in cows and buffaloes. The CLA has anticancer property, and it increases up to 310% in *ghee* prepared by indigenous method. Commercially available microbial feed additives enhanced growth by 12.0% and feed intake by 11.6% in fattening lambs for mutton production. As supplementation of concentrate mixture during post-weaning stages improved body weights of lambs, farmers fetched 25 - 33% more price in the market.

An antioxidant (vitamin E) in combination with liver stimulant was found detrimental for egg production in birds. Combination of melatonin and toxin binder alleviated adverse effects of aflatoxicosis in broilers.

The foot-and-mouth virus typing ELISA kits were manufactured, which ensured uniformity in application and test result across the country. Establishment of an international Foot-and-mouth Disease Reference Laboratory will facilitate Global participation and eradication of the disease from South Asia.

A 'FROGIN' software was developed for precise prediction and forecasting of haemonchosis in sheep. Complete *HN* and *F* genes of velogenic Newcastle disease virus were cloned for use as bi-cistronic DNA vaccine. PLG nanoparticles encapsulating outer membrane proteins of *Salmonella* Gallinarum induced good IgA antibody in chickens.

The marine fish landings in India during 2008-09 touched the 3.21 million tonnes mark with an increase of about 0.327 million tonnes (11.3%) against the estimates of the previous year. The percentage share of fishermen in consumer rupee (PSFCR) has also increased over the years. High-value fish like coastal tuna and oceanic tuna registered growth level of 23% and 39% respectively. The targeted fishery for the deep sea sharks on the west coast landed more than 14 species of sharks as well as chimaeras. Biosecured zero water exchange system technology is ready for on-farm demonstration and dissemination to farmers.

Post-harvest management and value-addition: A fermented drink/beverage from banana pulp and sorghum sprouts was produced from over-ripe bananas. The beverage can be preserved with flavour for 3 months under refrigerated conditions. For preparation of dried juice powder of citrus fruits, fresh fruits of four *Citrus* species, namely citron, acid lime, Nagpur mandarin and Mosambi, as well as juice blend of pummelo and citron fruits were utilized to manufacture the value-added products.

Carbonated beverages were prepared from mango, passion fruit and custard-apple. Two hair-care products, namely 'Aloe Shampoo' and 'Aloe Hair Cream' having shelf-life of more than 10 months were developed from *Aloe vera*.

Extrudates were prepared from cassava blended with corn flour, *maida*, wheat flour and finger millet. High protein and dietary fibre-enriched pasta were prepared from cassava-*maida* blends. The protein content could be enhanced to 11-12% with whey protein concentrate, defatted soy flour and prawn paste. Bonding applications was upscaled to 5.0 kg level and is ready for transfer. The solid adhesive was tested on various surfaces by a industry in Kerala.

A process patent (No. 1261/MUM/2008) has been filed by the Directorate of Medicinal and Aromatic Plants Research (DMAPR) at Indian Patent Office, Mumbai, for preparation of pure aloin from aloe through extraction and purification. The new method is easy, quicker, efficient (recovery up to 90%) and cost-effective (most of the solvent used can be recovered for reuse) and can be used for extraction of aloin of high quality from fresh, sun-dried, oven-dried or freeze-dried leaf exudates. As aloin purity of more than 90-95% can be achieved by this method, it is suitable for industrial purposes.

A technology was evolved for development of pulp and paper by mechanical pulping process (chemical free) from date palm leaf and carry bag, writing pad etc. The technology can be transferred to rural sectors at low capital investment. A lac-based formulation was developed for fruit-coating applications on apple and citrus fruits like kinnow and orange. The formulation yielded good results in respect of gloss and firmness to kinnow. Shellac-based dental plates were prepared. Natural-synthetic composite geotextile was used for protection of a part of the bank of Mayurakshi River (rainfed river) in West Bengal.

Pomegranate aril extractor is capable of processing whole pomegranate at a rate of approximately 30–35 fruits/minute, and this

technology was transferred for commercial exploitation. System for the storage of live fish with aeration was designed, developed and tested. The FRP silo for fish culture/holding system, which is first of its kind in the country, was designed and fabricated. Microbial assays were developed, which are useful in dairy industry as "ON FARM" milk screening test for β-lactam group. Health benefits of cow *ghee* were validated. Cow *ghee* decreases initiation and progression of mammary and gastro-intestinal tract cancer in rats.

A software Cotton Bale Manager was developed to perform design and generation of bale identification tag and to interface this bale tag with the bale database management software. Another software GINERP for managing a modern ginnery has already been commercialized.

Agricultural engineering and energy management: A number of implements such as manure spreader, hill drop planter, cumin planter, baler with reaping attachment were developed as tractor-operated machinery. A power tiller-operated two-row canopy sprayer was developed for cotton and pigeonpea that can remove more than 550 bud chips/hr/person. A suitable experimental model of continuous type animal feed block making machine was fabricated.

In a poultry litter-based biogas plant, the use of poultry litter increased the yield of biogas generation by 17% (from 66 to 83%) compared to normal cowdung-based biogas plant. The briquettes made from soybean and pigeonpea stalks can be used for domestic application, in gasifier and commercial boilers. A rapid process for ethanol production from kinnow waste (peel+ pulp) using galactose adapted yeast cells was developed. Significant achievements include development of novel micro-well chip based biosensor, revelation of methodology for isolation and purification of microbial polysaccharides, isolation of nitrate-reducing microbes having potential to be used as probiotics in mitigating methane emission for eco-friendly livestock production.

Agricultural human resource development: Efforts are being made for continuous upgradation and maintenance of standards and quality of higher agricultural education in the country through professional support and financial aid to the Agricultural Universities. The National Academy of Agricultural Research Management, Hyderabad, started the two-year post-graduate diploma programme on management (Agriculture) besides its other two programmes on Information Technology management and Intellectual Property management. Accreditation was granted to five State Agricultural Universities (SAUs) and to the MBA programme of the Rajasthan Agricultural University, Bikaner. Thus 31 institutions are accreditated for higher quality education.

Construction of one museum each in 38 SAUs, allocation of Rural Awareness Work Experience (RAWE) Programme to 44 Agricultural Universities (AUs) and institution of "Norman Borlaug chair in Agricultural Biotechnology for crop improvement" are expected to improve the quality of education. To face the emerging challenges, the Model Act for AUs in India was revised and communicated to all AUs for adoption. A national core group formed by the ICAR, has revised the course curricula and syllabi of all PG (masters and doctoral) programmes to make them utilitarian, updated and competitive. A new component of International fellowship was introduced for pursuing Ph.D. programme at the Indian Agricultural Universities and Overseas Universities for Indian and overseas candidates. More than 3,000 theses have been digitized and full text data uploaded (*http://www.hau.ernet.in*). The 'Agropedia' has further diversified and over 30,000 people from 165 countries visiting the site (*www.agropedia.net)*. aAQUA SMS and voice services are reaching more than 10,000 farmers regularly.

Information, communication and publicity services: The Council has redesigned and further developed website (*www.icar.org.in*). The *ICAR News* and *ICAR Reporter* were made available on-line, besides several other publications. Guidelines were developed for bringing uniformity in the websites of ICAR institutes.

The ICAR institutes/SAUs are being connected to National Knowledge Network through an electronic digital broadband to encourage sharing of resources for collaborative research and education. Under "e-Publishing and Knowledge System in Agricultural Research (E-PKSAR)", a fully automated, on-line electronic publishing system is being implemented for eleven journals/ periodicals. More than 1,000 research articles/ features were published in the noted periodicals of the ICAR during the year. A professional get-up was imparted to popular periodicals that included design, layout and contents.

Technology assessment, refinement and transfer: During the year, KVKs have assessed appropriate technologies by conducting 26,028 trials in 8,254 locations. Towards empowerment of rural women, KVKs have also assessed 99 technologies under the thematic area of drudgery reduction, health and nutrition involving 280 locations. A total of 86,285 frontline demonstrations involving an area of 51,101 ha were conducted by KVKs. Under the frontline demonstrations conducted, 76,206 were on oilseeds, pulses, cotton and other important crops covering an area of 30,664 ha.

A total of 4,600 demonstrations on-farm implements covering an area of 4,212.23 ha were conducted. Further, 5,479 demonstrations were conducted on 16,225 units of various enterprises including dairy, piggery, poultry, sheep and goat rearing, fisheries, bee-keeping, mushroom cultivation, nutrition gardening, sericulture, organic composting, home science and bio-products.

In the case of farmers' capacity building, 39,912 training programmes were organized, benefiting 11.27 lakh farmers and farm women. As many as 12,978 skill-oriented training programmes were organized for 3.10 lakh rural youths. A total of 3,929 training programmes were conducted covering 103,428 extension functionaries of state departments. The KVKs also organized 3.04 lakh extension programmes, benefitting 106.85 lakh farmers and extension personnel to create awareness about improved agricultural technologies. The KVKs have conducted 240 training programmes and 128 crop demonstrations by utilizing demonstration unit of rain water harvesting with micro-irrigation system.

The KVKs have produced seeds, planting materials, bio-products, livestock material, poultry and fisheries to a tune of Rs 1,304.47 lakh benefiting 4.22 lakh farmers. During the year, the KVKs produced 2.08 lakh quintal of seeds including cereals, oilseeds, pulses, commercial crops, vegetables, flowers, spices, and fodder and fibre crops. Besides, KVKs produced 146.09 lakh seedlings and saplings and provided to 159,000 farmers. Other achievements include motivation of more than 48,000 farmers in backward areas with large population of tribals; adoption of suitable drought mitigation measures with suitable advice to the farmers; introduction of lac cultivation in Jharkhand, Chhattisgarh and Madhya Pradesh as a major income-generating activity, particularly under rainfed/dryland situations.

A road map based on technological interventions has been adopted to enhance the production and productivity of *rabi* crops to cover the deficit in food production during the year.

Finance: The Budget Estimates (BE) and Revised Estimates (RE) of DARE and ICAR (Plan and Non-Plan) for 2008-2009 are Rs 2,680.00 crore and Rs 2,982.64 crore, respectively, and BE for 2009-10 (Plan and Non-Plan) is Rs 3,314.00 crore.

IP portfolio management: Patents were granted to the ICAR in 8 fields of invention. The ICAR institutes secured 4 Trademarks to distinguish the ICAR products. Six copyrights were registered by the ICAR institutes to protect their software from unauthorized copying. The premise of centralized planning and decentralized execution for Intellectual Property Management in the ICAR was strengthened. Some of the ICAR institutes have entered into MoUs with private and public sector companies for commercialization of plant varieties/hybrids.

Awards and incentives: Fifty-five awardees under twelve different categories were conferred awards. These comprised three Institutions, 47 scientists including nine women, three farmers and two journalists.

Partnership and linkages: The Memorandum of Understanding was signed between ICAR and Biodiversity International for Scientific and Technical Co-operation. Besides, four Collaborative Projects were approved for implementation by the various institutes of the ICAR. The ICAR is imparting training to foreign nationals belonging to Iran, Sri Lanka, Ethiopia, Rwanda, Myanmar, Bhutan, Botswana, Iraq, Nepal, Vietnam and Nigeria under agricultural knowledge empowerment. In Protocol activities, DARE facilitated foreign delegations, Indian scientists to foreign countries on deputation. The Council under the National Agricultural Innovation Project (NAIP) has also approved 61 sub-projects on the cutting-edge agricultural and allied technologies. These sub-projects have very diverse partnership such as ICAR institutes and State Agricultural Universities, general universities, IITs, IIMs, CSIR laboratories, other central and state government departments, private sectors and NGOs.

The Council is committed to meet the emerging challenges in the field of agriculture and allied sectors through technological interventions. Human resources to generate appropriate location-specific technologies and inter-institutional knowledge support is one of our priority areas. Alleviation of hunger, poverty and strengthening of livelihood security are our goals to achieve. In the wake of global climate change and looming global food crisis, our responsibilities have increased manifold, but I am sure, the pro-active steps taken by the Council will certainly help us in ensuring the food security for millions of countrymen.

(Mangala Rai)
Secretary,
Department of Agricultural Research and Education,
and
Director-General
Indian Council of Agricultural Research

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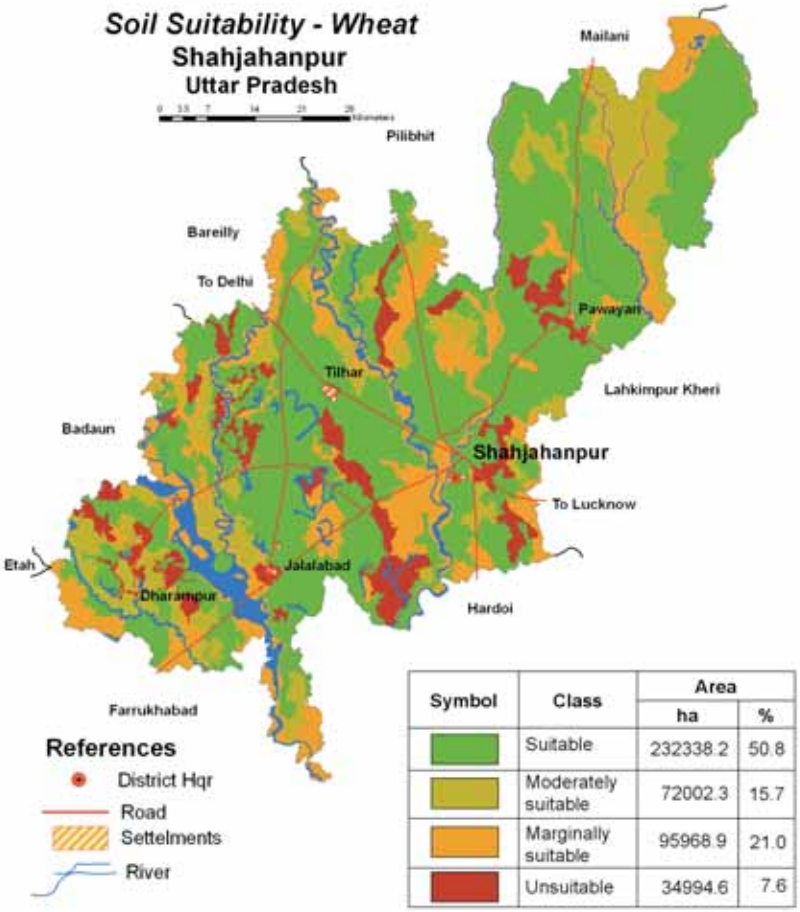
Soil and Water Productivity

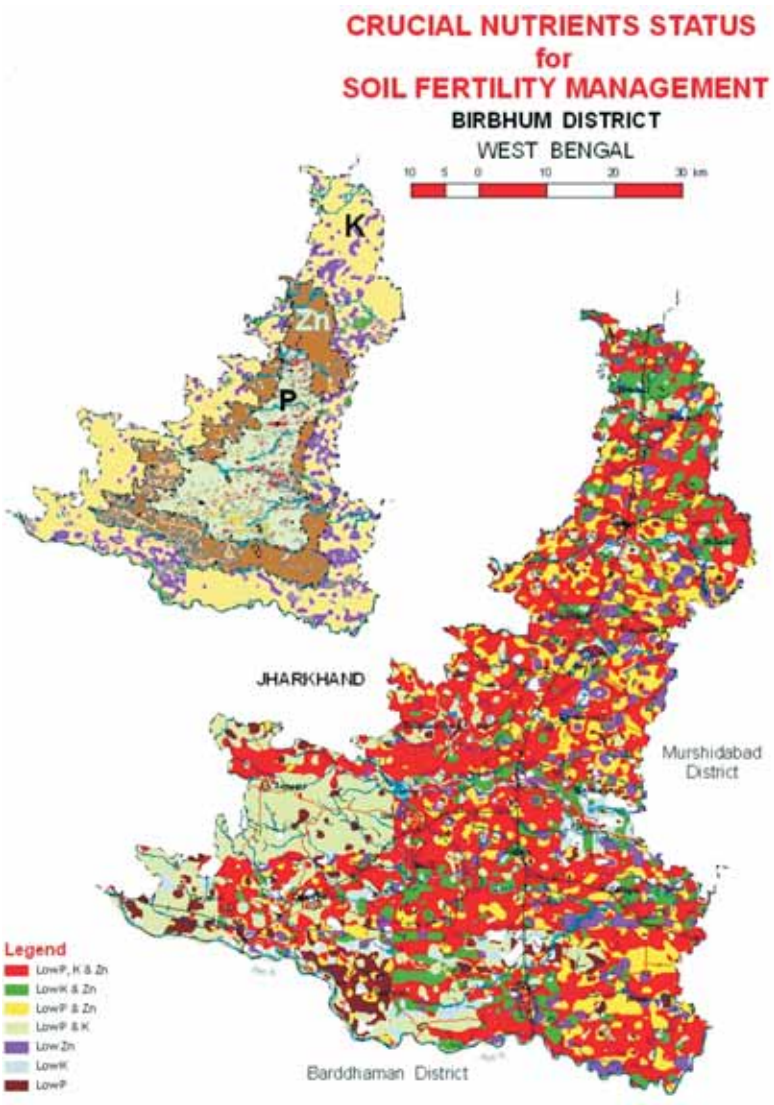
Soil site suitability map: The soil site suitability map for wheat in Shahjahanpur district of Uttar Pradesh was mapped on 1:50,000 scale. A total of 18 soil series were identified and mapped into 25 units as series associations. The dominant wheat-based cropping systems recommended in the district are rice-wheat and sugarcane-wheat.

Critical soil-nutrient status of Birbhum district of West Bengal: GIS-based soil nutrient mapping at 1 km interval in Birbhum district showed multiple nutrient deficiencies, namely phosphorus, potassium and zinc in 37.4% area; phosphorus and potassium; phosphorus and zinc; potassium and zinc in another 15.9, 14.4 and 11.7% area, respectively.

Digitized database of salt-affected soils: The salt-affected soils maps on 1:250,000 scale were digitized to prepare a composite map for the arid and semi-arid regions, covering Rajasthan, Gujarat, Madhya Pradesh and Maharashtra using GIS.



Symbol	Class	Area	
		ha	%
	Suitable	232338.2	50.8
	Moderately suitable	72002.3	15.7
	Marginally suitable	95968.9	21.0
	Unsuitable	34994.6	7.6



Spatial analysis with the agro-climatic zones was done to show regional and zonal distribution of salt-affected soils.

Soil carbon stocks under major rainfed production systems in India: Soil carbon pool (SOC) plays a crucial role in soil quality, availability of plant nutrients and ecosystem services. Dryland soils in India have potential to sequester carbon, if appropriate land use and management practices are adopted. The SOC stocks in soil profiles across the country showed wide variations and followed the order of Vertisols> Inceptisols>Alfisols>Aridisols. Inorganic carbon and total C stocks were higher in Vertisols than in other soil types. Soil organic carbon stocks decreased with depth in the profile, while inorganic carbon stocks increased with depth. Among the production systems, soybean, maize and groundnut-based systems showed higher organic carbon stocks than other production systems**.** The highest contribution of organic carbon to total carbon stock was found in upland rice system. Organic carbon stocks in surface soil layer increased with rainfall (r=0.59), while inorganic carbon stocks were found to be more in low rainfall regions (less than 550 mm). Cation-exchange capacity (CEC) showed better correlation with organic carbon stocks than with clay content in soils.

Rainwater harvesting in dryland: Water is most crucial resource for sustainable agricultural production in the dryland/rainfed areas. However, the major part of the rainwater coming over the farmers' field in these areas goes away unused as runoff. The runoff from the contributing fields is chanalized into the pond. In light soil, the dugout ponds are lined to improve the storage efficiency by containing the seepage.

This technology was taken to the farmers' field by the CRIDA team as a drought-proofing measure in Sithagonthi village of Adilabad district, Andhra Pradesh receiving average rainfall of 1,050 mm annually. The amount spent in digging the pond was recovered within the first year with a good harvest of tomatoes, chickpea crop and growing fishlings in pond.

This injected enthusiasm in the farmers of this

area and the district authorities of Adilabad had allocated an amount of Rs 20 lakh for upscaling this intervention.

Enhancing groundwater recharge and water productivity in north-west India: The sustainability of agriculture in north-western states comprising Punjab, Haryana and Uttar Pradesh is threatened due to alarming decline in water-table, increasing pumping cost and related environmental impacts. The efforts to increase water productivity and multiple use of water and pond renovation are planned in a major way by the CSSRI in 100 villages in Haryana, Punjab, Uttar Pradesh and Gujarat. The project aims to augment groundwater resources and improve water productivity per drop of water to handle contingencies arising on account of climate change and water scarcity. Recharge shafts and recharge cavities were installed at 55 sites in Haryana, Punjab, Uttar Pradesh. Further, intervention by laser-land leveling was completed in another 20 sites. Recharge of rainwater through recharge shaft during monsoon raised the groundwater levels considerably and improved groundwater quality in the vicinity.

Recharge filter–a low and effective method for groundwater augmentation in Vasad (Gujarat): The low-cost recharge filter is useful in removing suspended impurity and rejuvenating groundwater aquifer through abandoned tubewells and open wells in arid and semi-arid regions. The design has been useful for small farmers having contributing runoff area less than 4.5 ha. The

A CASE STUDY

Watershed management in drought-prone Bundelkhand region

Garhkundar-Dabar in Tikamgarh district of Madhya Pradesh is a true representative of Bundelkhand region and one of the most disadvantaged districts identified by Planning Commission, Government of India. The NRC for Agroforestry, Jhansi, an ICAR unit, has started a watershed development programme during 2005–06 in participatory mode. This watershed comprises 3 village panchayats (partially) and inhabits 895 human and 2,648 animal populations. About 72% farmers are marginal land holders and majority belongs to OBC (50%), SC (28%) and ST (16%).

Conservation measures in watershed included construction of 8 check dams in series of approximately 10 km length in the *nallah.* These check dams were constructed on third and fourth order streams. In addition, 150 gabion structures of various sizes were laid down in first and second order streams, so as to check silt inflow in main water course. Three *khadins* (water spreader) were constructed in depression to check concentrated flow of runoff. About 40 ha of land was protected by construction of marginal bunds along *nallah.* These bunds were provided with proper spillways (15 nos.) to safely drain excess runoff.

In addition to mechanical measures, plantation of about 6,000 multipurpose trees was made along the nallah, 12 different agroforestry models were introduced at the farmer's field (6.5 ha) along with suitable crop demonstration for dissemination of technologies. Further, for the additional livelihood support, lac cultivation and value-addition to the system through natural resin and gum were also introduced. Local variety of *ber* was improved through budding which yields additional income. Four Self-Help Groups [(SHGs) (2 men and 2 women)] were formed and exposed to other successful SHGs for getting confidence and capacity building. They have started activities like *agarbatti* making, earthen pots making, goat rearing, *murti* making, hiring diesel pump and cooking vessels, aquaculture etc. Two of the woman SHGs have net asset value of Rs 31,856 and 25,000, respectively as on date in a span of 3 years and both of them have become reliant in terms of small credit requirement.

During this year when rainfall is below normal (24%), there is sufficient surface (24,000 m^3) and sub-surface water (all 107 open wells are filled with water) harvested in the watershed, whereas more than 90% wells are dry outside the watershed in nearby villages. Watershed development programme increased the cropping intensity (96–116%) vis-à-vis productivity and generated employment for 7,500 man-days.

recharge filter consists of a pit of 1 m dug into the soil and lined with LDPE (250 micron thickness) sheet. The base is graded towards middle where lies a perforated pipe leading to the recharge well. A wire mesh (2 cm × 2 cm opening) box casing filled with suitably graded stones/ geo-textiles is fixed around the collecting pipe to ensure dirt and sediment-free water. The graded filter materials are laid in layers of 30 cm each, with the bottom layer consisting of pebbles/ gravels of size 40 mm preceded by the middle layer having size of pebble/grits of 20 mm. The upper layer is coarse sand (clean) of grain size a little higher than 2 mm. The maximum size of graded stones laid in the bottom layer should not exceed 40 mm to avoid damage due to punctures in LDPE sheet. The top of the recharge filter is covered with agro-net / geojute (0.25 mm opening) to stop sediments to clog the sand surface. The approximate cost of the recharge filter is between Rs17,000 and 50,000 excluding the delivery cost to the open/tube well.

Zinc-solubilizing bacteria for alleviating Zn deficiency: An effort was made to develop a cost-effective, socially acceptable and environmentally safe bio-zinc formulation for maize growers. The CRIDA under AMAAS Project isolated 2 zinc-solubilizing *Pseudomonas* strains (P29 and P33) to cater to zinc deficiency. These strains were found most promising and comparable with that of 25 kg/ha zinc sulphate application or seed priming with 1% zinc sulphate solution treatments.

Alleviating drought stress in plants: In addition to genetic and management options, a low-cost option of utilization of stress-tolerant rhizosphere microorganisms for enhancing drought stress-tolerance in plants was studied. A large number of *Pseudomonas* strains were isolated from rainfed regions of India and based on number of desirable characters *P. putida* 'GAP-P 45' was found most promising in terms of rhizosphere colonization and production of extra-cellular polysaccharides and soil aggregation. Inoculation with this strain improved the rhizosphere soil aggregation significantly and resulted in better water potential of maize and sunflower plants when subjected to stress. There was a significant improvement in the root adhered soil owing to the gum production and bio-film formation. Detailed studies showed that the organism was able to induce synthesis of novel proteins in the plants conferring tolerance to drought stress. Preliminary field evaluation on sunflower indicated that seed treatment with 'GAP-P 45' resulted in better crop growth and yield during the *kharif* season of 2009 which was a severe drought year.

Inland fishery resources assessment: Remote sensing imageries were used to establish relation between water quality of closed water bodies and land-use pattern of watershed. Digital Elevation Model technique was utilized to delineate catchment area and streams for 4 water bodies in West Bengal to create a land-use map.

Isolation of arsenic-transforming microbes for remediation: More than 40 species and strains of bacteria were isolated from aquatic environments and some other sources. These strains can reduce soil-bound arsenic by oxidizing it and thus help reduce its mobilization and toxicity.

Arsenic in inland open water environments: An appreciable level of arsenic was detected in ponds and fish from arsenic-affected and industrially exploited Damodar river system in West Bengal, but not in the unaffected areas. *Catla catla* exhibited the maximum accumulation of arsenic (60% samples above permissible limit of 100 ppb), followed by *Labeo rohita* (39% samples >100 ppb) and *Cirrhinus mrigala* (21% samples >100 ppb) indicating risk of arsenic poisoning through consuming fish produced in the arsenic-affected region.

Remote sensing techniques for estimation of aquaculture farms: Methodology to automatically delineate aquaculture farms was developed. The selected images comprised water class, aquaculture farms and agriculture. The vector layer was created for water bodies by digitizing water class features in the digital image. Using this methodology, the automatic delineation of aquaculture farms for larger areas in less time has become possible with high resolution data.

Bioremediation of shrimp farm discharge water: Bagasse as biostimulator to remove ammonia and nitrate from shrimp farm discharge water was assessed by carrying yard experiments and field trials. Enhanced growth of nitrifying bacteria was observed on the bagasse and the same was confirmed by molecular techniques including RT-PCR. Hence, bagasse can be used as a successful biostimulator for the removal of ammonia and nitrate in shrimp aquaculture. This technology is available for adoption by farmers.

Coral and sponge resources on a GIS platform: Documentation of coral and sponge resources on a GIS platform in Netrani islands of Karnataka, Grande island of Goa, and Palk Bay area using Line Intercept Transact method revealed that coral cover has decreased from 41% to 13% in Palk Bay and alterations in community structure were also noticed as compared to that in 2004. ❑

3

Farming Systems

Viability of site-specific nutrient management in rice-wheat cropping system: On an average (9 locations), site-specific nutrient management (SSNM) outyielded farmers' practice (FP) by around 2 tonnes/ha (~ 36% higher). This improvement was achieved at an average benefit: cost ratio (BCR) of 5.8, which means that every extra rupee invested in nutrients for SSNM over FP produced extra crop value of Rs 5.8 on a net basis.

NB 4- a high-yielding local cowpea selection of Goa: Field evaluation of selected local cowpea accessions in rice fallows under residual soil-moisture situations in Goa revealed that cowpea accessions NB 4 at 45 cm spacing recorded the highest cowpea seed yield (1,137 kg/ha) and biomass yield (5.68 tonnes/ha).

A new mustard variety: CS 56 (Triveni), a new raya variety, identified as CS 234-2 with higher oil content (37.4%) released for late-sown irrigated conditions of Zone II (Sriganganagar, Bathinda, Ludhiana, Hisar, Bawal, Navgaon, Delhi). The average yield of this new cultivar was recorded 1.28 tonnes/ha which was nearly 15.2, 57.8 and 17.2% higher over the national checks Vardan, Varuna and Kranti respectively.

Drought-tolerant variety of horsegram mutant: During 2009 severe drought, horsegram served as a successful contingent crop for sowing even up to September. Considering its importance in drylands, the CRIDA developed and released a drought-tolerant horsegram mutant (CRIDA 18R) for the south zone. The variety is early maturing (85–95 days) with synchronized podding, tolerant to pod shattering, yellow mosaic virus and powdery mildew. In farmers' fields, it recorded a mean grain yield of 912.0 kg/ha which was about 40% more over national checks.

Superior gonda types: *Gonda* (*Cordia myxa*) fruits constitute an important vegetable and pickling material in the desert, especially during summers when other vegetables are meager. Its wood is used in making minor agricultural implements. To select superior genotypes, evaluation of its germplasm for 3 years was carried out which resulted in selection of 3 superior accessions, namely 'G 2025' (19.7 kg/plant), 'G 2012' (17.5 kg/plant), 'G 2061' (12.1 kg/plant).

Superior *karonda* cultivars: *Karonda* (*Carissa carandus*) fruits are used for making pickles, jams and *chutneys*. Its germplasm evaluated for the last few years resulted in selection of two superior genotypes, namely pink fruits (CZK 2001-17) and purplish green fruit (CZK 2000-1).

Complementary cropping systems for high productivity and profitability: To ensure efficient resource use with high productivity and profitability, 7 cropping systems along with land configurations, *in-situ* green manuring, residue incorporation, zero/minimum tillage and intercropping approaches were evaluated. The conventional rice-wheat system generally gives rice-equivalent yield of ~ 10 tonnes/ha and profitability of Rs 166/ha/day under irrigated condition. However, by substitution of conventional rice variety with hybrid rice, an increase in yield of about 2.16 tonnes/ha could be achieved. Similarly, comparable rice-equivalent yield (15.3 tonnes/ha) could be harvested from maize cobs + cowpea - wheat (ZT)- greengram(ZT, G+R) on flat bed system with productivity of 41.8 kg/ha/year and profitability of Rs 267/ha/day. The system involving pegionpea + blackgram - wheat (ZT)-greengram was also equally better in terms of productivity (44.8 kg/ha/day) with highest benefit:cost ratio (2.24) due to low cost of cultivation.

Multi-tier cropping system in tribal dominated eastern ghats of Orissa: Papaya intercropped with ginger + pigeonpea (8:2) and boundary plantation

SUCCESS STORY

Management of seasonal waterlogged areas of coastal ecosystem

To enhance productivity of seasonal coastal waterlogged areas pond-based farming technology (deep water rice in *kharif* + watermelon, okra, spinach, chili in winter + on-dyke vegetables-fruits + fish inside pond) was conceptualized and evaluated in a representative deep waterlogged areas (1–2.5 m water depth) of Puri district, Orissa.

The pond-based farming technology enhanced the net water productivity to Rs 7.29/m^3 and net returns of Rs 26,735/ha compared to Rs 1.4/m^3 (net returns Rs 22,100) in rice. Improved deep water rice cultivar Hangseswari gave 2.4–2.5 tonnes/ha yield in *kharif* season in deep waterlogged situation which was about 200% higher than of local cultivars. This pond-based farming technology can be replicated in 3.4 m ha deep water areas of eastern India.

A MoU was signed (repatriate agreement) between Directorate of Water Management, Technology Information, Forecasting and Assessment Council (TIFAC), DST, GOI, New Delhi and a NGO (AID, Bhubaneshwar) for large-scale dissemination of the technology.

Deep water rice Hangseswari in farmer's field

Pond-based farming system to enhance productivity of seasonal deep waterlogging areas

of gliricidia, registered yield of papaya to the tune of 15.45 kg/tree with lowest runoff as well as soil loss (1.893 tonnes/ha). Among different intercrop combinations, ginger + pigeonpea showed significant superiority for different yield attributes, namely pods/plant, pod length, seeds/pod and test weight in comparison to other intercropping combinations of runnerbean + pigeonpea and *ragi* + pigeonpea. Boundary plantation of gliricidia improved various biophysical measures and yield of papaya fruits tree to the tune of 46%. Further, intercropping of fruit trees (papaya and drumstick) improved the yield of ginger up to 37%. Green leaf manuring of gliricidia improved biophysical measures like plant height, number of secondary branches of drumstick to the tune of 17.5 and 5% respectively. Similar treatment on ginger beds improved number of tillers (8.44), finger no. (6.34) and ginger yield (11,986 kg/ha).

Gmelina-turmeric-based agroforestry for humid and sub-humid zone: *Gmelina arborea*, a fast-growing N-fixing tree species is suitable for rainfed uplands of humid and sub-humid regions. The species can ameliorate soil physical condition and improve soil productivity, besides providing timber. It attains a height of 25–30 m and dbh of 40–45 cm within 10 years of growth and is of good timber value. Turmeric as a shade-tolerant crop can be successfully grown with a yield recovery of 80% and with a benefit:cost ratio of 2.16. A farmer can generate net returns of timber worth Rs 3,000–4,000 after 10 years of growth and 7–8 tonnes/ha of turmeric from 5 years of tree growth.

Gmelina with turmeric, sapota, teak-based agroforestry system for hilly zone of Karnataka: This technology is suitable for adoption in transitional and hilly zone with medium/deep soils under irrigated condition. Sapota was planted at a recommended spacing of 10 m × 10 m. Three teak plants planted in between two sapota plants across the slope. The first teak at 3 m from sapota and subsequent two teak trees at 2 m, thus leaving 3 m again between last tree and sapota. On either side of sapota and teak, guinea grass was planted in a strip of 1 m width. In between two rows of sapota+trees, field crop was grown for initial 8–10 years based on canopy coverage. Initially paddy was grown for 6 years, South African maize for

SUCCESS STORY

Farming system model for small and marginal farmers of eastern India

Rainwater harvesting system was designed and agricultural diversification model (on-dyke horticulture, fisheries, cultivation of diversified field crops, short-term fruits like papaya, banana, floriculture like marigold, tuberose etc.) with harvested rainwater was developed for small and marginal farmers through multiple use of water. The same model was implemented in Bahasuni watershed of Dhenkanal, Orissa and by adopting the technology farmers are earning Rs 22,810–35,000/ha. Owing to harvesting of spring and rainwater, irrigated areas of 2 villages of the watershed increased from 3.2 ha (2002–03) to 26.5 ha (2008–09) where 55 tribal families were benefited. The technology has been recommended for inclusion in the 'National Rural Employment Guarantee Act (NREGA) for implementation in watersheds of eastern Indian states.

Agricultural diversification with harvested rainwater

3 years and sunhemp for next 3 years until crown coverage was observed. The space available for agricultural crops was reduced gradually depending upon growth of sapota and tree species. Cultivation of arable crops became difficult after 13 years. At the end of 17 years teak planted adjoining sapota were harvested for pole purpose. The teak was retained for timber purpose up to 28 years. The technology will help for commercial entrepreneurship for higher income with net returns of around Rs 22,000/ha/year after 28 years. It also acts as green cover conserving soil, moisture and fertility, besides generating employment during the off-season.

Thornless cactus– an unconventional feed source for arid region livestock: Cactus has 8% dry matter (DM) and 26.55% mineral rich ash, comprising 9.42% acid insoluble ash (AIA) and 90.52% acid soluble ash (ASA). Animals, namely cattle, sheep and goat, had shown fairly good acceptability, palatability and dry matter intake for chaffed cactus cladodes with conventional grasses/ straw. Animals have registered significantly higher body weight gains against the grasses/straw control. Besides, the water requirement of animals on cactus + grass/straw feed was considerably reduced, making the cactus a feed admixture of choice in the water scarcity desert. Also the mineral deficiencies in desert animals will be corrected by feeding the mineral rich cactus + grass/straw mixture.

SUCCESS STORY

Fish farming in harvested water system

Shri Manabendra Moharata, a farmer at Bhataparagarh village, Khurda district of Orissa, produced about 11 crore carp spawn, 1.7 crore fry, 8 lakh fingerlings and 3 tonnes of yearlings in harvested rain water from the catchment areas of the hilly terrains. The IARI National Award for 2009 was presented to him for this innovative activity. The technical advice for the same was provided by the CIFA, Bhubaneshwar.

Feeding of mineral rich resource-thornless cactus to Tharparkar cattle (*inset:* thornless cactus)

Lobster farming in open sea: Lobsters were cultured in floating cages in open sea along Vizhinjam coast. The lobsters attained weight of 200–350 g in 4½ months with 85% survival rate and yielded 200 kg produce.

Organic shrimp farming: A low-input shrimp farming technology with low stocking density of 6 nos/m^2 using organic principles was developed, with a production of 1.2 tonnes/ha. In organic farming of *Penaeus monodon*, low fish meal feed was applied in the ponds along with yeast-based organic preparations and vermicompost as other organic inputs. The shrimps so produced were healthy and free from WSV, IHHNV, YHV and GAV diseases. Substantial gain in the production level (15%) and improvement in size at harvest (10%) with better FCR (6.57%) by following organic principles were achieved.

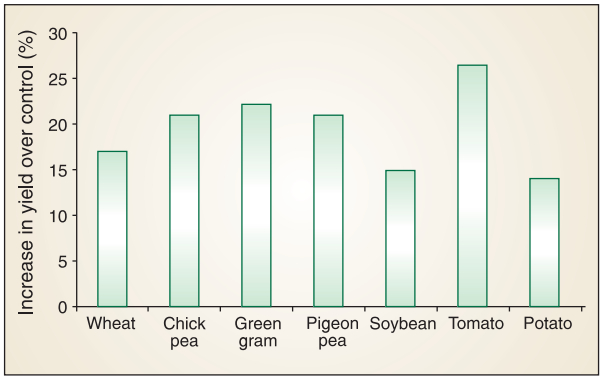
Inland saline resource utilization for aquaculture: *Penaeus monodon* culture technology was refined successfully with a stocking density of 6 PL/m^2 in inland saline farm at Rohtak Centre, Haryana using groundwater with 10% salinity. The production achieved was 1.3 tonnes/ha with the survival rate of 85%, food conversion ratio (FCR) of 1:1.2, within a period of 110 days. ❑

4

Climate Change

Impact of increased carbon dioxide on crops: A rise in atmospheric carbon dioxide to 550 ppm enhanced the yields of wheat, chick pea, greengram, pigeon pea, soybean, tomato and potato between 14% and 27%. There was a under controlled environment conditions (free air CO_2 enrichment, Open Top Chambers) and modeling. In most of the crops this was accompanied by a small reduction (2 to 10%) in the protein content. In plantation crops, viz. coconut, arecanut and cocoa, increased CO_2 led to higher biomass.

The larval duration of two pests- *Spodoptera litura* and *Achaea janata* - in 550 ppm CO_2 was studied. The larval duration of *Spodoptera litura* increased by 1 to 3 days in groundnut, castor and blackgram. Similarly, the larval duration of *Achaea janata* on castor increased by 2 days at elevated CO_2.



Increase in yield of different crops as CO_2 concentration was enhanced to 550 ppm

Carbon sequestration potential of coconut: The carbon sequestration potential of coconut plantations was assessed using field measurements and simulation modeling for 4 major coconut growing states accounting for 90% of the production, viz. Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. The carbon sequestered in stem in coconut plantations is 0.732 million tonne of carbon every year. These values will be significantly higher, if the carbon sequestered in other plant parts of the coconut such as shell and coir are also considered. This suggests that coconut has a large carbon sequestration potential.

Assessment of farmers' coping strategies to climatic risks: A survey was conducted in dry temperate regions of Spitti in Himachal Pradesh to assess farmers perception of increasing climatic risks and the strategies adopted by them to cope with these risks. All farmers realized that climate is changing. They have experienced increased frequency of dry spells and a reduction in snowfall. They also noticed that the flowering pattern and fruit setting of trees has advanced by almost a week.

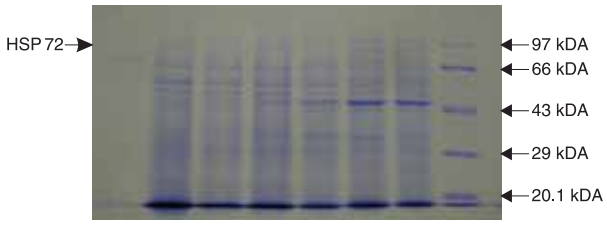
The farmers increased their investment on storage structures. Apple farmers switched to varieties with less chill unit requirement to cope up with increasing heat stress. Many farmers planted short duration crops like peas, turnip and black lentil as these crops also provide better returns in a short time. Since these areas receive low rainfall but considerable snow, and the soils are sandy and highly drained, some farmers also invest in water harvesting.

Vulnerability of coastal fishing villages of Maharashtra to sea level rise: The CMFRI reported that about 75 coastal fishing villages of Maharashtra are located within 100 m from the high tide line. To find out the vulnerability of these fishing villages to sea level rise, validation of available primary data from vulnerable fishing villages along Maharashtra coast was completed by ground truthing by using GPS. For ground validation, data were collected from Ground Control Points (GCPs) at different elevations from all 5 coastal districts of Maharashtra, and images were generated for all 5 coastal districts of Maharashtra.

After geo-referencing these villages, 3 different scenarios of sea level rise were created to determine critical area likely to be submerged. Base mark (0 m), points at 0.3 m, 0.6 m and 1.0 m were obtained through software to calculate the perimeter and area for 3 SLR scenarios. All elevations are generated from mean sea level by the software. The results were validated by ground-truthing during field observations. A sample map thus generated for Juhu fishing village, Mumbai is given below. Consolidation of all the maps to identify vulnerable coastal fishing villages in Maharashtra is under progress.

Projected area of inundation of Juhu fishing village, Mumbai for 3 sea level scenarios; blue colour indicates 0.3 m, blue+yellow 0.6 m, blue+yellow+red 1.0 m rise in sea level

Adaptation of livestock to climate change-role of HSP's: A study on Sahiwal and Holstein Friesian crossbred (Karan-Fries) heifers was carried out to find out the pattern of expression of HSP72 under natural environment and at extreme temperature exposures in a climatic chamber (40ºC and 50% RH and 45°C and 50% RH for 4 hr). It showed that HSP72 protein level increased due to thermal exposures; relatively Karan-Fries exhibited higher increase (106%) than Sahiwal (22.4%).



SDS-PAGE of HSP72 (purified, sigma) and total protein in lymphocyte cell lysates of Sahiwal and Karan-Fries exposed at 45°C and 50% RH. Lane 1- HSP72 (purified), lane 2 and 5- Before exposure, lane 3 and 6– after 2 hr of exposure, lane 4 and 7 after 4 hr of exposure; Lanes 2,3, and 4 are for Sahiwal and 5,6, and 7 are for Karan-Fries. M- Molecular weight marker

Emission of greenhouse gas

Assessment of greenhouse gas inventory that identifies and quantifies a country's primary anthropogenic sources and sinks of greenhouse gas emission is central to any climate change study. India being a party to the United Nations Framework Convention on Climate Change needs to develop, periodically update, publish and make available to the Conference of Parties, a national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gas. Accordingly the inventory of greenhouse gas emission by Indian agriculture was developed for the base year 2000.

Greenhouse gas inventory for Indian agriculture for the base year 2000

Source	CH_4(Tg)	N_2O(Gg)	CO_2 eq.(Tg)
Ruminant	10.1	–	252.0
Rice cultivation	3.5	–	87.3
Manure management	0.1	0.1	2.5
Crop residue	0.2	4.0	4.9
Soil	–	132.3	39.4
Total	**14.7**	**137.3**	**386.1**

Tg, million tonnes; Gg, thousand tonnes

In 2000, Indian agriculture contributed 386.1 million tonnes (Tg) CO_2 eq. The agriculture sector primarily emitted methane CH_4 (14.7 Tg) and nitrons oxide N_2O (137.3 thousand tonne, Gg). The emission sources accounted for in the agriculture sector are enteric fermentation in livestock, manure management, rice cultivation, agricultural soils and burning of agricultural crop residue. The bulk of the greenhouse gas emission from the agriculture sector was from enteric fermentation through ruminant (65%) followed by rice cultivation (23%) and the rest were contributed by manure management, burning of agriculture crop residue (1%) and application of N fertilizer to soil (10%) and manure (1%).

Methame emission: Livestock rearing, an integral part of Indian agriculture, is the major contributor of methane (CH_4). Although the livestock includes cattle, buffaloes, sheep, goats, pigs, horses, mules, donkeys, camels and poultry. The bovines and the small ruminants are the most dominant feature of Indian agrarian scenario, and the major source of methane emission. Methane (CH_4) emission due to enteric fermentation in 2000 was estimated to be 10.1 Tg. Buffalo and indigenous cattle, which are the main milk-producing animals in the country, contributed 44% and 42% total methane emission from livestock sector. Crossbred cattle emitted 8% and the small ruminants emitted about 7% of methane.

In India rice is cultivated under various water management conditions, depending on availability of water. Methane emission due to rice cultivation was estimated to be 3.5 Tg. Continuously flooded

Area and methane emission in various rice-ecosystems in India

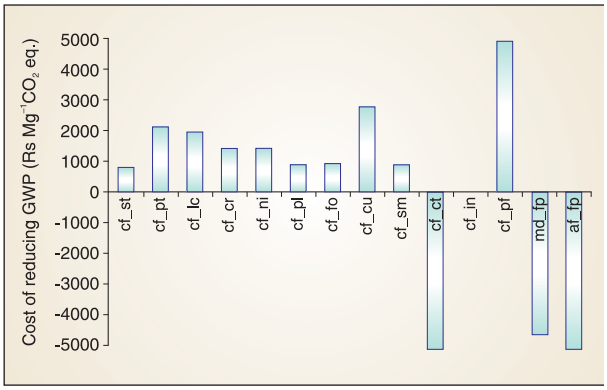
Ecosystem	Water regime	Area (M ha)	Emission (Gg)
Irrigated	Continuous flooded	6.85	1,111
	Single aeration	9.08	598
	Multiple aeration	9.49	175
Rainfed	Drought prone	8.66	570
	Flood prone	4.35	827
Deep water		1.37	218
Upland		4.83	0
Total		**44.62**	**3,499**

rice emitted maximum methane (1,111 Gg) followed by flood prone (827 Gg) and single aerated (598 Gg) rice cultivated areas.

N_2O emission: During 2000, Indian agriculture produced 137.3 Gg of N_2O-N. Nitrogenous fertilizer application contributed 68% of that emission followed by manure (13%) and crop residue (11%) and soil mineralization (8%).

Though the inventory of greenhouse gas (GHG) emission from Indian agriculture is fairly robust but it still suffers from various deficiencies like non-availability of country specific emission factors, lack of adequate monitoring stations and data quality. To capture the diverse soil and climatic conditions, different management practices and socio-economic status of the farmers influencing GHG emission, an appropriate national exercise is needed. This will not only improve estimates of emission and related impact assessments, but also provide a baseline from which future emission trajectories may be developed to identify and evaluate mitigation strategies.

Greenhouse gas mitigation: A decision support system, named InfoNitro (Information on Nitrogen Management Technologies in Rice), has been developed to quantify inputs, outputs and balance of N in soil; greenhouse gas emission and N use efficiency with the prominent N management technologies in rice. Sixteen technologies, which differed in water regime, method of N application,



Marginal abatement cost for reducing global warming potential (GWP) from the baseline technology of continuous flooding and farmers' practice (cf_fp) in Haryana. With resource conserving technology (cf_ct), mid-season drainage (md_fp) and alternate flooding (af_fp) technologies GWP is reduced without any extra cost involved. With integrated nutrient management (cf_in) technology GWP is increased.

forms of N and tools of fertilizer recommendation were analyzed for their greenhouse gas emission and N loss reducing potential and economic return in Haryana, a rice growing region in India. The technologies reduced global warming potential by 1 to 9%. Resource conserving technology was the most cost effective strategy to reduce N loss and greenhouse gas emission whereas integrated N management cost high for mitigating greenhouse gas emission.

Estimation of carbon footprint by marine fishing boat

It is estimated that annual CO_2 emission of marine fishing boats in India was 3.6 estimated million tonnes during 2005–2007. It was found that the mechanized boats emitted 1.67 tonnes of CO_2 per tonne of fish catch, and motorized boats with outboard engine emitted 0.48 tonne CO_2 per tonne of fish catch. Among the mechanised craft, the trawlers emitted more CO_2 than the gillnetters and dolnetters. Based on the data available on the number and size of fishing boats in India in the past years, it is estimated that CO_2 emission per tonne of fish caught has increased by 64% in 25 years.

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5

Genetic Resources

CROPS

Germplasm conservation

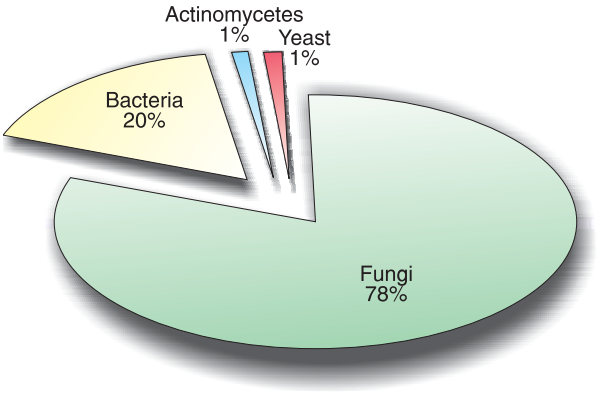
About 2,892 accessions were collected, including 869 of wild species. A total of 294 herbarium specimens were added to the National Herbarium of Cultivated Plants, taking the total holdings to 20,012 specimens. Germplasm added to the National Genebank for long-term storage included 9,526 accessions of orthodox seed species; 247 accessions of non-orthodox species were cryostored and 42 accessions were added to the *In vitro* Genebank.

Germplasm under exchange comprised 32,260 accessions imported from 45 countries, which included international trial material (5,373) and transgenics (132). Promising introductions were—wheat with disease resistance (EC638278-315) from USA; barley with higher yield, lodging-resistant, good malting quality, resistant to covered and false loose smut, spot form of net blotch and spot blotch (EC657888-89) from Canada; paddy with high yield (EC637732-35) from USA, blast-resistant and *Rice tungro* virus-tolerant (EC638157-178) from Philippines and drought-tolerant (EC639584-757) from Kenya; soybean resistant to soybean mosaic virus, stem canker, bacterial pustule, frogeye leaf spot and peanut root-knot nematode (EC638228-642) from Taiwan; and tomato resistant to bacterial wilt, fusarium wilt and tomato mosaic virus (EC654678-686) and heat tolerant lines (EC654694-699) from Taiwan.

A total of 8,280 accessions were characterized and evaluated. Germplasm field days (5) were organized for maize, *kharif* and *rabi* pulses, oilseed brassicas and wheat, barley and triticale. Besides, 5,093 accessions were supplied for research and crop improvement within the country. Phytochemical evaluation of germplasm was undertaken in rapeseed-mustard (721), sunflower (36), safflower (352), linseed (85), walnut (17), almond (39) and *Salvadora oleoides* (20) for oil content and medicinal and aromatic plants (485) for active principles.

Promising genotypes were identified for high yield in advanced varietal trials (based on three-year data) in chenopods (IC415477 with 10.34 q/ha), *Momordica dioica* (SKNK-679 with 8.13 q/ha) and *Jatropha curcas* (JH-1 with 16.59 q/ha). Phytochemical characterization of promising genotypes identified in advanced varietal trials was done for lysine content in grain amaranth (RMA-30 with 4.9%) and protein content in rice bean (PRR-2 with 21.5%), adzuki bean (EC340267 with 21.3%) and buckwheat (IC 125938 with 13.4%).

The National Bureau of Agriculturally Important Microorganisms has more than 2,000, 500, 30 and 20 culture collections of fungi, bacteria, actinomycetes and yeasts respectively.



Germplasm registration

Registration of germplasm of potential importance is an important activity and 720 germplasm lines have so far been registered. About 117 proposals including cereals (46), millets (10), legumes (13), oilseeds (7), fibre and forage crops

(15), vegetables (5), fruit/nut crops (1), ornamentals (6), medicinal and aromatic plants (8), commercial crops (3) and tuber crops (3) were approved for germplasm registration.

DNA fingerprinting

Germplasm accessions of various medicinal plants (190) such as vetiver (*Vetiveria zizanioides*), palmarosa (*Cymbopogon* sp.), giloe (*Tinospora cordifolia*), brahmi (*Bacopa monnieri*) and kalmegh (*Andrographis paniculatus*) were fingerprinted with RAPD (Random Amplified Polymorphic DNA) and ISSR (Inter-Simple Sequence Repeat) markers. The SSR (Simple Sequence Repeat) markers were developed in finger millet, jute (EST-SSR/ Expressed Sequence Tag-SSRs) and *Vigna* (genomic SSRs). Analysis of SSR polymorphism data in natural populations of *Vigna* (30) indicated substantial gene flow between the cultivated and wild forms/types of greengram (*V. radiata* and *V. radiata* var. *sublobata*) and blackgram (*V. mungo* and *V. mungo* var. *silvestris*).

Phytosanitation

A total of 73,217 imported samples including transgenics and trial material were processed for quarantine clearance. Of the 3,364 samples found infested/infected with different pests 3,293 samples were salvaged. Sixteen Phytosanitary Certificates were issued for export of 1,120 samples. Important interceptions included insects (*Bruchus emarginatus, Carpophilus hemipterus, Rhizopertha dominica, Sitophilus oryzae, S. zeamais, Systole coriandri, Tribolium castaneum, Typhaea stercorea*; nematodes (*Aphelenchoides besseyi, Pratylenchus penetrans, Rotylenchulus reniformis, Tylenchorhynchus* sp.); fungi (*Acremonium strictum, Alternaria raphani, A. sesami, A. ricini, A. solani, Colletotrichum dematium, C. graminicola, C. capsici, Drechslera maydis, D. oryzae, D. sorghicola, D. sorokiniana, Fusarium longipes, F. moniliforme, F. oxysporum, F. poae, Macrophomina phaseolina, Peronospora manshurica, Puccinia carthami, P. helianthi, Rhizoctonia solani* and *Sporisorium* sp.); and viruses (Alfalfa mosaic virus, Bean yellow mosaic virus, Broad bean stain virus, Broad bean wilt virus, Cowpea mild mottle virus, Pea enation mosaic virus, Peanut mottle virus and Pea seed-borne mosaic virus).

HORTICULTURE

Mango: One of the largest field gene banks of mango germplasm has been maintained at CISH, Lucknow, having 735 accessions collected from diverse agro-ecological zones of the country. Under AICRP on STF, 78 accessions and 16 superior clones were collected at different centres. At IIHR, Bangalore, morphological characterization was carried out for 20 mango accessions as per Bioversity International (IPGRI) Descriptor. Fourteen STMS primers, which showed high PIC values, were employed for the gene-scan analysis of 80 mango cultivars using automated DNA sequencer. The genetic analysis for 14 STMS primers data was generated for a total of 269 mango cultivars from the germplasm collection, using Cervus 3.0 software.

Guava: At CISH, Lucknow, 122 accessions of guava on its National Active Germplasm Site were added.

Litchi: Four new accessions and two clones of Bombai were added to field gene bank at GBPUA&T, Pantnagar, and BCKV, Mohanpur, of AICRP on STF centres.

Banana: At NRC on Banana, Trichirapalli; 24 accessions of banana which included wild species, land races and cultivated varieties were added to the field gene bank.

Citrus: A total number of citrus accessions collected and maintained at NRC on Citrus, Nagpur, are 602. Among them, Exotic-50, Rootstock-19 and Scion-31 (Mandarin, Sweet orange, Pummelo and grapefruit) were collected mostly from USA, Japan, Australia and Niger. In AICRP on Tropical Fruits, nine new accessions were collected at Tinsukia by survey in Asom, Mizoram and Arunachal Pradesh.

Grape: At NRC on Grapes, Pune; the national grape germplasm was further strengthened by adding 12 wine and 2 rootstock genotypes, thus bringing the total number of accessions to 458.

Pomegranate: More than 25 variants from 'Bhagawa' population were identified from Maharashtra, Karnataka and Andhra Pradesh.

Different variants from cv. 'Bhagawa'

Arid fruits: In ber, 318 *Ziziphus* genotypes/ strains are being maintained in the National Germplasm Repository of CIAH, Bikaner. A total of 70 accessions of *Z. nummularia* were collected and eight promising accessions are being evaluated for suitability as rootstock and tolerance to abiotic

stress. The date palm offshoots of cultivar Siwi and Amhat were introduced from Arab Republic of Egypt in 2009 and planted in the field for evaluation. A total of 60 date palm varieties/ genotypes are being maintained in field repository and evaluated for morphological, yield and quality attributes. In pomegranate, a total of 154 germplasm are maintained at CIAH, Bikaner, and 45 at CHES, Vejalpur. Seventeen germplasm of bael at CIAH, Bikaner, and 15 at CHES, Vejalpur, are being maintained and evaluated. Recently, 5 genotypes were collected from Sikar, Chomu and Jaipur districts of Rajasthan.

Plantation crops: Five distinct coconut accessions were collected from Andhra Pradesh, bringing the total coconut germplasm collections to 370. The coconut collections include aromatic coconut, Jonnalarasi tall and spicata types with orange and yellow nuts. In arecanut, five ecotypes from North Bengal have been added to the germplasm bringing the total to 153. In cocoa, one hybrid and 19 clonal accessions were obtained from Malaysia and UK, respectively, bringing the total to 222.

Oil palm: The genetic diversity of the 23 *E. oleifera* palms were assessed using 54 random primers. About 238 alleles were scored, of which (72.69%) were polymorphic. Maximum similarity was found to be 0.895. Cluster analysis revealed 5 clusters and 4 palms were standing apart.

Cashew: Fourteen germplasm accessions collected from NEH region (4) and Andaman (10) were added to National Cashew Field Gene Bank (NCFGB), raising the total germplasm conserved so far to 527. Two wild cashew types (Jungly cashew) were collected from Andaman and Nicobar Islands for conservation in NCFGB. Forty-four germplasm accessions from nine morphological clusters were fingerprinted with nine primer pairs of SSR markers of cashew. The accessions, NRC

Fruit of wild cashew (*jungly caju*)

97 and NRC 12, were highly divergent and pair of accessions like NRC 12 and NRC 67, NRC 71 and NRC 121, NRC 9 and NRC 126, and NRC 111 and NRC 112 showed highest similarity supported by 83–100% bootstrap values.

Under AICRP on Cashew, 47 accessions had bold nut character with a nut weight ranging from 7.0 to 15.0 g, 81 accessions had 28.0–38.5% shelling at Bhubaneshwar, while accession NRC 131 had a high shelling percentage of 32.7% at Jagdalpur. At Bapatla, T.No. 10/19 had maximum mean annual nut yield (14.32 kg/tree) and maximum cumulative nut yield for 12 harvesting (76.13 kg). H 303 gave a cumulative yield of 80.3 kg for 12 harvesting at Bapatla and 77.64 kg for 13 harvesting at Bhubaneshwar.

Potato: JX 90, a new parental line, has been registered with NBPGR with INGR No. 09069. It is a late blight and early blight resistant and high-yielding potato parental line with high yield under early and medium crop duration. JX 90 is a selection from the progeny of cross CP 1346 (Krirrinee) × MS/78-62. It possesses high general combining ability for horizontal resistance to late blight and resistance to early blight. Generally, early bulking varieties are susceptible to late blight. However, JX 90 combines high horizontal resistance to late blight with early bulking. This line performs well for yield under early (75 days) and medium (90 days) maturing in Indian plains and plateau region. Under early (75 days) maturing, it gives yield of 25–30 tonnes/ha, which is at par with early-maturing variety Kufri Ashoka. Under medium (90 days) maturing, it gives 33–38 tonnes/ ha yield, which is at par with cultivar Kufri Pukhraj.

Onion and garlic: About 212 germplasm of onion and garlic were collected, which included 109 red onion, 57 white onion and 46 garlic germplasm from Karimnagar, Nizamabad and Adilabad districts of Andhra Pradesh; Garchiroli, Chandrapur, Yavatmal and Nanded districts of Maharashtra; and Narainpur, Bastar and Dantewada districts of Chhattisgarh.

Tuber crops: The germplasm was enriched with the collection of 30 indigenous and 29 exotic collections of sweet potato. In addition, 48 new accessions of yams collected from Meghalaya, Tripura, Asom and Kerala were added to the existing (873) collections. Besides, wild yams were also collected from Khasi hills of Meghalaya, Barmurah forest of Tripura and Western Ghats. In Aroids group, 42 new accessions comprising taro (37), *Xanthosoma* (3) and *Amorphophallus* (2) were collected from North-Eastern Hill Region.

Mushroom: About 217 specimens of different wild mushrooms were collected. Out of them, 192 were identified up to genus level. Studies on germplasm characterization revealed wide interspecific variation among 41 strains of *Pleurotus* species.

Black pepper: The characterization of 734 germplasm resulted in identification of high-yielding accessions, namely KM III, Angamali, KM II and Valiyaramundi, with more than 2 kg/vine of green berry yield.

Cardamom: Five new unique cardamom collections, namely Pacchaikai, Pink Stem, Parrot Green, Nattu Vazhukka, and Koadi Mysore, were collected from Megamalai area of Tamil Nadu and added in collection. Among 313 cardamom germplasm evaluated at Mudigere centre, accession Pothamedu recorded highest green capsule yield (208 kg/ha), followed by D 141 and Cl 730. Under CVT, entries CL 722, PS 27, MCC 309 and MCC 246 were found promising for dry capsule yield (347.96 kg/ha). At Myladumpara centre, accessions MHC 26 (1317 kg/ha), MCC 73 (1172 kg/ha), MCC 246 (1155 kg/ha) and MCC 309 (1033 kg/ha) were identified as high-yielders.

Turmeric: A total of 140 microsatellites containing genomic DNA fragments were isolated from turmeric, adopting selective hybridization method with di and trinucleotide biotinylated probes. Eight polymorphic primers were identified for amplifying SSR containing ESTs. The biologically active peptide turmerin isolated from all the 13 species of *Curcuma* showed highest concentration in C*urcuma sylvatica* (320 mg/100 g).

Ginger: An accession, Acc. No. 195, was identified with high pollen fertility of 67.73% and is being utilized in crop improvement.

Paprika: Twenty-seven new paprika accessions were purified by single plant selection and selfing. The capsaicin content among germplasm accessions varied from 0.0081 to 0.513%. The lines, ICBD-10, Kt-pl-19 and EC-18, were found promising with high colour value and low pungency.

Tree spices: A total of 38 clove, 122 nutmeg, 42 cinnamon and 10 cassia germplasm have been collected. Characterization of cinnamon germplasm at Pechiparai led to the identification of Sel-65 with a bark yield of 420 g of dried bark/tree and leaf yield of 6.3 kg/tree. A local collection from Pechiparai was also identified for high leaf yield of 6.0 kg/tree and bark yield of 314.75 g/tree.

Floriculture: Under AICRP on Floriculture at Bhubaneswar, five new HT and 3 miniature varieties of rose were added to the existing germplasm of 201 HT, 73 Floribunda, 45 Miniature and 8 climbing roses. The Delhi and Pantnagar centres added 20 and 54 new collections, whereas Ludhana centre added 20 new collections and are maintaining a germplasm collection of 117 HT, 55 floribunda, 5 miniature and 3 polyanthas.

Orchid: The characterization of 89 endangered and rare orchid species were done. About 162 orchid species are maintained evaluated for various useful horticultural trials. In *Coelogyne nitida*, three new variants were identified. Diversity analysis and DNA profiling in 10 *Cymbidium* species were done using RAPD markers. Out of 20 decamer primers, 10 arbitary primers produced a total of 180 distinct major bands. Of which 98% were polymorphic. RAPD analysis of 15 vandaceous orchids indicated 98% polymorphism. In eight *Dendrobium* orchids, morphological trials were analysed using RAPD analysis. The genetic distance measured based on Squared Euclidean Distance ranged from 5–23%.

Ashoka: Forty-two accessions are maintained and evaluated at KAU, Trichur. The accessions collected from Thrissur and Trivandrum districts showed vigorous growth represented by its increased height, number of leaves and higher girth of stem.

Ashwagandha: Out of 131 evaluated, accessions MWS-312, MWS-315, MWS-108, RAS-53 and RAS-39 had significantly higher seed yield as well as root yield per plant than the best check, JA-20. The new collections, 31 at CCSHAU, Hisar; 67 at RVSKVV, Mandsaur and 137 at MPUAT, Udaipur, have been made for further evaluation and maintenance.

Giloi: Characterisation of 43 germplasm was carried out. On the basis of starch granules size, five classes, namely very small, small, medium, big and very big, have been made. Starch shape also varied among different accessions. Out of 43 accessions, 34 were characterized using RAPD markers and maximum polymorphism was found in OPC followed by OPA and OPD primers.

ANIMALS

Registration of animal germplasm: Registration of Animal Germplasm was started at the NBAGR, Karnal, provide protection to the valuable animal genetic diversity and facilitate its access for genetic improvement. Accession numbers were given to each of the 129 well defined breeds of species of livestock and poultry, and these were published as a special feature in the *Indian Journal of Animal Sciences*. Guidelines, application form for registration were prepared and are being distributed to potential stakeholders for registration of new populations as breeds. The information is also available on the NBAGR website (www.nbagr.ernet.in/GUIDELINES.pdf).

Phenotypic characterization

Marathwadi buffaloes: The Marathwadi buffaloes are found in the Marathwada region of Central India, especially in Parbhani, Nanded, Bid, Hingoli and Latur districts of Maharashtra state. The average body length, height at withers, heart girth, horn length and face length were 134.21±1.28

Morphometric parameters of mithun

			Adlt wt (kg)	Ht at with (cm)	Body length (cm)	Heart girth (cm)	Face length (cm)	Tall length (cm)	Neck circle (cm)	Neck length (cm)	Ear length (cm)	Horn length (cm)	Horn circ. (cm)
Nagaland	Female	n	7	11	11	11	11	11	11	11	11	11	11
		Mean	370.29	128.25	190.29	182.95	41.29	88.79	76.22	45.34	21.96	28.21	29.38
		STDV	36.75	4.95	9.07	7.72	4.68	3.76	8.17	4.83	1.96	3.85	5.02
		Error	13.89	1.49	2.73	2.33	1.41	1.13	2.46	1.46	0.59	1.16	1.51
	Male	n	4	11	11	11	11	11	11	10	11	11	11
		Mean	411.50	128.23	185.29	188.54	45.17	91.73	94.85	44.28	20.95	31.35	40.34
		STDV	38.86	8.30	13.51	12.89	2.16	6.27	7.72	5.17	1.68	5.81	5.65
		Error	19.43	2.50	4.07	3.89	0.65	1.89	2.33	1.63	0.51	1.75	1.70
Arunachal Pradesh	Female	n	5	7	7	7	7	7	7	7	7	7	7
		Mean	339.40	123.96	185.21	177.41	40.64	86.33	74.79	43.71	21.79	23.64	27.36
		STDV	31.37	3.60	9.08	7.28	2.06	5.93	7.84	3.90	2.23	6.25	3.54
		Error	14.03	1.36	3.43	2.75	0.78	2.24	2.96	1.48	0.84	2.36	1.34
	Male		335	123	200	179	44	83	76	49	24	29	40
Mizoram	Female	n	8	8	8	8	8	8	8	8	8	8	8
		Mean	363.94	125.90	186.60	176.79	40.76	83.29	73.00	45.76	19.88	23.81	28.54
		STDV	32.68	2.87	7.31	5.60	2.21	11.24	3.63	5.17	1.81	4.24	4.19
		Error	11.55	1.01	2.58	1.98	0.78	3.97	1.28	1.83	0.64	1.50	1.48
	Male		398.5	132	195	178	43	81	81	40	21	31	37
Manipur	Female	n	4	6	6	6	6	6	6	6	6	6	6
		Mean	334.00	124.67	186.42	182.68	41.47	81.92	73.75	49.33	19.08	22.50	25.00
		STDV	14.38	4.37	5.52	10.32	2.43	3.32	6.93	15.76	1.02	3.13	4.86
		Error	7.19	1.78	2.25	4.21	0.99	1.36	2.83	6.43	0.42	1.28	1.98
	Male	n		2	2	2	2	2	2	2	2	2	2
		Mean		127.50	197.50	186.00	43.50	85.00	95.00	47.50	21.00	33.25	45.50
		STDV		7.78	9.19	1.41	2.12	5.66	8.49	7.78	1.41	0.35	7.78
		Error		5.50	6.50	1.00	1.50	4.00	6.00	5.50	1.00	0.25	5.50

Adlt wt: Adult weight, Ht at with: Height at wither, Horn circ.: circumference

cm, 125.60±0.627 cm, 182.55±1.08 cm, 54.47±1.11 cm and 45.95 ±0.30 cm respectively. Marathwadi buffaloes are reared under low input system and have moderate milk production varying from 4 to 8 litres/day.

South Kanara buffaloes: South Kanara buffaloes are medium built animals distributed in Mangalore, Udupi and Shimoga districts of Karnataka. The average body length, height at withers, heart girth, horn length and face length were 112.8±3.3 cm, 113.1±2.9 cm, 154.2±2.9 cm, 42.1±2.2 cm, 42.5±0.7 cm respectively. The average daily milk yield of South Kanara buffaloes is about 3.9 ±0.3 litre. The length of lactation varied from 210 to more than 360 days with an average of 313.6±10.2 days. The lactation milk yield varied from 420 to 2,520 litre with a mean of 1,206.8 ±110.1 litre. The average age at first calving was 41.4±1.9 months and the mean calving interval 543.4 ±51.3 days.

Sangamneri goat: The Sangamneri goat, a dual-purpose breed of India, has made its place in the rural economy of Nasik, Ahmednagar and Pune districts of Maharashtra. About 40% of the goats have long hair at the thigh. In adult animals the average height at wither, body length, chest girth, paunch girth, face length, horn length, ear length, tail length (cm) and body weight (kg) are 68.78 ± 0.38, 68.63 ± 0.38, 72.66 ± 0.43, 76.93 ± 0.46, 16.73 ± 0.09, 13.23 ±0.10, 17.21 ± 0.08, 15.13 ± 0.08 and 32.21 ± 0.22, respectively. The average daily milk yield recorded under farm conditions was 0.860 litre and lactation yield of 77.40 litre in about 160 days of lactation.

Morphometric characterization of mithun: The recording of morphometric parameters of four strains of mithun (Nagaland, Arunachal, Manipur and Mizoram) kept in the institute farm are given here.

Vembur sheep: Vembur sheep also known as Pulli Adu, is found in Virudhunagar, Tirunulveli and Thuthukudi districts of Tamil Nadu. Vembur

Rams of Vembur sheep

Camels as a draught animal

Camel keepers were studied in 7 *tehsils* of Bikaner district. The transformation of camel use is investigated on pre-tested survey performa by participatory approach from villages of Bikaner district, viz. Bachchhasar, Gadwala, Jasrasar, Udasar, 8 KYD Chak, Khajuwala, Lunkaransar, Mahajan, Pugal, Nada, Seruna, Lakhmisar, Salasar, and Kolayat. Most of the camel keepers (77.52%) are putting their camel to work at an age of 4 years whereas few (22.48%) put them to work at 3 years of age. Mostly (76.82%) male camels are being used for carting, farming and other agriculture operations whereas only23.18% female are used for this purpose. An average income of Rs 350–450/day is generated from camel carting at the village level but fetches more in the city areas.

sheep are medium to tall, well-built, hardy and strong with a straight topline. The sheep can trek long distances in search of grazing material. The average body weight, body length, height at wither and chest girth are 38.5±1.24 kg, 69.3±1.07 cm, 78.2±0.83 cm and 84.3±0.95 cm in rams and 28.5±0.27 kg, 64.1±0.27 cm, 73.9±0.24 cm and 75.1±0.28 cm in ewes, respectively. Age at first lambing is about 18 months and lambing interval is 11.6 months. Lambs are sold @ Rs 700–800 at marketing age of about 3 months after which the sale price is about Rs100/kg live weight. Mutton fetches a price of about Rs 150/kg.

Munjal sheep: Data on body biometry of Munjal sheep was obtained from Karnal (Haryana), Bhatinda (Punjab) and Hanumangarh and Ganganagar (Rajasthan). Very few animals of Munjal type sheep are now available in these areas. Average body length, height at withers, chest girth, paunch girth, ear length, tail length are 83.64, 80.38, 91.76, 94.33, 18.81 and 47.90 cm, respectively, in male, and 75.59, 73.24, 83.77, 86.90, 18.47 and 42.01 cm, respectively, in female. Adult weight averaged 60.04 and 43.94 kg in male and female, respectively.

Evaluation and characterization of indigenous pigs: Phenotypic characterization of 3 indigenous pigs (Nagaland local, Khasi local and Ghungroo) of Eastern and North-eastern India was completed. The weight at weaning was higher in female (in comparison to male) in Khasi local pig, whereas, it was reverse in Ghungroo pigs.

Zanskari ponies: Biometric indices of true-to-Zanskari breed of horses were recorded in their home tract in and around Leh, Laddakh (Jammu and Kashmir). The average height at wither of Zanskari breed was 126 cm, lesser than the standard height criteria, i.e. 150 cm, for differentiating horses from ponies and as such these equines come under the category of ponies. Average height was slightly higher in stallions (127.21 ± 7.57 cm) than mares (125.45 ± 4.74 cm). Beside this, average body length (123.07 vs 129.5 cm), heart girth (144.4 vs 148.9 cm), hind leg length (80.11 vs 79.95 cm), canon length (16.18 vs 15.80 cm), height at knee (37.57 vs 36.95 cm), face length (53.79 vs 53.75 cm) and face width (15.68 vs 15.25 cm) did not vary significantly among the stallions and mares. Hair coat was thick and quite similar to that of Spiti ponies. Grey was the most prominent coat colour followed by bay and black.

Molecular characterization

Molecular characterization of Motu, Ghumsuri, Binjharpuri, Kumaoni Hill cattle; Marathwari, South Kanara buffalo; Changthangi, Deccani, Muzaffarnagri, Ganjam, Jalauni, Marwari, Sonadi sheep and Arunachali mithun was completed using microsatellite based genotyping.

Diversity analysis of livestock breeds: The diversity analysis of different breeds of cattle, buffalo and goats was carried out to establish the relationship among different breeds. The global F-statistics revealed F_{ST} value of 4.5% across South Kanara and Marathwada buffalo populations. The Nei's genetic distance between individual animals revealed 2 distinct clusters of South Kanara and Marathwada buffaloes with some overlapping. In phylogenetic tree using average square distance with UPGMA, the 3 studied cattle populations of Orissa clustered together and then with Kumauni cattle population. Within Orissa, Binjharpuri and Ghumsuri cattle populations joined first and then with Motu cattle.

Immune response genes in indigenous cattle: Analysis of the sequences of tlr-4, tlr-9, mcp-1 gene and nos2a genes in indigenous cattle breeds revealed that tlr-4 gene contained 91 snps spread over the length of 10.8 Kb of gene. Of these approximately 22% of snps were present in the coding regions of the gene. Only one snp present in the exon-2 of the gene resulted in an amino acid change from Ile to Asn. Over the length of approximately 5.1 Kb, only 19 snps could be observed in Sahiwal cattle. All the snps were substitution mutations. The mcp-1 gene showed the occurrence of 23 snps across the gene length of 3156 bp of the gene. There was approximately one snp for every 137 bp length of the mcp-1 gene. The fezl gene was studied across the *Bos indicus*, exotic and crossbred cattle populations and the Mehsana, Murrah and Banni buffalo populations. All the animals studied contained a glycine insertion in them. Accordingly all of them got grouped as being potentially susceptible to mastitis.

Expression analysis of Bcl2, Hsp72 and TLR4 genes: The expression analysis of Bcl2, Hsp72

ß-casein A1/A2 variant in indigenous cattle breeds

Animals (618) of 15 Indian zebu cattle breeds from different agro-climatic regions of India along with 231 buffaloes of 8 river buffalo breeds were genotyped in beta-casein (CSN2) locus by PCR-RFLP method. The ß-casein A1/A2 frequency data indicated predominance of A2 variant (0.987) in zebu cattle breeds while buffaloes indicated only A2 milk type.

PCR-RFLP of ß-Casein (CASB) Taq I showing A2A2 and A1A2 genotypes

and TLR4 genes carried out in the thermal challenged (48°C/56%RH for 2 h) Murrah buffalo along with Tharparkar and Karan-Fries cattle revealed no change in expression profile of these genes. Hsp72 expression increased in buffalo, 2h after heat shock and returned back to 0h level after 4h, whereas, Karan-Fries animal showed decreased expression of Hsp72 during 0h, 2h and 4h after heat shock treatment.

Diversity analysis of buffalo breeds: Nei's genetic distance between individual animals of Marathwadi and South Kanara buffaloes revealed two monophyletic clusters of respective source populations. F_{ST} value of 0.071 indicated considerable genetic differentiation among these two breeds.

Leptin and mammary derived growth inhibitor genes: A non-synonymous change resulting in amino acid variation from alanine to valine in leptin gene was detected and *HaeIII* genotyping protocol was developed for screening of SNP (single nucleotide polymorphism). A polymorphic nucleotide T/C was detected at 53Int2 position in MDGI gene, and Bah RFLP genotyping protocol was developed for the screening of SNP. Screening of 200 Mehsana buffaloes along with association studies in 67 samples having milk production records showed no significant association of SNP with any of the performance records.

Diversity analysis of sheep breeds: Genetic profiling of unrelated individuals belonging to Deccani, Muzaffarnagri, Ganjam, Jalauni, Marwari and Sonadi sheep, revealed high level of genetic diversity in them. The level between breed differentiation was moderate (<15%). Global F_{ST} values indicated that 11.2% of the total genetic variation could be explained by breed differences and the remaining 88.8% by differences among individuals. Marwari and Sonadi were the closest, while Deccani and Sonadi showed highest degree of genetic differentiation.

Genotyping of Kathiawari and Marwari breeds: Genotyping of Marwari and Kathiawari horses showed high heterozygosity, indicating adequate genetic diversity among both the populations.

Microsatellite analysis in Indian dromedary breeds: Forty microsatellite primers known to be polymorphic in camelids were successfully amplified in the Indian dromedary breeds. Number of alleles at these loci ranged from 2 to 7. Maximum number of alleles were in Bikaneri (76) followed by Jaisalmeri (74) and Kachchhi (69) breeds. The consensus tree was also constructed. A high degree of homozygosity was observed among the Indian dromedary breeds.

Marker for higher adult body weight in yaks: An AFLP (amplified fragment length polymorphism) allele was found with higher frequency in yaks with higher adult body weight. Adult male and female yaks with body weight greater than or equal to mean $+1.5\sigma$ were grouped as elite animals. Frequency of AFLP marker allele in the elite group was 78% in male and 66% in female group. The overall frequency in the male and female groups was as 0.28 and 0.12, respectively, suggesting a stronger selection pressure on sires than on dams. The marker information could be incorporated in marker assisted selection for higher adult body weights in yak, as the body weight determines draught and pack ability and quantity of meat production.

Cloning, sequencing and homology studies on *SRY* gene: The *SRY* gene typing in yak, cattle and their hybrids was done based on *SRY* nucleotide sequence data for cattle (AB039748) and yak (AY079143). Numbering of restriction sites refer to the Genbank entry AB039748 for bovine *SRY*. The individuals showing polymorphisms were identified and further probed by direct DNA sequencing.

The study indicated high degree of sequence homology in *SRY* gene among yak and cattle. Mutations in *SRY* gene were used to develop simple assays to identify male mediated introgression in yak × cattle hybrids. Delineation of the sequence homology in *SRY* gene among yak, cattle and their hybrids may help analyze the cause of male infertility at gene level.

Milk fat associated genes polymorphism: DNA sequencing of milk fat percentage regulating genes FASN, MOGAT1 and MOGAT2 in yaks revealed polymorphism in these genes at various positions resulting in amino acid changes. Homology studies showed 97, 99 and 98 similarity in the FASN,

Population genetic diversity in yaks

An RAPD analysis showed that yak population reared in an organized herd is highly homogenous (similarity coefficient=1). A comparison with few other individuals belonging to different yak tracts of India also produced strikingly similar genotypic profiles. This remarkable homogeneity could be attributable to either high level of inbreeding or to the limited diversification among the yak population in India.

MOGAT1 and MOGAT2 genes, respectively, between *Bos grunniens* and *Bos taurus*. No transcription-start-sites and zinc-finger-residues were found in the sequenced region of the 3 genes.

Genetic studies on mithun: Karyotypes for male and female mithuns were prepared and cytogenetic analysis was carried out, which included estimation of relative length and centromeric index. Idiograms were also prepared for both male and female mithuns. The protocol of C- and R-banding (RB-FPG method) was standardized for the mithun chromosomes.

Genetic characterization of kappa casein gene of mithun: Kappa casein genetic variation among mithun strains were studied using PCR-RFLP technique. PCR products between exon 4 and intron 4 region of CSN3 gene was 270 bp. HindIII produced definite restriction sites in mithun yielding approximately 230 bp, 180 bp and 90 bp fragments. EcoRI, MboII and Sau3AI were having no cutting site in the region of exon 4 and intron 4 of mithun CSN3.

Genetic characterization of microbes available in mithun rumen fluid: The PCR amplification of 16S rDNA was done for *Prevotella ruminicola* (ferments protein, hemicellulose and starch), *Prevotella bryantii* (ferments protein, hemicellulose and starch), *Ruminobacter amylophilus* (ferments protein and starch), *Selenomonas ruminantium* (ferments sugar/dextrins) and *Treponema bryantii* (ferments cellobiose, xylose, arabinose and glucose) using 20–50 ng total DNA in 25 µl reaction volume. Some of the PCR products of above mentioned bacteria were cloned into *Escherichia coli* DH5α using pGMET vector.

Candidate marker approach for selected economic traits: Comparative evaluation of reproductive traits, viz. estrogen receptor (ESR), prolactin receptor (PRLR), retinal binding protein 4 (RBP4) and growth hormone (GH) gene in Ghungroo, Meghalaya Local, Naga Local and crossbred pigs revealed the presence of heterozygous genotype (AB genotype) of ESR gene in Ghungroo and Hampshire × Assam local animals.

Molecular characterization of chicken germplasm: Five chicken pure lines of PDP (PD1, PD2, PD3, PD4 and PD5) being used for development of varieties for rural poultry, were characterized using 15 microsatellite markers, of which 14 markers were polymorphic. The number of alleles for different microsatellites varied between 2 and 6. The Nei's genetic identity and other estimates indicated varied genetic distance among different lines. Five alleles were found for each of the five microsatellites (located on chromosome E48, 10, 5, 2 and 1) in Naked neck population.

Genetic marker and trait association in chicken: In prolactin promoter of White Leghorn chicken 28 haplotypes were identified. The h1/h22 haplotype combination produced significantly highest number of eggs up to 52 and 64 weeks of age and significant effect of haplotype combinations was recorded on several egg quality traits. The prolactin gene expression was the lowest in h1/h22 and highest in h1/h5 combination. The birds with higher prolactin expression showed lower egg production.

A 390 bp fragment of melanocortin receptor-4 was analyzed in 2 layer (IWH and IWK), 2 native (Aseel and Kadaknath) and Naked neck populations. Three alleles (*A*, *B* and *C*) were observed in IWH, IWK and Kadaknath populations, while only 2 alleles (*A* and *B*) were observed in Naked neck and Aseel breeds. The amino acid sequence of this fragment indicated that *C*-allele was different from *A*- and *B*- alleles by having lysine amino acid at 28th position as against glutamic acid in *A*- and *B*- alleles.

Effect of Naked neck gene on economic parameters: The body weight varied significantly among the genotypes carrying Naked neck gene in homozygous and heterozygous condition. The *NaNa* genotype recorded heavier weights at 4 and 6 weeks of age. The *NaNa* birds had significantly higher dressing percentage, lower feather percentage and lower abdominal fat. The cell-mediated (PHAP) and humoral (SRBC) immune responses were higher in *NaNa*/*Nana* genotypes. The serum cholesterol content was lower in *NaNa* and *Nana* genotypes, compared to normal birds.

Native fowl genomics for disease resistance and molecular breeding for high yielding chickens: Profiling the genetic basis of disease-resistance against avian leukosis and sarcoma virus (AL/SV) [against sub types: B, D and E] was taken up in native breeds Kadaknath (KN) and Aseel [including the varieties: Aseel Peela (AP) and Aseel Kagar (AK)] vis-à-vis White Rock, a commercial broiler breed. The KN, AP and AK segregated for both the susceptible and resistant alleles, i.e. TvbS1 and TvbR. The TvbR was represented through heterozygotes only in the native populations, and no carriers could be detected

either in AP or White Rock. Frequency of TvbR in KN and AK was 0.10 and 0.0625 respectively. The PCR-RFLP concluded that our native flocks also segregated for the same resistant allele, as found in their custom-bred stocks. Incidentally, the TvbS1 was the type of susceptible allele found in these test-samples, while the international reports state records an additional type of susceptible allele TvbS3 besides TvbS1.

The frequency of TvbR could be enhanced by identifying all the carriers from a population of Kadaknath chickens and by their subsequent *inter-se* matings. It was concluded that genetically-resistant populations (for ALVB resistance) could be developed from within KN and Aseel, by selective breeding and its introgression into other high-yielding chicken populations, particularly broilers and layers.

Allelic profiles of Aseel and Kadaknath: Microsatellite allelic profiles of Aseel and Kadaknath breeds of native chicken were developed with 24 markers and out of these, 2 loci, MCW266 and LE174 demonstrated monomorphic and 14 demonstrated bi-allelic patterns. Five loci revealed 3 alleles and 2 loci demonstrated 4 alleles with varied frequencies in Aseel and Kadaknath breeds.

MHC haplotypes resistant to Marek's disease (MD): IWI and IWK pure line layer populations were screened for MHC class II alleles. The predominant MHC type was B2 followed by B21. In IWK, B13, B15 and B19 were not found. In IWI, all B types tested were found, except B13. B13, B15, B19 were considered susceptible to MD while B19 and B2 were considered resistant to MD. MHC screening of MD tumors revealed that majority were of B19 type, which is considered susceptible to MD.

Collection, preservation and molecular characterization of veterinary pathogens: Standard operating procedures (SOPs) for animal cell culture, bacterial culture, storage of bacterial/viral pathogens, and working guidelines for sample acquisition, characterization, and reposition were developed. Bacterial isolates (90) and viral isolates (6) were preserved. PCR amplification and partial sequencing of 16S rRNA genes has led to the confirmation of *Aeromonas* spp., *Bordetella bronchiseptica*, *Streptococcus* spp., *Corynebacterium* spp., *Pseudomonas* spp., *Proteus* spp. and ß-hemolysine positive *Staphylococcus* species. A significant finding was isolation and identification of *Pantoea agglomerans* strains from cases of equine abortions.

Network Project on Animal Genetic Resources

***In-situ* conservation:** Under *in-situ* conservation of different breeds of goats, 50 Beetal male kids are being reared at the flocks of farmers. At Navsari, the number of selected elite Surti goats is now 170. The physical traits and body measurements were recorded. Male kids were selected on the basis of dam's milk yield, which ranged from 180 to 188 litres. The birth weight of selected male kids ranged from 2.4 to 3.3 kg and their weaning weight ranged from 9.0 to 11.0 kg.

***Ex-situ* conservation programme:** Four Ponwar cattle bulls, were used for semen donation. Only two semen samples, having post-thaw motility of 40% were found fit for cryopreservation. Out of the 11 Kherigarh cattle bulls put under training for semen donation, 6 bulls are being used for semen production. Post-thaw motility of two bulls was 55–60%.

On an average 1,100 semen doses/bull of cattle from the 8 procured bulls of Krishna Valley cattle were stored. Semen doses were supplied to cattle development centers in Bagalkot and Belgam districts. Artificial inseminations (AI) resulted in average conception rate of 55.95%.

Semen doses were also frozen from prized bulls owned by farmers for conservation of superior germplasm. About 3.5 lakh doses of frozen semen from superior test and progeny tested proven bulls are being maintained.

National gene bank on animal genetic resources: In addition to already existing semen doses from 9 breeds of cattle, 6 breeds of buffalo, 1 breed of sheep, 2 breeds of goat and 1 breed of camel, 15,000 semen doses of Jaffarabadi buffalo, 8,000 of Kherigarh cattle, 230 of Ponwar cattle and 360 semen doses of Arunachali yak were added to the Gene Bank.

Characterization of the ectoine biosynthesis genes halodurans

Ectoine, a cyclic tetrahydropyrimidine and a compatible solute, plays a major role in preventing plasmolysis of bacteria in saline environments. Ectoine has recently gained importance as it is used in dermopharmacy in anti-ageing creams, skin creams, as a component of shampoo and as an adjuvant for vaccines. The putative ectABC gene cluster from *Bacillus halodurans* was heterologously expressed in *Escherichia coli* and the production of ectoine was confirmed by HPLC analysis. The activity of the ectA protein was confirmed by an acylation assay. The transgenic *E. coli* accumulated up to 4.6 mg ectoine/litre culture. This is the first report of an engineered *E. coli* strain carrying the ectoine genes of the alkaliphilic bacterium, *B. halodurans*.

FISH

Microorganisms for aquatic bioremediation: Efficient heterophilic nitrifying, aerobic denitrifying, agarolytic and sulphur oxidizing

Forensic identification of whale shark meat

Whale shark (*Rhyncodon typus*) is an endangered species protected under schedule 1 of the Indian Wild life Protection Act 1972 and was designated as endangered species under "Convention on International Trade" in April 2001. Forensic investigations using DNA barcoding resulted in the identification of whale shark meat and hence, revealing the illegal trading of this species. Thus, DNA barcoding provides scientific evidence which can be used effectively in curtailing illegal trade of endangered organisms and the technique will go a long way in preserving biodiversity.

Endangered whale shark (*Rhincodon typus*)

bacteria which can be used for bioremediation of shrimp farm discharge were identified. The diversity of chemolithoautotrophic bacteria isolated from coastal waters was examined by the creation of metagenomic clone libraries for functional genes such as ammonia monooxygenase gene (amoA), nitrite oxido-reductase (norB), nitrous oxide reductase gene (nosZ), nitrite reductase (nirS) and nifH gene. Sequences obtained were deposited in the GenBank. The amoA gene sequences exhibited 81–82% identity to *Nitrosomonas europaea*, *Nitrosococcus mobilis* and *Nitrosomonas eutropha*, which were also similar to particulate methane monooxygenase (pmoA) gene sequences. The norB genes are closely affiliated with *Nitrobacter* sp. especially *Nitrobacter winogradskyi* and other uncultured beta-proteobacteria available in the GenBank. The levels of nucleotide similarity with uncultured bacteria bearing *norB, nirS* and *soxB* ranged from 78–82%, 79–82% and 77–82%, whereas amino acid similarity was 79–87%, 80–88% and 76–86% respectively. A molecular tool was also developed for the detection of chemolithoautotrophic bacteria, and is being offered to private entrepreneurs for commercialization.

Genetic characterization

DNA barcoding of fishes: DNA barcodes (1,509) of over 400 fish species were prepared for Indian fishes. More than 1,107 barcode sequences were submitted to the National Centre for Biotechnology Information Gene Bank. In addition, 21 DNA barcodes of helminth parasites of fishes were also prepared. The material was procured from both marine and freshwater sources. A total of 3,403 fish samples of 656 marine species from almost all coastal states and 739 samples of 132 finfish species and 57 samples of 12 shellfish species from freshwater sources (Ganga, Brahmputra and Peninsular rivers) were assessed for the study.

Barcoding of five species of tuna was carried out and deposited with the gene bank of NCBI (http://www.ncbi.nlm.nih.gov/taxonomy).

Microsatellite markers in Indian catfish: Seventeen Type-I markers were identified in Indian catfish (*Clarias batrachus*), which will be particularly valuable for genetic mapping and serving as anchor loci for comparative genomic studies. In addition, 12 polymorphic microsatellite loci were identified, which are useful in determining genetic variations in wild populations of *C. batrachus*.

Vitellogenin gene expression: A rapid and sensitive reverse transcriptase-PCR method was standardized to detect change in fish vitellogenin gene expression. This method successfully detects vitellogenin gene expression in male *Labeo bata* exposed to 17-ß estradiol at a concentration of 100 µg/litre. As vitellogenin gene is not expressed in male fishes under normal condition, expression in males provides a sensitive indicator of fish exposure to estrogenic compounds and endocrine disruption. The method can be used in bio assessment of aquatic pollution, which causes endocrine disruption hampering fish breeding and recruitment. ❑

6

Crop Improvement

Rice: The Central Sub-committee on Crop Standards, Notification and Release of Varieties released two hybrids (Sahyadri 4 and GK 5003) and eight varieties (Akshaydhan, Varadhan, Sampada, Pushyami, Pusa Basmati 6, Gontra Bidhan 1, Amal mana and CR Dhan 40). The State Variety Release Committees have recommended 16 varieties and one hybrid for different situations in 6 states.

Based on three years of testing (2006–08) in the All India Coordinated Rice Improvement Programme, 33 cultures were identified as most promising for various ecosystems.

Swarna *Sub-1:* Swarna Sub-1, a rice variety, was released for cultivation in shallow lowland areas of coastal Orissa. It is similar to its parents in all qualities, excepting dark green colour of foliage and hull colour. It yields 5–5.5 tonnes/ha in 140–145 days. It is tolerant to complete submergence of about two weeks

Varieties released by Central and State Variety Release Committees during 2008–09

Variety	Grain type	Ecosystem	Resistant to pests/diseases	Recommended for state/region
			Central Releases	
Akshaydhan	LB	Irrigated	R-NBl, MR-ShR, BS, LB, RTD, WBPH	Irrigated areas of Jharkhand, Andhra Pradesh, Tamil Nadu, Karnataka
Varadhan	SB	Irrigated	R-LBl, RTD, WBPH	Irrigated areas of Uttarakhand, Haryana, Uttar Pradesh, Jharkhand
Sampada	MS	Irrigated	R-LBl, MR-WBPH	Irrigated areas of Bihar, Chhattisgarh, Maharashtra, Tamil Nadu, Kerala
Pushyami	LB	Irrigated	R-BPH, WBPH, MR-ShB	Irrigated areas of Andhra Pradesh, Tamil Nadu, Gujarat, Maharashtra
Sahyadri 4	LS	Irrigated	MR-LBl, NBl, BS, RTD	Irrigated areas of Maharashtra, Punjab, Haryana, Uttar Pradesh, West Bengal
GK 5003	LS	Irrigated	R-LBl, NBl	Irrigated areas of Andhra Pradesh, Karnataka
Pusa Basmati-6	LS	Irrigated	MR-LBl, RTD	Traditional basmati growing areas of Haryana, Uttarakhand
Gontra Bidhan-1	MS	Irrigated	MR-BPH	Irrigated areas of Punjab, West Bengal
Amal Mana	ELS	Rainfed/ irrigated/ coastal saline soils	R-SB, LF, whorl Maggot case worm and blue beatle; MR-LBl, BS, ShBl	Waterlogged and coastal areas of West Bengal, Orissa, Andhra Pradesh
CR Dhan 40	SB	Direct seeded and transplanted	R-GM, MR-LBl, BS	Direct seeded areas of Jharkhand and transplanted areas of Maharashtra
			State Releases	
JRH-8	LS	Rainfed/irrigated	Tolerant to abiotic stress	Madhya Pradesh
Thanu	MS	Irrigated	MR-BL, ShR	Irrigated areas of Kanataka
CR Boro Dhan-2	MS	Boro season	R-BL, ShBl; MR-YSB	Boro areas of Orissa
Hanseswari (CR Dhan 70)	SB	Semi deep water	T-WBPH; MR-LBl, ShBl, SB, BPH, GM	

Contd...

Variety	Grain type	Ecosystem	Resistant to pests/diseases	Recommended
Jaldihan-6	LB	Irrigated	–	West Bengal
Nua Kalajeera	MS	Irrigated	R-RTD, MR-BS, LBl, NBl, ShR, Plant hoppers, GM-5	Orissa
CR Sugandh Dhan-3	MS	Rainfed low land	MR-GM	Orissa
CR Dhan-10	LS	Irrigated	MR-GM	Orissa
AAUDR-1	MS	Upland direct seeding	T-SB	Gujarat
Phule Samrudhi	LS	Irrigated	MR-BL, SB	Maharashtra
Manaswini	LS	Irrigated	R-BS, GM1, LF, BPH, WBPH, SBWE, MR-Bl, ShBl, RTD	Orissa
PKV Khamang	SS	Rainfed/irrigated	MR-LBl, NBl, BLB	Maharashtra
Narendra Mayank	SG	Irrigated	Submergence tolerance	Uttar Pradesh
Narendra Jal Pushp	LB	Irrigated late	Submergence tolerance	Uttar Pradesh
Malviya Sugandh-105	MS	Irrigated	MR-LBl, NBl, BS, SB	Uttar Pradesh
Malviya Sugandh 4-3	LS	Irrigated	MR-LBl, BLB, BPH,	Uttar Pradesh

R, Resistant; MR, moderately resistant; MS, moderatey susceptible; BL, blast; BLB, bacterial blight; BPH, brown plant hopper; BS, brown spot; GM, gall midge; LB, long bold; LF, leaf folder; NBI, neck blast, SB, short bold; ShBl, sheath blight; ShR, sheath rot; RTV, rice tungro virus; WBPH, white backed plant hopper

and is also suitable for late planting with aged seedlings.

Improvd Samba Mahsuri has good agro-morphological features

Sahbhagi Dhan: Sahbhagi Dhan was identified for release for cultivation in drought affected areas of Jharkhand and Orissa. Drought-tolerant, Sahbhagi Dhan yields 3.8 – 4.5 tonnes/ha in about 100 days and can withstand terminal drought for at least two weeks. It is resistant to leaf blast and moderately resistant to brown spot and sheath rot, and also moderately resistant to stem-borer and leaf folder. It has good cooking quality and long-bold grain.

Wheat: Wheat varieties identified for release

Wheat varieties released

Variety	Season	Areas for adoption
HS 490	Late sown, restricted irrigated condition	Hills of Jammu and Kashmir (except Jammu and Kathua districts), Himachal Pradesh (except Paonta Valley and Una district), Uttarakhand (excluding tarai region), Sikkim and hills of West Bengal and NE states
PBW 590	Late sown, irrigated condition	Punjab, Haryana, Delhi, Rajasthan (except Kota and Udaipur divisions), West Uttar Pradesh (except Jhansi division), Jammu and Kathua districts of Jammu and Kashmir, Paonta Valley and Una district of Himachal Pradesh, and tarai region of Uttarakhand
Raj 4120	Timely sown, irrigated condition	East Uttar Pradesh, Bihar, Jharkhand, West Bengal (excluding hills), Orissa, Asom and Plains of NE states
CBW 38	Timely sown, irrigated condition	East Uttar Pradesh, Bihar, Jharkhand, West Bengal (excluding hills), Orissa, Asom and plains of NE states
MP 1203	Late sown, irrigated condition	Madhya Pradesh, Chhattisgarh, Gujarat, Kota and Udaipur divisions of Rajasthan and Jhansi division of Uttar Pradesh
UAS 415(d)	Timely sown, irrigated condition	Maharashtra, Karnataka, Andhra Pradesh, Goa and plains of Tamil Nadu
PBW 596	Timely sown, restricted irrigated condition	Maharashtra, Karnataka, Andhra Pradesh, Goa and plains of Tamil Nadu
MACS 2971 (dic)	Timely sown, irrigated condition	Maharashtra, Karnataka, Andhra Pradesh, Goa and plains of Tamil Nadu

Promising genotypes for wheat products

Product	Genotypes
Chapati (>8.0/10.0)	GW 391, HD 2987, C 306, PBW 175, Raj 4120, K 0307, K 8027, HD 2888, Lok 1, GW 322, HI 1531, HW 2004
Bread (>575 ml loaf volume)	WH 1061, WH 1062, AKAW 4627, MACS 6222, MACS 6273, UAS 304, UAS 305, HP 1913, HD 2987, WH 1021, NW 2036, GW 173, HD 2864, HD 2932, MP 1203, NIAW 917, NIAW 34, Raj 4083, HI 977, NI 5439, HD 2781
Biscuit (>7.5 spread factor)	HS 502, HS 490
Pasta(>6.5/9.0)	PBW 311, PDW 314, UAS 419, DDW 12, GW 1245, PDW 233, WH 896, HD 4672

Promising genotypes were identified for individual quality parameters both for *T. aestivum* and *T. durum*

Genotypes for individual quality and nutritional parameters

Parameter	*T. aestivum*	*T. durum*
Sedimentation value	WH 1080, CBW 38, HD 3002, PBW 625, K 8027, HI 977, HD 2987, HD 2987, NI 5439	WH 896, A-9-30-1, GW 1250, HI 8699, HD 4720
Grain hardness index	HS 240, C 306, HD 2888, HI 1531, NIAW 1415	UAS 415, HD 4720, AKDW 4021, PDW 315, MACS 1967, AKDW 2997-16
Yellow pigment	HS 240, TL 2942, HS 490, DBW 17, PBW 373, NW 2036, NI 5439	UAS 419, PDW 233, WHD 943
Iron	WH 1063, PBW 613, C 306, PBW 175, PBW 396, Raj 4120, MP 3224, K 0616, PBW 612, HD 2888, MACS 6222, UAS 304, NIAW 34	GW 1245, HD 8627, HI 8680, AKDW 2997-16
Zinc	HS 502, HS 490, PBW 610, WH 1061, WH 1063, DBW 39, HD 2987, HI 1531, MACS 6222, UAS 304, HP 1913, AKAW 4627, Raj 4083	DDW 12, WH 896, MACS 1967

are: VL 907, HD 2967, PDW 314, DBW 39, HD 2967, HD 2985, MPO 1215 (d), UAS 304, MACS 6222, MACS 6273, AKAW 4627, HD 2987, HW 5207, KRL 210 and KRL 2.

Donors for resistance: The genotypespossessing multiple disease resistance were idetified. They are resistant to:

Rusts +
MR to leaf blight (LB) + R to karnal bunt (KB)+ flag smut (FS): **VL 912**
R to Karnal bunt (KB)+ flag smut (FS)+ powdery mildew (Pm):**HPW 285, HW 2308**
R to FS and Pm: **TL 2955 (T)**
HR (infection 0.0%) to KB)+FS: **UAS 414 (d)**
R to KB+ FS: **HS 471, UP 2719. DDW 11 (d), HI 8672 (d), GW 385**
Leaf and stem rusts +
R to FS and Pm: **MACS 2980 (dic.), DDK 1033 (dic.)**
R to KB+ FS: **HW 3094.**
Stem and stripe rusts+
R to KB+ FS: **HPW 267, VL 895.**
Leaf and stripe rusts+
R to KB+ FS: **RAJ 4130, NIAW 1188.**
Rusts and loose smut: (highest loose smut infection up to 5.0%): HW 5202, TL 2945 (T).
Stem and leaf rusts + loose smut: MACS 2963 (dic), MACS 2971 (dic), DDK 1031 (dic), DDK 1032 (dic), HW 1095 (dic), HW 5305 (dic), WHD 938 (d),

All three Rusts+
+ Root aphids (RA): **VL 898, HW 5030, Raj 4101**
+Flag smut (FS)+RA: **HS 493**
+ Leaf blight (LB)+RA: **VL 912**
+Karnal bunt (KB)+FS+RA: **DDW 11**
+ Shoot Fly (SF): **HW 5207, HW 5209**
Stem and leaf rusts+
+RA: **KRL 210**
+LB+RA: **MP 1194**
+KB+RA: **DBW 32, KRL 213, MP 1200**
+FS+RA: **Raj 4119, PBW 573, HW 5104, HW 5103, PBW 587**
+ SF: **DBW 32, MACS 3598**
+Brown wheat mite (BWM): **HW 2308, HD 2957, Raj 4119, HD 2956**
+BWM+MR to FA: **HW 3094, MACS 3598**
Leaf and stripe rusts+
KB+FS+RA: **MPO 1204**

Quality Improvement: Product-specific genotypes were identified for *chapati* (>8.0 score

out of 10.0), bread (>575 ml leaf volume), biscuit (>7.5 spread factor) and pasta (>6.5 score out of 9.0).

Barley: A dual-purpose variety, RD 2715, with yield advantage of green and grain has been released for commercial cultivation. It is suitable for cultivation in Madhya Pradesh, Gujarat, and Kota and Udaipur divisions of Rajasthan and Bundelkhand division of Uttar Pradesh under irrigated timely sown conditions. This is a very good option for farmers using barley as a source of green fodder in December/ January. Some promising entries for malting purpose are given here.

Maize: Fourteen hybrids and two composites have been released for different agro-ecological conditions. The hybrids/composites released are given here.

Germplasm registration: Nine inbred lines of maize (seven normal and two QPM) have been registered at NBPGR, New Delhi. The characteristics and other details including INGR numbers are given below:

Sorghum: Varieties identified for release are SPSSV 6 (CSV 24SS) of sweet sorghum. It has higher fresh cane and ethanol yield, and total soluble sugars. The new variety responds to higher fertility levels yielding more juice. Stem-borer damage is relatively lesser than that in SSV 84. SPSSV 6 matures in 119 days, 3 days earlier than SSV 84. The variety is identified for all sorghum-growing states for biofuel production,

Sorghum variety CSV 24 SS

Promising barley entries for malting quality traits

Trait	Timely sown	Late sown
Hectolitre weight	BH924, PL835, PL836, BH927	PL835, DWRUB52, BH931, RD2668
Grain plumpness	DWR85, PL837, DWRUB73, DWR82, PL836	DWRUB78, DWRUB73, PL837, DWR81
Protein content (low)	RD2778, DWR81, RD2779, DWR83	RD2778, RD2552, DWR83, BH928, K914
Husk content (low)	BH927, PL835, BH926, RD2777	RD2668, PL835, DWR83, DWRUB52
Malt friability	K913, RD2777, K914, DWR85	DWRUB52, RD2668, DWRUB78, RD2776
Hot water extract	DWR83, PL835, DWRUB73, DWR85	RD2777, DWRUB52
Filtration rate	DWR81, DWR85, DWRUB73, BH927	DWR83, DWR86, DWR81
Diastatic power	BH926, DWR85, PL835, DWR84, K913, DWRUB76, PL836	DWR82, DWR86, K915, RD2779
Beta glucan (%)	K913, K914, K915, K551, RD2778, RD2779	RD2779, K914, K915, K551
Overall score	DWR85, RD2779, DWRUB73, K913 and K914	DWR83 (six-row type), RD2776, PL835 and DWR86 (two-row type)

Maize hybrids/composites released

Hybrid	Pedigree	Area for adoption	Characteristics
HM 11	HKI 1128 × HKI 163	Across the country except Himalayan belt (*rabi*)	Late, orange, semi-dent, resistant to MLB, nutrient responsive
NAH 2039	SKV 50 × MAI 135	Karnataka	Late, yellow, flint, resistant to SDM
EH 434042	–	Karnataka	Late, yellow, flint, resistant to SDM
DHM 111	BML 6 × BML 15	Andhra Pradesh	Late, yellow-orange, semi-flint, nutrient responsive
DHM 113	BML 2 × BML 7	Andhra Pradesh	Late, orange, semi-dent, tolerant to MLB, TLB

Contd...

Hybrid	Pedigree	Area for adoption	Characteristics
DHM 117	BML 6 × BML 7	Andhra Pradesh	Medium, yellow-orange, flint, nutrient responsive
NK30	NK 191 × NK132	Punjab, Haryana, Delhi, Western Uttar Pradesh, Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra	Late, yellow-orange, flint, nutrient responsive
NK 6240	NK125 × NK 128	Punjab, Haryana, Delhi, Uttar Pradesh, Bihar, Jharkhand, Orissa, Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Rajasthan, Gujarat, Chhattisgarh, Madhya Pradesh	Late, yellow, flint
PAC 740	(740 FF × 740 FM) × 740 M	Punjab, Haryana, Delhi, Western Uttar Pradesh	Late, orange, flint, resistant to MLB
JKMH 502	M104 × M101	Punjab, Haryana, Delhi, Western Uttar Pradesh	Late, yellow-orange, semi-flint
SMH 3904	MI201 × MI 211	Eastern Uttar Pradesh, Bihar, Jharkhand, Orissa, Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra	Late, yellow-orange, semi-flint
Pinnacle	–	Eastern Uttar Pradesh, Bihar, Jharkhand, Orissa	
DKC7074R	–	Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra	Early, orange, flint
900 M GOLD	–	Punjab, Haryana, Delhi, Karnataka, Andhrar Pradesh, Tamil Nadu, Maharashtra	Late, yellow, semi-flint
Vivek Sankul 35	Early heterotic pool 1	Jammu and Kashmir, Himahal Pradesh, Uttarakhand, North-Eastern hills	Extra-early, yellow
Vivek Sankul 37	VL Makka 16, Pop 31, C_4 HS bulk (Alm), VL 87, VL 89, VL 90, D 831 and D 941 Extra-early, yellow	Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra	

and SPV 1746 with good fodder yield and tolerant to grain mold than CSV 15 and resistant to downy mildew is suited for Karnataka, Maharashtra, Madhya Pradesh and Gujarat.

Pearl millet: Six hybrids and three open-pollinated varieties (OPVs) that have been identified for release for various agro-ecologies are HHB 216 (MH 1421), RHB 173 (MH 1446), PAC 909 (MH 1435), HHB 223 (MH 1468), KDBH 1151 (MH 1456), NMH 69 (MSH 199), CSBV 6 (MP 479), ABPC (MP 484), and Pusa Composite 612 (MP 480).

Small millet: VL 207, a high-yielding, grain smut resistant variety of barnyard millet was released at national level for cultivation in all barnyard-growing states except Tamil Nadu and Gujarat. Proso millet variety, TNAU 151, was released for all prose millet-growing states.

Three finger millet varieties were released for cultivation in different states. They are GPU 66, a high-yielding and suitable for cultivation in all ragi-growing zones in Karnataka; KMR 301, a high-yielding, long duration and suitable for both *kharif* and winter seasons of Karnataka and Sri Chaitnya (VR 847), a medium-duration variety, is suitable for cultivation in Andhra Pradesh.

Varieties for release

The GPU 67, a finger millet variety is high-yielding and resistant to lodging because of its semi-dwarf stature and profused tillering ability. This variety has been recommended for cultivation in Karnataka, Chattisgarh, Jharkhand, Maharastra, Tamil Nadu and Uttarakhand.

The TNAU 164, a high-yielding proso millet, has been recommended for cultivation in Andhra Pradesh, Bihar, Karnataka, Maharashtra, Tamil Nadu and Uttarakhand. The OLM 208 and OLM 217, little millet varieties, were recommended for cultivation in Chattisgarh, Gujarat and Orissa.

Finger millet: Finger millet, GPU 67, is suitable for Karnataka, Chattisgarh, Jharkhand, Maharashtra, Tamil Nadu and Uttarakhand. It yields 16% more than checks. This is semi-dwarf with erect flag leaf and profused tillering.

Little millet: Little millet, OLM 217, has been identified for release for Chattisgarh, Gujarat and Orissa. It has 14% more yield than national check with high resistance to rust, grain smut and sheath blight.

Forage crops

Varieties identified for release: Among forage crops, Napier bajra hybrid, RBN 13, oat varieties,

NDO-1, OS-346 and JO-03-91; cowpea variety, UPC-628 and Tall Fescue variety, EC 178182, were identified.

Bundel Guinea-2 (*Panicum maximum*), IGHC 03-4 (*Heteropogon contortus*) and JHPM 05-2 (*Pennisetum glaucum*) have been identified.

Guinea grass: Effect of ploidy on expression of individual apomixis components (apomeiosis and parthenogenesis) was studied in a 38 member ploidy series represented by 3*x*, 4*x*, 5*x*, 6*x*, 8*x* and 9*x* ploidies developed by Hybridization-Supplemented Apomixis-Components Partitioning Approach (HAPA) utilizing embryo-sac clearing and FCSS. The data suggested that expression of individual apomixis components is enhanced with the increasing ploidy.

Pearlmillet: More than 1,200 F_1s originating from pearlmillet (2n=4x=28) and *P. squamulatum* (2n=8x=56) were established in field and characterized cytologically utilizing leaf flow cytometry possessing similar genomic content showing non-involvement of any unreduced gamete from the parents.

Cenchrus: Rare occurrence of sexual plant in *Cenchrus ciliaris* was identified (IGFRI-CcSx-08/1) using pistil-clearing technique and characterized by DNA profiling. The plant shows distinct morphology and flowering behaviour as compared to any other commonly found apomictic plants of *C. ciliaris*. RAPD analysis of sexual plant using random primers (OPJ-13 and OPP-14) produced plant specific bands of 225 bp and 1.2 kb, respectively. Using DNA fingerprint, this plant can be easily distinguished from other *C. ciliaris* plants. This sexual plant of *C. ciliaris* is an elite genetic material for molecular studies of apomixis.

Mineral content of wheat straw varied across the country. The P (0.04–0.1%), Mg (0.15–0.19%), Cu (4.4–6.2 ppm) and Zn (12.2–18.36 ppm) contents were deficient in wheat straw, while Ca content (0.59–0.82%) was adequate. Iron concentration was several times higher in all the samples. Fibrolytic enzyme (avizyme) treatment @ 4 g/kg feed of wheat straw improved the digestibility of organic matter (65.7 vs 61.7%) and fibre fractions (NDF 61.5 vs 58.2%) in crossbreed calves.

The mineral status in paddy straw samples from different states revealed that only Ca content (0.49–0.88%) was adequate in dietary need of cattle, whereas P (0.03–0.15%), Mg (0.06–0.09%), Cu (4.8–6.7 ppm) and Zn (12.4–28.8 ppm) were deficient.

Underutilized crops: High-yielding entries identified in advanced trials for hills are IC 415477 (10.34 q/ha) in chenopod; EC 008707 (11.95 q/ha) in adzuki bean; H3765 (10.28 q/ha) in Job's tear and for plains is SKNK-140 (7.78 q/ha) in Kallingada.

Promising genotypes for quality were SKNK-501 (13.6%) for protein content and IC415236 (5.8%) for lysine content in grain amaranth; PRR-2 (21.50%) for protein content in rice bean and EC 341953 (21.70%) for protein in adzuki bean.

The supplementation of rice-bean flour (20 and 40%) with wheat increased the quality parameters of biscuits in respect of protein, fat, ash and crude fibre. The texture and acceptability of sweet balls prepared by supplementation of rice bean flour (40%) with Bengal gram were also at par with un-supplemented ones.

The demonstrations conducted at farmers' fields in Gujarat and Maharastra indicated that growing Amaranth was profitable over wheat and chickpea and best suited to marginal farmers with scant resources. The crop requires lesser number of irrigation and is free from diseases and insect–pest attack The benefit:cost ratio in growing Amaranth ranged from 1.97 to 2.69 as against 1.37 to 1.83 in chickpea and 1.73 to 1.87 in wheat at different farmers' fields.

Groundnut: Five groundnut varieties, viz. VRI (Gn) 6, TG 51, Ajeya, Girnar 2, ICGV 00348 and Mallika (ICHG-00440), were released for different agroclimatic conditions. Groundnut variety, ICGH 00440, is large-seeded and suitable for export purposes.

Ground variety Girnar 3

Groundnut varieties identified for release: Varieties identified for release are: K 1319, R 2001-3, GPBG 5, CSMG 2003-19, HNG 69 and Girnar 3 (West Bengal, Orissa and Manipur).

Rapeseed-mustard: Four varieties (RB 50, RGN 145, NRCHB 101 and Pusa Mustard 21) and two hybrids (NRCHB 506 and DMH 1) of

NRCHB 506: the first Indian mustard hybrid

Indian mustard and two varieties of yellow sarson (NRCYS-5-2 and YSH 401) have been notified for different mustard-growing regions. DMH-1 and Coral 432 (PAC 432) (hybrids); NPJ 112 (Pusa Mustard 25) and NRCDR 601(varieties) of Indian mustard, and RYSK 05-02 of yellow sarson were identified for release.

Soybean: Germplasm line, EC 538828, was found to possess relative tolerance to terminal drought, whereas soybean variety, NRC 2, was identified drought tolerant. It showed delayed wilting symptom (7 days after the withdrawal of water) and took maximum time to reach permanent wilting genetic resource. Soybean variety, JS 97-52, was identified for cultivation in central Zone.

Sunflower: KBSH 53, a hybrid with seed yield of 20–27 q/ha and 42–44% of oil content and tolerance to powdery mildew, has been released for Karnataka. This hybrid is better than KBSH44. Another hybrid, PSH-569, has been identified for cultivation in Punjab. It gives seed yield of 20–22 q/ha and matures in 100 days. It has 40% oil content.

Safflower: SSF-658, a wilt and aphid tolerant variety, with seed yield of 15–18 q/ha was released for all safflower-growing areas of the country. It exhibited 14–28% yield superiority over the control. It matures in 128 days and it has 28% oil content.

Non-spiny safflower variety SSF-658

Castor: GC-3, a wilt resistant variety, having 30% more yield than GC-2, has been released for Gujarat. It is resistant to wilt and tolerant to *Macrophomina* root rot. It has 40% oil content.

Sasame: Varieties, RT-346 (Rajasthan Til -346), AKT 101 and Gujarat Til-3, having high yield and other desirable characteristics have been released for cultivation in different areas.

Niger: IGPN-2004-1 (Phule Karale-1), a high-yielding, early-maturing variety was released for high rainfall areas of Maharastra and Karnataka**.** Another KBN-1, a high-yielding, early-maturing variety, was released for cultivation in *kharif* areas of Karnataka**.**

Linseed: Varieties identified for release are LC-2063 for Punjab, LCK 5021 for Bihar, Jharkhand, West Bengal and Uttar Pradesh, SLS-67 for Bundelkhand region of Uttar Pradesh, Madhya Pradesh and Rajasthan, LMS 149-4 for Chhatisgarh, Maharashtra, Karnataka, Andhra Pradesh and Orissa.

Pulses: Seventeen varieties in pulses have been identified for release for different regions of the country. They are: IPCK 2004-29, Shubhra, Phule G 0517and PKV Kabuli-4, (chickpea), IPM 02-03, Pusa 0672 and PKVAKM 4(greengram), KU 99021, COBG 653 and NUL 7(blackgram), IPF 5-19, Pant P 74, TRCP 8 and VL 46(fieldpea), Pant L063 and Pant L024(lentil), and Gujarat Rajmash 1(rajmash).

Arid Legumes: Horse gram entry, VLG-19, has been identified for release for northern India. It matures early (91 days) compared to the control (105–108 days).

Jute: Notified jute varieties, viz. Sidhartha (JRC 517) and Sashi (JRC-532) tolerant to drought and waterlogging for capularies jute growing areas and Monalisa (RRPS-27-C-3), tolerant to foot and stem-rot, yellow mite, stem weevil and semilooper were notified for midland jute growing areas. Sumit (JBM-2004-D), a mesta variety was notified for West Bengal, Orissa, Asom and Bihar. Sunhemp variety, Swastika (SUN 053), was notiifed for Uttar Pradesh, West Bengal, Orissa, Madhya Pradesh and Bihar.

As many as 43 germplasm accessions consisting of both jute (18) and sunnhemp (25) were collected from Haryana and Punjab. Donors for premature flowering resistance amongst the olitorius germplasm were identified. Flax germplasm accessions, Polf 15, Polf 31 and H 43, were identified as potential donors.

Application for registration of 15 notified extant varieties (JRO 632, JRO 3690, JRO 66, JRO 524, JRO 7835, JRO 878, JRO 8432, JRO 128, S 19, JRC 212, JRC 7447, JRC 321, Padma, JRC 698 and JRC 80) developed by CRIJAF, Barrackpore, one notified extant variety (Bidhan Pat-3)

Germplasm registration

Name	INGR No.	IC No.	Centre	Characteristics
HKI-288-2	8071	IC563956	Karnal	Late maturity, yellow and flint grain and MLB resistant
HKI-1126	8072	IC563958	Karnal	Late maturity, yellow and flint grain and MLB resistant
HKI-1040-4	8073	IC563959	Karnal	Medium maturity, orange and flint grain and MLB resistant
HKI-1015WG-8	8074	IC563961	Karnal	Medium maturity, orange and flint grain and MLB resistant
HKI-1347-4LT	8075	IC563964	Karnal	Late maturity, white and flint grain and MLB resistant
HKI-164D-4(O)	8076	IC563965	Karnal	Late maturity, QPM, yellow and semi-dent grain and MLB resistant
HKI-164-7-6	8077	IC 563966	Karnal	Late maturity, QPM, orange and semi-dent grain and MLB resistant
VQL1	08011	IC 542343	Almora	Medium, yellow, semi-flint, trp >0.6%
VQL2	08012	IC 542344	Almora	Early, orange, flint, trp >0.6%

developed by BCKV, Kalyani, and two new varieties (JRO 204 and IRA) developed by CRIJAF, Barrackpore, have been send to PPV& FR Authority, for their registration. The DUS testing of two newly-released varieties (JRO 204 and IRA) are in progress.

Four olitorius accessions, OIN 125, OIN 154, OIN 651 and OIN 853, showing mean PDI of 5.0 or less were categorized as moderately resistant to *Macrophomina phaseolina*.

Phylogenetic analysis of begomovirus complexes associated with yellow-vein mosaic disease of mesta revealed that in eastern India, the disease was associated with different variants of MeYVMV and CLCuMB, whereas in northern India it is associated with different variants of MeYVMBV and LuLDB. Interestingly, in southern India the begomovirus complexs consisted of MeYVMBV and LuLDB.

Sugarcane: Identified sugarcane varieties for Punjab, Haryana and western Uttar Pradesh are Co 118 with moderate red rot resitance, Co 233; for both waterlogged and water stressed situations; Co 232 was identified for waterlogged and red rot disease for eastern Uttar Pradesh, Bihar, West Bengal and north-eastern states.

Collection of wild *Saccharum* germplasm: An exploration for the collection of wild *Saccharum* germplasm from Uttarakhand and Himachal Pradesh was organized during September-October 2009. A total of 53 accessions comprising *Saccharum spontaneum*, *Erianthus fulvus* and *Miscanthus nepalensis* were collected.

Cloning and tissue-specific of a new gene promoter: The upstream of one of a new *ubi* gene with 1929 bp was cloned and sequenced. Analysis of sequence data showed that the immediate upstream of start codon of the gene has introns and exons. Above it is the promoter sequence of 239 bp together forming the regulatory system. The promoter sequence has the promoter elements, TATA box and CAT box, and also *cis* activating sites for roots, guard cells and xylem specific expression. Tobacco transgenics with pCAMBIA 1305, where *gus* gene is driven by new promoter, were developed. In tobacco, tissue-specific expression (in guard cells, xylem and roots) of the *gus* gene was observed.

Genes for drought resistance: Attempts were made to identify candidate genes for drought resistance in sugarcane. The mapping population of Co 740 × Co 775 was categorized as susceptible (23%), moderately susceptible (33%), moderately resistant (20%), resistant (14%) and tolerant (11%) based on cane yield and quality characters, and physiological parameters after imposition of drought during the formative phase. Polymorphism between drought resistant and susceptible clones has been observed in RT-PCR analysis for the candidate gene primers IGS, Nit, cAPX, DHAR, prokin, PIN1 and SOD in resistant clones, while GST 1 gave two specific bands in susceptible parent and progeny. SOD gene showed 98% homology with the drought inducible protein in *Saccharum* hybrid. The IGS showed 95% homology with rice genomic DNA and 80% homology with hypothetical proteins expressed in rice genome.

Tobacco: Two varieties / hybrids of FCV tobacco and two varieties of *bidi* tobacco with high yield potential or with resistance to pests were identified / recommended for cultivation in different regions of country.

The tobacco varieties, viz. N 98 for southern light and black soils of Andhra Pradesh, Sahyadri (KST 28) for light soils of Karnataka, Vedganga-I (NBD 43) for Nipani in Karnatak and ABD 105 for Gujarat were identified. The tobacco genotypes having potential alternative uses for high oil content, protein, nicotine and organic acids were identified.

Mango: At CISH, Lucknow, a hybrid namely Hybrid 1084 between Amrapali and Janardhan Pasand was found promising. It has got attractive dark red colour on peel and better shelf-life. The hybrid is dwarf in stature, heavy and regular-bearer.

Guava: CISH GS 35 is a promising heavy-

bearer, half-sib progeny of Allahabad Safeda guava. It produces roundish, smooth, medium large fruits (200–250g). Mature fruits have white flesh, sweet taste along with muskiness developing light yellow colour on ripening. Fruits have TSS 13.4°Brix, acidity 0.42% and vitamin 'C' > 250 mg per 100g fruit and present grittiness of outer flesh. It is soft and medium-seeded (0.93g 100 seed).

Papaya: At IIHR, Bangalore, advanced generation of hybrid progenies of papaya from the combination Surya × Tainung-1 were evaluated for various characters. The hybrid progeny number 28-5 had desirable fruit quality, producing 600–800 g fruits with deep pink colour and high TSS (13–14° Brix) with good keeping quality.

Citrus: At NRC on Citrus, Nagpur; Nagpur mandarin-75, Acid lime-12 and Mosambi-5 were selected as superior clones. Two clones, one early-maturing-N_2 (early-March and early-November) and another less seeded-N_5 (less than 3 seeds/ fruit) were identified.

In *in-vitro* regeneration of citrus, ovules were excised from 8–10 weeks old fruits of Nagpur mandarin and cultured in MS medium supplemented with various organic compounds. Cotyledonary embryoids obtained from MS + ME medium were subcultured and MS medium supplemented with various growth regulators. kinetin in combination with IAA promoted plantlet formation.

Calli derived from epicotyl segments of Troyer citrange (*Citrus sinensis* × *Poncirus trifoliata*) chethali, an important rootstock for Nagpur mandarin and acid lime, were subcultured on regeneration medium (MS fortified with BAP). Rooting occurred from one-month-old shoots subcultured in ½ MS medium supplemented with IBA. *In-vitro* regenerated plants successfully survived in sterilized soil mixture containing soil, sand and cocopeat with 50% survival

Multiple shoots were obtained from mature axillary bud explant / single node of mature trees (>10 years old) of *Citrus limonia* cultivars Rangpur lime Gonicoppal and Brazillian Rangpur lime. When cultured in MS medium supplemented with BAP, kinetin and NAA. *In vitro* proliferated shoots rooted when shoots were cultured on MS supplemented with IBA. Rooted complete plantlets transferred to micro pots having sterilized soil mixture with 50% survival.

The acid lime clone, TAL-94-14 (New), at Tirupati, mandarin selection - 5 at Akola, Khasi mandarin CRS - 4 at Tinsukia, sweet orange selection-2 at Rahuri and Kodur Sathgudi at Tirupati, are continued to be promising.

Banana: Embryo rescue has been standardized for wild species and hybrids involving wild species. Germination efficiency of wild species even after 15 months has been achieved using hormonal pre-treatments. Embryo rescue studies have shown that 80–95% mature embryos could be regenerated into plantlets through direct organogenesis. Genetically transformed banana cv. Rasthali with chitinase gene (chi-II) was confirmed for the presence of transgene through southern blotting. Forty differentially expressed EST's were identified in Sigatoka resistant cultivar Manoranjitham through SSH approach and deposited in NCBI.

The AFLP polymorphism has been studied for drought tolerant (Poovan and Imbogo) and susceptible (Nendran and Calcutta 4) lines of *Musa*. About 15 unique bands have been identified using 64 AFLP markers, of which, seven were specific for tolerance and eight were specific for susceptible. These putative diagnostic markers could be converted into SCAR marker for use in early screening of progenies for drought tolerance. The cDNA libraries have been created for identifying the resistant genes against Sigatoka leaf spot disease and nematode.

The Budu Bale (Pisang Awak) at Arabhavi, Mettupalyam (Pome) at Coimbatore, BRS-3 (Cavendish) at Jalgaon, KBS 8 (Dawarf Cavendish) at Kovvur and Kovvur Bontha (Monthan) at Kovvur have been found promising in banana.

Sapota: A high-yielding clone, DHS 1 (2/1), identified earlier continued to show its superiority.

Jackfruit: One off-season bearing type of jackfruit weighing 40 kg has been identified by Periyakulam centre.

Grape: About 157 accessions were evaluated for 10 fruit characters. Maximum heritability was obtained for seed weight, indicating importance of this character for selection. Bunch weight and number of berries per bunch contributed maximum to total variability among 157 accessions as revealed by principal component analysis.

Fifty-four different grape accessions were analysed with 22 microsatellite primers and their fingerprints were developed. Graphical user interface, functional design and coding for different modules were completed for creating database for molecular marker data of grape germplasm.

Pomegranate: Sixty-one varieties/ecotypes/ landraces of pomegranate were evaluated for growth parameters. The maximum variability was recorded with respect to leaf area (25.83%), followed by plant spread and thorn length. Bedana Sedana, Spendanader and IC-1203 recorded plant height > 275 cm and Nana was dwarf type (63.67 cm). However, flowering was recorded in more than 85% germplasm after two years.

Studies on flower biology revealed three kinds of flowers in pomegranate—Bisexual, Male and

Intermediate. The flower bud development took 19.29 days in Bhagwa and 20.40 days in Ganesh. The total number of flowers per plant from 2-year-old orchard was 124 and 133 in Ganesh and Bhagwa, respectively. The peak period of anthesis in pomegranate Bhagwa and Ganesh was between 10 AM and 12 noon. Pollen viability in pomegranate ranged from 84.0 to 95.0% and pollen viability was slightly higher in Ganesh than Bhagwa. More fruit setting in cross-pollinated fruits (47.77%)was recorded than in self-pollinated ones (16.6%).

Litchi: At NRC Litchi, Muzaffarpur; 24 desirable clones of litchi Shahi and China for extended harvesting season and improved quality characteristics have been identified. One bunch-bearing clone of Shahi was also identified from the Motihari area of Bihar.

A bunch-bearing clone of Shahi litchi

Almond: Five exotic soft-shelled almond cultivars were evaluated to identify high-yielding cultivars having superior nut and kernel quality. Cultivar Waris was found highest yielder (5.14 kg/tree), followed by Makhdoom (4.94 kg/tree) and Non Pareil (4.64 kg/tree). Non Pareil was earliest (126 days), followed by Pranayaj (135) and Waris (137). Kernel recovery was highest in Non-Pareil (65.7%), followed by Merced (63.4%) and Pranyaj (59.9%).

Apricot: Ten apricot cultivars were evaluated for fruit yield and table quality. Genotype CITH-Apricot-1 was found most promising recording maximum yield (14.5 kg/tree), followed by CITH-Apricot 2 (10.5 kg/tree). However, genotype CITH-Apricot 3 has more sweetness (16.0°Brix), followed by CITH-Apricot 1(14.9°Brix). These varieties are being multiplied at large scale.

Walnut: A total of 178 indigenous selections and 15 exotic varieties have been established and are being evaluated for various economic traits. Out of 195 genotypes, 49 have come to bearing stage whose nut and kernel weight ranged from 6.23 to 24.46g and 5.09 to 11.11g respectively in

CITH-Walnut 1: an excellent walnut variety with export quality traits

4th year of age with CITH-Walnut 1, recording the highest nut weight (24.46 g) followed by LG 10 (20.30g) and KPT 5 (18.11g). On the basis of nut and kernel characters, genotypes namely CITH-walnut 1, CITH-walnut 2, CITH-walnut 3, CITH-walnut 4 and CITH-walnut 5 have been identified and being multiplied on large scale for testing and release at national level.

Strawberry: Twenty-one strawberry cultivars were evaluated under open field conditions at Mukteshwar during 2006–09. Blackmore, Chandler, Gorella, Camarosa and Oso-Grandy performed better in terms of plant growth, yield and fruit quality.

Almond: For better pollination, six honey bee colonies per hectare and cultivar IXL as a pollinizer were found beneficial for increasing fruit setting, higher nut and kernel yield. The fruit setting increased by 22% and nut yield by about 12–15%.

Apple: On the basis of blooming period the main cultivars and pollinizers in apple have been categorized as:

Very early bloomer: Mayan, Schlomit, Micheal; **Early bloomer:** Chaubattia Princess, Chaubattia Anupam, Summer Red, Prima, Vermouth Spur, Vance Delicious, Mollie's Delicious; **Mid-to late-bloomer:** Gala Mast, Oregon Spur, Starkrimson, Cooper 4, Skyline Supreme, Top Red, Spur Type Red Delicious, Royal Delicious, D. K. Delicious, Well Spur, Red Chief, Hardy Spur, Star Summer Gold, Gala Mast, Red Spur, Rich-a Red and Red Delicious. The **Pollinizer cultivars were categorized as: Very early to early:** Manchurian crab, Crab apple (*M. baccata* USA), Tydeman's Early Worcester, Red Gold and **Mid-to late.** Snow Drift, Golden Hornet, Stark Spur, Golden Delicious and Golden Spur.

The low-chilling cultivars, Schlomit, Micheal and Mayan, were very early to bloom and the

Top-working with pollinizer varieties for increased pollen availability

blooming of *Malus baccata* (USA) synchronized with these cultivars as a good pollinizer, followed by flowering in Manchurian crab. The *Malus machurica* is very profuse bloomer and has a very good characteristic of extended blooming duration which synchronizes with most of main cultivars. The fruit setting was higher (37–43%) under controlled cross-pollination, followed by open-pollination (32–52%) after placement of bee hives @ 7/ha in comparison to fruit setting of the previous years (9–25%) without bee hives placement.

During blooming period, rainy days accompanied by hail-storm and low temperatures (>13 °C) as well as high wind velocity affected the foraging of pollinators. The *Apis mellifera* was badly affected and bee causality was maximum under inclement weather. The *Apis cerana indica* was found to be better adapted under these climatic conditions. Top grafting of pollinizers on main apple cultivars during mid-February by cleft or side bark and tongue budding during 30 June – 15 July gave higher success. Successive growth of scion wood of Golden Delicious, Tydeman's Early Worcester, Red Gold, Stark Spur and Golden Spur resulted in better shoot growth, however bloom intensity was better in crab apples like Manchurian, Golden Hornet and Snow Drift.

Arid Fruits: The individual cultivars could be identified using a specific flavonoid spot or combination of spots. The data were further analysed using NTSYS software to assess the relationship among cultivars. It was observed that popular Gola, Kaksol Gola and Ladu were more closely related than other cultivars.

At CHES, Godhra, 3 chironji germplasm lines (CHES-C 1, CHES-C 2 and CHES-C 7) were found to be promising. Two promising lines of jamun, viz. GJ 2 and GJ 8 were found promising and proposed for release.

Coconut: Of the 20 accessions evaluated, higher nut yield was recorded in IND 071S, IND 027S, IND 148, while higher copra yield was obtained in IND 027S, IND 026S, IND 071S, IND 148, IND 002S, respectively. Of the 71 coconut accessions, including 58 tall accessions and 13 dwarf accessions, copra content ranged from 70.4 to 349 g. The accessions, IND 085S, IND 023S and IND 034S, were found promising for copra content; with 300 g copra/ nut. Among dwarfs, coconut germplasm accession, IND 092S, recorded copra content of 219.80 g.

Based on the storability and firmness of copra, IND 030S, WCT, Kalpa Mitra and IND 082, respectively, were found better suited for ball copra production. The hybrid IND 058S × IND 069S, was found superior for nut, copra yield and tender nut traits.

Analysis of dwarfs using 14 microsatellite markers showed that, MYD and COD were monomorphic, whereas heterozygosity ranged from 0.3 to 0.4 in talls. The UV treatment was found to induce more growth in coconut embryos under tissue culture conditions.

The nucleotide and protein sequences pertaining to genes induced during somatic embryogenesis, viz. *SERK* (somatic embryogenesis receptor kinase) and *BBM* (*BABY BOOM*) were retrieved from the NCBI. Nucleotide sequences coding conserved domain amino acid was selected for oligomer designing. These degenerate primers were used to amplify, clone and sequence *SERK* and *BBM* genes in coconut.

For molecular tagging of coconut root (wilt) disease, 18 degenerate primer pairs were used to amplify Resistance Gene Analogues (RGAs) from coconut. Initially, the annealing temperature for each primer pair was standardized using gradient PCR. After PCR, electrophoresis was carried out and amplicons of expected sizes were eluted, cloned and sequenced. Two of the clones showed homology to RGAs from other plant species.

Kalpatharu: Considering higher coconut yield (15,750 nuts/ha), better copra outturn of 2.7 tonnes/ ha @ 15.48 kg/palm/year with oil content of 67.2%, drought tolerance attributes and adaptability to water deficit regions, accession IND 125 S is recommended for cultivation in Karnataka, Tamil Nadu and Kerala.

Kalpa Samrudhi: Considering the superiority of coconut hybrid IND 376 (a hybrid between IND 058 S × IND 069 S) for higher nut yield, (117 nuts/palm), high copra out turn (25.72 kg/ palm/year), oil yield of 3.04 tonnes/ha under rainfed conditions, semi-tall habit, good tender nut water quality (TSS 6% Brix), and yield (346 ml/ tender nut) and drought tolerance nature, this hybrid is recommended for cultivation in Asom and Kerala.

Arecanut: Performance of arecanut germplasm accessions collected from NE region was found

to be better than others and, accessions, VTL-29 II, VTL-12, VTL 18 III, Nalbari and K & J hills, recorded higher yield ranging from 2.81 to 3.58 kg chali/palm/ year.

Forty-nine tissue culture derived plantlets from YLD resistant arecanut palms were field planted for evaluation against YLD. Clonal fidelity test using RAPD indicated that 98% of progenies are similar to mother palms.

The DNA of arecanut sample from YLD resistant and susceptible palms was screened with ISSR primers (UBC 820-840) and 40 RAPD primers (OPAF and OPAB). Reproducible primers are selected (UBC828, UBC835, UBC822, OPAF11, OPAF13, OPAF18, OPAB3 AND OPAB7) for further testing of resistant and susceptible palms. The CNZ 01, CNZ 03, CNZ05, CNZ 18, CnCirB3 and CnCirC09 primers showed amplification of arecanut DNA. Resistant genes were collected from NCBI database and analyzed for conserved regions based on multiple sequence alignment. The primers were synthesized for NBC-LRR regions. The primers were used to amplify the resistant genes from YLD resistant areca palm. Amplicons at expected size were eluted from the gels and cloned, and are being sequenced. Resistant genes from different categories from various crops were analyzed for consensus region and motifs.

Under bioinformatics, databases on plant growth promoting rhizobacteria (PGPR) and sequences of all the available phytoplasma have been developed. Protein kinase gene family in palms was analyzed for disease resistance, OBP sequences were analyzed for red palm weevil of coconut.

Oil palm: Under characterization of interspecific hybrids of *Elaeis oleifera* or the American oil palm produces more liquid oil due to higher unsaturated fatty acid content compared to commercial species (*Elaeis guineensis*). However, due to erratic and poor yield, *E. oleifera* is not cultivated commercially. Interspecific hybrids have potential of combining yield and quality in oil. Interspecific crosses were made involving *E. guineensis* and *E. oleifera* palms. Bunch component analysis of hybrids showed intermediate values for bunch weight as well as bunch related parameters including proportion of parthenocarpic fruits. However, oil/mesocarp oil/bunch were lower than those of the parents. Fatty acid composition showed intermediate value between the two parental species for all fatty acids. Wide variability in fatty acid composition was found in progenies of two specific interspecific crosses. Since performance of each palm is different, individual interspecific hybrid palms were assessed based on total unsaturated fatty acids and oleic acid content and 20 superior palms were selected, which could be employed for further back crossing to combine quality of palm oil and yield.

After several extensive experiments with spear leaves collected from mature palms, callus induction, somatic embryo induction and maturation including plantlet regeneration have been obtained from spear leaves. Standardization of media for callus induction and somatic embryo induction was also possible from immature inflorescence collected from mature palms. Refinement and confirmation of the above protocols are under progress.

Cashew: Three hybrids, H-66, H-68 and H-43, yielded 4.0, 5.2, and 5.6 kg/tree in fifth harvesting with a cumulative yield of 23.8, 24.0, and 25.1 kg/tree, respectively. Hybrids, H-125 and H-126, yielded 7.0 and 6.0 kg/tree in fifth harvesting with a cumulative yield of 26.4 and 23.7 kg/tree, respectively. At Jhargram, maximum nuts were recorded with Kanaka (14.75), followed by Vengurla 6 (13.75) and Dhana (11.75).

Onion: Bhima Red variety has been developed through bulb to row selection method from a base population of B-780. After transplanting it takes 120-140 days for harvesting. The bulbs possess attractive red colour, round shape with higher marketable bulbs. This variety yields around 30 tonnes/ha in *rabi* season. This variety is also suitable for late *kharif* season with a yield potential of 50 tonnes/ha.

Garlic: Bhima Omkar line has been identified for high yield and better quality. It has been developed through clonal selection. Its bulbs are medium in size, compact and white in colour. Average marketable yield is 7.7 tonnes/ha with an average of 18-31 cloves per bulb.

Mushroom: Among the 19 strains of *Pleurotus florida* evaluated for yield, strain Pl-900 gave earliest fruiting and highest biological efficiency (108.3%).

Potato: Two hybrids, Kufri Nilima and Kufri Frysona, were recommended for release as varieties.

Kufri Nilima is a medium-maturing hybrid, resistant to late blight and cyst nematodes. It is suitable for cultivation in Nilgiris hills of Tamil Nadu.

Kufri Frysona produces oblong tubers of attractive shape with shallow eyes and white flesh colour. Its tubers are free from most of the external and internal defects. The average total tuber yield is 39.8 tonnes/ha with an average French fry grade tuber yield of 25.8 tonnes/ha. The tubers contain on an average 22% dry-matter content and have very low reducing sugar content (< 100 mg/100 g fresh tuber weight) and negligible enzymatic browning. The variety is suitable for planting in the main season in Indo-Gangetic plains and matures 100–110 days after planting.

Coconut: Two varieties, Kalpatharu and Kalpa

Samrudhi, have been developed.

Kalpatharu gives higher coconut yield (15,750 nuts/ha), better copra outturn of (2.7 tonnes/ha) with oil content of 67.2%, drought tolerance and adaptability to water deficit regions. It is recommended for cultivation in Karnataka, Tamil Nadu and Kerala.

Kalpa Samrudhi hybrid, IND 376, gives higher nut yield (117 nuts/palm), high copra outturn (25.72 kg/palm/year), oil yield of 3.04 tonnes/ha under rainfed conditions. It is semi-tall and provides good tender nut water quality (TSS: 6% Brix), and yield (346 ml/ tender nut), and drought tolerant. It is recommended for cultivation in Asom and Kerala.

Black pepper: Two advanced lines, INGR 8099- *Piper thomsonii* (IC-398863) - for sex change from male to bisexual plant and INGR 8100- *Piper nigrum* (IC-563950) – a novel spike variant with proliferating spikes were registered with NBPGR for their unique characters.

Cardamom: Evaluation of hybrids under PET 1 and PET 2 led to the identification of five hybrids, namely CCS-1 × RR-1, RR-1 × CCS-1, MB-5 × GGASH, NKE 19 × GG, GG × NKE 19.

Cassia: The elite line A1 (IC No. 370400) with high cinnamaldehyde content in bark oil (81.5%) and leaf oil (80.5%) has been registered with NBPGR, New Delhi.

Ginger: A high-yielding ginger variety, Subhada, has been recommended for release.

Cumin: A cumin variety, RZ-345, from Jobner was recommended for release.

Fennel: UF-205 from Jobner, LFC-84 from Guntur and HM-219 from Hisar were identified for release.

Fenugreek: The entries RMt-361 from Jobner, LFC-84 from Guntur and HM-219 from Hisar were identified for release.

Coriander: Three varieties, RCr-728, LCC-170 and DH 206, were identified for release.

Cassava: Three cassava hybrid lines, CMR-3, CMR-63 and CMR-70, with extractable starch content of 24.6-25.8% were identified as promising under irrigated plains of Tamil Nadu.

Mandookaparni: A distinct elite plant type of medicinal plant mandookaparni (*Centella asiatica*), collected from Faizabad, Uttar Pradesh, was characterised at DMAPR. The new plant type having accession No. IC 561247 was bigger in leaf size and superior to local plant type in yield and quality. Fresh herbage yield was about three times more the elite plant type compared to local plant type. Asiaticoside was 1.62% in registered material while local type had 1.47% active principle. Characterisation based on molecular markers also revealed the distinctness of IC 561247. It is registered as INGR No. 08105 as an elite germplasm with superior yield and quality.

Orchid: Two clones of cymbidium hybrids, namely H × B/2008 clone-01 and H × B/2008 clone-02, were identified as promising.

Gladiolus: Under multilocational testing of AICRP, Pune, Hybrid GKGL-94-77 is superior in spike qualities.

Gerbera: At Hessaraghatta, gerbera line, IIHR 99-1, has been identified for release as Arka Krishika.

BIOTECHNOLOGY

Novel genes and promoters: For the development of effective and efficient transgenic crop mutant populations of *Arabidopsis* tagged with promoterless GUS gene were generated. A mutant line of *Arabidopsis* exhibiting wound inducible expression of GUS exclusively in stems has been identified from a T-DNA tagged mutant population. The GUS expression is stem-specific and observed only after wounding.

Biparental inheritance: Using progenies of crosses involving different CMS lines and fertility restorer/euplasmic lines, it is established that mt-DNA is biparentally inherited in *B juncea*. Pollen mediated mt-DNA transmission was found in all the progenies. Further, paternal mt-DNA was transcribed and maintained throughout the life-span of progeny plants. The first instance of mitochondrial recombination under natural conditions from biparental inheritance of mt-DNA, has been documented and could be useful for detailed studies on mitochondrial inheritance in angiosperms and for mitochondrial genome manipulation through sexual hybridization.

Targeted integration of *Bacillus thuringiensis cry1Fa1* gene at *Flavonoid-3-glucosyltransferase* (*F3G*) (anthocyanin biosynthesis pathway) locus in brinjal was achieved. Gene targeting resulted in high level expression of *cry1Fa1* in leaf, stem epidermis and fruit epidermis, susceptible to 'Brinjal Fruit and Shoot Borer' (BFSB). In addition, gene targeted transgenic brinjal did not show any phenotypic effect or loss of function of the target gene (*F3G*).

Tomato Genome Sequencing: Of the total 31 BACs in the BAC minimum tiling path of long arm of chromosome 5 of tomato with total size of 3.435 Mb, 16 of BACs have been sequenced. Additional 9 BACs of total size 1.046 Mb have been sequenced that have now gone to other chromosomes, giving total of 4.481 Mb of BACs identified for sequencing. The sequence data of 29 BACs (3.212 Mb) in the MTP of chromosome 5 has been processed to high quality of international standards. Further annotation of 2,342 predicted genes from 170 tomato BACs for ITAG has been made functional. The genome wide annotation of

R-genes for tomato genome snapshot paper has also been done. All the Phase III BACs from SGN have been downloaded and done gene prediction, total 11,019 genes predicted in 645 BACs. Submission of 8 BACs in Phase III and 16 BACs in Phase II to NCBI and SGN portals, including 5 BACs for other tomato chromosomes has been done. Additional 11 BACs for chromosome 5 are in phase I that will be upgraded to Phase II and submitted soon.

SpicEST: A database of ESTs of two major spices, turmeric and ginger, was developed and hosted (www.spices.res.in/spicest). SpicEST contains all ESTs of these plants, their annotation, and information on SSRs and SNPs.

Cassava: In cassava, drought responsive genes, Dehydrin, LEA and WRKY genes PCR product, were amplified (400–600 bp) using CE-165 parent. The disease resistant gene, NBS region of Resistance Gene Analog (RGA), was amplified (600 bp) using MNga-1 parent and all genes were cloned to plasmid vector for sequencing.

Guggal: Sixty different random decamer primers were screened with the three bulks to identify markers associated with sex expression of which only three primers were found to be associated with sex expression.

Potato: The institute has successfully validated a Sequence Characterized Amplified Region (SCAR) marker RYSC3 for the detection of Ry_{adg} and used it to identify a parental line (YY-6/3 C11) carrying the gene in triplex state. The triplex status of line was confirmed by studying segregation ratio of marker in its test cross progeny and PVY resistance of this line was also confirmed by challenge inoculation, followed by ELISA and Immuno Electron Microscopy to check virus multiplication. This is the first instance where MAS has been used as a tool in pre-breeding of potato.

SEED

Breeder Seed Production: Breeder seed of cereals (3,707 tonnes), pulses (1,336 tonnes), oilseeds (2,185 tonnes), fibre crops (11.5 tonnes)and forage crops (154.3 tonnes) was produced.

Quality seed production: The total quality seed production of field was 63,416.3 tonnes.

Participatory seed production: A total of 31,898.3 tonnes of quality seed was produced under participatory seed production programme at farmers' fields at various centres.

Seed production technology

To avert the problem of Zn deficiency in many parts of the country in seed production, application of $ZnSO_4$ either @ 50 kg/ha as basal dressing or 25 kg/ha as basal along with foliar spraying @ 2g/litre twice at one week interval enhanced seed yield and seed quality.

Spraying of ethrel @ 0.1% 45 and 60 days after sowing was found to effectively suppress interspersed staminate flowers in NES pistillate and also maintains genetic purity considerably in castor.

Seed Storage

Polylined gunny bags/ polylined cloth bags were emerged as most useful packaging material over conventional gunny bags for storing seeds of field crops for one planting season at 10% moisture content. It was found to maintain seed quality above IMSCS. Being cheaper, such bags are to be popularized among farmers in the country for storing seed material of field crops.

Cotton seed (fuzzy seed, wet acid delinted seed and dry gas delinted) can be safely stored for 12 months in polylined jute bags.

Seed processing

In grading safflower seeds, presently recommended sieve of 1.2 mm has been found to be ineffective since inert matter even cannot pass through it. For grading safflower seeds, 2.2 mm sieve was found to be economical and highly effective.

For grading hybrid rice seeds, 1.85 mm × 20 mm sieve was found to be effective for higher seed recovery, more physical purity and higher seed vigour index.

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Livestock Improvement

ANIMAL IMPROVEMENT

Cattle

Frieswal Project: Frieswal female population at 38 Military Farms was 17,169 including 10,714 adult cows, 5,120 young stocks and 1,335 calves. The strength of elite cows at various Military Farms was 1,093. Semen doses (253,011) were produced and 53,190 were distributed during the year. The average age at first calving of Frieswal cows was 979.56 days. The effects of farm and season and year of birth were significant on age at first calving. The least squares means of service period, dry period and calving interval were 172.83, 125.14 and 449.81 days, respectively, and were significantly affected by farm, parity and season and year of calving. The overall least squares means of 300 days milk yield, total milk yield, peak yield and lactation length were 3,292.67 kg, 3,326.90 kg, 15.06 kg and 331.80 days, respectively.

Estimates of heritability for age at first calving (0.07), total milk yield (0.047), 300 days milk yield (0.050), peak yield (0.050), semen production (0.015), dry period (0.006) and calving interval (0.014) were low.

Indigenous Breeds Project

Hariana unit: The female herd strength was 1,390. The breeding population contained 844 females and 10 breeding bulls. The overall conception rate was 56.54% and 162 daughters were born during the year. The per cent cows in milk, wet average and herd average were 42.52, 4.52 kg and 1.98 kg, respectively. Average age at first calving, first lactation milk yield and peak yield, 300 days or less milk yield and lactation length were 1,369 days, 1,066 kg, 6.44 kg, 1,066 kg and 246 days, respectively. First dry period, service period and calving interval averaged 180, 138 and 428 days, respectively. The breeding value of Hariana sires for milk yield and draughtability confirmed that these 2 traits (milk and draught) are of different nature.

***Ongole unit*:** The female herd strength was 1,250. The breeding population contained 718 females and 8 breeding bulls. The overall conception rate was 45% and 197 daughters were born. The per cent cows in milk, wet average and herd average were 30.16, 2.76 kg and 0.77 kg, respectively. Age at first calving averaged 54.36 months. Average lactation milk yield, 300 days or less milk yield, peak yield and lactation length were 441 kg, 437 kg, 2.70 kg and 155 days, respectively. The first service period, dry period and calving interval averaged 333, 385 and 598 days, respectively.

Buffalo

Field progeny testing of Frieswal bulls: The work is being undertaken at the GADVASU, Ludhiana; KAU, Mannuthy and BAIF, Urulikanchan, and overall conception rate at 3 units was 41.2, 40.5 and 50.2%, respectively. The average first lactation 305 days lactation milk yield of daughters in first five sets showed increasing trend in milk yield at GADVASU, Ludhiana (2,698 to 3,006 kg); KAU, Mannuthy (1,958 to 2,458 kg) and first four sets at BAIF, Urulikanchan (2,848 to 2,978 kg). Similarly the average age at first calving showed a decreasing trend among the progenies of different sets at GADVASU, Ludhiana (1,192 to 921 days) and BAIF, Urulikanchan (1,008 to 992 days) and KAU, Mannuthy (1,136 to 1,036 to 1,077 days).

Field progeny testing: During the year, 23,618 AIs were undertaken on farmers' animals of which 9,692 were of Murrah breed at the 4 centres, and 13,926 Jaffarabadi, Surti and Pandharpuri. Total

Network Project on Buffalo Improvement

Under seventh set, 12 bulls were progeny tested and bull No. 4915 from NDRI, Karnal, top ranked with sire index of 2,116 kg. The superiority of this bull was 17.26% over contemporary daughter's average of 1,777 kg. Bull No.1796 from GADVASU, Ludhiana ranked second with sire index of 2,092 kg with superiority of 15.81% over contemporary daughter's average of 1,790 kg.

11,005 pregnancies were obtained and 5,658 calves born during the period.

Sheep

Under the programme of genetic resource improvement, the production and reproduction traits of Malpura, Chokla, Magra and Marwari breeds are being improved. One of the tools for enhancing mutton production from native sheep is introduction of prolific gene from Garole sheep. The introduction of *FecB* gene from Garole into Malpura and backcrossing of GM with Malpura increased body weights of Garole × Malpura, Malpura, GMM lambs over GM halfbreds at birth, 3, 6 and 12, months by 37.8, 34.9, 23.0 and 20.9% respectively. Moreover GMM ewes produced 40.00% twins in the flock.

GMM ewe

Network Project on Sheep Improvement

Chokla: The improvement programme through selective breeding is in progress to improve Chokla sheep for carpet wool production. The greasy fleece yield in first 6 monthly clips, adult 6 monthly and adult annual were 0.957, 1.101 and 2.303 kg respectively. Tupping was 96.8%. Lambing on ewes available basis was 86.51%. Overall, survivability irrespective of age and sex was 93.84%. The selection differential for 6-month body weight and GFYI were 4.09 kg and 381 g, respectively, for rams.

Fat percentage in buffalo milk

The average fat percentage in Murrah buffalo milk samples from all centres was estimated as 7.88% based on 4,219 records. The average percentage of fat in different breeds varied between 6.90% in Nili-Ravi and 8.61% in Jaffarabadi breed.

Breeds	Average fat % in milk
Murrah	7.88 (4,197)
Nili Ravi	6.9 (108)
Bhadawari	8.09 (604)
Jaffarabadi	8.61 (260)
Pandharpuri	8.04 (180)
Surti	7.33 (446)
Swamp	7.73 (193)

Marwari Unit: The Marwari sheep is being improved for carpet wool production. The overall tupping and lambing on ewes available basis were 96.17 and 85.04% respectively. Average annual greasy fleece yield during the year was 1,326 g.

Muzaffarnagri: The Muzaffarnagri sheep is being improved through selection for mutton production. The male lambs were selected using selection index incorporating body weight at 6 months and first 6 monthly greasy fleece weights. The least square means for birth, 3, 6, 9 and 12 month body weights were 3.71, 15.21, 21.21, 22.61 and 26.56 kg respectively. Tupping was 93.7%. Lambing per cent based on ewes available and tupped was 89.3 and 95.6 respectively.

Deccani: Average body weights of Deccani sheep at birth, weaning, 6, 9 and 12 months of age were 3.41, 16.40, 21.41, 22.93 and 23.98 kg, respectively. The tupping percentage was 94 while the lambing based on ewes available was 88%. Average age of ewes at first lambing was 640 days.

Nellore: The Nellore sheep is being improved for mutton production using selection index incorporating body weight at 3 and 6 months of age. The overall means for body weight at birth, 3, 6, 9 and 12 months of age were 3.15, 13.97, 18.12, 21.33 and 22.81 kg respectively. Lambing percent based on ewes available basis was 81.1. Replacement rate in ewes was 28.06%.

Magra: Magra sheep is being improved through selection for carpet wool production at Norangdesar, Gadhwala, Kilchu and Kodemdesar centres. Average greasy fleece weights at 6-months of age and adult annual were 1,037 and 2,215 g, respectively. Superior Magra rams/ram lambs were distributed to registered sheep breeders at 3 different centres.

Madras Red: Madras Red sheep is being improved for mutton production. In Chengalpettu district 4 centres each having a population of about 1,500 sheep, were identified for improvement. Superior ram lambs were distributed in all centres

Madras Red

and performance of their progenies was recorded. The body weights at birth and 3 months were 2.86 and 11.35 kg, respectively. Overall 84.42% lambing was observed during the year. Superior Madras Red rams/ram lambs were distributed to registered sheep breeders at 4 different centres.

Ganjam: Eight villages were identified under 3 centres in Ganjam district to improve Ganjam sheep. Overall mean of body weights for birth, weaning, 6 and 12 months were 2.68, 11.72, 16.75 and 24.49 kg, respectively.

Goat

Jamunapari: Male kids were born with higher birth weight and maintained this superiority up to 12 months of age. Average milk yield in 90 days, 140 days, and lactation length were 75.92±9.83, 120.87±4.43 litre and154.21±3.18 days, respectively. The average age at first kidding, weight at first kidding and kidding interval were 701.0±18.4 days, 34.46±0.28 kg and 288.0±8.18 days, respectively. The breeding efficiency and kidding per cent on the basis of does tupped were 89.21 and 106.84. The kidding rate was 1.55. Goats were supplied to farmers, SAUs, NGOs and other research institutions for improvement and conservation under field conditions.

Barbari: Overall mean for 90 days milk yield, 140 days milk yield, lactation yield, and lactation length among the Barbari does kidded during the year were 53.20±1.69, 93.76±7.99, 51.35±1.89 liters and 96.99±1.43 days respectively. The selection differential for the male kids selected was 7.1 kg for 9 months of body weight, and 6.2 liters for 90 days milk yield. Tupping percentage was 129% and kidding rate 1.48.

Sirohi: Performance of Sirohi goats with regard to body weight at birth, 3, 6, 9 and 12 months of age was 2.96±0.04, 11.14±0.16, 16.77±0.30, 21.55±0.30 and 24.52±0.36 kg, respectively. The milk yield in the does averaged 83.01±2.07 kg for 90 days, 101.99±2.62 kg for 150 days, and 100.70±2.35 kg for total lactation. Lactation length was 162.58±2.36 days. The kidding per cent on the basis of does available and does tupped were 85.19 and 86.17 respectively. The selection differentials of selected male kids from population for 9 months body weight and their dam's first lactation at 150 days milk yield was 0.96 and 20.56 respectively.

At Sirohi Field Unit located at Livestock Research Station, Vallabhnagar, MPUAT, Udaipur (Rajasthan), population growth of 95.31% was recorded. The least square means for body weight at birth, 3, 6, 9 and 12 months of age were 2.34±0.03, 12.72±0.16, 16.19±0.17, 19.42±0.26 and 22.95±0.32 kg, respectively. The overall least square means for milk yield over 90 days, 150 days, lactational yield and lactational length were 57.40±2.18, 87.08±2.91, 89.13±2.96 litre, and 155.49±0.70 days, respectively. The kidding rate (litter size) was 1.29.

Sangamneri: The least square means for morning, evening and total milk yield of Sangamneri goats were 457.17±2.98, 421.61±2.74 and 878.82±5.68 ml, respectively. In the progeny born from elite bucks age at puberty, age at first conception and age at first kidding were 232.55±1.12, 275.33±1.69 and 420.20±2.08 days, respectively.

Malabari: The overall least square mean body weights of Malbari goats recorded were 8.28±0.18 and 15.99±0.33 kg, respectively, at 3 and 6 months of age. Peak yield of milk in Malabari goats was 1,237.62± 75.44 ml. The percentage of singles, twins, triplets and quadruplets were 24.00, 61.47, 13.19 and 1.05 respectively.

Black Bengal: The body weights of Black Bengal goats at birth, 3, 6 and 9 months of age were 1.178 ±0.019, 5.323 ±0.117, 7.788±0.298 and 10.077±0.318 kg, respectively. The average weekly milk yields for first, second and fifth week were 1.179±0.006, 1.439±0.007 and 0.819±0.006 kg respectively. This breed is highly prolific and having 82.95% multiple births. The age and weight at first kidding were 234.70±0.52 days and 11.16±0.09 kg.

Ganjam: The average body weights of male Ganjam goats at birth, 3, 6, 9 and 12 months of age were 2.30±0.01, 6.83±0.01, 9.47±0.01, 13.78±0.02 and 17.62±0.02 kg, respectively. The average daily milk yield was 441.57±3.21 ml with total milk production of 76.10±1.23 liters in 172.34±1.67 days of lactation. The kidding percentage on the basis of does tupped was 66.99. In Ganjam district of Orissa this is a primary source of income of tribals (Gola). The goat rearing contributed 70.00% to their annual income.

Marwari: Overall means for body weight at birth, 3, 6 and 12 months of age were 2.89±0.13, 14.43±2.58, 17.93±0.54 and 20.86± 0.69 kg respectively. The cumulative milk yield was

52.118±16.18 kg for 30 days, 98.22±24.18 kg for 90 days and 137.85± 32.51 kg for 90 days of lactation. The kidding interval ranged from 278.25±16.249 to 305.41±9.922 days (288.456±11.157 days). The overall kidding per cent was 74.92%.

Camel

At the NRC on Camel the average birth rate on herd basis was 14.98% with nonsignificant effect of breed. The average death rate was 6.45% with significantly higher mortality in Arab cross animals as compared to the Bikaneri, Jaisalmeri and Kachchhi camels. The average herd growth was 8.53% with nonsignificant variation among the breeds and with maximum of 37.84%. The cumulative growth analysis indicated about 200% herd growth in about 22 years in the Indian dromedary breeds.

Milk production in dromedary breeds: The average daily milk production from two teats was 3,672.10±51.46 ml with no significant effect of breed. The highest milk production was 5,878.41±249.03 ml in a third parity camel. The average daily milk production of the individuals varied significantly with the month of lactation. Peak yield (4,783.54 ml) was observed in the third month of lactation. The highest milk production was observed in third lactation (5,988.99±30.53 ml) followed by fourth (3,900.69±56.33 ml), first (3,275.54±22.33 ml) and second (3,100.43±18.19 ml).

Rabbit

German Angora rabbits raised for fine wool production under temperate climate of Kullu valley, produced 190.15, 198.86, 161.67, 181.48 and 192.68 g wool, respectively, in first, second, third, fourth, and fifth clips. Attempts are being made to achieve a target of 1,200 g wool annually in Angora rabbits.

White Giant and Soviet Chinchilla breeds of broiler rabbit attained body weight of 1.91 kg and 1.84 kg at 12 weeks of age, and attempts are being made to increase the 12 week weight to 2.00 kg. Broiler rabbits have great demand for mutton in southern parts of the country, and the regional centre at Kodaikanal is meeting the requirement by supplying elite germplam to rabbit entrepreneurs.

Poultry

Poultry for egg: Under the AICRP on Poultry Breeding, six pure lines (IWH, IWI, IWD, IWF, IWN and IWP) of White Leghorn were improved through intra population selection. At the KAU, Mannuthy centre, the S-24 generation of IWN and IWP populations was evaluated up to 40 weeks of age. The hen house egg production up to 40 weeks of age increased substantially over previous generation in IWN (by 16.5 eggs) and IWP (by 18.9 eggs). The average genetic response for egg production up to 64 weeks of age in IWN (8.80 eggs) was higher than IWP (4.80 eggs) in the last 5 generations.

At the AAU, Anand, the S-8 generation of IWN and IWP strains showed that average genetic response of egg production up to 64 weeks of age (0.50 in IWN and 1.93 in IWP) was positive and significant over last seven generations. The egg production up to 64 weeks of age in IWP increased (by 7.3 eggs) over the previous generation.

At SVVU, Hyderabad, the pullets of S-27 generation of IWD and S-26 generation of IWF showed average genetic response for egg production up to 64 weeks of age for last 8 generations as 1.32 egg in IWD and 0.92 eggs in IWF. At CARI, Izatnagar, average genetic response of egg production up to 64 weeks of age was higher in IWI (1.91 eggs/generation) than IWH (0.03 eggs/generation) in the last five generations. The egg production up to 64 weeks of age increased in S-29 generation over the last generation in both IWH (by 14 eggs) and IWI (by 7 eggs).

At PDP, Hyderabad, 3 pure lines of White

SUCCESS STORY

Birds laid 305 eggs up to 72 weeks of age

Pure lines, viz. IWD, IWF, IWH, IWI, IWN and IWP of White Leghorn maintained at 4 different centres of the All India Co-ordinated Research Project on Poultry Breeding were under long-term selection. Crosses involving IWD × IWF (Hyderabad), IWN × IWP (Anand), IWN × IWP (Mannuthy) and IWH × IWI (Izatnagar) were evaluated at the PD on Poultry. The layers of IWN × IWP cross of Anand centre recorded average annual egg production (up to 72 weeks of age) of 304.9 eggs with the highest individual production of 352 eggs. About 61% birds of this cross produced more than 300 eggs and about 6% produced more than 340 eggs at 72 weeks.

Layers of IWN × IWP cross of Anand centre recorded average annual production of 305 eggs

Broodstock development

Broodstock of filament barb, *Puntius filamentosus* (freshwater fish); cobia, *Rachycentron canadum*; pompano, *Trachynotus* sp; grouper, *Epinephelus tauvina*; and red snapper, *Lutjanus argentius* (marine fishes) were developed in captivity for breeding and seed production

Leghorn (IWH, IWI and IWK), showed genetic and phenotypic responses of egg production to 64 weeks of age as 0.59 and 0.15 eggs in IWH and 0.80 and 0.36 eggs in IWI, respectively, over last 5 generations. The phenotypic response of egg mass to 64 weeks of age was positive (385 g) in IWK. Backward elimination procedure could be used to predict annual egg production from part period egg production to 60 weeks of age in layer lines with more than 82% accuracy.

Poultry for meat: Synthetic broiler strains, viz. PB-1, PB-2, SDL, CSML and CSFL, were improved through intra-population selection for body weight at 5 weeks of age. At Bengaluru, the PB-2 line and PB-1 line were improved. Body weight at 5 weeks of age increased by 155 g and 237 g in PB-2 and PB-1 populations, respectively, over previous generation. The body weight at 6 and 7 weeks of age was 1,500 g and 1,760 g in PB-2 and 1,568 g and 1,956 g in PB-1, respectively. The average genetic response for body weight at 5 weeks of age was 38.7 g/generation and the corresponding phenotypic response was 23.1 g. At GADVASU, Ludhiana centre S-33 generation of PB-2 and S-2 generation of PB-1 population at 5 weeks of age showed an improvement of 159 g in PB-1 over previous generation. The body weights of males were 1,492 and 1,980 g at 6 weeks and 1,856 and 2,005 g at 7 weeks of age in PB-2 and PB-1 population, respectively.

At the CARI, Izatnagar centre male (CSML) and female lines (CSFL) showed the phenotypic response of 5-week-body weight per generation as 19.0 and 21.9 g, and genetic response as 16.6 and 19.6 g, respectively. At PDP, Hyderabad, in S-19 generation of PB-1, body weight at 5 weeks of age was 906.8 g, which was improved by 22 g over the last generation on genetic scale. In S-18 generation of PB-2 line, the body weight at 5

Rural poultry

Four new centres for rural poultry production were added during the last part of the current year for developing location specific germplasm for rural poultry. The Agartala centre maintained and evaluated Tripura local black, CSML, CSFL and D08 variety (developed by PDP, Hyderabad) and produced 3 different types of crosses. The mean body weights of Tripura local black at 16 and 40 weeks of age were 822 and 1,444 g, respectively, and the egg production up to 40 weeks of age was 36.17 eggs. The body weight of D08 test cross at 12 weeks of age under backyard was 859 g.

At the Jabalpur centre G_0 generation of Kadaknath and Jabalpur colour line and G_3 generation of colour dwarf dam line were produced and evaluated up to 40 weeks of age. The body weights of Kadaknath × Jabalpur colour line, Jabalpur colour line × colour dwarf line and CSML × Jabalpur colour line at 6 and 8 weeks of age were 274, 355 and 370 g, and 431, 600 and 590 g, respectively, under free-range condition.

At PDP, Hyderabad, C1 (Control broiler × PD-3 Line), C2 (Pb2 line × PD-3 Line), C3 (PD-4 line × PD-3 Line), and C4 (PD-5 line × PD-3 Line) were evaluated for rural and backyard poultry production along with Vanaraja and Gramapriya. The body weight and shank length of C2 at 6 weeks of age was the highest (713 g and 78.04 mm, respectively) among all the crosses. The body weights of C1, C2, C3, C4, Vanaraja and Gramapriya at 12 and 15 weeks of age varied between 838 and 1,926 g and 1,317 and 2,908 g, respectively. The body weight was the highest in C2 followed by Vanaraja, C1, Gramapriya, C3

Adult male of C1 cross

Kadaknath chicken

Adult male of C2 cross

weeks of age was 1,046.6 g and was improved by 42 g over the last generation. In G-8 generation of the control broiler, body weight at 5 weeks of age was 929.5 g.

Gramapriya backyard poultry strain: Under the collaborative project with SKUAST-K for improvement of backyard poultry in Kashmir valley, 1,429 birds of 5 weeks of age were distributed to farmers in the selected villages under backyard system. The body weights of male Gramapriya at 12 and 20 weeks of age were 1,119 and 1,394 g, respectively, while those of female birds were 784 and 1,018 g, respectively. The birds matured at 165 days of age. The Gramapriya was widely accepted by the farmers of Kashmir valley.

Fishieries

Mud crab farming: A technology package for nursery rearing and grow-out culture of hatchery-produced megalopa larva of *Scylla tranquebarica* was standardized. Rearing in soil-based open ponds with natural hideouts ensured better growth and survival. Besides artificial hideouts were more practical and viable choice in comparison to natural sea weed, without compromising on survival and growth. The grow-out culture trials of *S. tranquebarica* carried out in West Bengal yielded an average production of 1.12 tonnes/ha, and in Tamil Nadu, a production of 1.3 to 2.8 tonnes/ha in a culture period of 4 months.

SUCCESS STORY

Diagnosis of nodavirus and extra small virus

A quantitative real-time assay for the diagnosis of nodavirus (*MrNV*) and extra small virus (*XSV*) of *Macrobrachium rosenbergii* was developed and standardized by the CIFE, Mumbai. The test can be used for routine diagnosis of diseases as well as to screen the broodstock and larvae in selective breeding programme for specific pathogen-free stock development. This assay is the first of its kind developed in the country.

Resident time of antibiotic residues: Scampi (*Macrobrachium rosenbergii*) and Indian white prawn (*Fenneropenaeus indicus*) accumulated a level of 12.5 ppb of antibiotics (sulfomethoxazole and trimethoprim) after one month of feeding, which reached to 18 ppb after 70 days. After stopping administration of antibiotics, there was constant degradation of antibiotics in the meat and no traces could be detected on 25th day. Studies showed that animals can be harvested safely (free of antibiotic residue) on 25th day after the administration of antibiotics.

Off-season spawning

Off-season spawning in the Indian major carp *Cirrihinus mrigala* was achieved during February by manipulation of photoperiod and temperature.

Derivation of rough attenuated variants: Two rough attenuated variants were derived from smooth virulent *Aeromonas hydrophila* types maintained in the Fish Health Management Division, CIFA, Bhubaneshwar, over a period of 8 years at 4ºC. The variants were checked to be rough LPS type and attenuated since they neither produced any disease nor mortality in the injected fishes. Rather, the immunogenic potential of these variants remained unaltered as compared to parent smooth types. Fish immunized with these variants separately and upon cross challenge resisted the infection and mortality due to several *Aeromonas hydrophila* types (O11, O13, O14, O34) and virulent isolates. The virulence of these bacteria was also checked by their growth characteristics on Comassie Briliant Blue (CBB) agar plates.

Improving sperm quality in captive broodstock of tiger shrimp: A management protocol to maintain male reproductive health/ reproductive viability in hatchery systems was developed, which otherwise is a major bottleneck due to the degeneration of reproductive tract and subsequent drop in reproductive performance in commercial tiger shrimp (*Penaeus monodon*) seed

Successful breeding of rare fish species Haragi Meenu

Puntius pulchellus (locally called Haragi meenu in Karnataka), a threatened species of peninsular carp endemic to the Krishna river basin, was induced bred for the first time in 2009. Fingerlings collected from the Tunga river were acclimatized to aquaculture ponds and raised to adult size. Sexual dimorphism was observed in the adults only during the breeding season. The selected females and males were administered recommended intramuscular dosages of the synthetic hormone and pituitary glands extract (PGE) successively at an interval of 6 h, after which females were stripped and the eggs collected in a dry enamel bowl. Immediately after this, the milt from males was stripped directly on the eggs. After 15–20 minutes of fertilization, the eggs were washed and transferred to a modified glass jar type hatchery. The first larva hatched after 48 hr, laden with a heavy yolk sac. After six days, the larvae were capable of active swimming and were fed with plankton. The breeding of *Puntius pulchellus* assumes significance specifically in the context of raising a carp species diversification in aquaculture. Adult male of *P. pulchellus* showing pink papillomatous snout.

production in captivity. It was concluded that sperm quality can be maintained if the spermatophore is expelled manually as without manual expulsion of spermatophore, the mean sperm quality differed significantly between 0 day and 30th day (3.2×10^6 vs 0.1×10^6/ml).

Spermatophore and sperm quality studied during different phases of moult cycles (post moult, inter moult and early pre-moult stages) revealed that the moult cycle has a strong influence on the quality of male gametes. Post-moult and inter moult stage males performed better than pre-moult and newly moulted shrimps.

On the basis of this information, maintenance of healthy/viable male broodstock in captive conditions in commercial hatcheries would be possible.

Epidemiology of iridovirus: Iridoviruses are one of the major threats for the aquaculture industry causing mortality in fishes. In India, iridovirus infections in fish have not been reported so far and the first case of mortality due to iridovirus was observed in a commercial seabass cage culture facility in Andhra Pradesh during summer 2008 when the salinity increased from 8 to 14 ppt and temperature from 28º to 32ºC. A DNA based PCR assay for the detection of both symptomatic and asymptomatic iridovirus infection produced an amplicon of 250 bp or 1.2 kbp product with two different sets of primers. Surveys conducted in Kerala, Tamil Nadu, Andhra Pradesh, West Bengal and Puducherry revealed that sub-clinical iridovirus infection in fish is widely distributed among many species of brackishwater and marine fishes along the east coast of India. This is the first report describing the existence of iridovirus in clinical and sub-clinical form among farmed and wild marine/brackishwater fishes in India.

Diagnostics for viral nervous necrosis: Viral nervous necrosis (VNN) is caused by betanodavirus. Screening for VNN conducted in Kerala, Tamil Nadu, Andhra Pradesh, West Bengal and Puducherry during the year revealed that betanodavirus is widely distributed sub-clinically along the east coast of India in target species as well as in low value fishes. About 16% of the total analysed fishes (n=168) gave positive results for the virus by (nested) RT-PCR assay. Samples found positive with any of these primers were further processed for confirmatory analysis. Electron microscopy of brain tissues from sub-clinically infected fish revealed multiple arrays of nodavirus like particles measuring around 35 nm in dimensions. Based on the sequence data, three primer sets were designed and are being used for the development of genome based diagnostics for betanodavirus in fishes.

Fish seed: Under ICAR Mega seed Project, seeds of Indian major carps (82.499 million), catfishes (0.909 million), ornamental fishes (0.688 million), shrimp (3.457 million), prawns (0.584 million), seabass (0.347 million), crabs (2.179 million) and molluses and others (6.441 million) were produced during the year 2008–09.

Year-round seed production of *Lates calcarifer:* The technology for seed production of Asian seabass was developed by which its seed can be produced round the year. Successful spawnings and hatchings were observed even at 14–17 ppt (during November – December), indicating that seabass can reach maturity even in lower salinities and this is attributed to domestication and improved broodstock management protocols. A large number of natural spwanings were obtained without hormonal inducement. Out of 0.487 million fry, 0.2 million were obtained from December 2008 and January 2009, the period which is considered as off-season.

Larval rearing technology under controlled conditions, standardized by Central Institute of Research for Brackishwater, was validated. Survival rate of 58% was achieved in the larval rearing phase. This success indicated that hatcheries meant for shrimp/scampi and mudcrabs can be converted as seabass hatcheries with required modifications.

Reducing anti-nutritional factors in aquafeed: Electron beam irradiation method was devised to reduce antinutritional factors in plant-based aquafeed ingredients. The 8/12 MeV microtron delivering energetic electron @ 10 kGy is optimum for reducing tannin, HCN and phytic acid to the maximum level of 60% in soybean, rubber seed cake and cotton seed cake, which translates into higher weight gain and higher feed efficiency in fish. The technology offers a wide opportunity to replace the costly animal protein sources with low cost plant ingredients in fish feed. ❑

8

Crop Management

PRODUCTION

Wheat: The long-term effect of five tillage options, *i.e.* conventional tillage, zero tillage, rotary tillage, strip tillage and bed planting were evaluated. The mean yield was 3.04% higher in rotary tillage, whereas 7.55 and 12.81% lower, respectively in strip tillage and bed planting, options compared to conventional field preparation. However, yield under zero and conventional tillage was similar. In six out of eight years and on mean basis, the yield recorded was highest in rotary tillage. Cost savings in zero tillage varied from Rs 2,500 to 3,000/ha and Rs 2,000 to 2,500/ha in rotary tillage.

Millets: Intercropping of 40 – 45 day old pigeonpea seedlings with finger millet (2 : 8) was found to be promising and remunerative in light red soils of southern Karnataka.Application of composted poultry manure @ 1.5 tonnes/ha in Uttarakhand and 2.0 tonnes/ha in red soils of Karnataka is a better option for organic cultivation of finger millet.Finger millet variety, Indaf-7, is a better choice for planting in *rabi* (second fortnight of October) for sustaining higher yield in southern dry zone of Karnataka (Mandya region).Sequence cropping of foxtail millet as an early *kharif* crop followed by pigeonpea or sunflower in *rabi* is a more remunerative cropping sequence for Rayalseema regions of Andhra Pradesh. Intercropping of kodo millet + soybean (4 : 1) is a better choice and remunerative practice for Bastar region of Chhattisgarh. Transplanting paired row of pigeonpea with finger millet is a boon to enhance productivity of pigeonpea (2,070 kg/ha) as well as finger millet grain yield (8,382 kg/ha) than drill sown pigeanpea (638 kg/ha and 6,250 kg FMGEY/ha) under rainfed conditions. The system provides an additional return of Rs 4,080/ha.

Groundnut: Bt cotton + groundnut intercropping at a row ratio of 1:3 was found to give high groundnut equivalent yield at Dharwad (Karnataka) and Junagadh (Gujarat) and at a row ratio of 1:1 at Jalgaon (Maharashtra).Groundnut varieties, TKG 19A, GG 7, GG 20, ICGS 76, CSMG 84-1, ICGV 86590 and M 13, were relatively tolerant to soil acidity, aluminium-toxicity, and Al-induced P-and Ca-deficiencies with a yield potential of 1,500-4,000 kg/ha and have been recommended for cultivation in NEH region.

Rapeseed-Mustard : Sesbania green manuring along with soil incorporation of mustard waste @ 2.5tonnes/ha in *kharif* season has shown beneficial effect on soil health as well as mustard yield. The beneficial effect of Sesbania + mustard straw incorporation was further enhanced when recommended dose of fertilizer (80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha) was applied to mustard crop. Mustard hybrids produced more yield at a 45 cm × 15 cm spacing. The wider spacing opens avenues to reduce the recommended seed rates of hybrid mustard by 33%, augmenting hybrid seed availability for more acreage.

Soybean: Soybean-wheat-maize-wheat rotation system was proved to be the best for productivity, profitability and energy efficiency. Ridge tillage and broad bed furrow significantly increased soil microbial biomass, soil enzyme activities and seed yield as compared to minimum tillage and flat bed planting under soybean-wheat and soybean-chickpea system.

Thirteen thermo-tolerant rhizobia surviving at 45°C have been identified.

Bacillus isolates, KHBD-6, KHBAR-1, BDSD-2-2C, KDMR-1-1, KHTH-4-1and KHBD-2-1A, were found promising for solubilization of zinc salts.

Sunflower: The highest seed yield of *kharif* sorghum was obtained with 150% RDF application, while *rabi* sunflower yield was highest with RDF application with preceding sorghum receiving RDF

+ sunflower residue incorporation. Sunflower equivalent yield was highest with 150% RDF to both crops, followed by NPK+CR-NPK to sorghum-sunflower cropping system.

Safflower: It is possible to substitute 50% N and P needs of chickpea-safflower rotation by seed treatment with PSB to chickpea and seed treatment in safflower by *Azotobacter/Azospirillum* and PSB without any adverse effect on productivity in Maharashtra.

Castor: Simultaneous sowing of castor and greengram in castor + greengram (1:1) intercropping system was found promising in north Gujarat under assured irrigation. Integrated use of organic sources and biofertilizers can help to reduce the fertilizer needs of castor. Integrated use of 75% RDF + 25% N (FYM) + *Azospirillum* (ST) + PSB was found beneficial and more remunerative for castor as compared to application of 100% RDF.

Sesame: Integration of RDF + two foliar spraying of urea (2%) at flowering + capsule formation stage resulted in maximum seed yield, net monetary returns and benefit: cost ratio. The highest sesame yield was obtained with 100% RDF + 2.5 tonnes/FYM + 20 kg $ZnSO_4$ + 25 kg $FeSO_4$/ha.

Niger: Integration of foliar spraying of urea (2%) at flowering and seed development gave higher yield and net monitory return. Pre-emergence application of Pendimethalin + sieving of seeds was found to control *Cuscuta* in niger most effectively with higher seed yield.

Linseed: JLS -9, JLT-26 and Kartika were observed to be the best for cultivation after soybean with recommended package of cultural practices even in late sowing at last week of November.

Pulses: The maize -wheat- greengram system recorded highest productivity (pigeonpea equivalent yield2, 953 kg/ha) as compared to other systems. Inorganic fertilizer application resulted in highest pigeonpea equivalent yield followed by organic treatment.

The bulk density, porosity and water-holding capacity improved considerably after the inclusion of pulses after completion of fifth cycle. The soil organic carbon content, microbial population and microbial biomass carbon also increased with incorporation of crop residues in pulse-based cropping system as compared to maize-wheat system.

Zero tillage led to highest consumptive use of water (108.5 mm) in chickpea. The highest consumptive use of water (102.4 mm) was recorded in no mulch against the lowest in cultural mulch. The chickpea genotype, KWR 108, was more efficient in water use (water-use efficiency, 19.28 kg/ha-mm) under rainfed conditions. Under irrigated conditions, RSG 888 RSG 143-1 was the most efficient in water use.

In maize-chickpea cropping sequence, application of FYM at 5 tonnes/ha to maize gave 14.2% higher grain yield of chickpea and 13.6 % chickpea equivalent yield over no FYM. Agronomic efficiency of phosphorus (kg grain / kg P_2O_5 applied) increased from 3.8 to 9.2 and 6.5 to 7.6 due to application of FYM and PSB, respectively.

Sowing pigeonpea on raised beds with 75% RDF through band placement gave higher pigeonpea yield than flat sowing and broadcasting.

Inclusion of green manure crop and pulses in rice-based cropping systems increased the productivity by 11.2% in rice-wheat- *dhaincha*, 8.2% in rice -fieldpea -greengram and 7% in rice - wheat - greengram cropping system as compared to rice -wheat. The highest net return was recorded in rice-fieldpea-greengram cropping system which was at par with rice-wheat-greengram, followed by pigeonpea-wheat. The highest benefit:cost ratio was recorded in maize-chickpea system (3.94), followed by pigeonpea-wheat (3.77).

Soil organic carbon content increased from initial level of 0.24 to 0.42% and 0.35% under organic and integrated production systems, respectively when chickpea, greengram and mustad were cultivated.

Arid Legumes: The application of 50% N through organic source (FYM)+50% through inorganic source (urea) recorded highest seed yield. Among the nutrient management treatments applied in the preceding crop clusterbean, application of 100% N through organic source (FYM) gave highest seed yield of cumin. The highest cumin equivalent seed yield of cropping system was recorded due to the application of 25% N through iorganic source of urea+75%N through FYM.

Sugarcane: In the first ratoon crop, paired row planting with fertigation at 100 and 75% of the recommended dose of fertilizer performed well with cane yield of 108.0 and 111.7tonnes/ha, respectively and was on a par with surface irrigated crop (111.3tonnes/ha). There was not much difference in Brix and sucrose content between drip irrigated and surface irrigated crop. There is a possibility of reducing 25% of N and K fertilizers and water saving of 42-51% through drip fertigation.

Bud chip technology: The conventional system of sugarcane planting requires about 6-8 tonness /ha seed cane. In order to reduce the quantity and improve the quality of seed cane, one alternative is to plant excised axillary buds of cane stalk, popularly known as bud chips. The bud chip technology could be one of the most viable and economical alternatives in reducing the cost of sugarcane production, besides other advantages.

This technique could be of immense uses to farmers.

Tobacco: Sunnhemp raised as a green manure crop and ploughed *in situ* at 45 days + *Azospirillum* @ 10 kg/ha + Phosphate Solublizing Bacteria @ 10 kg/ha along with 100% recommended dose of fertilizer (75 kg N+100 kg P_2O_5+50 kg K_2O/ha) to chewing tobacco at Vedasandur was an effective strategy to get high productity and net return.

*Efficiency of tobacco curing:*Integrated barn comprising Ventury furnace and modified flue pipe system reduced wood consumption for tobacco curing. Coffee husk was found to be a beneficial/ effective alternative fuel for curing tobacco at Shimoga. Coffee husk requirement for tobacco curing was estimated at 5.11 kg/ kg cured leaf.

Mango: The application of paclobutrazol @ 2.5 g a.i/plant during second week of July increased fruit yield and advanced harvesting time of Totapuri by 26 days. The rootstock, Nekkare, recorded maximum cumulative yield (216.55 kg/ tree) with scion Banganpalli. In planting system-cum high-density planting of mango, double hedge row system of planting gave highest yield at most of the centres. Heading back of branchlets at 50cm level on entire tree, during rest period before emergence of new growth along with application of paclobutrazol @ 10g a.i./ tree gave highest yield of Alphonso at RFRS, Vengurle, with and Neelam at Periyakulam

The formation of jelly seed, one of the most serious problems in mango Dashehari, particularly in northern belt, was characterized by loosening of pulp, jelly formation, off-flavoured and dull colour around stone, resulting reduction in shelf-life of fruits. The affected fruits appear normal from the outside but after slicing give an unpleasant appearance and become unfit for consumption.

An integrated management approach involving application of black plastic mulch (100-µ thick) in tree basin during October-November and foliar spray of dihydrated calcium chloride (2.0%), potassium sulphate (1.0%) one month before harvesting of fruits along with application of 150 g borax per tree in soil during November, has been found quite effective.

In mango Dashehari, branch angle and its relationship with bearing was studied and most productive branch angle was identified as $30\text{-}60^0$ from vertical axis as there were maximum fruits (49.33 %) on these branches with higher fruit weight. Least fruiting (6.88 %) was recorded from narrow angled branches of less than 30^0.

Guava: In planting system-cum high-density planting experiment, maximum cumulative yield was recorded in double hedge row system of planting at most of the centres.

Litchi: Maximum cumulative yield was obtained in double hedge row system of planting both at GBPUA&T, Pantnagar and BCKV, Mohanpur. The maximum cumulative yield was recorded when fruits were harvested with 50cm long branches at BCKV, Mohanpur.

Citrus: Leaf analysis and fruit yield data bank generated through exploration of 7 states across northeast India were analyzed through diagnosis and recommendation integrated system (DRIS) to determine leaf nutrient optima and geographical information system (GIS) to develop spatial variogram of nutrient constraints to delineate major production zones. The DRIS interpretation revealed leaf nutrient optima as : 19.7-25.6 N, 0.9-1.0, P, 9.9-19.3 K, 19.7-24.9 Ca, 2.4-4.8 Mg as macronutrients (g/kg), 85-249 Fe, 43-88 Mn, 3-14 Cu and 17-27 Zn as micronutrients (mg/kg) vis-à-vis productivity of 33-56 kg/tree. Maps for spatial distribution of nutrient constraints were superimposed, which delineated three most important citrus productivity zones.

Kinnow: The drip irrigation at 0.75 CPE and micro-sprinkler at 1.00 CPE gave best growth in kinnow. Similarly, maximum WUE and FUE were recorded with 0.75 CPE and 1.00 CPE, respectively.

Banana: At Arabhavi centre, 75% RDF / plant and 2 suckers/ hill gave higher yield while at Kannara, a plant spacing of 2m × 3m with three plants / pit (5,001 plants/ha) with 100% RDF recorded highest yield under high-density planting.

Sapota: Application of 100% RDF at three stages of growth, viz. 25% N + 100% P_2O_5 + 25% K_2O in June, 50% N + 50% K_2O in August and 25% N + 25% K_2O in October was observed to produce better results than the control.

Papaya: At Coimbatore centre, application of 30:30:30 g of NPK (60% RDF) applied @ 100:25:25% during transplanting to flower emergence, @ 0:50:50% from flowering to first harvesting and @ 0:25:25% from first harvesting to end of first cropping period recorded better fruit characters. Application of 100% RDF at three stages of growth, viz. 25% N + 100% P_2O_5 + 25% K_2O in June, 50% N + 50% K_2O in August and 25% N + 25% K in October gave better results than the control.

Aonla: Evaluation of aonla-based diversified cropping model at CIAH, Bikaner, demonstrated that ground storey crops performed well without affecting the yield of main crop. These crops played a vital role in supplementing N, P and K through residue incorporated in soil. The system gave a net return of Rs 53,050.00 with a benefit : cost ratio of 2.54 from aonla + bottle gourd purely under rainfed conditions of semi-arid ecosystem.

Under various planting systems, viz. square, hedgerow, double hedgerow, cluster and paired demonstrated that double hedgerow planting system

can be adapted by aonla growers for getting 123.79 % more yield over traditional square planting system under rainfed conditions.

Pomegranate: At CIAH, Bikaner, in 5-years-old tress pomegranate Ganesh, two sprays were applied during vegetative growth and at initial fruit development. Highest number of fruits (102.33) and maximum yield/plant (24.5 kg) were obtained in treatment of boric acid and zinc sulphate @ 0.25%. The fruit cracking was reduced to 9.96% by application of boron with zinc each at @ 0.25% compared to 22.33 % in the control.

Application of leaf litter of subabool (5 kg / plant) gave higher fruit yield (27.72 kg / plant) in six year trees of Ganesh. Application of leaf litter also increased soil organic carbon.

The application of different bioagents, *viz. Azosprillium*, *Azosprillium* + *Pseudomonas striata, P. fluorescens, Trichoderma viride* resulted in high dry- matter (total biomass), longer roots and more number of roots/ plant. Use of *Azospirillium* + *P. striata* improved photosynthetic and transpiration rate as compared to the control.

The maximum graft success (85.00%) was recorded with wedge grafting done on 30 January. The grafted plants during this period had perfect graft union, indicating high scion and rootstock compatibility. Four pomegranate rootstocks (Bhagawa, Mridula, Phule Arakta and Ganesh) were tested taking Bhagawa and Ganesh as scion varieties. Maximum graft success of 84%, was recorded with Mridula (rootstock) and Ganesh (scion) graft combination.

Grape: The double stem performed better than single stem. Similarly, maximum bunch weight, berry weight and berry diameter were obtained with vines trained as double cordon horizontal. However, overall yield was higher in four cordon system.

Different rootstocks varied in their response to IBA for successful rooting and their growth. Removal of leaves 6-8 days before grafting resulted in improved graft success and performance. Thompson Seedless grafted on nine different rootstocks was evaluated for different parameters. Higher bunch weight and yield recorded on vines grafted on 110R and Dogridge. Under salinity stress, Thompson Seedless grafted on B2-56 rootstock performed better than those grafted on Dogridge and Salt Creek and resulted in higher biomass and yield. B2-56 was more efficient in P and K uptake under saline irrigation.

Banana: Requirement of N, P_2O_5 and K_2O for producing one tonne of Poovan first ratoon banana was worked out as 11.52, 1.57 and 22.96 kg, respectively. Out of which, 51.2, 37.8 and 58.3 % of N, P_2O_5 and K_2O respectively were contributed by soil, and applied fertilizers contributed 58.2, 42.6 and 58.7 % of N, P_2O_5 and K_2O respectively.

Apple: In medium density plantation**,** 11 varieties of apple were planted on seedling root-stocks with pollinizer variety Golden Delicious at a spacing of 4m × 4m, accommodating 625 trees/ ha against 278 trees/ha in conventional system. During seventh year, with 55-60 % canopy cover, the yield was recorded maximum in Royal Delicious (12.35 tonnes/ha), followed by Red Chief (12.05 tonnes/ha), Oregan Spur (11.40 tonnes/ha) and Red Fuji (10.20 tonnes/ha).

In-situ moisture conservation in almond: Half moon system (left) and full moon system (right)

Almond: The maximum nut yield (2.22tonnes/ ha) and soil moisture content were recorded with full moon structure + plastic mulch followed by half moon + plastic mulch.

Walnut: Wedge grafting recorded highest success of 75% under polytrench followed by polyhouse (70%), while it was only 19.16% under open field conditions with an overall average of 54.66% when grafting was done during mid-March as against only 45.18% in tongue grafting.

Walnut propagation under polyhouse

Strawberry: Under polyhouse or in polytunnels, strawberry Chandler, Gorella, Camarosa, Oso Grandy and Addie, produced higher yield with better size of fruits compared to open field.

Coconut: Intercropping banana, hybrid Napier grass CO-3 and ash gourd in coconut garden under littoral sandy soil with husk and coir pith application resulted in higher yield. Higher coconut yield was recorded under coconut + vegetable intercropping system (130 nuts/palm/year) compared to monocropping of coconut (118 nuts/ palm/year).

Intercropping systems

- Ginger, tapioca, coleus, Amorphophallus and hybrid napier were found suitable for intercropping in black pepper garden (more than 15 years old).
- Sweet potato + red gram intercropping system (1.8 m strips each accommodating 3 rows) recorded significantly higher tuber equivalent yield (13.01 tonnes/ha) compared to other cropping system, followed by sweet potato as a sole crop (12.96 tonnes/ha). Maximum net return and benefit: cost ratio were recorded with sweet potato + red gram intercropping system.
- Elephant-foot yam intercropped in orchards gave higher net returns with sapota/mango orchard with recommended dose of NPK at Coimbatore, Dholi and Ranchi.
- For Dharwad and adjoining areas of Karnataka, *kharif* potato-*rabi* sorghum crop sequence was recommended for higher productivity and profitability with 20 tonnes/ha FYM and 100% of recommended doses of NPK to potato crop.
- For Kalyani and adjoining areas (West Bengal) in potato-okra-paddy cropping sequence, application of FYM @ 20 tonnes/ha and 100% recommended doses of NPK to potato and 50% of recommended doses of NPK to okra and 75% recommended dose of NPK to paddy was recommended for higher productivity and net return.
- Potato + garlic intercropping system in a 1:1 ratio with 100% recommended doses of NPK fertilizers to both the crops was recommended for Chhindwara and adjoining areas of Madhya Pradesh.
- For Kota and adjoining areas of Rajashtan, potato + *methi* (every fourth row of potato replaced by two rows of *methi* at 30 cm spacing) was recommended for higher productivity and net return.
- At Faizabad, intercropping of potato with garlic in a 3:1 ratio with recommended doses of NPK for both the crops was recommended.
- In Nilgiris, potato-Frenchbean combination has been found to reduce the build-up of potato cyst nematodes, enhancing soil organic carbon content due to nitrogen-fixing capacity of beans.

Economics of coconut based farming system involving coconut with integration of grass, pepper (trailed on coconut), banana (on border of garden), dairy and poultry resulted in the net return of Rs l,29,070 /ha. Sale of coconut, milk and broiler was found to give 91% of the revenue generated from the system.

Cowdung slurry application on vanilla grown as mixed crop in coconut garden was found to increase the number of infloresences (21), number of beans (208) and fresh bean yield (2.0 kg/vine), followed by vermiwash application and vermicompost + biofertiliser application.

Allelopathic studies in coconut-based cropping system indicated that the microorganisms are capable to catabolise the allelochemicals in leachates and nullify their plant suppressive properties.

The coconut yield was higher with the treatment, organic + inorganic manuring + tillage practice (158 nuts/palm/year) under rainfed situation. Application of 50 % VC +50% NPK recorded significantly higher nut yield (68.8 nuts/ palm/ year) and was on a par with application of 25% VC + 75% NPK (T2) treatment (66.3 nuts per palm per year.

Arecanut: In arecanut garden, mixed cropping with pepper, banana and citrus was found to be economically advantageous in North-East Region. In Sub-Himalayan Terai Region, aster, marigold and gladiolus performed better under arecanut garden.

Cashew: The yield in high-density plots (416 and 500 trees/ha) was significantly higher (1.13 and 1.12 tonnes/ha, respectively) than in normal planting system (200 trees/ha) (0.72 tonnes/ha) 7 years after planting. Cashew yield was appreciably higher in coconut husk burial (2.04 tonnes/ha) and modified crescent bund treatments (2.03 tonnes/ ha) than in reverse terrace (1.94 tonnes/ha), catch pit (1.39 tonnes/ha) and the control (1.48 tonnes/ ha) treatments**.**

Potato: At Deesa, 75% recommended dose of NPK (full dose of P and K and half of N as basal and remaining half of N applied 30, 37, 44 and 51 days after planting) through drip fertigation is recommended as it saved 25% NPK fertilizers, increasing potato productivity. The drip system should be operated for 45 minutes during November - January and 65 minutes during February - March at alternate days with the discharge rate of 4 litres/ hour. Irrigation at 25-30 mm CPE and mulching with paddy straw or any other locally available organic mulch material @ 5 tonnes/ha is recommended for higher yield of potato.

Mushroom: An average yield of 14.07 kg of button mushroom per quintal compost prepared by using combination of INRA and Anglo Dutch methods, was obtained from the trial in 40 days of cropping. The tenth and eleventh organic crops of button mushroom were raised successfully with an average yield of 10.13 kg and 7.43 kg mushroom/quintal, respectively. While evaluating different strains of paddy straw mushroom, highest mushroom yield was recorded in strain, OE-274, followed by BBH-1. *Lentinula edodes* was cultivated successfully on wheat straw where spawn run was completed in 48 days.

Black pepper: Irrigating of pepper vines once in a fortnight from March to May @ 50 litres/

vine enhanced pepper yield substantially. The mean dry yield obtained was 6.8 kg/vine in irrigation treatment as against 3.25/kg vine under rainfed condition.

Ginger: The experimental results at Kumarganj indicated that foliar spray of 0.05% zinc sulphate (60 and 90 DAP), 0.2% of borax (60 and 90 DAP) and 1.0% of ferrous sulphate (60 and 90 DAP) increased the yield (55.53 q/ha) and quality.

Tuber crops: Organic manure sources, *viz*. vermicompost @ 3.91 tonnes/ha (tuber yield 31.42 tonnes/ha) and coir pith compost @ 4.6 tonnes/ha (27.04 tonnes/ha) were equally efficient as a substitute to FYM 12.5 tonnes/ha (30.97 tonnes/ha) in cassava. The INM was worked out for sweet potato at Kalyani, Rajendranagar, Udaipur and Dharwad. The INM has been developed for taro cultivation. Significantly highest tuber yield of sweet potato (10.72 tonnes/ha) was recorded with the application of lime + FYM + NPK + $ZnSO_4$ with a yield response of 15 % over that of FYM + NPK, closely followed by lime + FYM + NPK + $MgSO_4$ (10.65 tonnes/ha). Application of 50, 100 and 150 % of NPK showed an increase of 63, 138 and 136 % tuber yield of sweet potato over the control.

Orchid: Good quality flowers were obtained from 100% leaf mould in terms of highest survival rate (100%), plant height (36.2 cm), number of leaves (12.3), width of leaves (1.6) and girth of bulbs (1.9cm) compared to other growing media within six months. *Cymbidium* hybrid 'H. C. Aurora' under 30% shade with 50% water regime showed maximum vegetative growth and backbulbs formation. Total chlorophyll content was maximum in 0% shade with 25% water regime. Nutrient analysis showed that fully opened flowers contain higher amounts of N (0.95%) and potassium (0.54%) as compared to bud stage. In *Cymbidium* hybrid 'Spring King', the pH of leachate of growing media decreased with the progress of crop growth irrespective of treatments.

Elephant-foot yam: Organic farming continued its superiority for the fifth consecutive year, producing significantly higher corm yield (34.81 tonnes/ha). The crude protein content of organic corms was significantly higher. The INM schedule including biofertilizers gave higher corm yield in different centres.

Caradmom: Biofertilizers, *Azospirillum* and P-solubilizers, were found to increase growth and yield of cardamom. Application of 100% inorganic nitrogen + 50 g *Azospirillum* + 5 kg FYM or 100% inorganic phosphorus + 50 g *phosphobacteria* + 5 kg FYM was found very effective in increasing yield.

Honeybees and pollinators

Apple blooms were visited by *A. mellifera, A. cerana*, Syrphieds, butterflies and coleopterans but honey bees contribute significantly in apple pollination. In apple orchards, fruit setting was 26.2% when four colonies of *A. mellifera* in a hectare were introduced with fruit setting of 16.7% in orchards without introduction of honey bee colonies.

Seed production of radish: For seed crop of radish variety Pusa Chetki, siliqua, setting, seed setting, seed weight and seed yield were higher in open-pollination as compared to plants caged with colonies of *A. mellifera* having two entrances. For an efficient pollination, 5 colonies of *A. mellifera* each at 10 frames bee strength per hectare are required.

*Cucumber:*In cucumber, fruit setting of 74.9% was obtained through honey bee pollination, while it was 12.2% in open-pollination. The augmentation of 6 colonies of *A. mellifera* produced 21.80 fruits/plant, yielding 10.84 tonnes/ha as compared to open-pollination (8 tonnes/ha).

*Litchi:*The fruit setting was recorded 38.4% in open panicles where honey bees were main pollinators as compared to 0.4% in panicles which were caged to exclude insects pollinators.

*Champaka (*Eugenia jambos*):* The fruit setting in *A. cerana* augmented plants was 43.50% with average fruit weight of 60.61 g and fruit setting in cage plants was only 29.54% with average fruit weight of 46.83 g, whereas pollination by stingless bees produced 59.62% fruit setting with an average fruit weight of 113.5 g.

Winged bean: In *A. cerana* introduced plots fruit setting was 63.96%, whereas in stingless bees fruit setting was 83.16% as compared to plot which were not introduced by bee colonies (22.22% fruit setting).

*Mustard:*There was a significant increase in mean number of pods (114-128 pods/plant) as compared to self-pollinated (103 pods/plant) and seed weight and seed yield/plant due to augmentation of *Apis mellifera* colonies.

PROTECTION

Sugarcane: Post-emergence herbicide Glyphosate was found useful to manage weeds including *Cynodon* and nutgrass which are persistent in nature, in both plant and ratoon sugarcane.

Management of red rot: Thiophanate methyl, a systemic fungicide at 0.25% alone or 0.1% concentration along with *Pseudomonas fluorescens* as sett treatment effectively controlled debris borne inoculum of red rot pathogen. The treated plots recorded significantly higher cane population than the untreated plots.

Treatment of setts with salicylic acid (0.05%)

in combination with culture filtrates of *Trichoderma harzianum* or application of *Trichoderma harzianum* (2 kg nucleus culture multiplied on 20 kg sterilized sulphitation press mud for a week; mixed with 200 kg fresh press mud before application to cater one ha) in furrows at the time of planting gave higher protection (79-87%) to cane crop in challenge inoculation with red rot pathogen (*Colletotrichum falcatum).*

Tobacco: Application of Fluchloralin @ 1 litre/ha along with irrigation just before the emergence of Orobanche in December decreased the Orobanche infestation, increasing the cured leaf yield of *bidi* tobacco at Anand.Application of neem cake to FCV tobacco @ 40 g/plant was effective against root grub in light soils of Karnataka.

IPM module having castor and marigold as trap crops and one spray of NSKS 2% was affective against *S. litura* incidence in bidi tobacco at Anand.

Fibre crops: Non-selective herbicides namely Glyphosate @0.8-1.2 kg/ha +2% urea or Glyphosate @0.8-1.2 kg/ha + Paraquat 0.48 kg/ha or Glyphosate @0.8-1.2 kg/ha + 2% ammonium sulphate effectively controlled the composite weed flora in between jute, mesta and roselle seed crops having 30-45 cm row-row spacing. Application of herbicides like Glyphosate and Paraquat through herbicide applicator was equivalent to conventional manual weeding twice (45.8 q/ha). Six row nail weeder was found suitable for killing wide range of weeds at early stage (4 and 15 DAE).Butachlor @ 3 kg a.i./ha with irrigation effectively controlled wide range of weed in jute crop when applied 10 days before sowing of jute.

Mango: At CISH, Lucknow, 48 pathogenic isolates of *Colletotrichum gloeosporioides*, the causal agent of anthracnose disease of mango were collected and characterized on the basis of cultural and morphological characters. The hopper population was positively correlated with temperature and negatively with relative humidity. Methyl eugenol trap @ 4/ acre were found effective in monitoring the fruit fly population. Three sprays, i.e. first spray with Imidacloprid (0.005%), second with NSKE (5%) after 21 days of first spray and the need-based third spray with Endosulphan (0.07%), when fruits were at pea-sized stage, was found most effective for hopper control at most of the centres.

For control of mango anthracnose, combi product (Carbendazim 0.1%+ Mancozeb 0.2%), Chlorothalonil (0.2%) and Propineb (0.2%) reduced anthracnose significantly at different centres. The minimum temperature of 13-15ºC and maximum of 28-32ºC and low RH 54-65% were congenial for the appearance and development of diseases in inflorescence.

Litchi: At NRC for Litchi, Muzaffarpur, the IPM strategy for minimizing fruit drop at early stage and fruit damage at harvesting has been standardized with cleanliness of orchard, setting of pheromone trap (*Conopomorpha cremenella*) and application of Trico cards @50,000 eggs/ha at panicle emergence stage and spraying of *Kamdhenu Keet Niyantrak*/Nimbicidine/Endosulfan at peanut and colour-break stage of fruits.

Pruning of infested twigs/leaves during June, just after fruit harvesting, followed by spraying of Dicofol @0.05% twice at flush emergence during September-October at 7 days interval effectively controlled litchi mite.

Guava: Soil application of *Trichoderma viride* along with FYM applied in root zone was found effective in reducing the incidence of wilt at BCKV, Mohanpur.

Citrus: The population of citrus psylla, bark-eating caterpillar, leaf miner and mites become more serious causing heavy damages. Leaf miner in citrus was effectively controlled by spraying of Imidacloprid (0.005%) followed by NSKE (5%) / *Bacillus thuringiensis* (Bt) at 0.1 %. Acetamiprid (0.005%), Fenvalerate (0.005%), Imidacloprid (0.005%) and Triazophos (0.05%) were found to be consistently effective in the management of citrus psylla (*Diaphorina citri*) and aphids (*Toxoptera citricida*) at Chethalli and Ludhiana in different seasons. In citrus, *Phytophthora* induced gummosis, foot rot, root rot and bacterial canker have been reported as major diseases at most of the centres. Citrus yellow mosaic disease has been re-recorded in newer areas like different locations in Maharashtra. Application of *Pseudomonas fluorescens* (0.5%) along with FYM (25 kg / plant) and neem cake (2 kg / plant) was found better in reduction of dry root rot of citrus.

Spraying Streptomycin sulpahte (100 ppm) and COC (0.3%) was found better against citrus canker at Periyakulam and Tirupati, while at Pusa NSKE (2%) was found effective. The release of biocontrol agents, viz. *Mallada boninensis* Okamols and *Tamarixia radiata* (Waterston) in citrus orchards resulted in 31-33, 47-49 and 26-30% reduction of blackfly, psylla and leaf miner population, respectively. Among several bio-intensive pest management modules against citrus blackfly and psylla, the module with clean cultivation + *Mallada boninensis* released @ 30 larvae/tree + foliar spray of sweet flag (3%) + *Verticilliuim lecanii* @ 5g/litre of water + trap crop, *Murraya koenigii* on border laies was found to be more promising. Field evaluation of biopesticides against citrus leaf miner under nursery conditions revealed that Abamectin @ 0.32 ml/litre of water followed by Spinosad @ 0.34 ml/litre of water and Novaluron @ 0.87 ml/litre of water were found effective for the period of 15 days.

Banana: The volatile components were identified from corms of Nendran (12) and Poovan (13). The NRCB-Ma/24 recorded 100 % stem weevil mortality in banana stem traps smeared with the entomopathogen. For management of banana scarring beetle tilling and clean cultivation with spraying of Acephate (0.1125%), followed by bunch covering successfully controlled the pest at Mohanpur. At Coimbatore, *Pseudomonas fluorescens* as both sucker treatment and soil application (10g as sucker application + *Pseudomonas fluorescens* (2.5 kg + 50 kg FYM mixture) @ 20 g/sucker as soil application) was effective in suppressing nematode population, root and corm index with increased yield of 56% over the control. Both tissue culture/ sucker grown plants were affected with viruses. The BBrMV, BSV, *Fusarium* wilt, Sigatoka leaf spot and Erwinia head rot remain as major diseases, occurring in different parts of the country. Planting disease-free suckers + dipping suckers in Carbendazim (0.2%) for 45 minutes followed by Carbendazim drenching (0.2%) or injecting the same @3 ml of 2% solution (5^{th}, 7^{th}, 9^{th} month) proved to be best in controlling *Fusarium* wilt disease.

Six endophyte isolates, viz. 73YMD, 83PCC 50YR, 51KMD, 56GCTR and 77CAMD, recorded 91.3 - 98.1% inhibition of spore germination as compared to the control. An epiphyte isolate 60pbe recorded 90.8% inhibition of spore germination. The rDNA-ITS sequencing of 18 isolates of Sigatoka leaf spot pathogens confirmed the presence of *Mycospharella eumusae* isolate.

Grape: At NRC on Grapes, Pune, weather-based disease forecasting for major grape-growing regions of country and advisory for disease management are placed on Institute website and updated weekly. The advisory has received overwhelming response from grape growers. An electronic database is being developed for grapevine diseases and insect pests.

Pomegranate: Survey of bacterial blight (55% orchard affected) and pomegranate wilt (45% orchards affected) was conducted. Out of 63 germplasm accessions screened for bacterial blight resistance under field conditions, 6 were found partially resistant (Patna 5, Nana, 1C-1182, IC-1197, IC-1198 and IC-1205). In net house conditions**,** screening of germpalsm under net house conditions revealed 3 accessions /hybrids (K x R, N X R and Nana) to be totally free from bacterial blight. For management of wilt, *in vitro* studies revealed complete inhibition of *C. fimbriata* by antibiotic cycloheximide (100 and 200 ppm) and boric acid (0.1 and 0.2%), whereas bioformulation of *Trichoderma viride* (0.1 and 0.2%) was found significantly superior over the control.

At IIHR, Bangalore, 85 F_2 hybrids of pomegranate were screened under epiphytic conditions for reaction to bacterial blight. Under greenhouse conditions, 230 hybrids were artificially inoculated with *Xanthomonas axonopodis* pv. *punicae*. About 25 plants were resistant to moderately resistant and 15 were free of symptoms.

Ber: Application of Fenvalerate (0.005%), or Endosulfan (0.07%) along with Bayleton (0.1%) significantly reduced the incidence of fruit fly and fruit-borer in ber Gola and Umran. Bayleton (0.1%) and Sulfex (0.2%) were found effective in controlling powdery mildew on ber.

Coconut: Fourty fluoresent pseudomonad isolates were obtained from coconut leaf vermicompost, of which 34 produced IAA in varying quantities. Nine endophytic bacilli from coconut roots and 12 coconut rhizospheric bacilli were found to inhibit both *Thielaviopsis paradoxa* and *Ganoderma* sp.

The Nonnegative Constrained Least Square (NCLS) algorithm, sub pixel classifcation of root (wilt) affected palm in IRS P-6 satellite data map showed that, among 7 southern districts of Kerala, nearly 30% of the coconut land cover is affected by coconut root (wilt) disease.

Combined application of *Bacillus subtilis* + *Pseudomonas fluorescens* was found effective in the management treatment of leaf rot disease in coconut. Placement of Mancozeb sachets in leaf axils around spindle leaf has been found to be an effective prophylactic measure for bud rot on coconut. For managing stem bleeding disease of coconut, soil application of *Trichoderma harzianum* + *T. virens* and root feeding of Tridemorph were effective.

By releasing parasitoids, infestation on coconut leaf by leaf-eating caterpillar could be controlled effectively. Evaluation of talc-based formulation of two virulent strains of *Hirsutella thompsonii*, viz. CPCRI-19 and CPCRI-51(II) resulted in 74-82% mortality of coconut mite in treated buttons.

The release of egg/larvae predator, *Cardiastethus exiguus*, in the crown of 10 % of coconut palms in garden, @ 50 bugs / palm at 5 days interval for six times consecutively at egg-early larval stages of coconut black headed caterpillar (*Opisina arenosella)* gave effective control of the pest in Tamil Nadu and Andhra Pradesh.

Cashew: The *Tribolium castaneum* and *Ephestia cautella* were found to be the common storage insect pests noticed in cashew processing units surveyed in Tamil nadu, Goa and Kerala. At Bapatla, Triazophos (0.1%) was significantly superior against inflorescence thrips followed by Profenofos (0.05%) which recorded a damage score of 0.46 and 0.64, respectively. Profenophos could effectively check the damage by leaf caterpillar,

leaf miner and thrips at Jagdalpur. The ë-cyhalothrin was effective in managing tea mosquito bug, thrips and apple and nut-borer at Vengurla and Vridhachalam. Chloropyriphos (0.2%) was the best treatment resulting in 100% of the treated trees without reinfestation by cashew stem and root-borer (CSRB) at Vengurle and Jhargram and 86% at Bhubaneswar, 78.38% at Chintamani and 72.73% at Jagdalpur.

Pest on TPS: A *Tribolium castaneum* Herb. has been identified as a new pest of untreated one-year-old true potato seed (TPS) stored in cloth bag. The infected TPS could not germinate in the field, resulting in severe loss in seedling establishment in nursery beds. Adult female lays about 400-500 clear white sticky eggs scattering them in the flour or foodstuffs. The eggs hatch in about 4-12 days into small brownish-white grubs, which are fully grown in 27-90 days under favourable condition and then pupate. The pupae are white in colour and pupal period ranges from 1 to 2 weeks. The pupae hatch into adults, which normally live for about six weeks.

Cardamom: Fifty-eight cardamom accessions were screened for leaf blight, rhizome rot and leaf blotch resistance under natural field conditions. The IC- 349646 was found to be resistant with an average leaf blight incidence of 20%. Twenty-three accessions exhibited highly resistant reaction to rhizome rot disease.

Turmeric: Maximum disease reduction of rhizome rot was observed with Metalaxyl-Mancozeb (44.5%) followed by copper oxychloride (36.5 %) compared to the control. *Apanteles taragamme*, an un-identified hymenopterous parasitoid and earwigs, were documented as natural enemies of shoot-borer (*Conogethes punctiferalis*) infesting turmeric. Four strains of entomopathogenic nematodes were isolated from 71 soil samples collected from rhizosphere of ginger and turmeric. Of these, one strain each was tentatively identified as *Heterorhabditis* sp. and *Steinernema* sp.

Ginger: Soft rot of ginger could be controlled by bio-fumigation using cabbage and mustard plant refuses. The bio-fumigation using cabbage increased germination and yield (8.5 kg/plot) by decreasing soft rot (2.25%) and bacterial wilt incidence.

Cumin: Spraying of Mancozeb @ 0.25% at 40, 50, 60 and 70 DAS was found to be effective in controlling blight. Soil solarization + soil application of *Trichoderma harzianum* + spraying of Mancozeb @ 0.25% at 60 DAS and application of vermicompost + soil application of *T. harzianum* + spraying of Mancozeb @ 0.25% at 60 DAS were also effective for controlling the disease.

Orchid: Anthracnose disease caused by *Colletotrichum gloeosporioides* was found to infect seriously in *Phalaenopsis* and *Cattleya* hybrids. Application of Mancozeb (200 – 500 ppm) + Carbendazim (200 – 500 ppm) reduced the infection of anthracnose. The black spot disease caused by *Aternaria alternata* was observed on leaves of *Coelogyne* and *Thunia* .

Tuber crops: Marigold and yam bean were found to be effective barrier crops for sweet potato weevil. Bio-intensive management of taro leaf blight was found to be effective in suppression of disease, increasing cormel yield at Dapoli, Dholi, Kalyani, Raipur and Rajendranagar. IDM package for elephant-foot yam was found to be effective in suppressing the diseases and enhancing corm yield. Yam bean seed extract was found to be effective as a biopesticide against aphids and leaf-eating caterpillars. Sweet potato weevil was found in all sweet-potato growing areas. Sweet potato viruses were also noticed in certain areas. Cassava mosaic occurring in serious proportions in Tamil Nadu, Kerala and Andhra Pradesh, was also observed in Faizabad. Taro leaf blight and elephant-foot yam diseases were found common in all taro-growing areas.

Mushroom:Various plant extracts, certain oils and two commercial formulations of neem were evaluated against *Mycogone perniciosa*. The *Tegets erecta* extract caused 27.34% inhibition of mycelial growth, whereas oils of *Allium cepa*, *Trachysepermum ammi*, *Nigella sativa* and *Coriandrum sativum* caused 100% inhibition of mycelial growth of *M.perniciosa*.

The studies of Carbendazim in processed and marketable mushrooms reduced to 28.6% from 81.9% in different mushrooms by simple washing. The nucleotide sequence comparisons of 5.8S rRNA identified 15 *Cladobotryum* isolates, into three taxa, viz. *C.dendroides*, *C.mycophilum* and *C.asterophorum*.

Integrated Pest Management

Parasitoids on Mealy Bug: Two new parasitoids, *Promuscidea unfasciativentris* Girault (Chalcidoidea: Aphelinidae) and *Aenasius bambawalei* (Chalcidoidea: Encyrtidae), were recorded, parasitizing *Phenacoccus solenopsis* on cotton and *Parthenium* in Maharashtra and Delhi, respectively. The parasitization on cotton as well as on weeds ranged from 20 to 70%. Hymenopterous parasitoid on mealy bug were found in Gujarat and Maharashtra. Entomo-pathogen, *Fusarium pallidoroseum*, was also isolated from mealy bug (*P. solenopsis*) cadavers collected from Haryana and Maharashtra. This pathogen was a key mortality factor of mealy bug in Punjab.

Weekly data on mealy bug was electronically

collected from 320 villages of eight districts in Punjab and was processed and put on the institute website for use by policy-makers as well as State Agriculture Department personnel for identifying hot spots and issuing advisories.

Database and information system on IPM: The NCIPM has initiated development of Plant Protection Personnel Information System (P3IS) and web-based crop-pest database and redesigning institute website under NAIP AGROWEB-ADDSIAR project. P3IS is a database of profiles of plant protection personnel of different disciplines provide information about human resources of plant protection. Online information module of system has been developed and loaded on the institute's website **(URL: www.ncipm.org.in/p3is/startpage.aspx)**. Development of web-based crop-pest database, information on key pests of 65 crops on different parameters have been collected and fed into the MS access database. The web-based user interface for accessing the pest information of different crops is in progress.

IPM / IRM strategies: The on-farm trials were conducted in Burj Bhangu village of Sirsa, Haryana, with hybrid RCH 134 Bt in one acre area and included sowing with two border rows of pigeonpea, pheromone traps for all bollworms, yellow sticky traps for whitefly and application of neem oil and Imidacloprid for sucking pests and Profenophos for mealy bugs. Recommended package of practices (RPP) included three applications of noital Thiomethoxam, Acephate and Imidacloprid for sap sucking pests and three Profenophos for mealy bugs. The results indicated that mean seed cotton yield was 2.73 tonnes/ha in IPM/IRM against 2.36 tonnes/ha in RPP field. The cost: benefit ratio in IPM field was 1:4.43 as against 1:3.65 in RPP field.

IPM technologies in vegetables: The IPM technology was developed and validated in bell pepper in village Daha, Karnal district, Haryana, in 10 acres, which resulted in reduction of number of sprays to 5-6 from 13-14, increasing yield up to 14.1 tonnes/ha from 12.2 tonnes/ha with farmers' practices, respectively with higher cost:benefit ratio of 1:2.99 in IPM compared to 1:2.48 with farmers' practice respectively.

The curd yield of cauliflower and head yield of cabbage were higher in IPM fields as compared with farmers' practices by 13-15%. Net returns for cauliflower in *kharif* season were Rs 1,22,958-1,68,111/ha in IPM fields and Rs 90,143-1,18,740/ha with farmers' practices. In late *rabi* season, net returns were Rs 88,820/ha in IPM as compared to Rs 70,620/ha with farmers' practices.

Agriculturally Important Insects

Potential predator: A neuropteran predator (*Micromus timidus)* with potential for biocontrol of sugarcane woolly aphid and *Aphis craccivora* has been identified and being exploited through conservation ecology of sugarcane agro-ecosystem.

Biocontrol potential of natural enemies: Two species of symbiotic yeasts namely *Pichia anomala* and *Candida apicola* capable of increasing the fecundity of *Trichogramma japonicum* have been identified and utilised in the diet of parasitoids in rearing protocol.

Strain of *Cryptolaemous montrouzieri* tolerant to Acephate has been identified. Populations of *Goniozus nephantidis* and *Cotesia flavipes* with higher biological parameters like higher adult emergence and sex ratio in favour of females have been studied.

Endophytic bacteria for disease management: Four endophytic bacteria were isolated from healthy pigeonpea plants. Of them, 3 were gram positive and one gram negative. Two isolates showed 40-48% inhibition of *Sclerotium rolfsii* under *in vitro* conditions.

Entomopathogenic and plant parasitic nematodes: Integrated use of talc formulations of antagonistic fungi with crop-soil sterilization (formaldehyde) in capsicum and tomato in polyhouses at Denkinkotai, Hosur, reduced the incidence of nematode-root wilt disease complex by 64% in treated beds compared to untreated ones.

Biological control of nematodes: The antagonistic fungi against reniform nematode (*Rotylenchulus reniformis)* in red gram (var. Vipula) in *kharif* 2008 at Rahuri revealed that combined application of *Trichoderma harzianum* @ 5 kg/ha and *Pochonia chlamydosporia* @ 20 kg/ha was most effective in reducing reniform nematode female population (15.6), increasing the yield of pigeonpea (1,750 kg/ha). The cost: benefit ratio was 1: 1.92.

Biological suppression of sugarcane pests: Large scale demonstration of effectiveness of *Trichogramma chilonis* against Plassey-borer was carried out at farmers' fields on Co BLN 9605 variety in 10 ha. Nine releases of *T. chilonis* @ 50,000/ha/release at 10 days interval from second week of July to first week of October, 2008 resulted in significant reduction of infested cane and higher cane yield (84,450 kg/ha) than at farmers' fields.

Biological control of rice pests: In Punjab, two field demonstrations on use of biological IPM package on organic rice revealed a higher net return of Rs 1,12,798/ha compared to farmers' fields (Rs 98,188).

Biological control of mango hoppers: Off-season spraying of *Metarhizium anisopliae* @ 1 x 10^7 spores/ml on trunk during November and one spray during flowering period reduced mango hopper (*Idioscopus nitidulus)* incidence on mango.

SUCCESS STORY

Root-knot nematode management

Rice root-knot nematode, a pest on rice-wheat cropping system, has spread in south-west Haryana. In Badesara village (Bhiwani), farmers could only harvest paddy @ 7 q/ha during 2005-06; and increased paddy yield up to 21.5 q/ha. Poor management in nursery as well as in the main field, application of imbalanced fertilizer doses were recognised as predisposing nematode attack in paddy. In another farmer's field, Carbofuran was applied @ 1.5 kg a.i./ha during 2006-07 for management of rice root-knot nematode which increased paddy yield up to 55 q/ha.

In Tamil Nadu, application of *Verticillium lecanii* @ 1 x 10^9 spores/ml on tree trunk during off-season and one spray on shoots reduced the hoppers significantly.

Plant Parasitic Nematodes

Yield losses of 18% due to *Meloidogyne graminicola* in paddy, 27% due to *Meloidogyne* spp. in vegetable crops; 16% due to *Radopholus similis* in banana and 10% due to *Meloidgoyne incognita* in pomegranate in hot spot areas were estimated in Karnataka.

Inclusion of crop rotation with onion, garlic, potato and cauliflower in suitable cropping sequences led to reduction in population of root-knot nematode in vegetable-based cropping systems. While in summer, crop rotation of okra-potato-clusterbean led to maximum reduction in root-knot nematode population followed by okra, cauliflower and clusterbean.

Hot water treatment at 5^0 C for 30 minutes followed by foliar spraying of Carbosulfan @ 0.1% 40 days after transplanting reduced white tip nematode by 34%, increasing rice yield by 87% over untreated control.

Lesion nematode (*Pratylenchus thornei)* on chickpea was managed by seed treatment with neem seed kernel powder + *Trichoderma viride* both @ 5 g/kg seed, decreasing nematode population by 67% and enhancing the yield by 53.5% over untreated control. The same treatment against pigeonpea cyst nematode, *Heterodera cajani*, on pigeonpea was effective, resulting in significant reduction in nematode population and enhancing of yield and nodulation.

Intercropping of greengram with sesamum was effective in reducing root-knot nematode, enhancing the yield by 19.18%.

Reniform nematode (*Rotylenchulus reniformis)* on cowpea was managed by seed dressing with neem-seed kernel powder @ 10 g/kg seed, increasing the yield by 19% over untreated control.

Reniform nematode infecting blackgram was managed with the soil application of *Trichoderma harzianum* @ 2.5 kg/ha + *Pochonia chlmydosporia* @10 kg/ha, increasing the yield by 13.5% over untreated control in Rajasthan.

Root-knot nematode along with *Sclerotium rolfsii* complex on groundnut was managed with the seed treatment of *Pseudomonas fluorescens* @ 20 g/kg of seed and furrow application of *Pseudomonas fluorescnes* @ 2.5 kg/ha, increasing pod yield, with reduced stem rot and root-knot nematode disease.

Citrus nematode, *Tylenchulus semipenetrans*, on citrus was successfully managed by using Carbofuran @ 1 kg a.i./ha, reducting nematode population by 38.4% and enhancing the yield by 32%. Further, *Pochonia chlmydosporia* @ 20 kg/ha was also effective in reducing nematode by 26.7%, enhancing yield by 27.5% over untreated control at Hisar.

Treatment combination of paring and hot water at 55^0C for 20 minutes to banana rhizomes against root-knot nematode followed by field application of Carbofuran @ 0.3 g a.i./ha + neem cake @ 1 kg/plant significantly reduced the root-knot nematode by 40.6%, increasing banana fruit yield by 43.4% over untreated control at Anand. This treatment was also effective against burrowing nematode, lesion nematode and *Helicotylenchus multicinctus* nematode complex on banana in Kerala and Karnataka.

Pesticide residues: There were no residues of Imidacloprid 200 SL on chilli when applied thrice at 10 days interval at 50 and 100 g a.i/ha at Jaipur, Rahuri, Kalyani and Vellayani in red chillies at harvesting (36 days after last spray) and soil 20 days after application. Half life of Imidacloprid in chilli fruits were estimated as 1.027 days. Dissipation / persistence of combi-formulation Trifloxystrobin (25 %) and Tebuconazole (50 %)-75 WG on apple were studied at four locations. None of the residues was detectable in apple fruits and soil at harvesting after two foliar applications of formulation given @ (100+200) and (200+400) g a.i./ha, 40 days before harvesting. When four applications of the same formulation was applied on grape @ 175 and 350 g/ha, residues of Trifloxystrobin (25 %), its metabolite or Tebuconazole (50 %)-75 WG were found to dissipate below detectable level of 0.01 mg/kg in 15 days at recommended dosage.

Foliar sprays of Quizalofop-ethyl (5 % EC) on blackgram given at 50 and 100 g/ha at Anand, Ludhiana and Kalyani did not show presence of any residues at harvesting, i.e. after 94 days of spray. On onion crop, Quizalofop-ethyl 5 % EC residues in onion bulbs were not detectable on

5th day of sampling when applied at 50 and 100 g/ha . Harvest time resideus of combi-formulation of Flusilazole (12.5 %) and Carbendazim (25%)-37.5% SE on paddy crop were below detectable limit when the formulation was applied at 960 and 1920 ml/ha.

For the fixation of maximum residue limit (MRL) of deemed registered pesticides supervised field trials have been conducted for Carbaryl on grape and sesame; Phorate on cotton and cowpea; Quinalphos on Bengal gram, brinjal, cabbage, cauliflower, cotton, onion, groundnut, paddy and potato; Zineb on turmeric; methyl-parathion on blackgram and cotton; mancozeb on ginger, cauliflower and potato.

The modified Quick, Easy, Cheap, Effective, Rugged, Simple (QuEChERS) method for pesticide residue analysis in fruits, vegetables, cereals, pulses, tea, etc. was developed and validated.

White grubs and soil arthropods

Lepidiota mansueta has also appeared as a severe key pest of potato, sugarcane, blackgram and Colocasia affecting almost ten villages in Majuli of Jorhat district of Assam. The *Lepidiota stigma* was observed to damage maize in Himachal Pradesh; due to its biennial life-cycle heavy crop damage has been observed in alternate years. In Rajasthan, *Holotrichia consanguinea* was found to be predominant species, infesting almost all *kharif* crops. In some parts of Western Rajasthan (Bikaner Division), *Maladera insanabilis* was observed to cause damage to groundnut crop.

Seven new species of scarab beetles, *viz. Anomala perplexa, Lepidiota mansueta, Maladera insanabilis, Schizonycha ruficollis, Adoretus versutus, Brahmina coriacea, Adoretus bomblinota*, were identified from Asom. Among 35 species of whitegrub recorded in Uttarakhand hill, *Holotrichia longipennis* Blanch. was recorded as predominating species, followed by *Anomala lineatopennis, Anomala demideata* and *Brahmina coriaceae.* Sugarcane producing blocks of Haridwar districts were infested with *Lepidiota mansueta* Burmeister. The bio-ecology study of this white grub sp. revealed that life-cycle is completed in two years.

Brahmina crinicollis was found to cause extensive damage in pear orchards. Adult beetles feed on flowers and reduced fruit setting. On a single inflorescence, 10-15 beetles congregated, flowers were completely destroyed. Maximum emergence of beetles occurred in March.

The *H. serrata* is being reported as a pest of sugarcane in several parts of Kanataka after nearly 35 years of a mass campaign carried out to control this pest in Belgaum dstrict. Unusual emergence of *H. reynaudi* was recorded 15 years after its successful management in Tumkur district.

Healthy and milky white diseases affected *Leucopholis lepidophora* larvae collected from field

SUCCESS STORY

Management of white grubs

Success with *in vitro* production has been achieved with *Paenibacillus popilliae* Dutky that is a spore forming bacterium to cause milky white disease in white grubs. *P. popillae* is not easily amenable for *in vitro* culturing. As many as 16 local isolates have been collected from the field infected grubs in Karnataka. The bacterium could be successfully cultured on an artificial medium with proline, charcoal and an antifoaming agent such as pig fat as the important components. An average of 2.9 to 4.2 × 10^7 sporangia per ml could be produced on this medium. The sporangia produced by *in vitro* method when tested for their infectivity against the III instar larvae of *Holotrichia serrata* and *Leucopholis lepidophora*, could cause milky white disease in both these species. Further work should provide a technology based on this bacterium to manage arecanut and sugarcane white grubs.

White grub management campaign: The beetles of white grub start emerging and aggregate on host plants, especially on neem from mid-May after some pre-monsoon rains; emergence continues in June-July. Collaborative programme on management of white grubs in western Uttar Pradesh on a community basis with a sugar mill is in place. All the neem trees in all the 40 villages were provided with aggregating pheromone and sprayed with Chlorpyriphos/ Imidacloprid. The large-scale campaign in the target area resulted in huge beetle collection and in a sharp decline in the grub population, reducing the infestation to negligible extent in sugarcane.

Agricultural acarology

The rice panicle mite, *Steneotarsonemus spinki*, has been observed as one of the major mite pests in West Bengal, reducing 25-30% yield in lET-4094 and lET-4786. Low mite population was observed on rice variety, Masuri. Maximum reduction in rice panicle mite population was observed in Dicofol treated plots, followed by

Propargite, Fenazaquin and Carbofuran treated plots. The application of Propargite (0.05%) was better than Dicofol (0.05%), wettable sulphur (0.125%) and ethion (0.1%) in reducing mite damage.

Out of 25 varieties investigated for reaction to panicle mite, *Steneotarsonemus spinki*, at Mandya in Karnataka, no variety was completely free from tarsonemid mite damage on flag leaf sheath. Mean sheath mite population recorded on different varieties ranged from 0 to 134.3 per flag leaf sheath. Varieties like CTH 1, BPT 5204, KHRS 26, lET 7191, KHP 2 and Shakthi recorded <10 cm length of leaf sheath discolouration with lower mite damage (<2%).

The extent of loss of dry chilli due to yellow mite infestation was 11.39% in Guntur variety and 18.56% in *Byadgi Kaddi* in Karnataka. Byadgi Kaddi variety recorded more number of mites as well as more mite damage compared to Guntur. Screening of chilli lines for reaction against yellow mite, *Polyphagotarsonemus latus*, revealed that PBC-61, Udaipur-2, BVC-47 and BVC-53 were free from yellow mite infestation.

Pesticide resistance in *Tetranychus urticae* was monitored in Kolar and Bangalore districts. Resistance to Dicofol was high, compared to wettable sulphur, Fenazaquin, Propargite and Diafenthiuron. The level of resistance to all pesticides showed a gradual increase in a cropping season as evidenced by bioassays carried out at monthly or bimonthly intervals. Monitoring of resistance level in mites to acaricides has shown that *Tetranychus urticae* has developed 1.5 fold, resistance to Dicofol at Navsari, 1.6 fold at Wada, 1.9 fold at Dungri, and 2.7 fold at Sandhier in Gujarat.

Investigations on biological control of spider mite, *T. urticae*, using Phytoseiid predator, *Neoseilus longispinosus* clearly indicated that Frenchbean plants provided optimum food for spider mites up to 50 days and hence the prey mites can be mass produced on Frenchbean plants up to 50 days. When 20 days old Frenchbean plants were infested with 5 spider mites per leaflet and with prey : predator ratio of 100:1, maximum number of predators (up to 125 per leaflet) could be harvested when Frenchbean plants were 65 days old.

Propargite 57 EC at 850 g ai/ha significantly reduced yellow mite on chilli after three rounds of spraying with increased yield of 24.01 tonnes of green chilli fruits/ha. Spiromesifen 96 g ai/ha, Diafenthiuron 450 g ai/ha, Milbemectin, 4 g ai/ha, Chlorfenapyr 75g ai/ha and Fenazaquin (125g ai/ha) were significantly more effective in reducing yellow mite population in chilli up to 14 days after each application. Effectiveness of mineral oil at 1 % was more evident with second application when the yellow mite population became low and it was next to synthetic insecticides in effectiveness.

Chilli lines tolerant to mite in Karnataka were: PBC 631, Udaipur-2, BVC-47, CA-14, 7A, 8A X CA14, CMS 2B, PJ X 8O, CMS 7A, CMS8A, CMS6B, CMS 6A and CMS7B. Chilli lines Suryamukhi 4, Canning Suryamukhi 6 and 7, Suryamukhi Bullet 5 and 6, Canning Bullet 3, BC-CH-SL-4, Black Cluster, CH-1, K-1, CO-3 and CO-4 showed moderate resistance to *Polyphagatarsonemus latus* lower yellow mite infestation in CA-71, CH3, CO3, CH1, Punjab Surkh and BC-CH-SL-4 lines of chilli

Okra varieties, AOL-04-U2 and JOL-05-07, were found tolerant or less susceptible to spider mite, *T. macfarlanei* due to low leaf hair density in Gujarat.

The efficacy of horticultural mineral oil at 0.75-1%, was modest with 62% reduction in spider mite population on okra. The effectiveness of mineral oil (causing 80% reduction) on chilli against yellow mite was comparable to that of newer chemical acaricides.

At Kalyani, *T. urticae* tolerant varieties have been identified in pointed gourd (BCPG-5), cowpea (Shwetha and Lola) and okra (P-7 and DSU-1), recording less number of mites on leaves.

Application of Fenazaquin (@125 g ai/ha), Propargite (@570 g ai/ha) and Diafenthiuron (@400 g ai/ha) offered significant control of spider mite on brinjal at Ludhiana for two weeks.

Rice sheath mite (*Steneotarsonemus spinki*) infestation, much noticed in the east-cost states, was more significantly checked with application of Propargite (0.05%).

The application of mustard cake and glyricidia leaf compost were found more promising over newer acaricides against *Steneotarsonemus spinki* on rice in West Bengal.

Holistic nutrient management in coconut gardens with FYM, recommended NPK fertilizers and micronutrients like boron, zinc, calcium and sulphur, neem cake and root feeding of azadirachtin, reduced mite infestation, improving nut yield in Karnataka, Tamil Nadu and Gujarat. Abamectin/ Milbemectin @4-5g ai/ha, Diafenthiuron @450g ai/ha, Chlorfenpyr @75g ai/ha, Propargite @570g ai/ha, Fenpyroximate @30g ai/ha and Fenazaquin @125g ai/ha were used against insecticide-resistant *T. urticae* on tomato crop.

The *Bt* cotton accessions were found severely infested by yellow mite while some *Bt* brinjal entries in Ludhiana recorded severe infestation of spider mite (*T. urticae*).

Successful and economic mass production of both prey mite (*T. urticae*) and its potential obligate phytoseiid predator (*Neoseiulus longispinosus*)

using Frenchbean plants has been demonstrated. When *Neoseiulus longispinosus* was released at 1:50 and 1:100 (predator: prey) ratios caused complete elimination of spider mite on polyhouse roses in 2-3 weeks.

In IPM experiments, application of Abamectin was detrimental to *Neoseiulus longispinosus* predator at least for one week. Potentiality of insect predators like *Stethorus pauperculus, Scolothrips* sp. and of *Chrysoperla carnea* was good at Coimbatore .

Check list of phytoseiid mite fauna prepared for four agroclimatic regions in southern Karnataka comprises 51 species under 14 genera. Predatory phytoseiid genera, *Amblyseius* and *Typhlodromus*, were found abundant in Himachal Pradesh and Punjab on pear, peach, plum, kinnow, litchi, pomegranate, mango and apricot apart from field and vegetable crops.

Agricultural Ornithology

Bird damage: In rice, Indian Peafowl (*Pavo cristatus*), Teals and Common Moorhen (*Gallinula cloropus*) caused damage 10.0, 5.0 and 12.0 respectively. While in wheat fields during sowing stage, migratory Shot-toed lark (*Calandrella cinerea*) and Calendar Lark (*Melanocorypha calandra*) caused damage to the sown seed up to 90%, compelling some farmers to re-sow their fields in Gujarat. In maize, hose-ringed parakeet caused damage up to 40% in Andhra Pradesh, while in sorghum bird damage ranged from 5 to 25% mostly by Rose-ringed Parakeet, Common Myna and unias (*Ploceus* species). After harvesting of groundnut, about 100kg/ha grains remained in fields as spillage. Several species of birds, viz. Demoiselle Crane Anthropoides Virgo, Black Ibis, Blue Rock Pigeon, Indian Ring Dove and Rosy Pastor fed on these grains.

Eco-friendly bird management: In Punjab, combined effect of reflective ribbon, manual drumming and scare crows was found effective (>95%) from bird attack for 18 sunny days at milky stage. The IPM at farmers' fields, different management modules during *kharif* consisting of net (1,471kg/ha) reflective ribbon (1,361kg/ha) and botanical spray (1,305kg/ha) proved effective in controlling bird damage in sorghum over the control (912kg/ha).

Birds like, Small Green Barbet (*Megalaima viridis*), White Cheeked Bulbul (*Pycnotus jocosus*) and Tree pie (*Dendrocitta vagabunda*) helped in the propogation of the recently surging *Momordica dioica*, a cucurbitaceous climber weed in agriculturre. The seed found in excreta of these birds readily germinated unlike the seeds harvested manually.

Role of beneficial birds in IPM: Fourteen species of insectivorous birds controlled rice insect pest, recording higher yield in experimental plot (3,215 kg/ha) than the control (1,895kg/ha). The IPM module consisting of HDP net, T-shaped perches and NPV were used to control *Helicoverpa armigera* larvae, from which T-shaped perches with NPV proved effective in controlling medium and large-sized larvae in pigeonpea in Gujarat. In castor, 22 species of birds controlled 48% of *Spodaptera litura*, while in Kerala Crow Pheasant (C*entropus sinenis*) devoured 5% of stem-borer larvae in cardamon and termites were voraciously fed by common crow (C*orvus splendens*). In tomato, 11 species of insectivorous birds reduced 25% of *Helicovepa armigera* larvae, while in chickpea 8 species of birds reduced 20-23% of *H. armigera*.

In muskmelon, watermelon and bitter gourd crops, artificial perches attracted 6-13 species of birds. Standardized nest boxes design for cavity nesting birds and succeeded in breeding success of 14 species of birds. The comparative studies on feeding behaviour of 3 species of owls Barn owl, *Tyto alba*, Fish eating owl, *Bubo flavipes* and spotted owlet *Athene brama* revealed that rodent remnants (82%) in Barn owl diet, crab remnant(65%) in Fish owl and insecta (60%) in Spotted Owlet were found throughout the season.

Insect biosystematics: Exploration of insect and mite biodiversity led to surveys in 19 states and 86 districts of India, covering all the important *kharif* agro-ecosystems. These have led to collection of 72,343 specimens of major insect and mite groups. Majority of these have been processed for biosystematic studies. These collections have

SUCCESS STORY

Rodent control campaign

Based on knowledge, attitude and practice (KAP) analysis, farmers' awareness through trainings, field demonstrations rodent control campaigns was organized on community basis in 80.0 ha cropped area in Penumachili village of Achata Mandal, West Godavari district. On the basis of mean live burrow counts, the bait requirement for the block was arrived. Bromodiolone (0.005%) poison bait was prepared by involving the farmwomen at temple centre of the village and the bait was made into packets of 10g each and applied @ one packet / burrow, covering field bunds, canal bunds and farmhouses. Rodent control success of 84.81 % in *kharif* and 90.58% in *rabi* was achieved in the village. As a result, farmers harvested an additional yield of 240.5 kg/ha in *kharif* and 202 kg/ha in *rabi.* Farmers were benefited with Rs 50 in *kharif* and Rs 54 in *rabi* for every one rupee spent towards rodent

taken the accessions of agriculturally important insect and mite biodiversity to more than half a million. More than 90 % of these had been taxonomically characterized and subjected to morphological studies.

The biosystematic studies have led to morphological characterization of 280 species under 50 genera of insects and mites of agricultural importance. These comprise more than 802 illustrations and photographs on taxonomic characters and field diagnostics. The highlight of these studies includes description of 53 new species of insects and mites of agricultural importance and a large number of parasitoids of biological control significance. These include description of two new species of mites, namely *Acalitus delhiensis* and *Cosetacus sharadi* published in a high impact factor international journal Zootaxa; diagnostics of lepidopterous pests of vegetables, in particular, the Pieridae; ecological observations on the outbreak of migratory locust *Locusta migratoria migratorioides* in the cold desert agro-ecosystems of Leh, Ladakh; revisionary studies on three genera of Coccinellidae and Chalcidoidea; updating and digitizing of computerized databases of identified insect collections at National Bureau of Agriculturally Important Insects and the National Pusa Collection at IARI; and preparation of illustrated diagnostic keys for the families of major insect and mite groups occurring in different agro-ecosystems of India.

Rodent damage vis-à-vis commensalization of field rodents

Indian gerbil, *Tatera indica*, essentially a field rodent species established its population in residential and grain storage areas. The gerbil species had shown predominance round the year with 57-85% share (mean 66%), followed by *Rattus rattus* (mean 34%). In Punjab, trappings carried out during August-September revealed the presence of *B. bengalensis* along with *R. rattus* in human inhabitations indicating commensalization of *B. bengalensis*. Its commensalization was also seen in residential premises including grain storage in both rural and urban areas (26.19%) of Assam, potentially threatening food security.

Rodent damage and behaviour

Bait shyness in *T. indica* and *F. pennanti:* Zinc phosphide induced bait shyness in *T. indica* persisted for 73-75 days at mean temperature of 31° C, which was reduced to 50 days at 21° C. The younger gerbils (<100g-body weight) recovered the shyness behaviour earlier to older ones. Similarly, in case of *F. pennanti* shyness behaviour lasted for 20-25 days.

Rodent abundance vis-à-vis mulching: The mulched fields encouraged higher rodent population in Assam. Maximum rodent abundance (4.67 burrows/20 m^2) and damage (11.65%) were recorded in water hyacinth mulched and intercropping with pumpkin as compared to 0.33 burrows/20 m^2, in the control.

Rodent damage: Rats and squirrels inflicted about 54.2% pod damage to cocoa, intercropped in coconut orchards. In South Andaman, rodent damage was observed preferably to young and tender coconuts in both dwarf and tall varieties. The damage of 8.57-26.67% was observed in all coconut-growing areas of South Andamans. In Asom, rice grown as *Bao* suffered maximum rodent damage (13.75%), followed by sugarcane (11.33%), pea (9.43%), rice grown as *Sali* (9.02%) and potato (8.98%). *Rabi* vegetables also suffered up to 9.89 % in pumpkin and 6.59 % in bottle gourd.

Rodent management strategies

Leaf powders of *Vitex nigundi* and *Polygonum* treated food recorded least preference by *Rattus rattus* in laboratory, indicating anti-rodent properties. Field trials with castor-based herbal repellent showed higher repellency against rice rodents, followed by castor oil *10%* and pongamia oil *10%* in Godawari delta region. Five days exposure of bait containing 0.1% eucalyptus oil to *B. bengalensis* revealed repellent effect of eucalyptus oil. Oral intubations @ 40 and 80 mg/kg dosage of pure gossypol and 100 and 200 mg/kg of seed extracted gossypol did not cause any toxic and antifertility effects in *B. bengalensis*.

Feeding trials with a plant origin compound, 'Bio' containig glucosides of *Tripterygium wilfordii* in noodle formulation (0.25%) is being done.

Single oral administration of three doses of triptolide to male *R. rattus* revealed no mortality at 50 mg/kg dose. However, at 100 and 150 mg/kg, it resulted in 16.67 and 33.33% mortality within 1-3 days. Sperm mortility, viability and morphology were found affected.

Application of zinc phosphide through plastic cover at tillering and maturity stage, removal of bushes and weeds, trimming and cleaning of bunds at monthly interval resulted 62.68 and 70.96% reduction in crop damage and rodent population, respectively. In Assam, trapping with cage trap@40/ha at maximum tillering stage followed by one application of 2% zinc phosphide baiting at panicle initiation stage could effectively control *Bandicota bengalensis* in irrigated *Boro* paddy. Per cent control success was more where bait was kept in paper bags.

Recommendation on modification in critical

timings of rodent pest management in groundnut crop has been included in package of practices for *kharif* crops of PAU, Ludhiana. Encapsulation of zinc phosphide in bait form has been successfully attempted.

Bamboo flowering and rodent problem in NEH Region: Gregarious flowering of *Melocanna bacifera* was reported in all the three Garo Hill districts and West Khasi Hills of Meghalaya and Assam. There was no sign of upsurge of rodent population in Meghalaya as rodent damage to almost all crops in bamboo flowering areas was normal except certain locations, where slight increase in damage was reported in paddy and maize. Feeding of bamboo fruits did not show any effect on reproductive parameters of rats under laboratory condition.

Under arid farming systems, double baiting by integrating acute and chronic rodenticides fetched highest rodent control success in pearlmillet and in moth on 15th DAT. Double baiting seemed to have an edge due to quicker and sustained management of rodent pests.

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Livestock Management

LIVESTOCK PRODUCTION

Strategic supplementation of macronutrients: Supplementation of locally available energy rich feed ingredient (*ragi* grain) to lactating cows increased milk production (1.0–1.5 kg) and milk fat (0.25–0.5%), and reduced milk urea nitrogen (MUN) and thereby increased cost-benefit ratio.

Strategic supplementation of maize grain and protected fat improved or maintained milk production in 60% of lactating cows. Supplementation of mixture of barley and mustard cake (1:1) to growing heifers on wheat straw based rations showed that the mixture of protein and energy was a better supplement than either barley or mustard cake alone. Mixture of maize and niger cake supplementation increased milk production by 0.5 kg/day in lactating animals. A limited supplementation of wheat bran (250 g/head/day) and common salt (20 g/head/day) or barley (250 g/head/day) and area-specific mineral mixture (20 g/head/day) improved the body weight gain in growing male calves under grazing condition.

Area-specific mineral mixture: Supplementation of area-specific mineral mixture to lactating cows improved feed intake, milk yield, milk composition, efficiency of feed utilization and reproductive performance (like early exhibition of post partum estrus, higher conception rate with single insemination). Increase in daily milk yield was 0.5–1.0 kg/animal/day and fat 0.3 – 0.5%. Nutrient utilization, and mineral status as well as general health of the animals improved on supplementing the area-specific mineral mixture.

Bioavailability of micronutrients: Tissue level utilization of Cu and Zn was more in ewes supplemented with organic than inorganic sources of Cu and Zn. Supplementation of organic mineral at lower levels as compared to inorganic minerals showed similar performance with respect to body weight gain, absorption and retention of minerals in male calves. Supplementation of Zn and Cu from organic sources was more effective in inducing estrus in anoestrus crossbred cows.

Reproduction: Flushing of 6 donor Frieswal cows superovulated with 300 mg follotropin-V resulted into recovery of 24 embryos, out of which 10 were morulae, 2 blastocysts, 7 degenerated and 3 unfertilized ova. Transfer of 7 good embryos

Management information system for *Gaushalas*

A database integrating data on different aspects of *Gaushalas* was developed. This database on 105 *Gaushalas* of Haryana, has information on history, breed-wise herd strength, assets inventory, budget and expenditure, entrepreneurial efforts made by *Gaushala* management, linkages with other agencies, breed improvement programmes, maintenance of milk recording and pedigree of animals, common diseases, constraints and manpower employed.

Evaluation of unconventional feed resources

Costlier conventional cake like soybean meal was replaced completely by canola quality rapeseed-mustard cake (RMC) as a protein source in the diet of young calves. Though glucosinolates (anti-nutritional factor) of RMC appear to have no adverse effect on nutrient utilization, its feeding significantly reduces the palatability of concentrate and overall performance of animals. Overnight soaking of RMC in water drastically reduced the level of glucosinolates, however, feeding of water soaked RMC did not improve animal performance. Lime treatment of castor seed reduced (58%) its ricin (anti-nutritional factor) content. Feeding of raw and lime-treated castor seed cake did not affect the nutrient utilization, biochemical profiles of rumen and blood plasma as well as histology of vital organs.

to 7 recipients resulted into 3 pregnancies, confirmed on rectal palpation.

Ejaculates (1–134 ejaculates/bull) were collected from 87 Frieswal bulls. Thirty-one bulls produced 235,011 frozen semen doses (7,581/bull/year). The overall mean abnormal head, mid piece, tail and total abnormal sperms in seminal ejaculates of Frieswal bulls were 10.27, 4.93, 13.93 and 29.13%, respectively. A large number of Frieswal bulls (63.41%) produced non-freezable quality semen with a very high occurrence of abnormal spermatozoa in the ejaculates.

Methane emissions from manure of Indian livestock: The methane emission from fresh dung of indigenous Tharparker breed of cattle was 8.22 mg/day and in Sahiwal was 9.06 mg/day. Emission of methane was higher, about two-folds, in crossbred cattle (15.06 mg/day in Karan Fries) and Murrah buffaloes (14.45 mg/day) compared to zebu cattle. Methane emission from fresh dung on dry matter basis was low in zebu cattle as compared to crossbred cattle. The annual methane emission estimates from dung of Tharparkar was 3.00 kg, Sahiwal 3.3 kg, Karan Fries 5.4 kg, and in Murrah buffaloes 5.2 kg. Methane emission on storage increased after 8–10 hr of deposition, and emissions were at peak in about 8–10 days after deposition. Diurnal fluctuations in methane emission were also observed and were related to ambient temperature rise. Emission of methane was at peak during afternoon and thereafter, it declined during night due to low fermentation activity and decline in ambient temperature.

Buffalo

Isolates of sulphate reducing bacteria (SRBs) were isolated — 7 from rumen of buffaloes and 7 from faeces of buffaloes. Significant increase in digestion and gas production was observed from wheat straw when some of the SRB isolates were added to buffalo rumen liquor inoculum.

High energy fed buffaloes, showed lower ovarian activity and gravid status, indicating adverse effect of abrupt change in ration. Field level demonstration indicated that replacement of cotton seed cake with cheaper mustard cake in prevailing feeding practices of cattle and buffaloes saved Rs 90/animal/month without compromising on milk production.

Bioavailability of micronutrients: Concentrations of Zn and Cu in fodders cultivated in various soils of district Meerut were within normal range. The Zn, Cu and Co content of water collected from different areas ranged between 0.059 and 0.2, 0.039 and 0.048 and 0.042 and 0.134 ppm, respectively. Groundnut cake and gram *chuni* had higher Zn than the reported values. The concentration of Zn, Cu and Co in blood plasma of cattle and buffaloes were optimum and within the normal range of 1.98–2.19, 1.36–1.63 and 1.23–1.85 ppm.

Enhancing conjugated linoleic acid (CLA) in milk: Green fodder feeding increased milk CLA in cows and buffaloes. Further, it increased up to 310% in *ghee* prepared by indigenous method. Feeding CLA during the exposure of rats on carcinogen, enhanced liver and RBC lysate antioxidant enzyme activities (catalase SOD and GST), reduced liver lipid peroxidation and mammary cancer risk (37%). Milk having high CLA (19.50 mg/g fat) may be consumed @ 3 litre/day (provide 3 g CLA) to have a protection against cancer; however, normal milk required more than 13 litre to achieve this protection.

Sperm quality: CASA parameters for sperm motility, progressive motility and rapid motility in higher, medium and lower fertility groups of bulls revealed that these parameters did not vary significantly between medium and high fertility group, whereas, differed significantly from the lower fertility group; thus enabling identification of poor fertility bulls.

The study on requirement of minimum number of sperms in an insemination dose to make more efficient use of quality semen from superior bulls,

SUCCESS STORY

'GARIMA'
World's Second Cloned Buffalo Calf

World's second cloned buffalo calf produced through the new and advanced 'Hand-guided cloning technique', was born at the NDRI, Karnal on 6 June 2009. The scientists of NDRI had developed this land mark technique, and had also produced the world's first cloned buffalo calf on 6 February 2009. This cloned buffalo calf was different from the first one, as in this case the used donor cell was taken from a foetus. However, in world's first cloned buffalo calf, produced earlier through this technique at the NDRI, the donor cell was taken from the ear of a newborn calf. In other words, this buffalo calf was a clone of foetus that had not even seen the light of the day. The hand-guided cloning technique is an advanced modification of the conventional cloning technique.

revealed that conception rate with 25 and 15 million dose of spermatozoa is similar. Pregnancy could also be achieved with 5 and 3 million dose of spermatozoa with conception rate of nearly 20%.

Sheep

Grazing resources constitute major source of forage for sheep under existing system of extensive management. Undeveloped lands yield 9–14q of forage during different months of a year. The dry matter (DM) intake in dry ewes ranged from 672 to 1,251 g, and digestible crude protein (DCP) 115.11 g and metabolizable energy (ME) 98.82 kJ. Sheep were unable to meet DM and DCP requirements except energy on undeveloped lands of semi-arid region of Rajasthan, and need strategic supplementation of the limiting nutrients for enhancing production and reproduction.

Prosopis juliflora (*Vilayati babool*) is widely found across the country and poorly utilized by animals owing to higher toxins. Methanol treatment was effective in ameliorating toxic effect but is relatively costlier.

Commercially available microbial feed additives containing *Saccharomyces cerevisae* + *Lactobacillus sporogenes* enhanced growth by 12.0% and feed intake by 11.6% in fattening lambs for mutton production.

Fat incorporation up to 5.00% level in the ration of lamb increased weight gain, improved feed conversion ratio, maintained carcass quality within acceptable norms, reduced feeding cost/kg weight gain, improved benefit: cost ratio, and was advantageous in lamb feeding for mutton production.

Malpura male lambs reared under intensive management system produced good quality semen at 9–12 months of age for breeding and AI purposes. The concentrate mixture feeding @1.5% of body weights during autumn increased the lambing rate to 91.6% compared to 72.7% in non-supplemented animals. The ovagen in conjunction with progesterone increased lambing percentage to 133% compared to 88.8% under routine practice in Malpura sheep. Daily milk yield of Patanwadi sheep was 783 g and of Malpura 515 g under optimum feeding condition.

Better lamb weight at young age

Most of the farmers sold their male lambs at 3–4 months of age at body weights of 12–13 kg mainly due to immediate financial requirements, feed and fodder scarcity in the region and also due to fear of mortality losses. The supplementation of concentrate mixture @ 1.5% body weight during post-weaning stages improved body weights by 24.18% and farmers fetched 25–33% more price in the market.

Goat

Oilseed cake containing diet for Barbari goats: Goats fed rations containing cotton seed cake and linseed cake in the ratio of 50:50 showed better results in terms of — weight of pregnant Barbari does just before kidding and weight of does just after kidding. Higher ratio of linseed cake in the diet of does was more effective for higher milk yield and subsequently higher body weight of kids up to 14 weeks of age. Diet containing cotton seed and linseed cakes in the ratio of 50:50 was more effective in pregnant and lactating Barbari goats and on the growth performance in kids.

Complete pelleted feed

Complete pelleted feed with concentrate mixture: roughage ratio of 40: 60 could be used for goat production without affecting any carcass traits and meat quality. This complete pelleted feed is economical also.

Post-thaw seminal parameters: Ejaculates form adult Jamunapari bucks (3–5-year-old) were prepared by conventional method of freezing and the results showed that 10% egg yolk and 4 hr of equilibration period was the best combination for semen freezing.

Effects of antioxidants on liquid storage of buck semen: Ejaculates from adult Sirohi bucks,

Reducing the post-partum interval

Indigenously prepared sponges/injections with hormones (eCG, PMSG,GnRH) were used in 16 Jamunapari goats and they were regularly checked for oestrus at 12 hr interval by an aproned buck for 30 minutes. Oestrus response and conception rate following the use of intra-vaginal pessaries in two groups of Jamunapari goats are as follows:

Treatment groups	Oestrus response (%)	Onset of oestrus (hr)	Duration of oestrus (hr)	conception rate (%)
Group 1	5/4 (80%)	21.00 ±10.24	24.00 ±12.96	75
Group 2	9/9 (100%)	34.66 ±5.81	22.66 ±2.40	77.77

prepared at various levels of different antioxidants revealed that semen extended to the diluents having antioxidants (3 mM vitamin C, 1.5 mM vitamin E, 5 mM glutathione oxidized and 5 mM glutathione reduced respectively) can be stored up to 96 hr at refrigeration temperature.

Camel

Nutrition: Camels supplemented with 2 kg concentrate mixture and 50 g mineral mixture/ day on cluster bean straw-based diet showed improvement in milk production by 0.74 kg/day. The camel calves obtained from the supplemented dam showed better growth rate than the calves from unsupplemented grazing animals.

Lana seed diet: Lana (*Haloxylon salicornicum*) seed feeding to camel revealed that camels preferred these seeds in arid region and showed fairly good digestibility; and it can safely replace the conventional concentrate feed.

Yak

Trace mineral supplementation: Supplementation of area-specific mineral mixture (Zn, Cu, Co and Mn in the ratio of 40:20:2:1) to yak improved growth rate as well as milk yield of animals. It increased conception and fertility of yak and birth weight of yak calves. A higher monthly body weight gain of 15.17±2.05 kg was recorded by feeding complete feed block as compared to 5.07±0.87 kg in traditional feeding.

Effect of copper supplementation on reproductive traits of yaks: The soil, feeds and fodders of the yak rearing hilly tract of Arunachal Pradesh are deficient particularly in copper. Yaks are genetically susceptible to copper deficiency. Supplementation of basal diet of yaks with copper sulphate (200 mg/animal/day) effectively enhanced the reproductive performance of animals as the number of animals exhibiting estrous increased significantly from 39.8% to 100%. The number of service per conception decreased to 1.5/animal/ conception from 3.5–4/animal/conception. Postpartum involution period decreased significantly (60–90 days from 1 to 1.5 year) after supplementation.

Deep freezing of yak semen: A protocol for deep freezing of yak semen was developed. Suitable semen extenders for deep freezing and refrigerated storage (at 5°C) were also evolved. For *in-vitro* production of yak and its hybrid embryos more than 50 oocytes were recovered from the yak ovaries within 2 hr of animal death. The quality oocytes were further cryopreserved by vitrification.

Adaptability of yaks: Yaks do not experience cold stress but are susceptible to heat stress during summer at an altitude of 2,750 msl. Temperature humidity index (THI) was suitably modified for yaks according to altitude and environmental conditions.

Diurnal variations on physiological responses: The study on diurnal variations in the physiological responses of yak calves, adult bulls and lactating cow revealed that the physiological responses were at minimum in the early morning and maximum during late afternoon. The physiological responses of calves were significantly higher than adult bulls and lactating yak cows during late afternoon. In all yaks physiological responses were significantly higher during summer compared to winter.

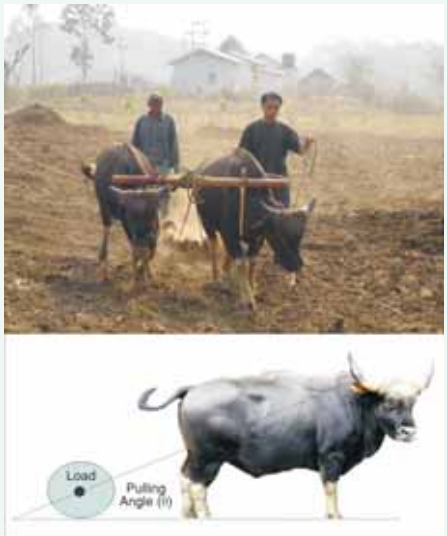
Environmental effect on female yaks: The environmental conditions influence the reproductive traits of female yaks. The breeding season starts in July and reaches its peak from September to November at altitudes of 2,750 m above msl. The exhibited estrous and conception rate were highest from September to November.

Mithun

Performance of mithun and Tho-Tho cattle on tree leaves based ration: Mithun, a unique animal of NEH region of India, has lots of similarity with Tho-Tho cattle, which are inhabitants of Nagaland. Mithun and Tho-Tho cattle fed on mixed tree leaves/shrubs (*Quercus polystachya, Dillenia pentagyna, Lagerstroemia* spp and *Ficus hirta*) with paddy straw (2:1 ratio on fresh basis) along

Draught capability

Mithun bulls were trained for work to assess their draught capability. Adult bulls were not much obedient and difficult for imparting training for work. Later 2 young bulls (less than 2 years of age and body weight ~140 kg) were trained successfully for work. The preliminary approximate estimation indicated that average draught power of a pair of mithun bulls was 0.60 KW.



with concentrate mixture revealed that mithun attained ADG of 507.8 g with DMI of 6.59 kg whereas cattle attained ADG of 392.8 g with DMI of 5.88 kg/day. Overall growth performance was statistically higher in mithun than that in cattle. Weight of the inedible organs like head, limbs and tail weight were more in mithun signifying a higher body sized animal in mithun than cattle. Mithun had higher dressing percentage than that of cattle. There was positive relationship of carcass weight with rib eye in both mithun and cattle. However, there was positive relationship of rib eye area with fat thickness in cattle whereas the relationship was negative in mithun.

Melatonin precursor supplementation alleviated aflatoxicosis

Aflatoxin inclusion in the feed @ 0.5 ppm caused significant reduction on the performance of broilers. Supplementation of melatonin (40 ppm-20 mg/kg bw through IP route and remaining half through feed @ 20 ppm) and its precursor (tryptophan-250 ppm) or toxin binder (250 ppm) numerically improved the performance when offered individually. However, the combination of melatonin and toxin binder significantly improved the performance. Combination of melatonin @ 40 ppm and toxin binder @ 250 ppm alleviated adverse effects of aflatoxicosis in broilers.

Pig

Hormonal regulation of fatty acid synthesis and desaturation: The exogenous growth hormone (GH) and insulin administration increased the body weight gain in grower pigs. Exogenous insulin increased serum GH, insulin, leptin and BUN while decreased serum triglyceride levels. Exogenous GH increased serum GH, insulin, triglycerides, glucose, and decreased BUN levels. The growth hormone decreased the expression of lipogenic genes fatty acid synthase (FAS) and stearoyl CoA desaturase (SCD) under both in *vivo* and *in vitro* conditions in porcine subcutaneous adipose tissue. The leptin under *in vitro* conditions decreases mRNA abundance of both FAS and SCD genes. The insulin increases expression of sterol regulatory element binding protein 1 c (SREBP-1 c), peroxisome proliferator activated receptor γ (PPAR γ) and CCAAT enhancer binding protein β (CEBP β) genes suggesting that insulin may activate lipogenesis and adipogenesis in adipose tissue.

Preservation of boar semen: Methods were standardized for the preservation of boar semen for carrying out artificial insemination (AI) in pigs. Boars of different strains and breeds were trained for semen collection. Gloves hand method of semen collection was standardized and evaluated for semen volume, sperm motility, percentage of live and dead spermatozoa and concentration of spermatozoa.

Poultry

Antioxidant based feed formulation and herbal drug: An antioxidant (vitamin E) with a medium dose (300 mg/kg feed) in combination with liver stimulant (5 g/kg feed) was found detrimental for egg production in birds. A proper combination (dose) of liver stimulant and antioxidant is to be given to the hen as these combinations are highly interactive and may cause reduction in egg production.

Effects of moulting by feed withdrawal and mineral induced method: After 14 days of forced moulting by feed withdrawal (FW), high zinc (ZnF) and aluminium feeding (AF), significantly reduced body weight in FW (25%) followed by ZnF (24%) and least in AF group. Caspases 2, 3 and 6 appeared to be the key players in the regression of ovary under moulting in both FW and ZnF treatment groups. Zinc induced apoptosis of hen's ovaries through an intrinsic mechanism. Apoptotic gene p53 appears to play a major role among the mitochondrial apoptotic genes in the regression of magnum. IFN γ gene was upregulated in uterine tissues of hens moulted by either FW or ZnF indicating its major role in the uterine regression during moulting in White Leghorn hens.

Trace mineral bio-availability in broilers is age related: Trace mineral (Zn, Mn, Cu, Fe and Se) uptake by broiler chicken as determined by their concentration in tissues (bone and liver) revealed considerable influence of age on mineral retention. The concentration of Zn (354–451 ppm), Mn (16.4–18.6 ppm), Cu (10.5–11.2 ppm) and Fe (254–321 ppm) in tibia significantly declined with the advancement of age from 2 to 4 and 6 weeks, implying higher need for these minerals during early period of growth. The same trend was also noticed with the uptake of minerals by hepatic tissue. In contrast, Se retention was more in tissues during the later period of growth (4 and 6 weeks) than that in the second week. The biological need of trace minerals was not the same in broilers for the entire 6-week period and supplemental levels are to be optimized based on age related needs.

Early post-hatch nutrition in broilers: Single intubation of starch, soybean oil, starch + casein, starch + soybean oil or starch + casein + soybean oil into the crop of broiler chicks immediately after hatch produced positive long-term effect on body weight of broilers. However, casein alone or in combination with soybean oil did not prove to be advantageous compared to the above listed combinations. The combination of carbohydrate

AICRP on Improvement of Feed Resources and Nutrient Utilization in Raising Animal Production

- Supplementation of bypass nutrients in the form of formaldehyde treated *guar* meal/rape seed meal and calcium salts of palm oil/rice bran oil to lactating buffaloes and cattle improved milk yield (1–2 kg/day/animal), reproductive efficiency and sustained peak milk yield for longer period
- Strategic supplementation of limiting macronutrients with locally available feeds and concentrate mixture to medium producing dairy cattle under field conditions increased milk yield (1–1.5 kg/day/animal), milk composition, and reproductive efficiency.
- Feeding of complete feed blocks or pellets to dairy cattle and buffaloes under grazing system improved milk yield (1.0 kg/day/animal), fat content and maintained the persistency of production. This approach is most suited for scarcity situations under field conditions.
- Areca (*Areca catechu*) sheath, a by-product of areca plantation proved a valuable roughage source for dairy animals, were superior to paddy straw with respect to nutrient utilization, mineral and lignin content.
- Supplementary feeding of concentrate mixture to kids of Jamunapari and Sirohi goats and lambs of Malpura sheep @ 1.5% of their body weight showed better growth and health, and attained marketable weight earlier than unsupplemented kids/lambs.
- Supplementation of copper and zinc in chelated form to lambs of Rambouillet sheep under intensive feeding system improved their antioxidant and immune status.
- Supplementation of protein through soybean meal along with other ingredients showed better growth and health in pigs. Supplementary feeding of mineral-vitamins-amino acid mixture to breeding and lactating sows resulted in increased weight of piglets, weaning percentage and better profit.
- Feeding of feed blocks comprising local feeds/fodders, molasses and minerals were advantageous to yak during winter in high altitude.
- Enriching and ensiling of sugarcane tops improved its nutritive value for feeding to cattle.
- Mineral profiles of soil, feeds/fodders and animals in Tripura and Sikkim revealed that calcium, phosphorous, copper, zinc and manganese were the most limiting minerals for livestock production in these regions.

and fat yielded better results than that of fat + protein. The chicks could utilize carbohydrate better than fat during initial post-hatch period.

Organic acid in broiler diet: Butyric acid @ 0.4% in the diet of broiler chicken enhanced body weight gain and feed conversion efficiency and reduced *Escheriehia coli* count. Several additional effects such as stimulated growth of intestinal villi, higher carcass yield and low abdominal fat content were also observed by dietary addition of butyric acid.

Alternate feed ingredients for Krishibro broiler: The Krishibro chicks responded similarly to 3-phase and 2-phase feeding regime during 0 to 6 weeks of age. Replacement of maize with dried distillery grains on *w/w* basis in their diet indicated that dried distillery grains could replace maize with beneficial effects up to 33% level, and higher levels of inclusion were detrimental. Sunflower cake could be used for replacing soybean meal protein up to 50% in the diet of Krishibro.

Nutrient requirements of Vanaraja chicks: Replacement of soybean meal with mustard cake depressed performance of *Vanaraja* chicks, and additives betaine, Cu, liver tonic etc. were not useful in amelioration. Dietary supplementation of certain herbal extracts improved feed conversion efficiency and antibody response in normal chicks. Na or Cl concentration in diet beyond 0.2% adversely affected cell-mediated immune response and enhanced tissue oxidation. Soya isoflavin in diet positively influenced tissue oxidation and immune response.

Pesticide residue in feed and poultry products: In northern region under study, the residue level of BHC in muscle of chicks ranged from 0.05 to 0.25 ppm whereas in liver, adipose fat, poultry feed and egg it was in the range of 0.02 – 0.1 ppm, 0.1 – 0.2 ppm, 0.15–0.25 ppm and 0.01 – 0.015 ppm, respectively. Samples collected from Haldwani and Lucknow had lower occurrence (8.33%) of residue of BHC than those of Gurgaon and Delhi. The level of DDT was recorded to be 0.03 – 0.1 ppm in muscle, 0.05 – 0.1 ppm in liver, 0.1 – 0.2 ppm in adipose tissues, 0.01–0.02 ppm in egg and 0.1–0.2 ppm in poultry feed. DDT was more (20%) in adipose tissue collected from Delhi market. Like BHC, samples from Haldwani and Lucknow had similar pattern of residue level of DDT. The market samples had relatively higher levels of residues as compared to that of the farm samples but all the samples analyzed had these residues below their MRLs.

Cloacal foam in quail reproduction: A study, carried out using perivitelline technique and AI to understand the actual role of foam during natural mating, revealed that foam has a role in sperm transport.

LIVESTOCK PROTECTION

Foot-and-mouth disease

During the year, 511 outbreaks were recorded as against 1,211 outbreaks during the year 2007–

08. Virus could be diagnosed in 376 samples (serotypes O-334, A-26 and Asia1-16). In all the geographical regions, other than central India, serotype O was the most prevalent one. Asia-1 was completely absent in Southern India, whereas type A was absent in the Central and Northern India.

This year, 53 virus isolates including 41 type O, 3 Asia-1 type and 9 A type field isolates were added to the National FMD Virus Repository. At present this national repository contains 1,455 (934, O; 264, Asia -1; 242, A;15, C) well characterized field isolates.

Molecular epidemiological analysis of 40 serotype O isolates, drawn from 14 states revealed complex genetic diversity of the field isolates in the country, which was not reflected in antigenicity. This year, 'Ind2001' strains re-emerged in Northern and Southern states of the country. The "PanAsia II" strain, which dominated serotype O outbreaks in previous year was restricted to only a few states, while the parental PanAsia strain (PanAsia I) was detected in Bihar, West Bengal and Orissa. In type A, all the isolates clustered within genotype VII and precisely in the VP3[59] deletion group.

FMD Control Programme

Seven regional FMD centers and the Central FMD Laboratory participated in the sero-monitoring programme. Gradual increase in protective antibody response was observed subsequent to phase 1 vaccination and the titre of the protective antibody level was monitored.

SUCCESS STORY

Foot-and-mouth disease kit (rDIVA-FMD Kit): Development and application

Foot-and-mouth disease (FMD) continues to be a challenge as far as international trade of livestock and their products is concerned. As FMD is endemic, vaccination with inactivated vaccine is the sole mode of control. In such a scenario, it is essentially required to have a DIVA test in place to differentiate virus infected animals from those vaccinated with inactivated FMD vaccine. ELISA was developed at the Central FMD Laboratory, Project Directorate on FMD, Mukteswar, for differentiation of FMD virus infected from vaccinated animals (DIVA). This indigenously developed rDIVA-FMD kit is the first of its kind in the country and was designed as per the OIE approved guidelines and its cost is one-fourth of the commercially imported DIVA kits. Random bovine serum samples (18,326) collected @ 100/ district from 234 districts covering 20 different states of the country were tested in DIVA ELISA; this revealed that 28% of the bovine population in the country to be FMD infected during 2008–2009 at confidence level of 95%.

FMD virus typing ELISA kits were manufactured and supplied which ensured uniformity in application and test result across the country.

FMD reference laboratory: The institute PD FMD has got the world recognition and is now a member of the Global FAO/OIE Network of FMD Reference Laboratories that constitutes of 10 other FMD laboratories in the world. This institute also participates in global FMD vaccine matching exercise, and is also a member of Global Foot and Mouth Disease Research Alliance (GFRA). Establishment of this international laboratory at Bhubaneshwar, with state-of-the-art features of bio-safety and bio-containment (BSL 3+) will facilitate Global participation, and eradication of the disease from South Asia.

Animal Disease Monitoring and Surveillance

Infectious bovine rhinotracheitis: Six suspected tissue samples were processed for the diagnosis of BoHV-1 infection and all were found positive by PCR using primers specific to the gB (443 bp) partial gene of BoHV-1. Detection of BoHV-1 in semen samples by real time PCR was optimized. Serum samples (4,821) collected from Andhra Pradesh, Gujarat, Jammu and Kashmir, Jharkhand, Karnataka, Maharashtra, Manipur, Orissa, Rajasthan, Tamil Nadu, and West Bengal were subjected to Avidin Biotin ELISA, and out of these 1,423 serum samples were positive for antibodies against BoHV-1.

Classical swine fever: Analysis of blood and tissue samples from swine for virus isolation showed at least two populations of subgroup 1.1-viruses involved in the outbreaks during 2006–08 in the country. Sero surveillance of pig serum samples from Andhra Pradesh (377), Karnataka (294), and Kerala (156) indicated that 25% samples were positive for antibodies against CSFV.

Brucellosis: Serum samples (948) with the history of abortion, repeat breeding problems and retention of placenta were collected and screened for the presence of anti-*Brucella* antibodies using

SUCCESS STORY

Development of Indirect ELISA for diagnosis of brucellosis in small ruminants

An indirect-ELISA (i-ELISA) for diagnosis of brucellosis in small ruminants was developed and optimized. Results of i-ELISA were compared with that of RBPT and STAT using sera (398 goats and 604 sheep) of small ruminants and taking CFT as gold standard. RBPT showed the least relative sensitivity in, both, sheep and goats, and I-ELISA could be used as a validated test for diagnosis of brucellosis in small ruminants.

PCR technique. The prevalence of anti-*Brucella* antibodies in cattle ranged between 11.66% and 61.17% (RBPT), 11.66% and 55.29% (STAT) and 39.50% and 75.29% (AB-ELISA). Out of 97 buffalo serum samples tested, 3 (3.09%), 1 (1.03%) and 5 (5.26%) showed positive reaction for the presence of anti-*Brucella* antibodies by RBPT, STAT and AB-ELISA, respectively. An indirect-ELISA (iELISA) was used for screening of brucellosis in swine, and *Brucella abortus* was isolated from pigs, which strengthens the notion that *Brucella* spp infects unnatural hosts also.

Trypanosomiasis: Sensitivity and specificity of diagnostic PCR for detection of carrier status of *Trypanosoma evansi* was tested. The primer pair showed 400 bp amplification with genomic DNA isolated from dog, lion and leopard. Detection of viability of *T. evansi* in frozen tissues showed that none of the mice revealed the presence of parasite on blood smear examination. In buffalo blood, the PCR could detect the genomic DNA isolated from buffalo on third day post-infection onwards. Screening of 1,015 serum samples for anti-*N. caninum* antibodies showed that among the sero-positive cattle 63.73% were having the history of reproductive failure whereas among sero-negative cattle only 16.03% had history of reproductive failure.

Food-borne pathogens: Food-borne pathogens were isolated and identified, and confirmed by PCR in livestock and livestock products, and an RTPCR assay was also standardized for *Listeria*.

National Animal Disease Referral Expert System: NADRES, developed to carry out epidemiological studies, is a web-based interactive programme, created using regression analysis based on databank animal disease trends, disease prevalence, meteorological data, land use data, human demography, soil pattern data and crop production data. It can predict the probability of the occurrence of 10 major livestock diseases in any particular district of the country. The program is available for the general public and can be accessed at www.nadres.res.in.

Patent application filed

- Recombinant antigen based rapid sero diagnosis of infectious bursal disease. (Patent application No. 491/DEL/2008 dated 03/03/2008)
- Development of a novel bilateral external skeletal fixation device for the management of long bone fractures in large animals (Patent application No. 1964/DEL/08)

Gasto-intestinal parasitism

Epizootiological studies on gasto-intestinal parasitism in livestock farms and villages of different climatic zones showed that in Rajasthan the suitable period for propagation of *Haemonchus contortus* and *Trichostrongylus* spp. is from mid-May to mid-October and from October to mid-February, respectively, in semi-arid zone and from June to mid-September (*H. contortus*) and October to April (*Trichostrongylus* spp.) in arid zone. A software 'FROGIN' was developed for precise prediction and forecasting of haemonchosis in sheep and evaluated in semi arid and arid zone of Rajasthan and anthelmintic intervention was made accordingly to limit the intensity of infection. Genetic improvement of resistance to *Haemonchus contortus* in Malpura sheep showed that magnitude of monthly mean FECs remained lower (15.02% in May to 72.43% in November) in R-line compared to S-line. Similarly, in Avikalin sheep, monthly mean faecal egg count (FECs) ranged from 4.61% (September) to 67.93% (November) lower in R line compared to S line. Keeping in view the level of anthelmintic resistance in *Haemonchus contortus* a mechanism based on conjunctiva colour (targeted selective approach) was developed for further reducing drenching frequency in sheep flocks. Implementation of this approach in sheep flocks reduced anthelmintic use by 70% as only 30% of animals required anthelmintic intervention during wormy season in Rajasthan. Prevalence of GI infection in Tarai of Uttarakhand, in cattle was highest (17.32%) in June, in buffaloes (16.66%) in February, in sheep (100%) and goats (95.31%) in July. In Sikkim, *Haemonchus, Bunostomum, Nematodirus* and *Oesophagostomum,* spp. helminthic infections were recorded higher in goats (76.16%) than cattle (31.49%) and yaks (26.66%). *H. contortus* was predominant infection in all the 3 species. Infection rate was higher in high rainfall area (60.7%) than rest of the zones with least infection (41.5%) in Western zone of Tamil Nadu. Immunization trials

SUCCESS STORY

Development of post milking teat dip for prevention of bovine sub-clinical mastitis

An ideal herbal post milking teat dip for prevention of sub-clinical mastitis in lactating dairy animals was developed to reduce the somatic cell count (SCC), total bacterial count (TBC), besides to minimize chemical residues in the milk. The newly developed polyherbal post-milking teat dip was developed using easily available medicinal herbs and its production cost is very low. The ingredient can be easily procured by the farmers and the dairy owners for its preparation. This polyherbal post-milking teat dip was effective in reducing the SCC and TBC in cows.

SUCCESS STORY

Bilateral External Skeletal Fixation Device for Treatment of Long Bone fractures in Large Animals

Management of long bone fractures in large animals is a great challenge to veterinary surgeons. Heavy body weight of animals, angular placement of long bones, and problems associated with postoperative management make the fracture fixation difficult. To address this a simple design involving fixation of bone fragments using transosseous fixation pins was developed which provides rigid fixation of long bone fractures and gives flexibility in the use of maximum number of transfixation pins for tackling compound fractures.

in sheep against *H. contortus* revealed that response of CD4 lymphocytes significantly improved following the priming and booster dose of H11 and H-gal-GP polypeptides.

Haemorrhagic septicaemia

A biofilm based vaccine was developed against sheep pasteurellosis and was found safe. More than 70 isolates of *Pasteurella multocida* belonging to cattle, buffalo, goat, sheep, pig, duck, poultry and deer were identified and characterized by conventional and molecular tools (PCR, REP-PCR, ERIC-PCR etc.). These isolates were typed as capsular types A, B and D and were sensitive to enrofoxacin, gentamicin, cefotaxime, cefatriaxone and ciprofloxacin antibiotics. The immunodominant plpE gene of *P. multocida* serotypes A, B and D was characterized by cloning and sequencing, and a new serogroup E of *Pasteurella multocida* was identified.

Bluetongue disease

Pentavalent bluetongue inactivated vaccine using montanide and saponin adjuvant was developed by two centres separately using Indian strain. The vaccine was released for commercialization. Eight isolates of BTV were isolated from goats and culicoides midges for the first time in India. Three new serotypes, i.e. BTV-3 (Kolkata and IVRI, Izatnagar) and BTV-16 and 21 (Hyderabad) were confirmed by RT-PCR and nucleotide sequencing. Thus 39 BTV isolates of 9 different types were deposited and maintained at the IVRI, Mukteswar.

Vaccines and therapeutics

- Complete HN and F genes of velogenic Newcastle disease virus responsible for outer membrane proteins (hemagglutinin-neuraminidase and fusion) were cloned in mammalian expression vector pVIVO-II-mcs for use as bi-cistronic DNA vaccine.
- Field trials of buffalo pox, orf, sheep pox, combined goat pox and PPR vaccines and safety testing of live attenuated camel pox vaccine revealed no adverse reactions.
- PLG nanoparticles encapsulating outer membrane proteins of *Salmonella* Gallinarum induced good IgA antibody response at local mucosal sites following oral immunization in chickens, for use as a suitable mucosal vaccine delivery system.
- The siRNA based antiviral therapeutic against rabies virus and bovine herpesvirus-1 was successfully analyzed in *in-vitro* cell culture.
- Staphylococcal lytic phages encoding anti-staphylococcal peptidoglycan hydrolyzing enzymes were cloned and expressed. Native peptides revealed a broad range of anti *Staphylococcus aureus* activity and are potential therapeutic candidates for mastitis therapy.

Diagnostics

Diagnostics like Taqman based one-step real-time RT-PCR, direct-ELISA and LipL32 for pestiviruses, brucellosis in sheep and goats and leptospirosis in cattle, respectively, were standardized.

Molecular characterization of pathogens/ receptors

- Sequencing of viral genomes from chicken, duck,goose and crow from west Bengal, Asom, Tripura and Sikkim revealed two phylogenetic groups of H5N1 viruses circulated during the period between January 2008 and May 2009, and the major group is closely related to isolates from Bangladesh.
- Out of 3 isoforms of β-tubulin gene, β-tubulin gene 2 could be identified as candidate gene for molecular detection of benzimidazole resistance of *Echinococcus granulosus*.

Ethno-veterinary medicine

Methanolic extract of *Ocimum sanctum* and *Tinospora cordifolia* showed potential against canine demodicosis. *Aegle marmelos* (*bel*) was effective in restoring ovarian cyclicity and improved fertility in anestrus buffaloes.

Surgical and clinical interventions

- A cervical splint for stabilization of fractures and dislocations of cervical vertebrae in dogs was successfully fabricated.
- The EDC-48 grafts were suitable for repair of skin and abdominal wall defects in rabbits.
- A cart for rehabilitation of dogs suffering from posterior paresis was developed.

SUCCESS STORY

Characterization of equine influenza virus isolated from 2008 outbreak in India

The disease was first diagnosed in Katra (Jammu and Kashmir) in last week of June 2008 wherein approximately 15,000 ponies and mules exhibited clinical signs. Subsequently, from July 2008 to March 2009, the disease was reported from Jammu and Kashmir, Himachal Pradesh, Delhi, Uttar Pradesh, Haryana, Rajasthan, Maharashtra, Karnatatka and West Bengal. Equines (2,414) from these states were screened, and 438 samples (18.14%) were found positive for EIV antibodies.

Typing of EIV isolates (5 from J&K and 2 from Karnataka) indicated H3 subtype isolates. Sequence analysis of haemaggltuinin gene of A/eq/Katra/06/08(H3N8) showed more than 98% sequence homology with A/eq/New Market/5/03, A/eq/Bari/05 and A/eq/Kentucky/5/02 isolates. Phylogenetic analysis of the HA gene confirmed the virus to be of Clade 2 of the Florida sublineage within American lineage. The HA1 gene sequence matched most closely to the isolates from China and that of Mongolia indicating introduction of the virus in India from northern international borders.

Quality control and production of veterinary biologicals

Different doses of viral vaccines (> 7 lakh), bacterial vaccines (2,870 doses) and diagnostics (91,194 ml) in addition to monovalent FMD vaccine (19.60 million) were produced and supplied to various establishments.

Equine diseases

A type-specific ELISA using EHV-1/4 recombinant glycoprotein G was developed. Multiplex PCR was further validated with 29 clinical samples suspected of EHV1/4, which differentiated the pathogens as EHV-4. Immuno-stick ELISA was developed as a pen-side test substitute to plate-ELISA for field diagnosis.

A laboratory-oriented kit was developed for equine piroplasmosis. The validation of this kit using OIE-approved CI-ELISA kit revealed DSp and DSn values of 0.97 and 0.96 for NRCE kit, which were comparable to DSp (0.95) and DSn (0.93) of OIE-approved CI-ELISA kit.

Veterinary type culture

At the recently established Veterinary Type Culture Centre standard operating procedures (SOPs) for animal cell culture, bacterial culture, and preservation were standerdized.

Field trial of equine herpes virus-1 vaccine: A field trial of an inactivated EHV-1 vaccine for control of abortions in pregnant mares was conducted, and its efficiency was checked with a commercial vaccine. Two booster vaccines were given at seventh and ninth month of gestation. Following vaccination, no adverse effect was observed. Response of vaccine was comparable to that generated by the commercial vaccine. This study revealed that vaccine developed by the NRCE could afford protective immune response in vaccinated animals and does not produce any untoward reaction in pregnant mares.

Diseases trend

Buffalo: Retrospective epidemiological analysis revealed that maximum mortality (7.03%) was in neonatal calves (< 1 month of age). Mortality trends revealed 29.17% pneumoenteritis, 27.15% pneumonia and 24.75% enteritis. Suitable package of practices have been developed for addressing the problem at field level.

Yaks: Yaks were screened by CHEKIT-*Chlamydophila abortus* enzyme linked immunosorbent assay for the detection of *Chlamydophila abortus* specific antibodies. The overall prevalence in yaks was 34.88%. The prevalence of *Chlamydophila abortus* specific antibodies was significantly higher in yak cows (40.74%) than among the bulls (25%).

Escherichia coli (EPEC) isolates from captive yaks revealed that 28.76% yak possessed at least one virulence gene. Among them 26.02% STEC and 2.28% EPEC strains were isolated. PCR showed that 35 (55.55%) isolates carried *stx1* gene, 51 (80.9%) possessed *stx2* gene and 10 both *stx1* and *stx2* gene.

Poultry: Administration of ND vaccine through feed and water was compared with that of regular intraocular vaccination in Gramapriya female line at PDP. HI antibody titers were 7.3, 6.5 and 7.5, respectively, in water, feed and ocular methods, respectively. Acidified iodine, peroxygen compound and acetic acid at 1%, 0.5% and 0.5% concentration, respectively, in hard water and soft water completely inactivated NDV both in the presence and absence of organic matter with 10 minutes of contact time.

FISHERIES

Capture Fisheries

Marine fish landings and catch structure: The marine fish landings in India during 2008–09 touched the 3.21 million tonnes mark with an increase of about 0.327 million tonnes (11.3%) against the estimates of the previous year. Pelagic finfishes constituted 53%, demersal fishes 27%, crustaceans 15% and molluscs 5% of the total landings. The west coast was the highest contributor

among regions and among states, Kerala (21%) followed by Gujarat (19%). Among the different commercially important varieties, oil sardine (*Sardinella longiceps*) was the single largest contributor to marine fish landings with 444,593 tonnes (14%) during the year, followed by penaeid shrimps (6.4%).

The estimated value of the total marine fish landings at the primary market level increased by 29% over 2006 touching Rs 171,330 million and earning over Rs 249,340 million in the retail market level. The percentage share of fishermen in consumer rupee (PSFCR) has also increased over the years.

High value fish like coastal tuna and oceanic tuna registered growth levels of 23% and 39% respectively. Studies on the exploitation pattern of oceanic tuna indicate its potential as a possible candidate for further exploitation while coastal tuna production has nearly reached optimum level.

The targeted fishery for the deep sea sharks on the west coast landed more than 14 species of sharks as well as chimaeras. Bramble shark landings by drift gill netters (DGN) is on the increase in Cochin during post trawl ban period.

Culture Fisheries

Costal aquaculture

Feed for mud crab: Digestibility coefficient for dry matter, protein and energy of sardine fish meal, *Acetes* meal, soya flour, wheat and rice was determined to ensure cost effectiveness in the formulation of an artificial feed for mud crab. Apparent energy digestibility was highest in fish meal and acetes meal (about 95%) in animal ingredients. Soybean meal also had high apparent digestibility (92%). The digestibility of rice and wheat was lower than that of the animal ingredients. The dietary requirement of calcium and phosphorus for mud crab *Scylla tranquebarica* was also determined using juvenile mud crabs. Diets containing 1–4% calcium showed better weight gain and minimal inter-moult duration (61 days to 56 days). Crabs fed with a diet without phosphorus showed poor weight gain and increase in carapace width. Diets containing 1.0–2.5% phosphorus showed better weight gain and increase in carapace width with minimal inter moult period (66 days to 52 days).

Biosecured zero water exchange system: The biosecured zero water exchange system technology adopted by farmers was further refined to improve the biosecurity protocols in shrimp farming. Use of beneficial microorganisms (*Lactobacillus, Bacillus, Pseudomonas* and probiotic yeast *Saccharomyces*) for controlling the pathogenic microorganisms and maintaining water quality was one of the major interventions in the refined technology. Under on-farm trial, an average production of 3,109 kg/ha, 80% survival, 7.95% gain in terms of production, 6.96% gain in survival rate and 10.24% gain in FCR were obtained in experimental ponds in comparison to the control ponds. The technology is ready for on-farm demonstration and dissemination to farmers.

Microfeeds for nursery rearing: A microdiet, with a nutrient profile of 45% protein and 12% lipid, was developed for the nursery rearing of

Myctophids (lantern fishes) — A potential deep sea resource

Deep sea shrimp trawlers operating off Kerala coast are harvesting huge quantities of *Myctophids* as by-catch. Large concentrations were observed in offshore areas at a depth range of 350–450 m. On an average, in a single day time operation, 250 kg of myctophids were caught off Quilon coast, which form about 41.6% of the total catch. This fishery has a good potential in fish meal industry and in formulation of value added products. The bycatch included three species of genus *Diaphus* (*Diaphus watasei, D. thiollieri and D. garmani*) and two species of genus *Myctophum* (*M. obtusirostre* and *M. fissunovi*). *Diaphus garmani* was recorded for the first time from Indian waters.

Utilization of salt affected lands for aquaculture—A successful carp seed rearing operation

Under the NAIP sub-project "A value chain on fish production in fragile agriculture and unutilized aquatic resources in Maharashtra", utilization of salt affected lands in western Maharashtra was taken up for carp seed rearing operations. The CIFE, Mumbai, developed demonstration units in the society-owned lands at the villages of Shere, Gondi and Malkhed, (Karad, Satara district, Maharashtra). Under the scheme, 0.25 million carp seeds were successfully raised and marketed. About 0.2 million fingerlings were raised to yearlings. Three ponds of 0.4 ha were stocked with carp fingerlings which were grown up to 250–300 g in 3 months. These results clearly showed the potential of utilization of salt-affected lands for aquaculture.

Fish Biomass Sampling (Karad)

Demonstration of carp farming system in NEH Region

The new "Composite Carp Farming" technology involving three exotic carps namely grass carp, silver carp and common carp stocked @ 3–4 fish/m^2 in a combination of 40–45%, 20–25%, 35–40%, respectively along with 10% rohu or chocolate mahseer has been demonstrated in farmers' pond in Manipur and Arunachal Pradesh. Supplementary feed was provided to the stock @ 2–3% of the body weight on daily basis and pond fertilization was done with organic fertilizers @ 9,000 kg/ha. The technology has been successfully adopted by the fish farmers in five districts of Manipur (21 farmers) and 13 districts of Arunachal Pradesh. Local KVKs and one NGO are also helping farmers in the dissemination of carp culture technologies.

Fish farm at Zero, Arunachal Pradesh

seabass fry (*Lates calcarifer*) and was successfully tested in a farm. The performance of the nursery feed was good with a survival rate of 50–72% in 30 days and the fishes attained an average body weight of 2–4 g. This feed technology is ready for commercial scale production.

Screening for emerging shrimp diseases: Emerging diseases, loose shell syndrome (LSS) and monodon slow growth syndrome (MSGS), besides white spot disease are affecting shrimp farming. Screening of the causative factors of LSS in black tiger shrimp farming confirmed the involvement of a filterable viral-like agent of about 13–24 nm size. This was purified from LSS affected shrimp. Transmission electron microscopic examination of the purified putative agent showed enveloped oval to elliptical shaped structures with a central dense core. Similar agents were also observed in nucleus of hepatopancreatocytes of LSS affected shrimp. LSS could be induced in healthy tiger shrimp by experimental challenge using purified virus-like agent and homogenates of hepatopancreas and muscle of LSS affected shrimp. Secondary bacterial infections caused by *Vibrio* sp. were common among these shrimps. Commercial products/compounds indicated that tested products could not mitigate the disease either in terms of prophylactic or control measures.

Farm grown *P. monodon* from farms with a history of extended culture period and growth retardation suspected to be affected by monodon slow growth syndrome (MSGS) were screened for Laem-Singh Virus (LSNV). Of the 110 samples collected, 83 (75.5%) were positive for LSNV. Screening of samples for co-infection by PCR showed positive results for IHHNV (26%), WSSV (13%) and PvNV (3%). Though LSNV was reported from India based on sample from one location, this is the first report based on an extensive survey and future research will focus on the development of improved diagnostics for detection of LSNV based on metagenomics approach.

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Post-harvest Management and Value-addition

Value-added ready-to-cook product from mustard leaves: A mixture of dried ingredients, 'ready to reconstitute mustard *saag'* was developed. The dried ingredients on mixing with lukewarm/ hot water yield the inherent taste and odour of staple ingredients. The taste and colour was observed to be acceptable on reconstitution. Ash content and crude fibre were observed to be 11.73% and 8.53% respectively.

Green chillies products precessing: One kg of green chillies yields about 130 g of green powder and 300 ml of puree. With an investment of about Rs 7 lakh, 200 kg of green chillies could be processed/day, thus deriving a value addition of almost 5 times the cost of green chillies, with ready market for such products. It is estimated that the pay-back period is as low as 1.9 years.

Pomegranate aril extractor: The machine is capable to process the whole pomegranate at a rate of approximately 30–35 fruits/min. with extraction capacity of 90–94% and about 2–4% damage. The technology has been transferred to M/s Padmatech Engineering Systems, Pune.

Development and quality evaluation of meat offals and vegetable waste incorporated pet food in extruded form: Value-added canine pet food samples utilizing byproducts of slaughterhouse were developed based on meat, meat, blood and bone and edible offals. This pet food incorporated 40% slaughterhouse offal (liver, blood, heart, kidney, chicken, pawn and MBM) and 50% fruits and vegetable residues, potato and *dal* residues and flours. Treatment with two natural preservatives, namely vitamin E (tocopherol) and C (ascorbic acid) was also adopted. Effect of storage on various qualities attributes of dog food samples including physico-chemical, microbiological, texture and quality were evaluated at 20 days intervals up to 120 days. The shelf-life of product is more than 6 months and found to be palatable to dogs.

Improved on-farm potato storage system: Potato storage system with tubular aeration reduced the storage losses compared to traditional pit storage in vogue in Karnataka. Accumulation of heat tended to be at the top in the traditional system, while it was lower and at the bottom in the improved system. Improved system recorded lower physiological loss of weight and total weight loss of tubers compared to the traditional system. At the end of storage of 1 tonne of potato for 3 months, PLW of 13.06% and 15.20% were recorded in bulk-stored potatoes of improved and traditional on-farm storage systems, respectively. Rotting damage in the bulk at the end of storage period was found to be 4.05% in the improved on-farm storage system compared to 6.85% in traditional on-farm storage system. The total sugar content of potato tubers was initially 295.89 mg/100 g fresh weight before storage, which increased to 402.67 mg and 423.98 mg/100 g in improved and traditional on-farm storage systems at the end of the storage, respectively.

Post harvest processing of *Aloe vera* leaves: A low-cost manually-operated *Aloe vera* extractor was developed. It consists of one pair of tapered roller swith varying clearance to accommodate leaves of differing thickness. The contra rotating rollers are operated with the help of a handle. It yields 10% higher quantity of juice as compared to manual extraction. It has a capacity of 12 kg gel/hr.

Hair care products from *Aloe vera:* *Aloe vera*, locally known as g*uar patha*, has several medicinal properties, and is used as an ingredient in manufacture of a number of medicinal and cosmetic products. It is a xerophytic plant, well adapted to the arid environment of Rajasthan. Although the plant is locally used as a vegetable, its potential has not been fully exploited, perhaps due to the highly perishable nature of the aloe juice.

The CAZRI has developed two hair care products from the aloe juice, namely 'Aloe Shampoo' and 'Aloe Hair Cream'. These products have shelf-life of more than 10 months. Apart from conditioning effects, the developed Aloe shampoo makes the hair silky, shiny and dandruff-free. Aloe hair cream, which also contains olive oil, castor oil, mustard oil and aonla, prevents hair fall and makes the hair strong.

Post harvest processing of *mahua* flower and seed leaves: A power-operated *mahua* seed decorticator was developed. It has a throughput capacity of 60 kg/hr and operated with 90.5% decorticating efficiency and 94.5%, whole kernel recovery at 10.5% mc. The cost of decortication for 480 kg of seed in the decorticator was found to be Rs 180 as against the manual decortication cost of Rs 840.

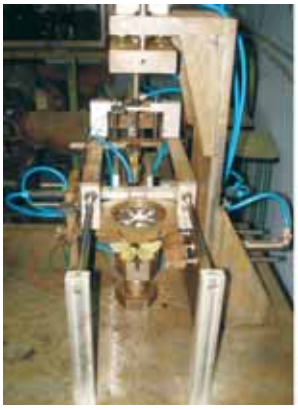
Soybean dehuller: The modified dehuller is capable of dehulling various sizes of grains without grading. The modified soybean dehuller is provided with a tapered dehuller drum having variable clearance of 8.5 and 5.2 mm at grain inlet and outlet ends, respectively. The dehuller drum surface was knurled for creating coarse surface and ribbed spirally with 1 mm diameter wire to improve dehuller efficiency and capacity. Dehulling was carried out at drum peripheral speed of 4.13 m/s for mixed sizes of soybean grains having moisture content from 7 to 9.16% (wet basis). The machine capacity was found to be 144 kg/hr with 3.0% broken and 100% hulling efficiency. The output of the dehuller is 40% higher than the older machine and consequently has lower specific power consumption.

Production of alcoholic banana beverage: A fermented drink/beverage from over-ripe banana pulp and sorghum sprouts was produced. The alcohol content in the beverage was between 11 and 13% after 68 hr of fermentation produced in 5 litre capacity vessel. The final clarity observed was 3.6–4.5 NT units. The fermented drink was clarified to the extent of 95.6% as compared to 8.87 and 13.4% in unfermented controls of beverage with and without sorghum, respectively, when added as an ingredient to the fermenting medium. Changes in tannins, sugars and carbohydrates in beverage took place during fermentation of beverage. The average yield of beverage with sorghum and without sorghum was 53 and 42%, respectively. The beverage can be preserved with flavour for 3 months under refrigerated conditions.

Fruit grader: Fruit grader with 3 sorting channels having capacity of 50 kg/hr for guava/ tomato was developed. The sorting channels are made of 4 endless rubber V-belts mounted on 4 sets of pulleys. The pulleys are spaced in such a way that the spacing between moving belts diverges from the feed end to delivery end, enabling the small fruits to fall down in appropriate collection tray placed below the moving belts. The top of belts has been dressed to form semi-circular cross section so that smaller fruits do not stay on the top of V-belt. The semi-circular top of the belt also prevents injury to the fruits. Idlers are provided to adjust tension of the belts. Commercial plastic containers are used for feeding hopper and collection trays to improve the quality of machine and to prevent damage to the fruits during the operation.

Expanding belt type fruit grader

Continuous feed type seed removing and segmentation equipment for *aonla*: A pneumatic model of continuous feed type seed removal and segmentation unit having capacity of 12–15 kg/hr for *aonla* was developed. The cost of the equipment has been estimated as Rs 40,000 and the equipment is under commercialization.



Aonla suction unit

Discharge of cut sample of *aonla*

Stone remover from mango fruit: Mango stone remover from the fruit has been developed. It consists of a number of wooden reapers and nylon brushes mounted on a mild steel shaft and is placed inside a sieve having 12 mm diameter perforations. Provision of spraying water inside the pulper been made. Preliminary trials were conducted with Totapuri. Pulp recovery and pulping efficiency for Totapuri variety were 75 and 96%, respectively. Recovery of pulp by mechanical destoner was 20% higher than the manual method of peeling and pulping.

Value-added products from groundnut: GG11 and GG20 varieties of groundnut having white bold kernels and lower oil content were selected for peanut milk preparation. The cleaned and whole bold kernels were sand-roasted at different temperatures (110 and 120°C) and duration (5 and 10 min.), followed by removal of skin and the germs of kernels. The split kernels were soaked in $NaHCO_3$ solution of different concentrations (1.0 and 1.5%) and for different durations (5 and 10 min.). Treated kernels were then cooked with water (in ratio 1:5 and 1:6) and ground in the domestic grinder using hot water. The aqueous solution obtained after grinding was filtered to obtain white peanut milk. Based on the sensory evaluation results, GG20 was found to be the most suitable variety for obtaining milk of good colour and flavour.

System for live fish storage: System for the storage of live fish with aeration was designed, developed and testeted for one year at Ludhiana. It consists of blower with pressure regulator, air filter, FRP tanks, diffuser stones, and distribution pipe assembly. 20 l of water is required to keep fish live for market purposes to store 5–8 kg of fish for a few days. The installed fish storage has a capacity of 350 kg. There was nil mortality ever after 24 hr of storage. Water temperature remained steady for 24 hr but *p*H increased from 6.7 to 8.6. The total dissolved solids (TDS) also increased with duration of storage from 0.44 to 0.800 mg/l and depend upon the variety of fish storage. The system costs Rs 30,000 for storage capacity of 200 kg and the cost of storage works out to Rs 1.50/kg for 24 hr, which helps to fetch almost 50% higher price as compared to iced/ dead fish.

Value-added products from low value and under-utilized marine and freshwater fishes of west coast: Fish sausage was developed using bulleye fish (*Priacanthus hamrur*), popularly known as disco fish and the recipe was standardized using potassium sorbate or Nisin as the preservative. Shelf-life studies of fish sausage as revealed after sensory evaluation showed that the sausage prepared using nisin (0.2%) could be stored up to 10 and 14 days under refrigerated (6±2°C) and ambient (28±2°C) conditions, whereas with potassium sorbate (0.2%), it was stored for 7 and 9 days, respectively.

Smoked fish was prepared using a low value fresh water fish, Tilapia (*Oreochromis mossambicus*), popularly known as *jilebi* fish. Brining of fish for 20 min. and smoking for 45 min. gave the product of highest acceptable score. The smoked fishes were packed in 200 µm polypropylene pouches using a vacuum packaging machine. The products packed with 50 and 100% vacuum stored at ambient condition were acceptable up to 4 and 7 days and for 21 and 28 days under refrigerated condition.

Fish fingers were prepared using Pink perch (*Nemipterus japonicus*), a low value marine fish. The recipe was standardized by changing proportions of fish-meat: potato-starch along with spices and additives. The sizes of the fingers, battering medium and frying time were also optimized. After frying in the oil, the fish fingers were subjected to bio-chemical, microbial and organoleptic evaluation. The results revealed that fish fingers prepared with 70:30 proportion of fish meat : potato starch and battered with 25% Bengalgram slurry gave a product of highest acceptability for the finger size of 60 × 10 × 10 mm.

Portable FRP silos for hi-tech aquaculture: The FRP silo for fish culture/holding system, which is first of its kind in the country, was designed and fabricated at CIFA, Bhubaneshwar. Experiments were conducted in the silos with IMC *Labeo rohita* with 3, 6 and 9 m^3 water volumes and 0.8, 1.6 and 2.4 m water depths, respectively and stocking density of 3 kg/m^3. Provision of pellet feed, water recycling through the biological filter and supplementary oxygen injection was made. Fish survival was higher in silos having water depth 0.9 m, followed by 1.8 m and 2.7 m. The silos with water depth 2.7 m have higher mortality due to lower dissolved oxygen concentration. The average survival was 94 and 88% for silos having water depths of 0.9 m and 1.8 m. The average fish growth was in the range of 478–523 g in 71 days during winters of 2007–08 and 442–466 g in 30 days in 2009 from average initial weight of 410 g.

Cotton bale manager software: A software called Cotton Bale Manager was developed to perform design and generation of bale identification tag and to interface this bale tag with the bale database management software. It was designed to generate a unique bar-coded customized label for each individual bale, integrated with bale information including the fibre properties. Each bale label includes information on the factory name, the press mark number, year of production, bar-coded bale ID and barcode.

Another software for managing a modern ginnery, namely GINERP was developed by CIRCOT in association with M/s SSPS, Hyderabad wherein bar-coding has been included as a bale management module. This software has already been commercialized.

Aaxial flow cotton pre-cleaner: A seed cotton pre-cleaner based on axial flow principle was designed and fabricated. This single cylinder axial flow pre-cleaner of 1,200 mm cylinder length has

CIRCOT axial flow cotton pre-cleaner

the capacity to clean 7–10 quintals of seed cotton/hr. For controlled feeding of seed cotton, a feeder assembly is also incorporated. The pre-cleaner is capable of removing effectively trash particles like leaves, bracts, *kawdi*, etc. and bring about significant improvement in the colour grade of cotton without any adverse impact on the fibre quality attributes. The cleaning efficiency of the machine was noted to be 25–30% and found to reduce the trash content in seed cotton by up to 1.5%.

Natural-synthetic composite geotextiles for protection of river-bank: Looking into the perennial problem and non-availability of indigenously produced geotextiles for specific use, a set of novel geotextile fabrics using jute/jute-coir blended yarn and polyolefin tape yarn were developed. The geotextile samples contain more than 60% (wt/wt) natural fibre. The production viability of the developed geotextiles was tested through continuous production of the geotextile fabrics using commercial-scale machines. The performance of the fabric samples was evaluated following ASTM standard test methods. The blended fabrics having much balanced property parameters are durable, more effective than both 100% natural and 100% synthetic fabrics and much cheaper than 100% imported synthetic geotextile fabrics. A successful field trial was conducted for protection of a part of the bank of Mayurakshi River (rainfed) at West Bengal using the developed geotextiles based on the principle of using geotextiles as reinforcing material for stable grass-turfing.

A total shower (till laying of geotextiles) during monsoon as recorded nearly 140 cm and then at the end of full monsoon period, even after release of stored water from Tilpara barrage @ 125,000 cusec (plus additional 40,000 cusec from local catchments due to a spell of spear-headed shower for continuously 3 days during the same period), no change (deformation), and zero erosion of the part of the river-bank under trial was observed. While, on the rest of the part (where geotextile was not used), signs of major soil erosion including rain-cuts (no. of rain-cut – 64/100 m length of river-bank) were clearly visible. It was also observed that Durba grass has been grown extensively in the more or less same extent on the geotextiles of all the combinations.

Knitted warm garments from jute-based spun-wrapped yarn

Jute (100%) and jute-polyester (75:25) blended core and textured polyester multifilament cover spun-wrapped yarns were developed using existing jute spinning machines. The spun-wrapped yarns so produced show a reduction in hairiness up to 86.1%, improvement in specific work of rupture up to 9.8% and specific flexural rigidity up to 23.6% over ordinary jute or jute-polyester blended yarn. The knitted swatch produced out of these spun-wrapped yarn using 7-gauge and 9-gauge needle in both single jersey and double jersey knitting machines showed very good dimensional stability even after 3 washing. The 2-ply and 3-ply yarn produced from single spun-wrapped yarn can be easily used in knitting machines and also in hand-knitting for the production of sweaters. The thermal insulation value of the sweaters

Machine knit sweaters

produced from spun-wrapped yarn is comparable with thermal insulation value of sweaters made from 100% acrylic and 100% wool.

Chemical-free hand made paper from date-palm fibre: The total domestic demand for paper in India is 7.2 million tonnes, whereas production is only 6.7 million tonnes. At present gap between consumption and production is 0.5 million tonnes. The paper industry has turned to fast growing wood species, alternative non-wood fibres like datepalm leaf fibre for paper production by mechanical pulping process is felt necessary. The process is economic and eco-friendly. NIRJAFT

has developed the new technology on development of pulp and paper by mechanical pulping process (chemical free) from datepalm leaf and different products, viz file-cover, carry bag, writing pad etc. The technology can be transferred to rural sectors at low capital investment.

Jute: Jute is normally retted in ditches/ponds/ channels under muddy/repeatedly charged water which often reduces colour and luster of the fibres and also incurs sizeable cost in carrying the material from the field to the retting spot. *In-situ* retting in polyethylene sheet lined micro pond was successfully done with less water (groundwater, 1:1, v/v) to get good quality fibre and the technique will be of immense help to jute farmers under drought condition.

Computerized system for analyzing jute yarn linear density: Under Windows XP operating system, GUI (graphical user interface)-based software was developed that captures data required for evaluation of yarn linear density from digital balance. It has the flexibility in capturing data from a wide range of balances with maximum capacity of 10 kg and readability range from 0.1 to 0.0000001. A module has been incorporated to the software that determines the linear density of yarn under 10 textile unit systems, including Jute, Tex (SI), Denier, Dtex, Ctex, Metric, Cotton (British), Worsted, Woolen (Skein) and linen with jute being the default system. Four options were provided for selection of units of length (viz yards, meter, cm and inch). Flexibility of changing the number, size and unit of cut length has been provided. A special computing facility for jute yarn was provided to obtain quality ratio, twist and/or twist factor and moisture adjusted results. A special module has been integrated to determine the minimum number of tests required to obtain the linear density within prefixed error level.

Blanket from jute and polyester hollow fibre: Jute and polyester fibres were blended and converted to yarn. From tensile tests the 80:20 jute/hollow polyester blended yarn was found to have more uniform trends in case of breaking tenacity, breaking strain and energy at break. The yarns were woven into blanket on handloom, trimmed and borders covered and stitched with satin cloth. It was observed that with the increase of hollow polyester in the blend fabric weight (FW) and TD increased, while blanket fabric thickness (BFT) decreased. Thermal insulation value (TIV) of the developed jute-hollow polyester blended raised blankets are higher than commercial woolen, but lower than that of commercial acrylic blankets. The dermal toxicity and comfort test of the developed blankets samples proved these to be non-allergenic to the sample population. Thus the jute-polyester fibre blended blanket provides a novel alternative use of jute, which is also quite economic to commercially available all wool or all synthetic blankets.

Modified flush door shutter solid core type: Jute stick particle boards, bonded with phenol formaldehyde (PF) resin, were developed first in laboratory and then manufactured in an industry (viz Corst Compostie, Baharampur, Murshidabad, West Bengal) on commercial trial basis in a study jointly conducted by NIRJAFT, Kolkata and IPIRTI, Kolkata. Solid core type flush doors were prepared by assembling the jute stick particle board and resin impregnated non-woven jute felt in a wooden frame. The boards were found to be boiling water resistant and having medium density with good mechanical properties. Modified flush door shutters thus made in confirmity with IS: 2202 (Part-I), 1999. This is an environment-friendly technology, which can save wood by replacing it with jute in manufacturing of flush doors.

Suitable lac insect-host plant combinations: Screening of 5 kusmi lac insect stocks, viz. kusmi crimson early, kusmi yellow, kusmi crimson late and 2 productive breeds, namely Kulajanga and Nawadih was carried out to identify the most suitable lac insect-host plant combination for sustained lac production. Lac encrustation did not detach from the stem thus ensuring quantity and quality of the broodlac produced. The mean (2 years) sticklac yield/m was 72.5 g in case of kusmi early stock compared to other stocks (55.2 – 58.4 g/m). The mean (2 years) sticklac yield/m was 96.8 g in case of kusmi late stock compared to other stocks (44.6–79.9 g/m).

Lac-based formulation (fresh coat) technology for fruit coating application at commercial plants: A lac-based formulation was developed for fruit coating applications on apple and citrus fruits like kinnow and orange. The formulation yielded good results in respect of gloss and firmness to kinnow. To evaluate and assess the performance of fresh coat on kinnow fruit at commercial level, about 40 litres of the formulation was tried at 7 kinnow waxing and grading plants at Abohar (Punjab). Approximately 83 tonnes of kinnow fruits were coated with the above formulation. There are 17 kinnow waxing and grading plants at Abohar

Kinnow coating in industry

Lac-coated kinnow

in Punjab, and they use commercial formulations such as NU Coat Flo, Citrashine, Stay fresh 451 and Stayfresh high shine for coating kinnow fruits. Chemical fungicides are added to control post harvest diseases in stored kinnow fruits. Application of fresh coat produced better results in respect of gloss, spread area and firmness to the fruits as compared to commercial wax. Other advantages of lac-based formulation over the available commercial ones observed are: it is natural, non-toxic and composition of lac-based formulation is well specified, no fungicide addition is required since lac has inherent property of antifungal properties, lac-based formulation does not produce any obnoxious smell during waxing operation, it is water-based and thus making the plant more versatile.

Aleuritic acid (technical grade) in pilot plant: Aleuritic acid is isolated from seedlac by saponification and several separation and filtration steps. There is a continuous growing demand of aleuritic acid in the field of perfumery and pharmaceuticals due to it being an excellent starting material for the synthesis of civetone, ambrettolide, isoambrettolide etc., which have musk like fragrance. A pilot plant of aleuritic acid was installed for providing training and demonstration and can produce 2 kg of technical grade aleuritic acid/batch from seedlac. Aleuritic acid (technical grade) was successfully produced in the plant with a yield of approximately 19% of the weight of fresh seedlac. The melting point and acid value of aleuritic acid was found to be 93–94°C and 178.6, respectively and its purity was around 96.5% (based on acid value).

Mango: At IIHR, Bangalore, carbonated beverages were prepared from mango, passion fruit and custard-apple. Fortification of beverage was done in mango with *aonla* antioxidants. Addition of ascorbic acid at 1,500–2,000 ppm during extraction of pulp from custard-apple, packaging the pulp in polyethylene bags and storage under frozen conditions at –18°C was found useful to prevent browning during frozen storage.

Storage life of mango could be extended to 5 weeks by MA-packing in micro-perforated D-955 film and storing at 8°C. Exposing mature fruits of sapota (Cricket Ball) to 500 ppb 1-MCP for 18 hr delayed ripening-rate and extended shelf-life to 12 days at RT (22–30°C).

At CISH, Lucknow, hot water treatment at 52 ± 1°C combined with Prochloraz (0.1%) for 10 min. was found effective for managing the post-harvest anthracnose up to 8 days at ambient conditions and up to only 3 weeks at low temperature (12 ± 1°C) storage of fruits.

Litchi: At NRC on Litchi, Muzaffarpur, technique for preparation of litchi nuts was standardized. It was found that fruits treated with KMS (0.1%), followed by citric acid (2%) and dried alternatively in sun-oven-sun for different periods gave quality litchi nuts.

Sapota: Mature sapota fruits (Cricket Ball) exposed to 50 ppm ethylene gas (liberated from ethrel solution) for 18 hr could be ripen uniformly in 5 days at RT (21–26°C) compared to 8 days in non-treated fruits.

Papaya: Papaya fruits (Taiwan Red Lady) exposed to 50 ppm ethylene gas in the ripening chamber for 18 hr could be ripen, with uniform colour and firmness, in 4 days at RT (26–32°C) and 7 days at 20°C at IIHR, Bengaluru.

Citrus: At NRC Citrus, Nagpur**,** for dried juice powder of citrus fruits, fresh fruits of 4 citrus species, namely *Citrus medica* L (Citron), *C. aurantifolia* (acid lime), *C. reticulata* Blanco (Nagpur mandarin) and *C. sinensis* (Mosambi) as well as juice blend of pummelo and citron fruits were utilized to manufacture the value-added products by mixing the encapsulating agents in filtered extracted juice, followed by homogenization. The spray dried juice powder recovery was of 13.51, 11.17, 10.49, 9.52 and 9.60%, respectively, in Citron, acid lime, blended juice (high acidic) as well as Nagpur mandarin and Mosambi juice (low acidic), showing higher powder recovery in high acidic fruits than low acidic fruits. The flavour, colour, aroma and TSS content of juice powder (rehydrated) were similar to natural juices in all citrus cultivars. However, vitamin C content of fresh juice reduced in juice powder. The powder particle size was recorded to vary from 0.33 to 0.77 micron in all citrus cultivars. The colour (a/b ratio) of Nagpur mandarin juice of fine powder was found to be slightly higher than that of juice, while trend was reverse in Mosambi juice. However, not much changes were observed for acidity and limonin content both in fresh juice and powder of all citrus species. Production cost of citron juice powder was cheaper (Rs 175/kg) than that of remaining citrus species

Shellac-based dental plates

The base plates are plastic compositions comprising shellac, fillers and colouring matter. The base plates can be easily softened over a flame and modeled to the desired shape. Upon cooling, the base plate retains its shape to form a strong and dimensionally stable intermediate base for the prosthesis. The plates were molded and tested through a firm in Delhi and 23 like heat stability, colour stability, solubility, resistance to climate changes, strength, softening, mould ability etc. were carried out and found to be highly satisfactory.

juice powder. Thus, powder of citrus species manufactured were of free flowing and good for different juice beverage preparation, ensuring the viability of processing industry in the country.

Black pepper: Black pepper samples stored with a moisture content of 10% under controlled atmosphere (90% nitrogen + 10% oxygen) for 480 days did not show significant variation in essential oil, oleoresin and piperine contents compared to the control.

Turmeric: Turmeric samples stored with a moisture content of 10% under controlled atmosphere (90% nitrogen + 10% oxygen) for 480 days showed minimal variation in essential oil and no variation in oleoresin and curcumin contents compared to the control. Processing with or without boiling or different drying methods did not lead to variation in oil, oleoresin and curcumin contents.

Ginger: Comparison of essential oil constituents of fresh and dry ginger rhizomes indicated that fresh rhizomes contained higher level of monoterpenes, namely, *Z*-citral and *E*-citral, whereas dry rhizomes were predominated by zingiberene, farnesene and sesquiphellandrene.

Cinnamon: The GC-MS analysis of chemical constituents of essential oils in leaves of *Cinnamomum sulphuratum, C. glaucescens, C. glanduliferum, C. macrocarpum* and *C. perrottetti* revealed that major chemical constituents in these oils were β-phellandrene, α-phellandrene, camphor, t-*caryophyllene* and *germacrene*-D, respectively.

Tuber crops: Production of cassava-cereal flour extrudates was perfected. Extrudates were prepared from cassava blended with corn flour, *maida*, wheat flour and finger-millet and nutrition facts determined and extrudates were also made from *Amorphophallus* flour and blends of cassava with cotton seed cake. High protein and dietary fibre enriched pasta were prepared from cassava-*maida* blends and their nutritional, functional and textural properties were studied. The protein content could be enhanced to 11–12% with whey protein concentrate, defatted soy flour and prawn paste. Starch-based adhesive for special bonding applications was upscaled to 5 kg level and is ready for transfer. The solid adhesive was tested on various surfaces by M/s Swarup Industries, Ernakulam, Kerala. In simultaneous saccharification and fermentation processes for bio-ethanol production from sweet potato starch at 40–50°C, 2 thermo-tolerant putative *Saccharomyces cerevisiae* strains (T1 and T3) were isolated which is necessary to mediate the process at high temperature.

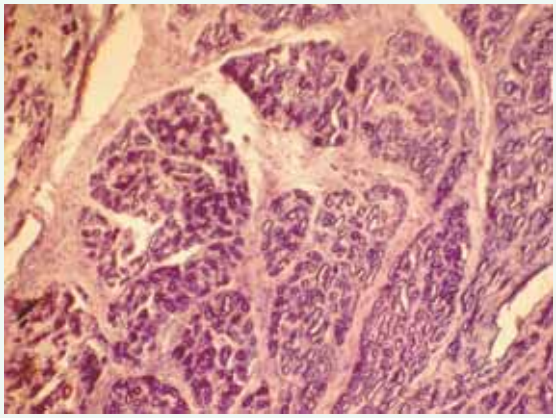
Patent filed on aloe:A process patent (No. 1261/MUM/2008) has been filed by DMAPR at Indian Patent Office, Mumbai, for preparation of pure aloin from aloe (*Aloe barbadensis*) through extraction and purification. Aloin (aloin A) is the major active principle in aloe. It is a pharmaceutically important compound and utilized for production of various drug intermediary compounds**.** The new method is easy to perform and can be used for extraction of aloin of high quality from fresh, sun-dried, oven-dried or freeze-dried leaf exudates. The method is also quicker, efficient (recovery up to 90%) and cost-effective (most of the solvent used can be recovered for reuse). Aloin purity of more than 90–95% can be achieved by this method, hence, suitable for industrial purposes.

Cow ghee confers protection against mammary gland carcinogenesis

Health benefits of cow ghee were validated. Cow ghee decreases initiation and progression of mammary and gastro intestinal tract cancer in rats. The tumour latency period was greater in rats fed on cow ghee (27 weeks) than on soybean oil diet (23 weeks). The tumor incidence and tumour volume and tumour weight were considerably higher in animals on soybean oil (65.4%) than on cow ghee diet (26.6%). No adenocarcinoma was observed in cow ghee group, while 8% of tumours in soybean oil group were adenocarcinoma.

Rat fed with soybean oil diet showing large tumour

Rat fed with cow ghee diet showing small tumour



Mammary fibroadenoma tumour showing high amount of fibrous tissue

Mithun milk proteins

Per cent contribution of different casein fractions in mithun milk was studied. It revealed that ß- casein was the highest (71.97%), followed by κ- casein (16.27). The per cent contribution of α-casein (αs1-casein and αs2-casein) was the lowest.

Distribution of casein fractions in whole casein of mithun milk

Casein fractions	Per cent contribution
α-casein	11.18 ± 0.47
(i) αs1-casein	4.32 ± 0.21
(ii) αs2- casein	7.45 ± 0.37
κ- casein	16.27 ± 0.99
ß- casein	71.97 ± 0.41%

Mithun leather

Mithun leather showed more properties of acceptance than cattle leather considering the following users' aspects apart from their superior physical and chemical properties to cattle leather.

1. Hide processed with intact hair has been a stuff of excellence having good usability as exotic outer cover for sofa.
2. Bag leather produced with mithun hide is very good as compared with conventional leathers produced from cow hides. It is soft and having much better body and roundness.
3. Shoe upper leather is also better not the least comparable with wares made from conventional cow hides.
4. Garment leather is also exclusively soft and can be an optimal substitute for the conventional leathers.

Orchid: Twelve hybrids of *Cymbidium* and 4 species of orchids were evaluated for their vase-life. Out of 4 stages, 75% opened flowers recorded highest vase-life with 8 HQS (200 ppm) *Cymbidium* hybrid Red Princess. In Dendrobium Hyb. Thongchai Gold, that opened flower contains 29%, half opened flower 28.25% and buds 16.17% of reducing sugars.

Microbial assay for detection of ß-lactam group: A real time microbial assay was developed. A comparison of the intensity of the test reaction with that of a control was taken as criteria to determine whether the sample is positive or negative (Patent Regd. #IPR/4.14.1/08073)**.** The assay can detect specifically ß-lactam groups in spiked milk within 15–20 min. at regulatory codex limits with negligible sensitivity towards non ß-lactam groups. The presence of inhibitors other than antibiotic residues in milk did not interfere with the working principle of microbial assays. The microbial assay-I (Rs 45/test) and assay-II (Rs 20.54/test) are cost effective. Both microbial assays can find immense application in dairy industry as "on Farm' milk screening test for ß-lactam group.

Goat products: Processing, techniques for manufacture of value-added products from spent goat meat were developed. Recipes, viz pickles, sausages, cubes, *shami kebabs*, *samosas*, patties, roll slices, cutlets, croquettes, meat balls, warm and serve meat curries and chevonetles were developed and standardized. The quality attributes of value-added meat products and their shelf-life were evaluated. Processing techniques for preparation of paneer, using different coagulants were developed and standardized.

Yak milk paneer: Standardized processing technologies for the preparation of yak milk paneer, low fat paneer, *churpi*, *churkam*, enrobed paneer fingers, dahi, ghee, vegetable extended paneer and whey beverage were developed.

Products from camel milk: In pursuits of transforming camel into a milch animal there had been continuous efforts in terms of selling camel milk as health drink and value-added camel milk products like flavoured milk, tea, coffee and *kulfi*. *Gulab-jamun***,** a new value-added product, was developed from camel milk.

Electrical stunning effect on fillet quality: Electrical stunning had no adverse effect on the quality characteristics of marinated fillets with added advantage of addressing poultry welfare concern during dressing of chickens. Likewise, chill-aged (5°C; 24 hr) deboning of fillets offered no real advantage in terms of yield, quality and storage stability of marinated fillets, except for relatively lower shear value over those deboned 4 hr post-mortem. The products remain microbiologically safe and acceptable up to 9 and 60 days of refrigerated (5±1°C) and frozen (18°C) storage, respectively.

Functional chicken scroll: Chicken scrolls processed with larger size (8±1 cm) breast/ drumsticks meat portions, marinated for 16 hr and oven-cooked were significantly superior. Optimization of suitable level of oat flour and sprouted moong suggested that 20% supplementary levels of either item as natural source of beta glucan/tocopherols rendered good quality product. Similarly, incorporation of 10% *jawar* (white millet/ sorghum) or 20% *bajra* (black millet) yielded better quality chicken scrolls. Use of 10% sprouted Bengalgram (another natural source of tocopherols) was also suitable for preparing this product. Sprouted moong was more cost-effective than sprouted Bengalgram for preparing chicken scroll.

Chicken nuggets: An economic formulation containing about 60% chicken meat for preparing

chicken nuggets at pilot scale was optimized for efficient utilization of culled layers and meat-type parent stock. Chicken nuggets can be safely stored for 4, 20 and 75 days under ambient (25°C), refrigeration (4°C) and frozen (–18°C) conditions, respectively. The retail price of chicken nuggets can be Rs 127/kg with a marketing cost of 20% and gross profit of 25%. The processor can earn Rs 2,780/day with an initial investment of about Rs 6 lakh.

Value-added egg product: Process of preparing egg quiches was standardized. Egg quiches prepared with 70% liquid whole egg and 15% chicken meat sausage, among other ingredients, were most acceptable and had a refrigerated shelf-life of 10 days in vacuum and 8 days in aerobic packaging with acceptable sensory and satisfactory microbiological quality. The cost of formulating 1 kg of cooked egg quiches was estimated as Rs 104.7 and that of one egg quiche weighing about 80 g was Rs 8.4.

Hides and wool: Value-added caps were prepared from yak hair by mixing 50% and 25% levels each of sheep wool and angora rabbit wool fibres.

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Agricultural Mechanization and Energy Management

A brief description of machines developed for land preparation, sowing/planting, spraying, harvesting and threshing, and energy for agriculture is presented here.

Light weight tool carrier for Asom: A lightweight tool carrier suitable for the local bullocks of Asom was developed. The unit weighs only 2 kg and can be easily carried by the farmer from the village to the field. It can also be used for carrying out various farm operations such as land preparation, interculture, ridge making and sowing.

Tractor-operated manure spreader: Farmyard manure spreader, developed earlier, was tested in the field using a 22 kW tractor. The manure application rate varied from 4.22 to 36.72 tonnes/ha at tractor forward speed from 0.41 to 1.12 m/s, respectively. The variation in the manure application rate over the swath of 2 m is less than 15%, which is the acceptable limit for spreading of granular fertilizers. It can be used for uniform application of farmyard manure in the field.

Tractor-operated cumin planter: A 5-row planter was designed with individual hopper and star wheel seed metering mechanism mounted on common frame. The height of hopper was kept as 40 cm to get accurate placement of seeds in shallow furrows. The machine was tested for cumin seed, besides fenugreek and coriander at National Research Centre on Seed Spices at Ajmer and on farmer's field. Seed rate of 10–12 kg/ha for cumin, 18–20 kg/ha for fenugreek an 10 kg/ha for coriander was obtained. Field capacity was 0.24 ha/hr

Plastic mulch machine for planting in plastic mulch conditions for groundnut and vegetables: Plastic mulch laying machine was modified to lay the mulch on two raised beds simultaneously. A tractor-operated 4-row punch planter consisting of modular planting units was developed to plant seeds on raised beds in plastic mulched condition. It was evaluated for groundnut and Frenchbean planting at the CIAE Farm and for Frenchbean alone at Indian Institute of Vegetable Research, Varanasi. The missing hills were found to be 8.5% and field capacity ranged from 0.12 to 0.16 ha/hr. It was evaluated with 22 kW (35 hp) narrow-wheel tractor having arrangement for tread width adjustment to accommodate the two raised beds. The benefit : cost ratio of 1.91 in case of groundnut and 2.12 in case of Frenchbean was recorded under plastic mulched condition apart from 30% saving of irrigation water.

Animal drawn manure spreader

Baler with reaping attachment: A tractor-operated baler with reaping attachment was developed in collaboration with indigenous baler manufacturer in Punjab. It was evaluated at CFMTTI, Budni in the paddy-harvested field. Effective working width of the machine was 1.55 m with the field capacity of 0.40 ha/hr. It could be operated at forward speed of 3.0 km/hr. Heights of stubbles before and after the operation of baler

were 267 and 125 mm, respectively. Average size of bales was 600 × 470 × 400 mm with the average weight of 10.5 kg/bale.

Whole crop maize thresher: A whole crop maize thresher was developed for shelling and conversion of stalk to chaff in a single operation. Field testing with whole crop of maize gave the output of 210 kg/hr. A tractor-operated multi-crop thresher was also modified with similar arrangement and tested on the farmer's field. The output of grain was observed to be 620 kg/hr with chaff size of 18 to 52 mm. This chaff was fed to the animals and 85% material present in the whole stalk was consumed. Moreover, significant saving in labour was found for detachment of cobs and transportation of crop from field to home in the range of Rs 2,000–2,100/ha. The threshing efficiency of electrically-operated and tractor-operated thresher was found to be 100% and cleaning efficiency was 98.6% and 96.2%, respectively.

Bio-mechanic studies of he-buffalo under controlled condition: A psychometric (controlled) chamber was designed and developed for bio-mechanic studies of animals. Experiments were carried out with he-buffaloes at different loads and speeds under different ambient conditions. It was found that he-buffaloes could be loaded up to draught of 14% body weight at 1.5 km/hr speed and up to 10% draught at 2.0 km/hr speed.

Animal-drawn manure spreader: A bullock-drawn manure spreader was developed to uniformly spread manure in fields by farmers owning bullocks. Power to auger and drum is given from ground wheel through chain and sprockets. Cost of the unit is Rs 25,000 with 0.66 tonnes/hr output capacity. The cost of operation is Rs 60/hr.

Animal feed block making machine : A suitable experimental model of continuous type animal feed block making machine was designed, developed and fabricated. The machine is driven by a 2 hp single phase, 1,440 rpm AC motor. A screw type metering mechanism has been designed to meter 23.0, 6.5, 18.5 and 25.5 g/revolution material with separate hoppers corresponding to clusterbean broken, *guar* gum powder, mineral mixture and common salt, respectively. All the metered raw materials are conveyed to mixing chamber to ensure proper mixing of the feed constituents with molasses. The gear pump is fitted with the machine to suck and spray precise quantity of molasses on to the mixture of feed constituents in the mixing chamber. The mixed material is fed to the block making device, which compacts it in the form of 50 mm × 150 mm strip that are cut into 250 mm long pieces. All three components of the machine like metering mechanism, mixing unit and block making unit were synchronized to work as composite unit called the animal feed block making machine. The machine makes 40 such feed blocks/hr at a cost of 50 paise/block against Rs 3 with manual method. The unit cost of the machine is about Rs 2.5 lakh.

Complete unit of animal feed block making machine

Controlled traffic rotary no-till slit drill/ planter: A reduction of 50 kg in the mass of the rotary no-till-slit-drill was achieved in Vertisols through modifications in the design. The modified unit was tested in combine/reaper harvested straw and non-straw fields, as compared to the conventional practice of 3 tillage operations and sowing. Wheat and chickpea responded well to the controlled traffic system in straw field as compared to both full plot and conventional sowing. The machine was also tried out under a collaborative activity on soybean-wheat cropping system with Indian Institute of Soil Science, Bhopal and similar results were obtained.

Tractor-mounted hill drop planter: A hill drop planter was developed with cup feed seed metering, constructional simplicity and suitability for various crops. Depth of seed placement can be adjusted between 25 and 60 mm as required for different crops. It follows the undulations on the field with hill-to-hill spacing adjusted by varying the number of pegs on the end wheel. Groundnut and maize were sown with the machine. The row spacing and hill spacing were found to be uniform. Thinning could also be carried out with ease. Average missed seeds ranged between 1 and 2%. Hills with more than 2 seeds were about 30% as a whole. Speed of operation should be less than 1.5 km/hr to avoid scattering of seeds by valve action.

Intra canopy pesticide application equipment for cotton and pigeonpea: A power tiller-operated

2-row canopy sprayer was developed. The average height of pigeonpea plants during testing was 1.89 m and the average height of lowest leaves was 0.81 m from the ground level. The diameter of the canopy at middle of the plant was 0.92 m. The row-to-row spacing of the crop was 140 cm. The system was operated at 3 kg/cm^2 pressure. The sprayer was evaluated for its performance by application of colour dye on pigeonpea plants. The power tiller was operated at the speed of 1.31 km/hr and the machine had a field capacity of 1.46 ha/hr.

Chipping sugarcane buds for nursery raising: Nursery raised from sugarcane bud chips and planting them in main field was found economical than traditional methods for seed multiplication. A-pedal operated sugarcane bud chipping equipment was developed at Industrial Extension Project Centre in collaboration with Sugarcane Breeding Institute, Coimbatore. More than 550 bud chips can be removed from the cane in one hour by one person.

Arecanut stripper: For minimizing drudgery of the workers with increased productivity and reduced expenditure, an impact type worker-friendly arecanut stripper with safety features was developed. The arecanuts are separated from bunches due to the impact force of pegs of rotating cylinder and the stripped areca nuts fall on the oscillating sieve. The oscillating motion of the sieve separates arecanut from the chaff and other impurities. A platform for the operator is provided at the height of 290 mm from ground level so that two workers can conveniently stand and hold the bunches. The entire unit is mounted on wheels for easy transportation within an arecanut plantation. The cost of the machine is Rs 15,000 (excluding engine or electric motor). It has many safety features and shields for the feeding chute. All the moving parts are provided with safety guards to prevent accidents.

RENEWABLE ENERGY

Operational research project on poultry litter-based biogas plant: A poultry litter-based biogas plant was constructed in village Hinotia (District Bhopal) by adopting the modified Janta (CCSHAU, Hisar) design incorporating hume pipe for inlet. The plant was initially charged with 100% cow dung and water in 1:1 ratio and after stabilization of biogas production, cowdung was replaced by poultry litter by 30% based on total solid content under solid state digestion conditions. The structural and operational evaluation of biogas plant was carried out for one-and-half years. The biogas produced fulfilled the fuel needs of a family of 6 members for day-to-day cooking. The use of poultry litter increased the yield of biogas generation by 17% (from 66 to 83%) compared to normal cowdung-based biogas plant.

Batch production of alcohol from agro-residues: Based on the optimized parameters for alcohol production from ground maize stalk and paddy straw (below 0.5 mm size), a laboratory-scale alcohol production plant (0.5 l/batch capacity) was designed, developed, fabricated and installed. The unit was evaluated for its capacity to produce ethanol. Operation of the plant was found to be satisfactory. The initial study indicated that alcohol production from the paddy straw was about 0.6 l/batch. The yield was about 290 ml alcohol/kg of paddy straw with alcohol content of 45%. In absolute term, the yield was 120 ml/kg of paddy straw. The yield of the alcohol from maize stalk was found to be 330 ml/kg of ground maize stalk with alcohol content of about 57%. In absolute terms, the yield was found to be about 188 ml/kg of maize stalk.

Improved briquetting machine: The existing briquetting machine was modified to reduce weight, space requirement, ease of replacing belts, feeding of the *char* and collection of briquettes. The output of the machine is 50 to 65 kg/hr depending on *char*. The average diameter of briquettes was 30 mm and length 35 to 80 mm. The weight of the machine has been reduced by 23 kg, besides ease of replacing belts, feeding of *char*, collection of briquettes, etc.

Briquetting of agro residues

Briquettes from soybean and pigeonpea stalks: The briquetting machine was tested for production of briquettes from soybean and pigeonpea stalks. The output of the machine for both stalks was found to be 350–370 kg/hr. The cost of production of briquettes was Rs 2.20/kg. A batch of 3,000 kg of stalk was converted into briquettes. The briquette size was 35 mm length and 60 mm diameter. The briquettes were tested using CIAE cook stove and local *sigri* to assess their suitability for domestic applications. These briquettes can

Large capacity low-cost fixed dome biogas plant

Technology for construction of low cost all brick masonry fixed dome type biogas plants in the capacity range of 10 to 90 m³ biogas/day was successfully developed, which cost up to 50% less than the floating drum type of plants. PAU, Ludhiana, converted floating drum plants to fixed dome masonry plants at 4 locations. All the 4 plants are since working satisfactorily and the *gurudwara* management has reported an annual saving of around 13 kl of diesel which was earlier used for cooking the *langar* (meals). Multi-location trials of the design have been successfully carried out at several locations in the country**.** So far, around 20 large capacity biogas plants (15 to 90 m³ capacity) have been set up at selected farmers' sites in Punjab, Karnataka, Goa and Madhya Pradesh.

be used for domestic application, in gasifier and commercial boilers.

Evaluation of 20 kW power plant: Biomass (wood chips)-based 20 kW power plant for electricity generation was commissioned at CIAE, Bhopal. The system has been initially tested on wood chips and electricity produced has been used to run the 11 kW electric motor of hammer mill of briquetting plant.

Natural convection solar dryer: A natural convection semi-continuous type solar farm dryer of modular design having separate air heater and drying chamber was developed. The aperture area of the solar air heater is 2.25 m². The drying chamber has been provided at the top of the solar air heater with opening for air outlet and an exhaust fan. The fan automatically switches on whenever air temperature at the inlet to drying chamber exceeds 60°C. Thirty kg of fresh fenugreek leaves was loaded in both the trays at the beginning and then on the upper tray at the start of 2nd and 3rd drying day. The efficiency during experiment on various drying days was 62%, 29%, 32% and 18%. The initial cost of the dryer is Rs 13,000 for 2.25 m^2 aperture area. Use of the fan is optional. The payback period of the system is 2 years. Field trials were conducted for drying of chilli at a farmer's place in Village Nathana, Distt. Bhatinda. In the solar dryer it took 5 to 8 days for drying of chillis for different trials. The drying time for chilli spread in the open sun varied from 15 to 20 days.

High rate bio-methanation plants for sago effluent: Based on the laboratory and small pilot plant study, a 50 m³/day capacity high rate biomethanation reactor was designed for treatment of 35,000 l/day of sago effluent. The diameter and height of the reactor are 2.55 m and 6.05 m, respectively. The volume of gas collection tank is 10 m^3. The high rate reactor was constructed and commissioned at a sago factory in Tamil Nadu. The total solids and volatile solids contents in the sago effluent were in the range of 2,000–4,250 mg/λ and 1,800–2,850 mg/λ respectively. The biological oxygen demand (BOD) was measured as 2,630–4,050 mg/λ. Around 75% of the BOD was destroyed during the treatment. The plant operation stabilized over a period of 40 days and 35–40 m^3 of biogas is generated every day. The system cost is Rs 2.50 lakh.

Solar photovoltaic system for electricity generation: Photovoltaic systems was installed and commissioned for 55 houses of a remote unelectrified village Dageria in district Dahod of Gujarat. Due to scattered nature of the houses, the power system was subdivided into 4 power pack units covering 43 families and the rest of the 12 families were provided with individual home lighting systems. The SPV panels, power supply poles and cables are intact even after 3 monsoon seasons and the power supply remained satisfactory.

Process optimization from production of cellulase and ethanol from cellulosic biomass: A rapid process for ethanol production from kinnow waste (peel + pulp) using galactose-adapted yeast cells was developed. Kinnow waste was treated with pressurised steam and vacuum filtered. The filtrate was fermented alone using *Saccharomyces cerevisiae* adapted to galactose medium produced 30% more ethanol and biomass in comparison to *S. cerevisiae* cells not adapted to galactose medium. Fermentation of the hydrolysate using *Candida tropicalis* yielded 5.94 g/l ethanol along with a xylitol concentration of about 5 g/l. Mixed culture solid state fermentation of soy hull supplemented with wheat bran using *Trichoderma reesei* and *Aspergillus oryzae* produced 1.07 FPU/ml and 1.21 IU/ml of cellobiase. Hydrolysis of the acid-treated rice straw using concentrated crude filterate extract hydrolyzed yielded 0.27 g glucose/g glucan.

IRRIGATION AND DRAINAGE ENGINEERING

Performance evaluation of drain envelope materials in Vertisols: The cost of the sub-surface drain envelope materials varies from 25 to 30% of the total cost of sub-surface drainage (SSD) systems depending upon the type of envelope materials. The SSD system with non-woven geo-textile fabric envelope resulted into 82% and 60% increase in sub-surface drain flow, respectively as compared to SSD without envelope. Sediment concentrations in sub-surface water drained through SSD without envelope was found to be 156.6 g/m^2 surface area of drain pipe. The maize crop

yield increased by 40% and 22.6% over the control (3.54 tonnes/ha) under SSD system with envelope and without envelope, respectively installed at 20 m drains spacing and 1.0 m drain depth. The SSD system with envelope resulted in 12% increase in yield of subsequent wheat crop over control. In heavy clay soils (Vertisols), the use of envelope materials is suggested for increasing the sub-surface flow through pipe drainage and effective drainage of temporary waterlogged areas. The hydraulic performance of coconut coir fibre and non-woven geo-textile fabric is at par. However, due to limited life of coconut fibre and long run higher cost as compared to geo-textile fabric (more than 25 years), the non-woven geo-textile fabric is suggested as envelope material for sub-surface drainage under Vertisols.

Autonmatic fertigation system for mango and guava: An automated drip fertigation system was adopted and installed in guava and mango orchards at CIAE farm. It has capability to operate on time basis and/or volumetric basis and/or sensor basis. The system has provision for independent valve and sequence programming for valves and backwash programming for sand filter. It has capacity to run independent fertilizer injector either on time basis or volumetric basis. The automated drip fertigation system performed with uniformity co-efficient, distribution uniformity and statistical uniformity more than 96%; co-efficient of variation of emitter discharge less than 0.05 and flow variation less than 20%. Techno-economic feasibility study indicated that adopted automatic fertigation system could be profitably used for 5–20 ha mango/guava orchard.

Growing processing quality potato using plastics mulch and drip irrigation: Plastics mulch with drip irrigation was evaluated against straw mulch to grow processing quality potatoes. Three drip irrigation levels of IW/CPE of 0.6, 0.8 and 1.0 and conventional check basin irrigation was applied. The mulches were applied after 55 days of sowing when the crop canopy was fully developed, which increased the minimum and maximum soil temperature by 2 to 3ºC and thus helped to maintain required soil moisture within the soil. The straw mulch did not affect soil temperature on a large extent. Both drip irrigation and mulch treatments affected the yield significantly with significant interaction effect. The highest average yield of 28.46 tonnes/ha was observed in the treatment under plastic mulch with drip irrigation, thus showing 32.1% increase, followed by organic and biodegradable mulches with an increase of 29.3% and 23.5% respectively over no mulch drip-irrigated crop.

Safety of lining from seepage water pressure: A technology to protect the polyethylene lining against the uplift pressure due to overland flow of water on sloppy terrains was developed, which was tested again with new water pond. Perforated plastic pipes of about 5 cm diameter were laid in trenches made in bottom of the pond. All the pipes (06 nos.) were made to converge to an outlet which led the water outside pond. Pipes were wrapped with coir rope to prevent choking of the perforations in the pipe. Then pipes were covered with sand. Above that plastic film was laid. Due to this arrangement seepage water was disposed out of pond safely and hydraulic pressure was released. Hence the damage to the lining was avoided.

Standardization of method for pond lining

Two water harvesting pond lined with LDPE sheet (250 micron) were constructed: first in research farm (480 m^3), and second in the farmers' field (1,000 m^3). The pond was dug as per the design, and bed and sides were made weed and stone free. Steps at 50 cm vertical interval were made on sides of the pond to hold the agrifilm at its place. On top sides, continuous trench of 30 cm × 30 cm was dug for the purpose of anchoring the agrifilm to prevent it from sliding down. Pre-emergence weedicide was also sprayed on sides and bed to arrest the weed growth. After the sides and bed were dressed properly, 10 cm thick layer of sieved sand was spread uniformly on bed and sides to provide cushion to the agrifilm. After that agrifim (250 µ) was laid properly in the pond. For joining, bitumen of 85/25 and 80/100 grade in the ratio of 2:1 was used. While laying too much stretching or tightness of the agrifilm was avoided, particularly on sides. Over agrifilm, soil cover of 15 cm was provided. Stone pitching on sides was done in the research field pond to safeguard the sides of the pond against erosion and any other external forces.

LDPE-lined ponds: Low-density polyethylene lined small ponds were found quite effective in providing supplemental irrigation to horticultural/vegetable production in hilly areas. Water resources of 2,417 m^3 capacity were developed at the farmers' field in Uttarakhand with funding under NHM in two clusters, i.e. in village Bhagartola in Almora and village Darim in Nainital and a total of 26 and 52 tanks were constructed in the two villages, respectively. The capacity of the tanks ranged from 10 to 289 m^3. The source of water for these tanks was runoff and low discharge natural springs. The farmer born the cost of earthwork, while the institute contributed for polyethylene and covering material (coal tar felt). Farmer shared 37% cost for tanks of 10–15 m^3 range, while it increased to 84% for tanks of 280–300 m^3 capacity. The cost/m^3 was also found to reduce from Rs 271 for 10–15 m^3 capacity to Rs 120 for tanks of 280–300 m^3 capacity. A total of 20 tanks out of

78 tanks constructed at the farmers' field, were evaluated for irrigation in different vegetable production catchments. It was observed the supplemental irrigation (in form of check basin) from such developed tanks helped in 14.7 to 27.8% increase in the productivity of different vegetables.

Gravity fed micro-irrigation system: Micro-irrigation in conjunction with LDPE-lined pond constructed on higher elevated terrace and operated by gravity was evaluated in participatory mode in the field of Mr Inder Singh, village Darim, district Nainital and funded by Horticultural Technology Mission project on micro-irrigation system. The system was hydraulically evaluated. To deliver 3 and 5 mm of water per irrigation, 0.75 L and 1.25 L was required to be deliverd from one emitter during winter (vegetablepea) and summer (Frenchbean), respectively. The overall emitter flow rate variation was 26.54% which is slightly higher than the acceptable limit of 20% (ASAE, 1985). The Christiansen uniformity co-efficient (CUC) was 86.29% which is within the permissible limit of 85% (ASAE, 1985). The overall distribution uniformity (Du) was found as 87.46%. The gardenpea and Frenchbean were grown using the micro-irrigation system. Garden pea had yield 6.3% higher in micro-irrigation as compared to check basin, but Frenchbean had comparable yields in both the methods. Though the vegetable yield was not increased significantly, the system helps in increasing the area under irrigation. The net present value (NPV) of net returns was calculated as Rs 160,523 and 65,223 for micro-irrigation and check basin irrigation, respectively at the current market price of Rs 7/ kg each for vegetablepea and Frenchbean. The micro-irrigation system had B:C ratio of 1.78 and IRR of 12.2 which is higher than check basin irrigation (B:C ratio 1.38; IRR 6.4%).

Mechanized system for production of *malai lachha*: A prototype of a mechanized system for production of *malai lachha* was developed. Trials were conducted with variable parameters such as lip-slot openings, concentration of milk and steam pressures. A combination of variable parameters, concentration of milk as 30% TMS, 3 layers of concentrated milk, 1 mm opening of the variable lip-slot die and 0.3 kg/cm^2 steam pressure with 60 min. of heating time was optimum for the production of best quality of *malai lachha.*

The advantages are: reduction in labour, hygienic design, reduction in operational time, uniform product quality, and capacity (1 kg/hr)

Resource-specific purse seine net: A tuna-purse seine net of 1,100 m length, 125 m depth, weighing approximately 10 tonnes and having mesh size of 120 mm was designed for big size fishery. Experimental-cum-pre-commercial fishing operations landed good catches of large yellow fin tunas, skipjack tunas, carangids and seer fishes, which evinced keen interest among the fishermen of Kochi. ❑

12

Agricultural Human Resource Development

Experiential Learning Units deal with personality development, assuring quality and relevance of higher agricultural education by accreditation and periodic revision of course curricula and such related aspects concerning infrastructure development, gender mainstreaming, capacity building of the faculty through training, overseas scholarship, rewards and recognition etc.

The National Academy of Agricultural Research Management (NAARM), a constituent component of the Division, complements in capacity building of the National Agricultural Research System (NARS). In addition, targeted capacity building of the scientists and teachers has been reinforced through Indo-US Agricultural Knowledge Initiative (AKI) by the Division.

Quality Higher Agricultural Education

In the ICAR the Education Division strives for maintaining and upgrading quality and relevance of higher agricultural education. The thrust areas identified under XI Plan continued to receive financial and monitoring support. One additional sub-programme of Niche Area of Excellence was added to the continuing list of 29 such sub-programmes. The Experiential Learning units were further augmented now totaling 220 units. To maintain the targeted number of emeritus scientists under the Emeritus Scientists Scheme, filling the vacant slots is now under progress. Financial support for the construction of museum and girls' hostels and international hostels has been extended to AUs. The overall financial and academic support to AUs continued for facilitating modern instruments and equipments to support post-graduate (PG) education and research, ICT environment, multimedia learning resources etc. Special grants announced by the Government from time to time have been continued to support high-performing universities and their colleges for refurbishing/renovation of laboratories, class rooms and farms. Under HRD programmes/ activities, faculty development, trainings through CAS, CAF, Best Teacher Awards, Fellowships and Scholarships were continued. An additional position of National Professor named "*Norman Borlaug Chair in Agricultural Biotechnology for Crop Improvement*" has been created in the specific field of agricultural biotechnology for crop improvement.

Development and Strengthening of Agricultural Universities

Under budget estimate, a development grant of Rs 367 crore for all AUs and Rs 3 crore to NAARM, Hyderabad, were extended. The Special Grants comprised: (i) Rs 73.37 crore out of the total grant of Rs 100 crore to Mahatma Phule Krishi Vishwavidyalaya, Rahuri, (ii) Rs 4.99 crore to Tamil Nadu Agricultural University, Coimbatore, and (iii) Rs 5 crore to GB Pant University of Agriculture and Technology, Pantnagar. In addition, Centenary grants were also awarded to Rajendra Agricultural University, Pusa (instalment for this year: Rs 15 crore), Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola (instalment for this year: Rs 12.69 crore) and Chandra Shekar Azad University of Agriculture & Technology, Kanpur (instalment for this year: Rs 14.28 crore).

Infrastructure Development

The foundation stone was laid by Dr Mangala Rai, Secretary, DARE and Director-General, ICAR on 10 April 2009 at CIFE, Mumbai, for Boys' Hostel and Sports complex. At University of Agricultural Sciences, Bangalore, construction of greenhouse at Horticulture College, Mudigere and laboratory building for commercial production of bio-agents at Agricultural College, GKVK, Bengaluru have been initiated. At Navsari Agricultural University, Gujarat, onion dehydration plant, commercial biofertilizer and banana pseudo-stem fibre extraction units were established.

In the Divisions of Indian Agricultural Research Institue, New Delhi, PG laboratories were upgraded and the lecture halls have been modernised by adding audio-visuals, LCD projectors and multi-media systems. Computer facilities have been improved. Internet facility for PG students has been provided at the hostels and guest- houses for trainees and visiting faculty. The Wi-Fi system has been created in students' hostels. The Post Graduate School Calendar which contains PG School rules and courses and their contents has been put on IARI website in Hindi and English. Laboratory manuals were prepared in the teaching disciplines for practical courses. A 'Student Career Development and Industry Interface Centre' has been established for career counselling and arranging frequent institute-industry interface.

At the College of Home Science, GBPUAT, Pantnagar, blending and spinning laboratory and visual ergonomics laboratory have been developed from ICAR Development grant. At the College of Agribusiness Management, a new complex consisting of classroom and faculty chambers, conversion of a classroom into smart classroom and setting of video conference facility have been completed. The College of Horticulture, Bharsar added five lecture rooms and eight laboratories, one hostel each for girls and boys. In the Department of Food Science and Technology, construction of a building for housing soya milk and extruded products has been completed and an oil-fired boiler and jacketed kettles have been installed. At the College of Forestry and Hill Agriculture, Ranichauri, renovation of biocontrol laboratory, culture room for micro- propagation, furnishing of seminar hall, classrooms and hostels has been done. Construction of new girls' hostel, seed processing unit, and data processing laboratory has been completed.

Extensive civil work worth Rs 4.61 crore such as construction of third floor of new administrative building, Ph.D. students' hostel for men, laboratory block for Institute of Organic Farming, post-harvest technology building at RHSC complex and food processing unit was undertaken by UAS, Dharwad.

Dr Mangala Rai, Secretary, DARE&DG, ICAR laying foundation stone of the Boys' Hostel at CIFE, Mumbai

At Orissa University of Agriculture and Technology, Bhubaneswar, extension of girls' hostel at Bhubaneswar, examination hall of College of Agricultural Engineering and Technology, renovation of buildings of College of Home Science, College of Agricultural Engineering and Technology, central library, conference hall, IPR Cell, boys' hostel of College of Agriculture at Chiplima and university main building have been done utilizing the share of ICAR grants.

International hostels/girls' hostel: Thirty-seven international hostels are under construction in 37 AUs during this year with an ICAR budget outlay of Rs 1,390 lakh. A grant of Rs 2,252 lakh was allocated for the construction of 63 girls' hostel in 48 AUs.

Special grants: A grant of Rs 4,197 lakh was allocated to Sabour College under RAU, Pusa; Nagpur College under PDKV, Akola, and Kanpur College under CSAUAT, Kanpur.

Educational museum: A grant of Rs 1,330 lakh has been extended for construction of one museum each in 38 SAUs.

Zonal sports complex: The budgetary allocation of Rs 170 lakh for North zone, Rs 180 lakh for East zone, Rs 200 lakh for West zone, Rs 190 lakh for South zone and Rs 140 lakh for Central zone was made for the development of sports complexes including one crore grant for each zonal centre (GBPUAT, Pantnagar; AAU, Jorhat; MPUAT, Udaipur; ANGRAU, Hyderabad, and JNKVV, Jabalpur).

Capacity building

Niche area of excellence: To strengthen and build excellence in human resource in research and education, the sub-programme of niche area of excellence was started in the X Plan with a view to providing optimal resources for most relevant, appropriate and applicable output and impact. About 30 sub-programmes are operational in diverse areas, focusing on sustenance of quality of natural resources through diversification and productivity enhancement. For this, an initial allocation of Rs 15.10 crore was made. Third Annual Review Meeting was held at BAU, Ranchi, during 28-29 October 2009.

The salient achievements made by these centres are given here. Three centres, viz. BCKVV, Mohanpur, YSPUHF, Solan and MPKV, Rahuri have uploaded their work in the university websites attracting many site visits.

At Anand Agricultural University (AAU), Anand, under 'Functional fermented dairy products

with synbiotics', two new products, viz. synbiotic whey drink with orange juice and synbiotic *lassi* with carrot juice were successfully formulated for the first time.

At Acharya NG Ranga Agricultural University (ANGRAU), Hyderabad, under 'Research and capacity building for improving water productivity in agriculture', there was saving of 37% water in aerobic rice as compared to transplanted rice.

At Assam Agricultural University (AAU), Jorhat, under, 'Enriched organics for sustainable agriculture', the centre has enriched its repository of mother cultures of *Azotobacter*, *Azospirillum*, *Rhizobium*, phosphate solubilizing bacteria (PSB) and biofertilizers along with 15% *Azolla* compost, 17.5 tonnes optimal compost, 13 tonnes biofertilizer based organics and 15 tonnes enriched compost.

At Birsa Agricutural University (BAU), Ranchi, under 'Sustainable soil, water and plant nutrient management for rainfed cropping system', soil microbial biomass carbon and nitrogen, potentially mineralizable nitrogen and labile carbon in acidic soils improved with liming and organic manuring with recommended level of NPK fertilizer application in continuously cropped soils.

At Bidhan Chandra Krishi Vishwa Vidyalaya (BCKV), Mohanpur, under 'Arsenic management options including organic agricultural systems in West Bengal', the multi-drug and Toxic Compound Extrusion Transporter (MATE) might be a candidate gene, whose restricting arsenic loading in the rice grain was elucidated.

At the Central Institute of Fisheries Education (CIFE), Mumbai, under 'Utilization of inland saline and sodic soil for aquaculture', the tiger shrimp (*Penaeus monodon*) could be cultured economically in inland saline area; production of 1,332 kg/ha in 105 days achieved with potassium fortification proving that it is an economically profitable activity.

Culture of banana shrimp (*Fenneropenaeus merguiensis*) and kuruma shrimp (*Marsupenaeus japonicus*) indicated that these can be cultured in inland saline areas with potassium fortification; as these species attain maturity under pond condition.

At Chandra Shekhar Azad University of Agricultrue and Technology (CSAUAT), Kanpur, under 'Bio-intensive IPM strategies for major pest and disease problems of Uttar Pradesh', out of 5 modules developed and validated, the following bio-intensive IPM module was found to be the best in 22 districts of UP (Central and Eastern UP) on chickpea, pigeonpea and lentil, resulting in high benefit-cost ratio as well as minimal plant infection and pod damage due to pod-borer and pod-fly and wilt-root rot incidence.

At Deen Dayal Upadhyaya Veterinary and Animal Science University (DDUVASU), Mathura, under 'Rural livestock production augmentation through disease monitoring and health intervention', characterization and confirmation of candidate strains for development of IBR virus marker vaccine and diagnostics, detection of genomic diversity of Rota virus in human and animal origin strains and development of quick detection PCR was done. Antiviral activity of 10 medicinal plants selected was tested on IBR virus (BHV-1) FMD Virus and Rotavirus.

At Govind Ballabh Pant University of Agriculture and Technology (GBPUAT), Pantnagar, under 'Quality production of major freshwater fishes for sustainable farming', international level education delivery and research facilities have been developed in freshwater aquaculture under the programme.

At Indian Veterinary Research Institute (IVRI), Izatnagar, under 'Veterinary biologicals', development of small ruminant vaccine, viz. sheep pox, ORF disease, high passaged goat pox and thermo-resistant PPR virus vaccine and their successful field validation, technology assessment of goat pox vaccine for licensing to commercial houses and development of platform technologies (recombinant protein and DNA based) for pox viruses, PPR virus, and *Texoplasma gondii* (Zoonotic) was done.

At Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, under 'Conservation, cultivation, processing and quality evaluation of medicinal and aromatic plants', resource generation through selling of quality medicinal and aromatic plant material, providing technical know-how to growers, NGOs, Ayurvedic and pharmacy college for cultivation and processing and Comprehensive Database of Medicinal and Aromatic plants species of Madhya Pradesh were prepared under transfer of technology programme.

At Marathwada Agricultural Universty (MAU), Parbhani, under 'Development of agrobased nutraceuticals for health security', the potential nutraceuticals like lycopene from tomato, bixin from annatto, curcumin from turmeric, carthamin from safflower, maltodextrin from corn starch, isoflavones from soybean and other bioactive compounds from noni fruits were processed from agro-based resources as fortifying agents to enrich need-based food products as functional foods.

At Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, under 'Protected floriculture and vegetable production', manpower was developed and trained through trainings for 88 farmers in small cluster and 50 agriculture diploma students. Out of these 26 farmers and six students have started their own polyhouses for cultivation of flowers or vegetables, whereas rest of the students resumed jobs.

At National Dairy Research Institute (NDRI), Karnal, under 'Buffalo production and reproduction

genomics', major genes involved in maternal to embryonic transition during embryonic development in buffalo were identified. Expression pattern of these genes helped to modify the existing IVF procedure in buffalo, for better success rate.

At Orissa University of Agriculture and Technology (OUAT), Bhubaneshwar, under 'Management of acid soils for sustainable crop production', integrated use of lime @ 0.2 LR and Boron @ 1 kg/ha to each crop increased the yield and nutrition of cabbage – okra – cowpea cropping system followed in acid soils. Integrated application of lime @ 0.2 LR and sulphur @ 40 kg/ha as gypsum/phosphogypsum increased the yield and quality of groundnut crop.

At Punjab Agricultural University (PAU), Ludhiana, under 'Soil and water resource management in high intensity cropping regions', a programme package called soil testing-based fertilizer recommendation (acronym STFR) has been developed for soil fertility evaluation and making fertilizer recommendation. This programme has been put in practice in soil and water testing laboratory.

At Sher-e-Kashmir University of Agriculture Science and Technology (SKUAST), Kashmir, under 'High value temperate horticultural crops of Kashmir valley', course curriculum developed for teaching at UG and PG level for proficiency upgradation in niche crops (walnut, almond, cherry, saffron and *Kala zeera*).

At Sardar Vallabh Bhai Patel University of Agriculture and Technology (SVBPUA&T), Meerut, under 'Isolation, characterization of production of bioagents', indigenous populations of egg parasitoids (*Trichogramma* spp), entromopathogenic bacteria (*Bacillus thuringiensis* and *Photorhabdus luminescens*), entomopathogenic nematodes (*Heterorhabditis indica* and *Steinernema asiatum*), Baculovirus of *Pieris bassicae*, granulosis virus (CPb GV) were isolated and identified based on morphology, biochemical tests and DNA finger print.

At Tamil Nadu Veterinary and Animal Sciences University (TNVASU), Chennai, under 'Molecular diagnostics for emerging avian viral diseases and their immunopathogenesis', whole genome sequencing of Newcastle disease virus isolated has been completed from three isolates for the first time in the country.

At University of Agricultural Sciences (UAS), Bengaluru, under 'Integrated drought management with emphasis on genetic engineering for developing crop plants resistant to abiotic stresses', since stress-specific DNA library of finger millet is diverse, several up-stress regulating genes were validated that are potential candidate genes to improve stress tolerance in crop plants.

At University of Agricultural Sciences (UAS), Dharwad under 'Microbial biotechnology for imparting resistance in plants against insect pests and pathogens', plant transformation vector carrying two genes each 42 encoding chitinase and B-1, 6 endogluconase gene from *Trichoderma virens* have been developed.

At Dr Yahwant Singh Parmar University of Horticulture and Forestry (YSPUHF), Solan, under 'Technology for sustainable apple production' bud-wood bank of nine cultivars of apple were developed. Among various horticultural mineral oils (HMO's) to control red spider mite, Rilso @ 1.5% was most effective, followed by orchol-13 and HP-summer oil.

Experiential learning: A total of 220 units are being operated in 45 AUs. These units greatly help in skill development and attitude building in undergraduate students and in linking agricultural education with professionalism. This sub-programme helped in transcending the mere knowledge-imparting education with limited practical training to experience-based behavioural change through comprehensive practice sessions involving all aspects of an agricultural enterprise, from production to consumption. Salient achievements specific to some universities are as follows:

At Rajasthan Agriculture University (RAU), Bikaner, vermicompost unit was developed from ICAR grant (Rs 80 lakhs) and production of vermicompost was started.

At University of Agricultural Sciences (UAS), Dharwad, crushing equipments and their trans-esterification units for the purification of crude oil extracted from bio-fuels and a model pilot plant have been procured and installed. Seeds from plantations have also been procured and demonstrated to the UG students. Efforts were being made to use the bio-fuels produced for running the vehicles of the university. The ICAR grant of Rs 15 lakhs to the Department of Textiles and Apparel Designing for the construction of laboratory unit-'Garment Manufacturing and Value Addition Technology' under Experiential Learning during 2006-07 was put to good use in imparting hands on training for UG students (2+2 Syllabus) in the most challenging fields, viz. garment manufacturing, design studio practices, value addition technology, traditional and contemporary surface ornamentation and fashion accessories. Department of Food Science and Nutrition utilized the ICAR grant of Rs 21 lakh for the purchase of wet and dry processing equipments to establish 'Food Processing and Value Addition units' under Experiential Learning in the year 2006-07 to impart hands on training to UG students. More than 250 processing equipments have been purchased to ascertain product development, value addition and for utilization of grains,

vegetables and fruits, and dairy products.

At Kerala Agricultural University (KAU), Thrissur for protected cultivation of high value horticultural crops like cut-flowers, cut-foliage, pot plants and cool season vegetables, two fan and pad systems of dimension 320 m^2 each and two open ventilated rain shelters of dimension 384 m^2 each were constructed. This facility will be used for the purpose of training students on raising various categories of high value horticultural crops.

At the College of Forestry and Hill Agriculture, GBPUAT, Pantnagar eight new courses under Experiential Learning have been developed and included in the graduation requirements of B.Sc. Forestry degree programme, viz. production and management of nursery stock, production and management of medicinal and aromatic crops, post-harvest technology of edible wild crops, soil quality analysis, handling and testing of forest seeds, diagnosis of forest pest and their management, application of GIS in forest resources management and environment impact assessment.

At the College of Agriculture under Junagadh Agricultural University, Junagadh requisite faculties on "Microbial pesticides production unit" have been set up utilizing ICAR grant for imparting hands on training on production and processing NPV against *Helicoverpa* and *Spodoptera* and fungal bio-insecticides like *Beauveria* and *Verticillium* spp.

At the College of Horticulture, Dr Y.S. Parmar University of Horticulture and Forestry Nauni, Solan, the ICAR share to the tune of Rs 55 lakhs was utilized for the construction of poly-houses, packaging house, irrigation system, farm store and polythene tunnels. A modern nursery with two polyhouses and one field laboratory equipped with cold storage, laboratory for students under College of Forestry was also established.

Ninety students of College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar were imparted training for handling bee boxes, queen rearing techniques, purification of honey for safe storage and acquainted with the functions of honey processing plant. Under hands-on training on production and processing of mushroom, these students produced 330 bottles of spawn of straw mushroom and 22.5 kg fresh mushroom. They were also acquainted with mushroom processing and preservation techniques like dehydration and pickling. Sixty students of third year B. Tech. (Agric. Engg.) were given hands-on training on preservation and value addition of different fruits and vegetables.

The students of College of Home Science registered under 'Family Resource Management' elective course were given hands on training on preparation of handicrafts from agricultural by-products. Students prepared different utilitarian and decorative materials from agricultural by-products. Students of B.V.Sc. and Animal Husbandry of the College of Veterinary Science and Animal Husbandry availed six months internship at various centres of activity on veterinary and animal husbandry across the State on areas such as (i) production of animal vaccine (ii) collection, processing, preservation, artificial insemination and management of livestock and (iii) prevention, control and treatment of captive wild animals and birds.

At NDRI, Karnal, construction of an external block of the Experimental Dairy at a cost of Rs 50 lakh has been completed to provide the B. Tech./ DT students with a wide variety of the practical aspects of the dairy and food processing activities.

At ANGRAU, Hyderabad, ICAR grant of Rs 112.0 lakh was utilized for setting up of facilities for hands-on training in the following 5 projects:

- Nurseries for vegetables and fruits including tissue culture technology, College of Agriculture, Rajendranagar.
- Green house production technology and mushroom production, College of Agriculture, Rajendranagar.
- Soil, water and plant testing laboratory at Agricultural College, Bapatla.
- Production of beneficial insects and other programmes at S.V. Agricultural College, Tirupati
- Training in home science production technology and value addition at PG and Regional College, Rajendranagar.

Six experimental units sanctioned to Maharana Pratap University of Agriculture and Technology University Campus, Udaipur have been made functional: (i) Renewable energy sources at College of Technology and Engineering, Udaipur (ii) Processing centre for food and vegetable and development of mixed food at College of Dairy and Food Science Technology, Udaipur (iii) Speciality food like high protein food, health food and milk food in College of Dairy and Food Science Technology, Udaipur (iv) Apparel Production Management Unit at College of Home Science, Udaipur (v) Bio-control unit at Rajasthan College of Agriculture, Udaipur (vi) Processing and Value Addition of Agricultural Products at College of Technology and Engineering, Udaipur.

The Colleges of Horticulture and Animal Husbandry, Marathwada Agricultural University, Parbhani utilized funds (worth Rs 70 lakh and Rs 40 lakh respectively from ICAR) for imparting hands on training to the students.

Modern agro-processing system for horticultural produce was established under the Department of Agricultural Engineering and Processing at the

Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut campus. The food processing unit mainly consists of multipurpose fruit and vegetable washer, crusher, pulper, juice extractor, steam jacketed kettle, chiller, homogenizer, pasteurizer, automatic filling machine, crown corking machine and a boiler for steam generation.

Emeritus Scientist Scheme: The major contributions under this include: Innovative approach to reduce postharvest losses in mango, guava and aonla, Site-specific nutrient management (SSNM) for sustaining soil quality and enhancing crop productivity in rice-wheat cropping system, Value addition to the non edible portion of fruits and vegetables for industrial use, Impact of climate change on Indian crops, Rapid bioremediation of environmental contamination caused by chlorinated pesticides, Strategies for enhancing traditional duck production system in under-privileged districts of TamilNadu, Genetic improvement of *Bacillus thuringiensis* S6 for its bioefficacy for the control of *Spodoptera litura*, Screening of collected germplasm and completion of experiments on agro-techniques aimed at enhanced productivity and quality in low chill pears, Tillage cum organics mediated rhizospheric modulation of winter initiated sugarcane ratoon for enhanced bud sprouting vis-a-vis cane productivity in subtropical India, Physiological studies on drought and high temperature stress tolerance in chickpea, Screening/ evaluation of genotypes having tolerance to high temperature at seedling stage with high seed yield and bold seed size in Indian mustard (*B. juncea*), diffuse reflectance spectroscopy in assessing soil properties of vertisols and associated soils for sustainable development of agriculture, hybridization of oyster mushroom *Pleurotus* spp.), Impact assessment of climate change on major pests of maize and mustard, development and phenotyping of SSD populations of bread wheat and mapping of novel genes for durable resistance to leaf rust and stripe rust from French cultivar Capelle Desprez, development and evaluation of a simple antigen-based serological assay for diagnosis and screening of leptospirosis in animals assessment of noise induced hearing loss (NIHL) and modification/design of safety gadgets, enhancing crop productivity through Aqua-ferti sowing under rainfed and limited water culture, design and analysis of agricultural research experiments involving sequences of treatments with carryover effects.

Rural awareness work experience (RAWE) programme: This aims at training strategies incorporating rural agricultural milieu, provide opportunity for an undergraduate student of the last year to engage in fieldwork activity, to review and analyze critically the real-world work experience and to refine decisions as a consequence and apply the result in practical life and field situation. Rs 263 lakh were allocated to 44 AUs during this year. The salient achievements are summarized below:

- The RAWE programme of the College of Horticulture, christened '*Niravu*' was formally inaugurated on 26 April 2009 by the Vice Chancellor of Kerala Agricultural University. The RAWE was divided into nine modules such as Spring-board module (personality and soft skills development); Participatory Rural Appraisal, watershed management analysis and farm management module, Entrepreneurship development programme; Regional Agricultural Research Station and Krishi Vigyan Kendra Training; NGO training; Agro-clinic and village stay programme. The fourth year undergraduate students are given training in each of the module.
- In JNKVV, under the RAWE programme of 229 (fourth year) students of College of Agriculture, Jabalpur, Rewa and Tikamgarh have been placed in different Krishi Vigyan Kendras. The students got a first-hand experience in dealing with the problems of crop production technologies, fruit and vegetables production technology, insect pests and diseases, soil health, production and management of livestock, critical analysis of resource available at the disposal of the farmers. RAWE students have also learnt the PRA techniques and collected all kinds of information of the villages and identified farmers' problems.
- The TNAU (Coimbatore) RAWE programme consists of Village Stay Programme for 30 days, ADA/ADH Placement for 15 days and NGO placement for 15 days. Under Agro Industrial Tie-up Programme (AITP), the

ANGRAU students participating in RAWE programme

students were placed in various agro-industrial firms to learn managerial skill, organization culture, business marketing and business communication. The final year B.Tech (Biotechnology) and B.Tech (Bioinformatics) students underwent Biotechnology/ Bioinformatics Work Experience (BWE) programme for 17 days.

- At GBPUAT, Pantnagar, evolution of textile articles through processing of wool with silk waste and cotton to create entrepreneurial skills in rural women has been carried out and value addition to agro and animal based fibers has been done. College of Horticulture Bharsar students are getting wide exposure through internship, viz. on plant health clinic village attachment, nursery establishment and industrial attachment. In the college of Agribusiness Management under summer placements scheme MBA (Agribusiness), MBA for engineers and MBA (Food Retail and Supply Chain) have got summer placement in various companies all over India.
- At Dr Y.S. Parmar University of Horticulture and Forestry Nauni, Solan, since the academic session 2001-02, 318 students (217 boys and 101 girls) have so far been trained in this programme. The students are subjected to practical training on the university stations of each zone under the overall supervision of the station/KVK's in-charges for one-third period of training and two-third period is spent in the farmers field and horti-industrial units of adjoining areas.

Best Teacher Awards: The Education Division extended fiscal support towards the reward and recognition of excellent teachers by mechanism of Best Teacher Awards in AUs.

Manpower development

All-India admissions and fellowships: The Council continued to promote merit and national integration through All-India Entrance Examinations for admissions at undergraduate and postgraduate level for certain proportion of seats in AUs and adequately supported with appropriate scholarship/fellowship provisions. The programs for faculty training in specialized, priority and cutting edge areas continued. The Council also provided for admission of foreign students in AUs.

All-India entrance examination for admissions to UG: For admissions upto 15% seats in agriculture and allied subjects other than veterinary sciences, 14 All-India Entrance Examination for Admission to undergraduate degree programmes (AIEEA-UG-2009) including the award of National Talent Scholarships (NTS) was conducted on 23 May 2009. In this examination, 19,469 candidates appeared out of 24,222 applicants and 1,621 candidates were finally admitted in 49 Universities through counseling. All the candidates who joined a university falling outside their state of domicile were awarded National Talent Scholarship (NTS) of Rs 1,000 per month.

All-India entrance examination for admissions to PG: For admissions to 25% seats in PG programmes at 54 Universities, including award of ICAR Junior Research fellowships, AIEEA-PG-2009 examination was held on 24 May 2009. A total of 14,405 candidates appeared out of 16,162 applicants in the examination and admissions were granted to 2,010 candidates.

All-India competitive examination for ICAR Senior Research Fellowship for Ph.D.: The examination was held on 25 January 2009 at 7 centres in the country. Based on the results, a total of 171 Senior Research Fellowships were awarded and 436 candidates were declared qualified for Ph.D. admission without fellowship in 13 major subject groups and 56 sub-subjects. The SRF amount is Rs 12,000/month for first and second years and Rs 14,000/month for third year with a contingency grant of Rs 10,000/year for all disciplines other than veterinary sciences. For veterinary science students, it is Rs 14,000/month for first and second years and Rs 15,000/month for third year with a contingency grant of Rs 10,000/year.

Junior Research Fellowships: About 472 fellowships were awarded in 19 subject groups (90 subjects). The amount is Rs 8,640/month for non-veterinary and Rs 12,000/month for veterinary students to pursue PG degree programme. Besides, a contingency grant of Rs 6,000/year is payable to all awardees.

Merit-cum-means scholarship (MCM): This scholarship is granted to students of economically weaker sections of the society to undertake UG studies in agriculture and allied science subjects in SAUs, ICAR DUs, CAU and CUs with agricultural faculty. Maximum 7% students from a suitable university are awarded the scholarship of Rs 500/month.

Internship assistance: This assistance is being given to all final year students of B.V.Sc. and A.H. programmes during their internship at Rs 400/month besides Rs 200 for undertaking to-and-fro journey to place of internship for 6 months.

Admissions of foreign students: During the first half of the year 2009-10, about 247 candidates from 22 countries have been processed/granted admissions in SAUs, AAI-DU, ICAR DUs, CAU and CUs having agricultural faculty. Candidates came mainly from Afghanistan, Bangladesh, Botswana, Bhutan, Ethiopia, Guyana, Indonesia, Iran, Iraq, Japan, Kenya, Myanmar, Nepal, Qatar,

Rwanda, South Africa, Sudan, Sri Lanka, Syria, Tanzania, Vietnam and Yemen. Maximum candidates came from Rwanda (56 nos.)

Summer/winter schools and short courses: To provide continuing education and training in highly specialized subjects to teaching faculty, 104 Summer/Winter Schools and Short Courses of 10 to 21 days duration were supported by Organization at ICAR Institutes and State Agricultural Universities. Out of these, 84 courses were of 21 days duration and 20 courses were of 10 days duration.

Centers of Advanced Studies/Centers of Advanced Faculty Training: The 31 Centers of Advanced Studies/Centers of Advanced Faculty Training (CAS/CAFT), continued towards capacity building of scientific faculty engaged in teaching at UG and PG levels. Around 1,300 scientists/ faculty members are trained annually under the scheme. The scheme has been under review for change in the nomenclature and mandate as would be Centers of Advanced Faculty Training (CAFT).

Promotion of Excellence and HRD

ICAR National Professor Scheme: An additional position of National Professor named "Norman Borlaug Chair in Agricultural Biotechnology for Crop Improvement" has been created in the specific field of agricultural biotechnology for crop improvement at IARI, New Delhi with the objective of developing a centre of excellence in this field.

Major achievements of six national professors comprised:

- The 'Pant-ICAR Sub-soiler-cum-Differential Rate Fertilizer Applicator' developed and being patented for breaking of compacted subsoil (upto 50 cm depth) and application of fertilizers has generated great demand from farmers, fertilizer industries, sugar mills and other institutions. This machine is now recommended for launch at National Level for subsoil structure modification and enhancing the 'Green Water' storage particularly in rainfed areas.
- Development of 'Pant-ICAR Deep Soil Volume Loosener-cum-Fertilizer Applicator' for sugarcane ratoon management. It is a technological breakthrough by cutting of old roots (off-barring) upto 30 cm depth between 75 cm rows and 90 × 30 cm paired rows, placement of fertilizers to both sides of rows at 20 ± 5 cm depths and pulverization of clods for moisture conservation is yet another technological breakthrough. This machine is recommended for soil cultivation in laser-levelled fields, as it leaves the field surface in its original form after operation. The machine is being patented.
- Field specific real-time fertilizer nitrogen management strategies using leaf colour chart, chlorophyll meter and optical sensor have been developed and standardized for rice and wheat. Field-to-field variability in N supply from all sources other than fertilizer and temporal variability in demand of N by the crop are very well taken care of by these and both nitrogen rates and timing of fertilizer nitrogen applications are fine tuned.
- Impact of climate change scenarios on the potential length of growing period: The length of the growing period (LGP) is the period (in days) during a year when precipitation exceeds half the potential evapo-transpiration. Trend analysis showed that LGP is likely to gradually decrease with time in several parts of India especially peninsular and southern India. This may call of redesign of systems and crop calendars to adapt to climate change indicating that we may have to re-look into changes required in cropping systems and crop calendars to adapt to climate change.

ICAR National Fellow Scheme: The areas of identified priority covered by 16 such positions at present include, developing regional plans for managing poor quality irrigation waters, development of Elisa-based immuno-diagnostics for classical swine fever, exploitation of metabolic diversity for isolation of genes involved in lipid biosynthesis, sustainability of watersheds in rainfed regions of peninsular India using GIS and remote sensing, senescence: mechanism in crops in relation to abiotic stresses, sink strength and their interaction, molecular characterization of Indian maize landraces and allele mining for agronomically important traits, improvement of strain of *Chaetomium globosum*, a potential antagonist of fungal plant pathogens and developing molecular markers for its identification, textile articles through processing of wool with silk waste and cotton to create entrepreneurial skills in rural women, identification and quantification of phosphatase hydrolysable organic Phosphorus sources for plant nutrition and refinement of a non-destructive technique for phosphatase estimation, decontamination of pesticide residues from edible commodities, assessing soil quality key indicators for development of soil quality index using latest approaches under predominant management practices in rainfed agro-ecology, development of technology of seed production and culture of feather back, *Notoprerus chitala* and two medium carps, *Labeo gonious and L. fimbriatus* for diversification of freshwater aquaculture, genome analysis of indigenous breeds

of cattle, buffalo and goats, study of gene interactions in developing *Drosophila* embryo and efficient design of experiments for quality agricultural research. Some of the salient achievements are as follows:

- The relationship between leaf senescence and antioxidant metabolism on the removal of the reproductive sink in a crop plant has been demonstrated. Removal of reproductive 'sink', i.e. spikelets from wheat at anthesis delayed the rate of flag leaf senescence. Plants without spikelets had higher reduced glutathione/oxidized glutathione (GSH/ GSSG) ratio and antioxidant enzyme activities than the control plants and the differences were apparent from 21 days after anthesis. The removal of the reproductive sink led to an increased antioxidant defense which may be contributing towards the delayed flag leaf senescence in wheat.
- A spray bioformulation of *Chaetomium globosum* developed, which proved effective in controlling late blight of potato, spot blotch and leaf rust of wheat (A patent is ready to be filed). A specific SCAR marker (Sequence Cleaved Amplified Region) has been developed for diagnosis of potential strains of *C. globosum* (A patent filed). The mechanism of antagonism is through antibiosis. A compound, chaetoglobosin A has been tentatively identified through NMR and GC-MS studies.
- Eight selected micro-watersheds located in four villages in the districts of *Rangareddy* and *Nalgonda* in Andhra Pradesh in AESR 7.2 were evaluated for agricultural sustainability using tools of Geomatics - GIS, Remote sensing and DGPS along with conventional methods like soil survey and analysis, PRA and socio-economic survey. A suite of 51 sustainability indicators (SI) were constructed and used to facilitate quantitative evaluation of various aspects of sustainability. Study indicated that for evaluating sustainability at watershed- level, the minimum data set of critical indicators were – efficacy of S & WC structures, soil moisture conservation measures, farm OM recycling, gainful employment, Contingency Crop Planning, crop diversity, security of tenure, gross agricultural income, crop production, local availability of cultivation of fodder, availability of irrigation facility and actual area under cultivation in the watershed.
- A software "Spatial Decision Support System (SDSS)" comprising Regional Resource Characterizing System (named ResourCeS©) and an Environment Impact Assessment Tool (named Usar©) was indigenously developed and their detailed user manuals (ISBN No. 978-81-88708-43-7 & ISBN No. 978-81-88708-45-1) are also in advanced stages of publication. Both ResourCeS© and Usar© have been registered for a COPYRIGHT. Using these tools, quality of irrigation waters was successfully validated on several farmers'/ controlled experimental fields in the Gurgaon and Karnal districts and on the Mewat, Faridabad and Palwal districts of NCR to show that they can be very useful tools for (a) targeting pollution contributing sources across different policy zones of NCR, (b) analyzing water use, water productivity and soil/water/vegetation health of any region of interest, (c) identifying areas with single/ conjunctive water use options and benchmarking/ analyzing canal irrigation performance in any canal command area, and (d) assessing (short/ long term) environmental impacts of wastewater applications on agricultural lands across different policy zones of NCR.
- Biological phosphorus fertilizer (Bio-phos) has been developed, which are now being used in farmer's field and saving 45-60 kg SSP application per hectare. The B:C ratio is 15. In general 16-25% increase in yield is expected in pearl millet, clusterbean, moth bean and mung bean crops under rainfed arid environment. A new method to measure resin phosphorus in arid soils has been developed. The basic anion exchange resin in Cl^- form was found to be the best resin under arid soils.
- A standardized double sandwich ELISA was standardized for detection of classical swine fever (CSF) virus antigen in 2063 tissues of pigs and 532 (25.79%) of the tested samples were found positive for CSF virus antigen. Twenty-two cell culture adapted CSF virus isolates confirmed by RT-PCR were kept in repository for development of a vaccine candidate from the local isolates. Standardized Immunoperoxidase test (IPT) was used for phenotyping these isolates. Liquid phase blocking ELISA (LPBE) was standardized for the first time in India for antigenic characterization of CSDF virus. Neutralization peroxidase linked assay was standardized for antigenic characterization of these isolates. The test is being validated for large scale screening of serum samples from vaccinated pigs to determine the protective antibody level and for sero detection of CSF virus specific antibodies in pigs.

Agricultural Universities/ programmes Accredited this year	
1. Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Srinagar	25.06.2009 to 24.06.2014 (five years)
2. Maharana Pratap University of Agriculture & Technology, Udaipur	25.06.2009 to 24.06.2014 (five years)
3. Sardarkrushinagar Dantiwada Agricultural University, Dantiwada	25.06.2009 to 24.06.2014 (five years)
4. Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur	25.06.2009 to 24.06.2014 (five years)
5. Junagadh Agricultural University, Junagadh	25.06.2009 to 24.06.2014 (five years)
6. MBA (Agri Business) of Rajasthan Agriculture University, Bikaner	25.06.2009 to 24.06.2014 (five years)
7. Rajasthan Agriculture University, Bikaner	Accreditation extended upto 05.08.2013

QUALITY ASSURANCE AND REFORMS

Accreditation: Accreditation was expedited through self-study reports of the AUs, scrutiny and recommendations of the ICAR Peer Review Teams and Education Division, ensuring the eligibility as per minimum accreditation criteria, and finally, the grant of accreditation by the Accreditation Board. This year, the Board granted accreditation to the additional five State Agricultural Universities (SAUs) and their programmes and, to the MBA programme of the Rajasthan Agriculture University, Bikaner. Also, the accreditation of the Rajasthan Agriculture University, Bikaner that was initially granted for two years in 2008, was reconsidered and granted for five years, i.e. up to August 5, 2013.

Revision of ICAR Model Act for agricultural universities: For enhancing the uniformity of structure, governance and efficiency of the agricultural universities in the context of emerging challenges, the Model Act for Agricultural Universities in India was revised and communicated to all agricultural universities for adoption.

Restructuring post-graduate course curricula and syllabi: The ICAR through a National Core Group, have revised the course curricula and syllabi of all PG (masters and doctoral) programmes to make them utilitarian, up-dated and competitive.

Workshop - Quality Assurance in Higher Agricultural Education

An ICAR sponsored workshop on "Quality Assurance in Higher Agricultural Education" was organized on 26 March 2009 at the Assam Agricultural University, Khanapara Campus, Guwahati. The workshop was the maiden effort for addressing quality improvement of agricultural education in the north-eastern hill region of the country. The need for not only improvement in quality of education but also to achieve excellence in imparting agricultural education was stressed. Various aspects including accreditation and criteria thereof, faculty development, student admission, evaluation and examination system, physical infrastructure, financial resources, academic governance, etc. were discussed.

Also, the academic regulations for PG education were revised for bringing uniformity in higher agricultural education in the country. Some agricultural universities have implemented the revised curricula and syllabi with effect from academic session starting July 2009 whereas others are in process.

Modernization of agricultural universities farms: This new mega programme with a budget outlay of Rs 421.95 crores for three years, was initiated in 2008-09 to provide a one time grant to all the State Agricultural Universities and Central Universities with Agriculture Faculty. A sum of Rs 85.57 crores to 43 agricultural universities was distributed during the year. University farms have been renovated and modernized using this support.

ICAR International Fellowships: A new component of international fellowship has been introduced for pursuing Ph.D. program at the Indian Agricultural Universities (AUs) and Overseas Universities for Indian and overseas candidates with the objective to develop competent human resource and showcasing the strengths of Indian ICAR-AUs system. Applications were invited through wide publicity and the selection of candidates for the award is in progress.

Indo-US Agricultural Knowledge Initiative

Under the Indo-US Norman Borlaug Fellowship Programme, 4 out of 15 scientists selected from NARS during 2008-09, completed their trainings in US Universities. A joint workshop on 'Linking Farmers and Agro-based SMEs to Markets' was organized on 16-17 March 2009 in New Delhi. Salient achievements of the research projects are as follows:

Pigeonpea genomics initiative: A variety of molecular markers have been developed from bacterial artificial chromosome end sequencing (BESs), micro-satellite or simple sequence repeat (SSR)-enriched libraries and mining of express sequence tags (ESTs) and genomic amplicon sequencing. About 21,000 SSRs identified, 6,698 SSRs are under analysis along with 670 orthologous genes using a Golden Gate SNP (single nucleotide polymorphism) genotyping platform, with large

scale SNP discovery using Solexa, a next generation sequencing technology, is in progress. Solexa sequencing is being used to explore the feasibility of generating whole genome sequence.

Development of vaccines and diagnostics for control of avian influenza in poultry: A total of 20 AIV (H5N1) Index isolates were selected from different outbreaks (2006-2008) and different geographical locations. On the basis of Phylogenetic origin, IVPI index, Propagation efficiency, cell culture adaptation, four isolates were selected as Haemoglutinin (HA) gene donor for the reverse genetics based vaccine development.

Technology for plant and dairy ingredients-based formulated and functional foods using extrusion technology: A total of 70 formulations having soy incorporation upto 25% have been designed to achieve the nutritive profile for school children in the age of 7-9 years. Out of them, 26 provided good quality ready to eat snacks after their extrusion cooking.

Genetics engineering for abiotic stress tolerance in crops: Cloned abiotic stress-related genes encoding transcription factors, viz. *NFY, ZF2, NAC1* and *Apx* from hardy crop species, and promoters such as zeaxanthin epoxidase and a synthetic promoter. Five gene constructs using transcription factor (TF) encoding cDNAs and abiotic stress-inducible promoters were prepared. Twenty four primary transgenics in rice and 42 in cotton expressing TF genes with enhanced tolerance to abiotic stresses were developed.

Sustainable water resources management: For remediation of poor quality water, levels of heavy metal concentrations in soils, waters, plants and food were estimated and constructed 2-basic wet land cell structure (20*80 m^2) at Ujina, Mewat (Haryana). Mesocosm at IARI, sewage plot side was developed to assess quality of wetland filter for determining optimal hydraulic retention time and screeing wetland vegetation. Two students from PAU, Ludhiana visited University of Florida for doctoral research work.

Information and communications technologies for capacity building model in water management: US India collaborative extension/ outreach and distance education: Reusable Learning Objects (RLO) on participatory watershed management, water user association, soil and water conservation, gender dimension, best management practices for soil and water use for rice-wheat cropping system of Punjab, soil moisture measurement, reclamation of salt affected waterlogged areas etc. were developed. Content Management System has been developed in Hindi to address the need for demand driven and value-added information for the use of local farming community.

Water harvesting for ground water recharge and bio-drainage for salinity control: Activated charcoal removed most of the chromium and nickel from the wastewater within six hours. Amongst the non-edible remunerative aromatic plants *Salvia aegyptica* and *Vitex nigundo* were found to be potential candidates for wastewater disposal.

On-farm water management for rainfed agriculture on benchmark watersheds in diverse eco regions of India: Systems of rice intensification (SRI) in rice and border irrigation in *rabi* crops in terms of agronomic productivity, economic profitability and social acceptability of RMP's for watershed management were executed and evaluated. The project concluded on December 31, 2008.

Water Management Review and Planning Workshop: A two days Final Review and Planning Workshop of Indo-US AKI Projects on Water Management was held at CSSRI, Karnal from 21-22 July 2009. Delegates from 3 ICAR Institutes (CSSRI, Karnal; IARI, New Delhi; CSWCRTI, Dehradun) and 6 State Agricultural Universities from India, and five scientists and students from 3 US universities (Iowa State University, Purdue University and University of Illinois) participated in this workshop.

National Academy of Agricultural Research and Management

Inauguration of PG Diploma in Management (Agriculture): The two-year Post Graduate Diploma in Management (Agriculture) was started at NAARM on 25 July , 2009 with the main objective of developing entrepreneurship skills for the youth to take advantage of the changing agricultural scenario in the country where primary, secondary and tertiary agricultural processes are gaining momentum for sustainable agriculture.

The PG Diploma course is a unique management course covering production, technology development and also agricultural marketing including agribusiness benefiting the students for direct employment. Twenty-seven graduates in agriculture and allied sciences were selected for this PG course through all India competitive examination.

HRD training programme for Programme Coordinators of KVKs: Technology assessment, refinement and demonstration should be tuned to the locational needs and these should be popularized at the ground level. Right technology combined with right methodology is the success of any extension activity. With these backgrounds, a training programme for Programme Coordinators of KVK of North East Region was organized for thirty-five KVK coordinators in July, 2009. ❑

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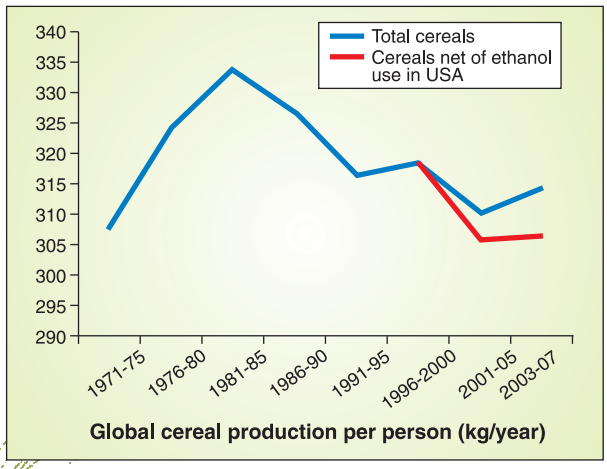
Agricultural Economics, Marketing and Statistics

AGRICULTURAL ECONOMICS AND MARKETING

Global food crisis: causes, severity and outlook: Global food prices have witnessed unprecedented surge after mid-2007, which has caused worldwide concern. The main factors for escalation in food prices were categorized as a result of (a) increase in price of crude oil, (b) supplies did not keep pace with demand for many years, and (c) diversion of grain for liquid bio-fuel. Long-term trend revealed that cereal production increased at a faster rate than population in the initial years of Green Revolution, which is reversed since 1980s. The growth rate in cereals turned out to be lower than the growth rate in population. Though there was some improvement in per caput availability of cereals during 2003–2007, this increase was not available in food due to diversion of foodgrains for bio-fuel. When total production is netted out for quantity of corn used for bio-fuel in the USA then per caput production reduced to 307 kg, which is the lowest during any five years period since 1971. This shows that the shortage of staple food has been building for several years and it became quite large and serious in the recent years.



Global cereal production per person (kg/year)

Shift in dietary pattern towards meat product particularly in China and India, and population growth in India contributed to surge in prices of staple food. Precautionary measures like export bans and rationing in various countries exacerbated the price increase. Long-term trends indicate high and rising prices in future over base period price of 2005. High food prices are seen as an opportunity in some quarters to improve income of farmers and to stimulate food production. Such an increase in production, contingent upon high prices, would keep food out of reach of a large segment of population. Therefore, due attention is to be given to agriculture sector to deal with the harsh reality of high food prices and its effects on poverty.

Economic and ecological benefits of system of rice intensification: Being the important ingredient of food basket of the common people, the declining productivity and per caput availability is a major policy concern in agriculture. System of rice intensification (SRI) increases production, reduces yield gap and ensures the household food security. To quantify the benefits of SRI and compare its performances with that of conventional practice of rice cultivation, a detailed survey was conducted among the 58 carefully selected SRI farmers in four districts of Tamil Nadu representing distinctive features of irrigation system. As the average farm size of over 90% farmers in Tamil Nadu is less than 1.4 ha, producing more food from less land and other inputs has become a necessity for their livelihood. A perception survey the farmers' motivation revealed that most of the farmers were aware of SRI method of cultivation and they have perfected the major principles. The series of field demonstrations and supply of

Fertilizer growth, imbalances and subsidies: trends and implications

Imbalance in fertilizer use, accompanied by serious slowdown after 1991-92 and growth and structure of fertilizer subsidies are the major concerns of fertilizer sector in the country. Empirical evidence revealed that imbalance in use of N, P and K has persisted for a long time at country level as well as in different states. Total fertilizer use in India declined from 18.49 million tonnes to 16.32 million tonnes during 1999-00 to 2003-04, and it was one of the factors for slowdown in agricultural growth during this period. Fertilizer production in India has remained almost stagnant for a decade now. This can adversely affect fertilizer use in the country as dependence on import has already exceeded 35% of fertilizer used in the country. Moreover, imports are now costlier than domestic production net of subsidies. There is a need to expand fertilizer production capacity in the country by encouraging investments and improving efficiency in this sector.

Prices of all the three major nutrients relative to price index of crop sector followed a big decline during 1983-84 to 1990-91. There was no significant decline in real prices of fertilizer after this. Subsidies on fertlizer very steeply increased in the recent years but this has not helped in raising domestic production of fertilizer. Among states, fertilizer subsidy per hectare of net cultivated area varies from Rs 393 in Rajasthan to Rs 3,167 in Punjab. Fertilizer subsidy as per cent of value of crop output showed that Punjab and Haryana receive highest benefit from fertilizer subsidy closely followed by Andhra Pradesh.

Assesment of effect of fertilizer subsidy on food security by estimating impact of reduction in subsidy on foodgrain production revealed that complete withdrawal of subsidies on fertilizer is likely to decrease foodgrains production by close to 9%.

Domestic production and import of fertilizer ('000 tonnes), 1990–91 to 2007–08

Year	N		P		K		NPK import	Import share (%) in total consumption
	Production	Import	Production	Import	Import	Production		
1990–91	6,993	412	2,051	1,016	1,326	9,044	2,754	23.3
1999–00	10,873	856	3,448	1,534	1,774	14,321	4,164	22.5
2000–01	10,943	164	3,734	437	1,594	14,677	2,194	13.0
2001–02	10,690	283	3,837	494	1,697	14,527	2,474	14.6
2002–03	10,508	135	3,908	228	1,568	14,415	1,932	11.8
2003–04	10,557	205	3,627	372	1,553	14,183	2,129	13.1
2004–05	11,305	413	4,038	307	2,058	15,343	2,779	15.3
2005–06	11,333	1,390	4,203	1,145	2,764	15,536	5,299	25.4
2006–07	11,525	2,704	4,440	1,373	2,076	15,965	6,153	27.8
2007–08	10,903	3,708	3,714	1,391	2,668	14,617	7,767	34.7

Impact of removal of fertilizer subsidy on foodgrains production

Particulars	Dimension
Elasticity of foodgrains with respect to fertilizer	0.2056
Elasticity of fertilizer use with respect to real price of fertilizer	–0.6159
Elasticity of foodgrains production with respect to real price of fertilizer	–0.1266
Weighted price of NPK 2004-05 (Rs/kg NPK)	12.5
Fertilizer subsidy in 2004-05 (Rs crore)	15,879
Fertilizer use 2004-05 (thousand tonnes)	18,398
Subsidy (per kg NPK)	8.63
Increase in fertilizer price due to removal of subsidy (%)	69.04
Impact of removal of fertilizer subsidy on foodgrains output (%)	–8.74

subsidized equipment facilitated the adoption. The innovative practice has several bio-physical benefits, namely increase in productivity, input saving and conservation of precious water resources. The results showed that the return to SRI is high ranging from Rs 14,875/ha to Rs 17,629/ha across the districts as compared to corresponding figure of Rs 9,263 to Rs 14,564 under conventional practices. Higher return is attributed to increase in production as well as substantial reduction in cost of cultivation. The most impressive is the savings in water (22–39%) and seed (92%) contributing to distinctive benefit-cost ratio of SRI. The organic supplementation due to compost, green manure and weed incorporation, enhanced soil microbial activities and aeration, use of solar energy and time saving owing to early transplantation, are some of the uncommon advantages of SRI. The gains due to women labour in specialized operations such as transplanting, harvesting and weedings indicate gender equity. The SRI provides opportunity for employment of the idle family labour in *rabi* season. The novelty is that SRI research outcome is inexpensive as the innovation is farmer invented and invariant to any variety, need not be new and

All India crop group wise growth in production (%)

Crop group	1970-71 to 1979-80	1980-81 to 1989-90	1990-91 to 1999-00	1996-97 to 2005-06
Cereals	2.66	2.89	2.24	0.13
Pulses	–0.01	1.54	0.84	–0.20
Oilseeds	1.11	5.15	1.92	0.64
Sugarcane	2.26	2.19	2.74	3.67
Cotton	2.61	2.57	2.68	2.40
Horticulture	2.88	2.64	5.84	3.12
Condiments and spices	2.90	4.71	4.97	4.25
Fruits and vegetables	2.88	2.27	6.00	2.91
All crops	1.79	2.03	3.02	1.66

modern input-intensive technology. The estimates of technical efficiency also clearly showed that SRI is more efficient (both in technical efficiency and economic efficiency). Therefore, appropriate strategy for upscaling the adoption is a *sine-qua-non* to achieve national as well as household food security. The successful models of SRI promotion have emerged, which need to be integrated for generalizing the practice. In the changing scenario, given the general acceptance of the practice and willingness to accept, the needed preparedness for implementation of the policy to scale up the adoption will go a long way.

Progress and potential of horticulture in India: The study examined patterns, trends and successes of diversification towards horticulture since 1970–71 at national and state level. Productivity and progress of horticulture was compared with other major crop groups. First output of horticulture, both condiments and spices and fruits and vegetables, increased at much faster rate as compared to growth rate of total crops sector during all the decades since 1970–71. Second, the growth rate in horticulture group was higher than all other crop groups except cereals and oilseeds during 1980–81 to 1989–90. Horticulture production increased by about 2.9% per year during 1970s when annual growth rate of total crop sector was 1.8%. There was some setback to growth rate of fruits and vegetables during 1980s, however, growth rate in condiments and spices accelerated to 4.7%.

The main factor underlying diversification in favour of fruits and vegetables was higher returns relative to other crop groups, and the difference in productivity between horticulture and other crops widened during 1980–81 to 2000–01. During 1980–81 to 2005–06 share of fruits and vegetables in total cropped area of the country increased from 2.8 to 4.9% and their share in crop output increased from 15.95% to 25.61%. There is some slowdown in productivity growth of all crop groups after 2000–01 but the change is negative for fruits and

Livestock sector composition and factors affecting its growth

Supply side as well as demand side factors of livestock sector showed that it possesses large potential for growth. Growth rate of livestock output slowed down from 2000-01 to 2005-06, which is a matter of serious concern. Data revealed that livestock sector growth can be accelerated by improving feeding, quality and composition of livestock, veterinary facilities, output marketing, and institutional interventions. The sector requires increased allocation of public resources and support to accelerate growth to achieve the targeted growth during the XI Five Year Plan. If the factors affecting livestock sector increase at the same rate as experienced during 1992-93 to 2004-05, output of livestock sector is likely to experience growth rate of 3.83%. To achieve targeted growth rate of 6% in livestock output, progress in livestock infrastructure, institutional efforts and availability of livestock feed is required to be accelerated by about 50%

Achieving targeted growth of XI Plan for livestock output

Source of growth/ factor	Elasticity of output	Scenario I		Scenario II		Scenario III	
		Factor growth rate	Output growth rate	Factor growth rate	Output growth rate	Factor growth rate	Output growth rate
In-milk bovine,%	0.413	0.96	0.40	1.51	0.62	0.96	0.40
Artificial inseminations done (-3)	0.237	5.38	1.28	8.43	2.00	5.38	1.28
Veterinary institutions (-1)	0.074	2.20	0.16	3.44	0.26	4.40	0.33
Surfaced road length (-2)	0.108	2.51	0.27	3.93	0.42	5.02	0.54
Per caput income	0.213	4.40	0.93	6.89	1.46	7.50	1.59
Membership of dairy cooperatives	0.116	4.15	0.48	6.50	0.76	8.30	0.97
Fodder area	0.113	2.65	0.30	4.15	0.47	2.65	0.30
Total			**3.83**		**6.00**		**5.40**

Figures in parentheses indicate lag period.

vegetables. The decline in productivity of fruits and vegetables needs to be addressed. Maharashtra maintained more than 5.5% growth rate and Andhra Pradesh showed acceleration in growth rate from 4 to about 5% between 1990s and 2000s. Last six years showed rapid progress in production of fruits and vegetables in Gujarat, Himachal Pradesh and Chhattisgarh, exceeding 10% annual rate of increase. Growth rate turned out to be either negative or very low in Asom, Karnataka, Rajasthan, West Bengal and Uttarakhand.

Supply, demand and trade of fish in India: The fish production in India has increased rapidly, nearly tripling from 2.44 million tonnes in 1980 to about 6.87 million tonnes in 2008. Domestic demand for fish in India is growing rapidly. The expansion of demand to match supply has to be a priority concern in the light of resource degradation, weak public support and investment, and potential worsening inequities in the global trade.

The income elasticities vary substantially across fish species by income group. But at the aggregate level for all the households, income elasticities range with narrow difference 1.61 for shrimp/ prawn to 1.66 for molluscs. Income elasticities for all the fish groups consistently fall with an increase in per caput expenditure (income) level of the household above the poverty line. None of the groups under study became an inferior good at the highest income quartile. This indicates that even a very rapid increase in aggregate per caput income in the projected period, fish consumption is not likely to turn an inferior good in India. The results revealed that when total income increases, people tend to spend more on fish, and relatively less on other types of meat.

Inland fish supply analysis revealed that supply of Indian major carps will increase significantly with time. The input demand and fish supply are sensitive to their own prices, suggesting that Indian fish producer responds to price changes in an effective manner. Price instruments along with technological policy are likely to be quite effective in fish supply. The increase in supply will make the fish available to the consumers at a cheaper price, which will increase the fish consumption in their food basket. Domestic demand for fish under the baseline scenario is likely to grow at an annual rate of 2.5% between 2000 and 2020. Highest growth in demand is projected for IMC (3.98%), followed by other freshwater fish (3.96%), and pelagic low value and demersal low value (2.0% each). Between 2000 and 2020 consumer demand for shrimp would decline at an annual rate of –1.97%, followed by demersal high value (–1.43%) and molluscs (–1.14%).

Fish production by production environment is projected for two decades using year 2000 as the base year. Total fresh fish output growth is projected slightly above 3%. The aquaculture output is expected to expand with higher growth about 4% per annum as compared to capture output which is likely to grow at about 2% per annum. Thus, aquaculture would expand faster than the capture.

Farmers' perception on Agriculture Debt Waiver and Debt Relief Scheme 2008: Agriculture Debt Waiver and Debt Relief Scheme 2008 (ADWDRS) was announced in budget speech of the Finance Minister in the 2008. Under this scheme, the Government of India provided a debt relief to the tune of about Rs 71,000 crore to small and marginal farmers. The main aim was to provide fresh loans to farmers who have become defaulters to the banks due to reasons beyond their control, so that they could restart their farming or economic activity. To study the implications of the scheme on farmers, a survey was conducted in the villages of Mahendergarh, Hisar and Karnal districts of Haryana during October–December 2008. Farm household level data were collected using a specially designed and pre-tested schedule to study the opinion of the farmers on the scheme. The response of the beneficiary and non-beneficiary farmers from the selected districts of Haryana regarding effects and their perception on the scheme are summarized here.

It was observed that ADWDRS did not affect the social harmony in the village and provided benefit to farmers who are not having sufficient income. Beneficiary farmers (87%) reported that they had planned to repay the loan before the announcement of the scheme. Mere 4% of the beneficiary farmers and 20% of the non-beneficiary farmers opined that there will be decreasing tendency towards non institutional loans. The reason is that formal lending institutions would be now more cautious in processing the loan

Changes in fish supply by production environment by 2020

Production environment	Production ('000 tonnes)		Change in production		% share in total	
	2000	2020	Quantity ('000 tonnes)	Per cent	2000	2020
Aquaculture	2,849.5	6,215.2	3,365.8	71.4	52.0	60.9
Capture	2,632.1	3,982.6	1,350.5	28.6	48.0	39.1
Total	5,481.6	10,197.8	4,716.3	100.0	100.0	100.0

Perceptions of selected farmers in Haryana on Agriculture Debt Waiver and Debt Relief Scheme 2008

Response	Beneficiary (%)	Non-beneficiary (%)
Non institutional loans should be waived off	97	97
Planned to repay before announcement	87	-
Encouraging people towards defaulting	38	99
Decreasing tendency towards non-institutional loans	4	20
Availed similar facilities in the past	1	2
Needed incentives for non-defaulters	100	100
Effects on social harmony of the village	1	0
Socio-economic changes in the family	4	0

applications for defaulters. Both category of farmers felt that the scheme should not be discriminatory and incentives should have been provided to the non-defaulters also.

STATISTICS

The database for the Hindi module of expert system on wheat crop management was designed that accepts UNICODE for the support of Hindi language. The variety selection module is now available in Hindi. The system displays varieties through state and zone map with the Hindi interface.

A β-version of Statistical Package for Animal Breeding (SPAB 2.1) was developed. The package is quite useful for animal breeders for estimation of genetic parameters and for formulating sound breeding strategies and selection processes. All the available programs have been grouped into 11 modules.

The new additions in SPAB 2.1 are:

- Application of Sanders correction and calculation of repeatability
- Estimation of heritability for threshold traits
- Recurrent selection and reciprocal recurrent selection
- Genetic advance in closed and open nucleus breeding schemes
- Testing the homogeneity of variance-covariance matrices (Likelihood ratio test)
- D-square analysis (Oblique axis and Iterative mini-max)
- Simulation of sib data
- Bootstrapping for estimation of standard error of genetic parameters
- Skillings and Mack non-parametric test.

Design Resources Server (www.iasri.res.in/design) developed to popularize and disseminate research in design of experiments among experimenters and research statisticians, used across 656 cities of 83 countries across the globe. It has been strengthened by adding the following material/ links:

- Modules for generation of simplex centroid designs and simplex lattice designs for experiments with mixtures that are quite useful for the experiments where a fixed quantity of inputs (may be same dose of fertilizer, same quantity of irrigation water or same dose of insecticide or pesticide etc.) are applied as a combination of two or more ingredients.
- Modules for online generation of randomized layout of factorial completely randomized designs and factorial randomized complete block designs.
- The facility of generation of field book for data entry has also been created for completely randomized designs, randomized complete block designs both for single and multi-factor experiments and Latin square designs for single factor experiments. The field book can be created as a comma separated value (csv) file or a text file.
- SAS and SPSS steps/ codes for (i) fitting non-linear models using SAS and SPSS on the sub-link non-linear models, and

Knowledge data warehouse for agricultural research

In Knowledge data warehouse for agricultural research, data mart related to crops were redesigned and 3 techniques of future projections, i.e., growth models, trend models and auto-regressive models were incorporated in on-line decision support system. The data marts also include derived parameters such as Cropping intensity index, Pesticides per cropping intensity, Pesticides per '000 irrigated area, Productivity, N ratio, P ratio, K ratio, Fertilizer intensity, Irrigation intensity. Multidimensional model of the census data related to household amenities was designed. On-line Analytical Processing (OLAP) cubes for the Census data (2001) were for all states were published. Thematic maps of productivity of various crops were digitized based on historical data using GIS software. Attempts were also made to calculate crop diversification index at state level. Further, data mart of crops, livestock and fisheries sectors was also updated.

(ii) performing cluster analysis for dimension reduction of the data.

– On the link Design for Factorial Experiments, a sub-link on Block Designs with Factorial Structure giving a bibliography on the subject as well as catalogue of three factor designs having orthogonal factorial structure with balance and permitting estimation of main effects with full efficiency and two factor interactions with controlled efficiency was uploaded.

For efficient designing of experiments for crop sequence experiments, a method of construction of block designs having orthogonal factorial structure (OFS) with balance was obtained in which all main effects are balanced in the sense that these are estimated with full efficiency. A catalogue of designs for three-factor factorial experiments having OFS and balance was prepared.

A procedure of simultaneous optimization of several ingredients for complete/incomplete multi-response experiments useful in food processing experiments was developed.

In the experimental situations, wherein experimental units are required to perform a series of tasks one after another under various experimental conditions and the conditions are altered from one session to another—for such experimental situations, two classes of nested designs involving sequences of treatments with same number of experimental periods and units have been obtained. The precision of estimation of direct and residual effects is more with the design having more number of levels of the nested factor.

Estimates of extent of farming practices, resources and activities with energy use were obtained using 59th round survey (2003) data. The estimates of total land possessed per farmer household (FHH) averaged over seasons (*Kharif* and *Rabi*) in different kinds of farming ranged between 0.008 ha and 1.238 ha for all-India and 0.011 ha – 0.894 ha in North Eastern Hilly (NEH) region. Estimated seasonal variations of these lands per FHH for all-India and NEH region ranged between 0.002ha and 0.381 ha and 0 ha and 0.320 ha, respectively. Fertilizers, organic manure, pesticides and veterinary services were available within the village to 6–93% FHHs, while improved seeds were not available to FHHs even within the reasonable distance (5 km) in most of the states. Percentages of FHHs using fire-wood for cooking, animal power for ploughing and harvesting and electricity for lighting, irrigation and threshing as main sources of energy in different states ranged from 20.6% (Punjab) to 92.1% (Rajasthan), 13.7% (Orissa) to 90.1% (Jharkhand) and 15.6% (Bihar)) to 94.5% (Punjab) respectively.

Methodology for obtaining surplus rain thresholds useful in developing rainfall-insurance programmes was developed and illustrated by analyzing data for Akola, Jhansi and Kheda districts of Maharashtra, Uttar Pradesh and Gujarat respectively. The chances of crossing these thresholds, appropriate rainfall distribution during the crop season is required for crop insurance. Various methods for estimation of parameters of generalized lambda distribution (GLD) were studied. The goodness of fit is examined by several methods. As an illustration, the probability density function of monthly rainfall data for Asom and Meghalaya meteorological subdivision showed that the method of maximum likelihood performed the best. For multimodal rainfall data, methodology of fitting mixture of distributions to 'body' and 'tail' using statistical learning theory is demonstrated. Three estimators of extreme value index are computed to fit the theoretical tail distribution to the rainfall data. "Structural risk minimization procedure" is applied to fit the 'body' of the rainfall distribution. As an illustration, the probability distribution of monthly rainfall data for Orissa meteorological subdivision is obtained by combined body-tail estimation method, and it is shown that Hill's method performed the best.

For computational analysis of SNPs at functional elements of rice genome, the genomic coordinates of functional elements were obtained and stored in database. A web page was developed for Agricultural Bioinformatics Lab (ABL) wherein links are provided to bioinformatics tools, local BLAST, etc. *BioPerl* and *.cgi* scripts are written for sequence alignment and filtering of BLAST report. SNPs along with their flanking sequences are collected and processed in a format suitable for populating database. Online local BLAST was developed to locate and quantify blocks of similarity between query sequence and database sequences. ❑

Estimation of mushroom production

Sampling methodology for estimation of production of mushroom was developed. This methodology would be time and resource efficient. In a pilot study the productivity of mushroom as estimated from data obtained through stratified two-stage random sampling was 4.46 kg/tray with 1.2% standard error. The productivity based on complete enumeration was 4.94 kg/tray. The magnitudes of standard errors and the closeness of the two figures indicated that the random sample survey based approach appears to be suitable for estimating production of mushroom.

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Information, Communication and Publicity Services

Directorate of Information and Publications of Agriculture (DIPA) continued its efforts to showcase ICAR's technologies, policies and other activities through modern dissemination technologies that cater various stakeholders in the field of agriculture. The first corporate film on the ICAR, *Drivers of Change*, was released during the year. The film is very effective and popular in creating the brand image of the ICAR at national and international forums. In the fast changing knowledge intensive era, the DIPA is committed to promote ICT-driven technology and information dissemination system for quicker and more effective delivery of messages. In this effort, the DIPA designed and developed Council's new website using an open source content management system called DRUPAL. The new website has been made more user-friendly with links to related organizations to serve the domestic and overseas users. House journals, *ICAR News* and *ICAR Reporter*, were made available on-line besides a host of other important publications. Over 450 inputs were prepared by indexing the published journal articles for inclusion in the AGRIS database of FAO. To speed up the network connectivity, lease line of ICAR Headquarters (KAB I and II) is upgraded to optical fibre and bandwidth is also upgraded to 10 Mbps from 2 Mbps. The effective security solutions such as Firewall, Anti Spam and Anti Virus were also implemented. Guidelines have been developed for bringing uniformity in the websites of ICAR institutes. The DIPA played a pivotal role in facilitating real time communication among ICAR institutes through IP Telephony and video conferencing.

Keeping pace with the current knowledge diffusion trends, 9,300 CDs/DVDs on various ICAR publications were reproduced and 1,600 copies were purchased by keen users. In addition, copies of complimentary CDs were distributed to various stakeholders. As a novel national initiative, ICAR institutes/SAUs are being connected to National Knowledge Network through an electronic digital broadband to encourage sharing of resources for collaborative research. So far, six research institutes/SAUs have been connected and other identified institutes will be connected shortly. Under the NAIP Sub Project "E-Publishing and Knowledge System in Agricultural Research (E-PKSAR)", a fully automated, on-line electronic publishing system is being implemented for eleven journals/periodicals of the ICAR. The ICAR Library is one of the consortium partners of NAIP Sub Project E-GRANTH under which the cataloging information of 12 partner libraries is being converted into International Standard Format (MARC 21) and will be merged as a "Union Catalogue of Agricultural Libraries" hosted by the IARI. The ICAR Library provided on-line user log-in facility to its members and bar-code technology has been implemented in circulation process.

As an endeavour to communicate research among scientific communities, the DIPA continued to publish research journals: *The Indian Journal of Agricultural Sciences* and *The Indian Journal of Animal Sciences*. In the former, 236 research papers, including five from foreign countries, were published while in the later, 328 research papers, including eleven from foreign countries, were published. A series of invited reviews from esteemed subject matter specialists was initiated in the research journals. To disseminate research and technologies in popular style to farmers and other stakeholders, the DIPA continued to publish periodicals, *Kheti*, *Phal Phool*, *Krishi Chayanika*, *Indian Farming* and *Indian Horticulture* with emphasis on success stories and technologies ready for adoption. Nearly 500 articles/features were published in the noted popular periodicals during

the year. A professional getup was imparted to popular periodicals that included design, layout and contents.

More than 100 publications on various disciplines of agriculture, animal husbandry, fisheries and allied sciences were published for different categories of stakeholders. The latest revised and expanded sixth edition of the most authoritative and benchmark publication on the Indian agriculture – *Handbook of Agriculture* – was published. About two lakh copies have been sold so far and is increasingly becoming more and more popular especially among the agriculture students, scholars, researchers, policy-makers and scientists. New areas like crop biotechnology, informatics in agriculture, intellectual property rights, apiculture, sericulture and indigenous technical knowledge in agriculture have been included in the *Handbook*. The ICAR has brought out an authentic publication depicting the impact, adaptation and vulnerability of Indian agriculture to changing temperature regime entitled "*Global Climate Change and Indian Agriculture*".

During the year, special efforts were made for diffusion of agricultural technologies at ground level through mass media and showcasing of technologies at various national/international expositions. The ICAR participated in more than twelve technology fairs/conferences to showcase its technological strength and information products. Newsworthy press material of topical value was released to print and electronic media to provide a wide publicity to ICAR activities. As result, the Council got wide coverage on various issues related to technologies, policies and success stories. The DIPA provided public relations and publicity support to more than 20 events that include international/national conferences, ICAR awards, foundation day, AGM, etc. The DIPA facilitated various special programmes pertaining to agriculture on Doordarshan and the All India Radio. Under the NAIP Sub Project "Mobilizing Mass Media Support for Sharing Agro-Information", media meets were organized at NDRI, Karnal; IARI, New Delhi; CIAE, Bhopal; CIFT, Kochi; CRRI, Cuttack; NAARM, Hyderabad; IISR, Calicut; CISH, Lucknow; and CIPHET, Ludhiana. These events were covered profusely by both print and electronic media.

Capacity building activities for the ICAR scientists were organized to strengthen the agricultural communication in the country. Over 30 scientists were provided with orientation training on creative writing in agriculture at the Indian Institute of Mass Communication, New Delhi and 22 scientists were trained for knowledge management at the Indian Institute of Management, Lucknow. A hands-on training programme on "Managing Bibliographical Research Information in Agriculture and Allied Sciences" was organized. Training and exposure on production management of publications was provided to the staff of the ICAR institutes.

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Technology Assessment, Refinement and Transfer

At present, there are 569 Krishi Vigyan Kendras (KVKs) which include 383 under State Agricultural Universities, 44 under ICAR Institutes, 91 under NGOs, 33 under State Governments and the remaining 18 under other organizations. The KVKs aim at assessment, refinement and demonstration of technologies/products. The KVKs have facilitated the backstopping for mass dissemination of contingent plan for drought and flood situations and played a vital role in the mitigation of drought like situation in various districts of the country. To show the potentiality of technologies, KVKs have organized Technology Week across the country involving SAUs, line departments, private agencies, non-governmental and farmers' organizations.

KRISHI VIGYAN KENDRA

Technology assessment and refinement

During the year, KVKs have assessed 1,913 technologies in 6,574 locations by laying out 18,425 trials on 465 crops on the farmers' field under the thematic areas, viz. Varietal evaluation; Integrated nutrient management; Integrated disease management; Integrated pest management; Integrated crop management; Integrated weed management; Resource conservation; Crop diversification including cropping systems, improved tools and implements; Processing, value-addition and quality improvement; Soil-test-based fertilizer recommendation; Bio-fertilizers; Entrepreneurship development; and Protected cultivation including seedling production.

Similarly, 189 technologies in 877 locations involving 2,692 trials under the thematic areas, viz. animal health, improved breeds, nutrition including feeds and fodder, production and management related to livestock, poultry and fisheries have been taken up for assessment. With regard to refinement of technologies, KVKs have refined 235 technologies in 803 locations by laying out 4,911 trials on the farmers' field.

KVKs have also assessed 99 technologies in 280 locations covering 1,025 women in the area of empowerment of rural women under the thematic areas of drudgery reduction, entrepreneurship development, and health and nutrition.

Frontline demonstration

A total of 86,285 frontline demonstrations in 51,101 ha were conducted by KVKs. Under the frontline demonstrations conducted, 76,206 were on oilseeds, pulses, cotton and other important crops covering an area of 30,663 ha. Besides, 4,600 demonstrations covering an area of 4,212 ha on-farm implements and 5,479 demonstrations were conducted on 16,225 units of various enterprises including dairy, piggery, poultry, piggery, sheep and goat, fisheries, bee-keeping, mushroom, nutrition garden, sericulture, organic compost, Home science and bio-products.

Oilseeds: During the year, 12,360 demonstrations were conducted covering 4,392 ha on different oilseed crops including groundnut, sesame, soybean, sunflower, *toria*, linseed, mustard, castor, niger, and safflower. The percentage increase in yield varied from 6.25 in groundnut to 38.93 in *toria* and on an average oilseed crops under demonstration gave 31.02% more yield than farmers' practice.

Pulses: During the year, 12,352 demonstrations were conducted covering 3,632 ha on several pulse crops including blackgram, chickpea, cowpea, field pea, frenchbean, greengram, horsegram, lentil, mash, moth bean, pigeonpea and *rajmash*. The percentage increase in yield varied from 23.14 in lentil to 52.19 in horse gram and on an average pulse crops under demonstration gave 34.69% more yield than farmers' practice.

Cotton: The frontline demonstrations on cotton

particularly with regard to Production technologies, Integrated pest management and Farm implements were conducted in major cotton-growing areas of 11 states involving 12,786 farmers in 10,068 ha. In Production technology(4,966 demonstrations in 1,986 ha), Integrated pest management technologies (1,673 demonstrations in 1,350 ha) and farm implements 6,147demonstrations in 6,732 ha) were conducted.

Performance of cotton hybrids and varieties: During the year, a large number of demonstrations involved *Bt* hybrids, wherein 4,827 farmers participated in demonstrations. Among them, *Bt* performed well as compared to others. In hybrids other than *Bt*, *desi* hybrids, *Gossypium hirsutum* × *G. barbadense* hybrids, *G. hirsutum* × *G. hirsutum* hybrids were demonstrated in 172, 150 and 300 locations, respectively. The *G. hirsutum*, *G. arboreum* and *G. herbaceum* varieties of cotton were demonstrated in 605 locations.

Other crops, farm implements and tools, and crop hybrids: A total of 33,522 demonstrations were conducted covering 10,924 ha on cereals, horticultural and other commercial crops. In farm mechanization, KVK have organized 4,600 demonstrations covering 4,212 ha with respect to tillage equipments and tools; Inter-tillage equipments and tools; Planting/sowing equipments; Plant protection equipments and tools; Harvesting equipments and tools; Threshers and post harvesting; and Processing equipments.

Durung the year 5,186 demonstrations on hybrids were conducted covering 1,646 ha on maize, paddy, pearl millet, sorghum, wheat, berseem, groundnut, linseed, sunflower, sesame, soybean, rapeseed/mustard, *toria*, castor, blackgram, greengram, lentil, *rajmash*, redgram; napier grass, sorghum, coconut, turmeric, bitter gourd, bottle gourd, brinjal, broccoli, cabbage, capsicum, cauliflower, chillies, cucumber, french bean, okra, onion, pea, potato, pumpkin, summer squash, sweet pepper, tomato, papaya, watermelon and jute. The percentage increase in yield varied from 9.20 in sunflower hybrid RSFH 1 to 130.60% in papaya hybrid Surya.

Livestock, poultry, fishery and other enterprises: KVK have conducted 5,479 demonstrations on 16,225 units of various enterprises including dairy, poultry, piggery, sheep and goat, fisheries, bee-keeping, mushroom, nutrition garden, sericulture, organic compost making, home science and bio-products.

Training programmes

During the year, 56,819 training programmes were organized with the participation of 15.40 lakh farmers including rural youth and in-service extension personnel.

Farmers: A total of 39,912 training programmes were organized for the benefit of 11.27 lakh farmers and farm women on various technologies to update their knowledge and skill. The beneficiaries including farm women were 168,898 in increasing production and productivity of crops; 161,807 in plant protection; 103,650 in production of inputs at site; 5,802 in household nutritional security; 6,404 in animal production and management; 65,354 in soil health and fertility management; 49,339 in

Demonstration of chaff cutter usage

Performance of cotton hybrids and other varieties in frontline demonstrations

Hybrid/variety	No. of farmers/ demo	Area (ha)	Demo yield (lint kg/ha)	Local yield (lint kg /ha)	Increase (%)	Demo cost (Rs/ha)	Local cost (Rs/ha)	Demo benefit: cost ratio
Bt hybrid	3,600	583.44	731	631	20.41	11,695	13,555	3.1
Desi Hybrid	172	27.9	733	688	6.64	6,125	7,652	3.2
G. hirsutum × *G. barbadense* hybrids	150	24.28	549	472	16.34	18,642	19,253	2.1
G. hirsutum × *G. hirsutum* hybrids	300	48.56	481	363	32.55	13,035	14,325	3.4
G. herbaceum variety	125	20.34	301	250	22.13	6,563	5,563	2.7
G. hirsutum variety	350	56.66	508	437	17.21	13,489	14,263	3.1
G. arboreum variety	130	20.64	426	335	28.18	8,621	6,821	2.4
Total	4,827	781.82	532	454	20.49	11,163	11,633	3.0

commercial production of vegetables; 67,508 in processing and value-addition; 40.950 in capacity building and group dynamics; 24,824 in integrated farming system; 29,596 in orchard management; 26,048 in entrepreneurial development; 48,269 in farm machinery, tools and implements; 37,087 in fruit crops; 31,189 in resource conservation technologies; 63,888 in animal nutrition; 55,479 in fisheries; 12,349 in water management; 36,993 in animal health; 4,083 in production and value-addition; 7,648 in ornamental plants; 5,049 in tuber crops; 7,675 in agro-forestry; 4,845 in plantation crops; 5,449 in spice crops; and 56,742 in economic empowerment of women.

Rural youth: The beneficiaries were 28,972 in increasing production and productivity of crops; 4,160 in orchard management; 46,112 in production and value-addition; 52,868 in livestock production and management; 38,704 in economic empowerment of women; 14,558 in farm machinery, tools and implements; 9,636 in fisheries; 53,146 in production of inputs at site; 4,308 in capacity building and group dynamics; 21,836 in entrepreneurial development; and 36,052 in commercial horticulture. There were 12,978 skill-oriented training programmes for 3.10 lakhs rural youth.

Extension personnel: A total of 3,929 training programmes were conducted covering 103,428 participants. These were organized for extension functionaries working in government and non-governmental organizations related directly or indirectly with the development of agriculture. The

Water harvesting tank: KVK, Shimla

trainings were imparted to upgrade their knowledge and skills in frontier areas of agriculture technologies. These beneficiaries were 37,755 in increasing production and productivity of crops; 4,607 in production of input at site; 14,214 in plant protection; 128 in resource conservation; 10,456 in soil health and fertility management; 195 in integrated farming system; 9,473 in livestock production and management; 1,928 in farm machinery tools and implements; 5,594 in economic empowerment of women; 7,444 in capacity building and group dynamics; 5,766 in capacity building for ICT applications; 151 in processing and value-addition; and 5,717 in house-hold nutritional security.

Sponsored training programmes: Out of a total 56,819 training programmes conducted by the

Extension Activities

Activities	No. of programmes	No. of farmers	No. of extension personnel	Total no. of beneficiaries
Advisory services	79,503	372,279	5,423	377,702
Diagnostic visits	22,891	81,093	3,443	84,536
Field day	3,411	222,683	9,052	231,735
Group discussions	101,165	310,438	12,965	323,403
Kisan ghosthi/farmers meeting	4,519	324,667	11,086	335,753
Film shows	5,739	122,306	6,865	129,171
Self-help group conveners meetings	1,585	32,622	2,921	35,543
Kisan mela	899	5,207,510	35,412	5,242,922
Exhibitions	1,848	2,566,833	542,027	3,108,860
Scientists' visit to farmers' field	51,990	225,605	6,483	232,088
Plant/animal health camps	5,513	108,273	3,477	111,750
Farm science club	816	17,981	1,768	19,749
Ex-trainees *sammelan*	440	13,446	541	13,987
Farmers' seminar/workshop	3,703	121,617	60,54	127,671
Method demonstrations	5,876	119,100	9,419	128,519
Celebration of important day	602	62,143	4,782	66,925
Special day celebration	102	18,621	1,575	20,196
Exposure visit	13,633	89,309	5,639	94,948
Total	304,235	10,016,526	668,932	10,685,458

SUCCESS STORY

Mithun-microchip technology by KVK, Papumpare, Arunachal Pradesh

Mithuns are semi-domesticated animals in Arunachal Pradesh and traditionally, mithuns are identified based on their ear notching (done during the calf-hood), horn structures, body-coat colour pattern, sex or the body size. Due to the close similarity between the mithuns of different owners in the locality, often it creates conflicts for the mithun ownership among the owners. Taking the degree of social importance in view, staff of KVK, Papumpare has initiated the micro-chip implantation drive as a means of identification of true owners of mithun in the locality in collaboration with State Forest Department.

A total of 155 mithuns had been micro-chipped by the KVK, Papumpare, in collaboration with the State Forest Department for identification of disputed mithuns in the district. This initiative has helped the local community to a great extent as the doubt and conflict about the ownership of mithuns in the district was eliminated. The awareness and use of microchip technology as a fool-proof identification for mithun was created among the farmers. The application of the microchip technology is accepted by the government and it helped to extend the benefit to a larger population in other districts of Arunachal Pradesh and similarly in the North-eastern region.

Microchipping of mithun

SUCCESS STORY

KVK interventions in drought mitigation

During *kharif* 2009, the monsoon was erratic and deficient by 28% for the country as a whole. The ICAR took the initiative by establishing weather advisory services and its updating on daily basis. Consequently, with the backstopping from Zonal Project Directorates of the Council and Directors of Extension Education of SAUs, KVK have provided weather advisory services through electronic and print media, organization of technology demonstrations and trainings, technology weeks, camps, etc. Introduction of alternate crops/varieties was the major interventions. Demonstrations on sesame, soybean, groundnut, pigeonpea, blackgram, greengram, cowpea and *rajmash* were mainly conducted. In cereals, demonstrations on short duration paddy, maize, *jowar* and *bajra* were laid out. Cotton, French bean, niger, sweet orange, cashew and tapioca related technological demonstrations were also conducted out by the KVK. An area of 36,675 ha with the participation of 56,719 farmers was brought under demonstrations on resource conservation technologies in states facing drought.

KVKs for the farmers and farm women, rural youth, and extension personnel, 6,091 were conducted on sponsorship by various organizations covering 2.55 lakh participants.

Vocational training programmes: A total of 2,763 programmes were specifically conducted for 54,924 rural youth on orchard management, production of inputs at site, economic empowerment of women, livestock production and management, production and value-addition, entrepreneurial development, capacity building and group dynamics, fisheries, farm machinery, tools and implements.

Extension activities: The KVKs have organized 304,235 extension activities involving 106.85 lakh farmers and extension personnel for backstopping about improved agricultural technologies.

In addition, 64,643 extension programmes were organized by KVKs through electronic and print media to have wider coverage in the districts. It include electronic media, extension literature, newsletter, newspaper coverage, technical articles, technical bulletins, technical reports, radio talks, TV talks, animals treated in animal health camps, popular articles, technical books, leaflets and folders, and lectures were delivered.

Production of technology products

KVKs have produced technological products like seeds, planting materials, bio-products, livestock material poultry and fisheries to a tune of Rs 1,304.47 lakhs benefiting 4.22 lakh farmers.

Seeds, planting material and bio-products: During the year, the KVK produced 20,898 tonnes of seeds including cereals, oilseeds, pulses, commercial crops, vegetables, flowers, spices, fodder and fibre crops. These seed materials have

SUCCESS STORY

Management of white grubs in lower hills of Uttarakhand

In North-western Himalayas, cereals, millets, pulses, oilseeds and vegetables are cultivated in 1.32 million ha with an estimated production of 3.44 million tonnes under rainfed condition. An array of insect pests and diseases cause a severe crop damage leading to low crop production. Among these, white grubs are the most destructive insect pests of agricultural and horticultural crops of Uttarakhand hills. The damage caused by the grubs may vary on an average from 10 to 30% and sometimes leads to complete crop failure. The grubs are reported to damage almost all the crops such as upland rice, finger millet, barnyard millet, maize, horse gram, soybean, French bean, chilli, potato, tomato, brinjal, okra, cole crops, apple, pear, plum, peach, apricot, pomegranate and forest trees.

The newly developed "VL-whitegrub beetle trap-1" is more efficient in trapping the beetles and is about half the cost of the previous models. In addition, an attempt was made to isolate and characterize a bacterium which is found potent for the management of the grubs. Out of 48 local strains, isolated from diseased whitegrubs and tested against 2nd instar grubs of predominant species, *Anomala dimidiata*, the isolate WGPSB-2 was found highly toxic causing more than 90% mortality in the grub population. Based on various morphological, physiological, biochemical and molecular tests, the isolate WGPSB-2 was identified as *Bacillus cereus*. A dose of 10 kg/ ha was found most promising under field conditions for the management of the grubs.

Both the technologies were demonstrated in an integrated manner in the five adopted villages of low hills of Uttarakashi and Uttarakhand. Depending on topography and other aspects of the mountain, light traps were installed at strategic locations of the adopted villages. Altogether, 47 light traps were installed and beetle catches recorded from June to October of every year. Beetles catch of 1.25 lakh, 0.72 lakh and 0.31 lakh was recorded during 2006, 2007 and 2008 respectively, which have resulted in a significant reduction of grub population. Overall 41.92 and 75.28% reduction in beetle population was recorded during 2007 and 2008 over the previous year. Besides installations of light traps, talc formulation of *B. cereus* strain WGPSB-2 was applied in the compost pits of the farmers and subsequent applications were made at their fields. Crop-wise pit samplings were done every month of pest incidence to monitor the grub population. Significant reduction in grub population to the tune of 32.75, 74.45 and 80.30% was recorded.

The light trap and the bio-pesticide are found very effective for the management of white grubs if used in a combined manner on entire village basis. Both the cost effective and environmentally safe technologies have now become popular in combating the devastating pest problem of the farmers of Uttarakhand hills. The integrated effect of the two novel technologies, the insect light trap and bio-pesticide has shown a reduction of 74.11–87.80% grub population in three years in the adopted villages. Considerable increase in yield of tomato, potato, chilli and French bean was recorded in adopted villages over non-adopted villages. Approximately 125 ha. area was covered and about 495 farm families were benefited through the white grub management programme.

Technology week

Technology week was organized by 171 KVKs benefiting 1,20,831 participants which includes 76,701 men and 44,130 women. The technology week was organized under public-public and public-private partnership mode in which activities such as live demonstrations, exhibitions and scientists-extension personnel-farmer interactive sessions were included. During the technology week celebration, need- based technologies on crop improvement, crop production, crop protection, post-harvest processing, horticulture, livestock, farm implements and machineries, fisheries and allied sectors were demonstrated and explained to farmers, members of SHGs, extension officials and others. Seminars were conducted on thematic areas of local importance with a focus on agro-based enterprises and income generation activities. Agricultural exhibitions involving SAUs, ICAR Institutes, public sector organizations, etc. were organized by KVK to disseminate technologies. Besides, valuable technology products, viz. seeds, bio-fertilizers, bio-pesticides, improved implements, publications, etc. were provided to the farmers through sale counters.

been provided to 1.15 lakh farmers by earning Rs 777.76 lakhs. KVK produced 146.09 lakhs seedlings and saplings of commercial crops, vegetables, fruits, ornamental, medicinal and aromatic crops, plantation crops, spices, tuber crops, fodder and forest species. These planting materials have been provided to 1.59 lakh farmers by earning Rs 258.72 lakhs. The KVK produced bio-products and earned Rs 117.39 lakhs benefiting 48,471 farmers. The KVK provided poultry materials to 55,569 farmers and earned Rs 103.65 lakhs. The

Technology backstopping and interface programmes

The Directorate of Extension of the State Agricultural Universities conducted 122 programmes for providing technological and methodological backstopping to 3,109 KVK staff. The Zonal Project Directorate conducted 59 programmes with the participation of 2,266 KVK staff. The KVKs organized 589 Interface programmes through the meetings of Scientific Advisory Committee, sponsorship of special programmes and developing functional linkages.

SUCCESS STORY

Farmers-scientists interaction

KVK conducted farmers-scientists interaction on livestock-rearing practices, fodder production, fish production, sensitization about health related problems, etc. A total of 399 interactions were held with the participation of 14,876 stakeholders. Animal health camps (298) were organized in which 49,731 animals were attended. Quality seeds of cereals, pulses, oilseed, vegetables, cotton, fodder crops were distributed to the farmers. A total of 639.08 tonnes seeds were distributed in 12 states by KVK.

KVK also provided fisheries materials to 42,203 farmers and earned Rs 9.21 lakhs.

Livestock, poultry and fish fingerlings: The KVK produced breeds (dairy animals, piglets, rabbits, sheep and goats) of 2,085 livestock materials and earned a revenue of Rs 37.74 lakhs benefiting 1,212 farmers. The KVK produced various breeds/strains of poultry birds (chicken, duck, quail and turkey). Through the production of 1.22 lakh poultry birds, KVK have earned a revenue of Rs 103.69 lakhs benefiting 55,569 farmers. Through the production of 141.48 lakh fish fingerlings, KVKs earnerd a revenue of Rs 9.21 lakhs benefitting 42,203 farmers.

Diagnostic facilitation

A total of 1.58 lakh samples including 1.42 lakhs soil samples, 1.23 lakhs water samples, 3,172 plant material, 479 manure samples and 84 other samples were analyzed benefiting 1.40 lakh farmers from 30,330 villages. This generated a revenue of Rs 83.02 lakhs.

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Gender Issues for Technological Empowerment of Women in Agriculture

The Directorate of Research on Women in Agriculture through in-house, network and inter-institutional projects as well as AICRP on Home Science and NAIP on V-PAGe, generated gender related information on different sectors of agriculture.

Gender Knowledge Centre: Gender Knowledge Centre portal (knowledgecentre.drwa.org) was developed to provide information on theoretical and conceptual background of gender concepts, approaches, and analytical framework for gender analysis.

Database on women in agriculture: A database on women in agriculture was created on the basis of Databook of AICRP Home Science**.** Data pertain to state-, landholding- and activity-wise participation profile and decision-making profile of men and women. Data were collated to create more meaningful tables on the extent of women's participation in different activities in farming and livestock management and involvement in different types of decision making.

Reference system: To create a repository of the studies conducted in different parts of the world and provide stakeholders access to such studies, references were collected and 1,038 were entered into the database. Sources comprise annual report, journals, proceedings, thesis and books. A user friendly interface was developed to help access the theme-wise and year-wise references.

Small scale entrepreneurship in livestock production: The study on resource base, traditional knowledge and participation of farm women in livestock production conducted in Orissa, Uttar Pradesh, Asom and Nagaland revealed that rural women spent more than 3 hr/day on performing activities related to livestock management such as feeding, watering, cleaning of shed and removal of cow dung. Mix species of animals were reared by them based on the socio-economic and natural resources in the region. The constraints involved in rearing small ruminants were high cost of feed and medicine, inadequate knowledge of scientific feeding, housing and health cover measures. Women belonging to nuclear families were more involved in rearing cattle and buffaloes and were better in adoption of improved technologies. Azolla production provided new options for resource poor women as a source of protein rich feed and could replace 100% groundnut cake to reduce the feed cost up to 40–50% in duck ration without any deleterious effect on palatability and growth performance. Improved strains of 4–5 week-old chicks were provided to women self help group after vaccination for rearing under backyard. The contribution of backyard poultry to overall household income varied widely ranging from Rs 1,000 to 3,170/women from 6 to 8 birds over a period of 5 to 6 months. Varieties of improved forage crops were maintained at the DRWA farm for evaluation in gender perspective.

With a view to gender mainstreaming in aquaculture, in collaboration with CIBA, Chennai crab fattening was introduced for the first time among WSHG members in two sites in Chilika lake of Orissa. Bamboo, locally available material,

Documentation of women specific ITKs

Popular techniques of household storage of cereals and pulses practiced by farmwomen were documented, which helped to save up to 70% foodgrains from grain weevils. Rice storage with garlic saved the rice from insect pest up to one year while use of 500 g turmeric per 75 kg rice saved stored rice from insect pest up to three years. Storage practices of ginger, chilli and fenugreek were also identified. Puduga made from paddy straw is very common to store cereals and pulses in Bhanjnagar area of Ganjam district in Orissa.

was used to fabricate pens. During the fattening period of 5 months a profit of about Rs 2,000 was earned.

Gender sensitive extension model: The Village level Para Extension Worker (VPEWs) approach tested various capacity building methods such as pre-seasonal training, review meetings, exposure visits, method demonstrations, result demonstrations, diagnostic visits, field days and farm literature. The changes were observed in VPEWs in the attributes like message delivery, technology performance and organizational abilities. The model was very effective in creating general awareness on scientific farming methods, and demand for farm information and technology.

Group approach and low cost methods suitable for resource poor women in agriculture labourers (WALs) was followed in developing agro-based enterprises namely mushroom cultivation, rice processing, *baddi* making, bee keeping and backyard. Mushroom cultivation proved to be highly suitable enterprise in terms of average production and profit and use of leisure time.

Tribal women in agriculture and allied activities: The tribal women were engaged in crop and livestock production in a limited manner and depended on collection of non-timber forest products and wage labour for meeting the needs of food, fuel and fodder. Farm based occupations accounted for primary source of income for 55% tribal households while for 35% it was secondary occupation.

Participatory evaluation of low cost weaning mix formulated based on protein and vitamin rich sweet potato was carried out with 138 mothers/ farmwomen from different villages. Ninety-seven participants accepted the technology.

Mushroom — An Intervention for Women Empowerment

Self help group named 'Jai Sriram' in Salepur Block of Cuttack district in Orissa, has emerged as a path finder for women empowerment. The process of empowerment of farm women in straw and oyster mushroom cultivation was initiated. The scientists endeavoured best to maintain group cohesiveness through motivation, focus group discussions, exposure to successful units, regular advisory services and sharing of experiences of successful farmers. Training-cum-demonstration was organized followed by the support of critical inputs like spawn and polyethylene. Regular follow-up was also arranged to help women achieve competency. The first phase started with the enterprise of 30 beds of oyster mushroom. The investment was Rs 450, total yield was 50 kg, out of which they consumed 30 kg at home, and total income was Rs 800 with a profit of Rs 350.

The enterprise has now branched into individual enterprises with 10 – 30 beds in each household to enable easy marketing. The male counterparts appreciate the farmwomen in this type of endeavour, as it did not disturb the household activities. The women used their leisure time for about 2 hr/per day and earned good income. The farmwomen felt that oyster mushroom is more profitable with lesser investment compared to straw mushroom. Regarding leadership development, the SHG President Smt Sabitri Rout took initiative to train a group of members and out of them three have become trainers in mushroom cultivation. The nearby villages were covered in conducting training-cum-demonstration and now more women has come forward to take up the enterprise in a large scale. Gramya Bank, Tangi sanctioned a loan of Rs 2.5 lakh.

All India Coordinated Research Project on Home Science

Gender database: The gender disaggregated data from 1,760 households from Haryana, Punjab, Karnatak, Rajasthan, Andhra Pradesh, Asom, Uttarakhand, Himachal Pradesh and Maharastra revealed that women have better control over homestead land and off home land.

Drudgery reduction: Drudgery involved in different farm operations was assessed and suitable tools and equipment including mechanical winnower, mat nursery, spreading tool, improved sickle, harvest bag, ring and piler cutter, improved hand weedders, hand rake, row seeder, neem seed pulverizer, clod breaker, fodder collector, paddy thresher, gopal khore, stubble collector, trishul weeder, cotton stalk puller, *jowar* harvester, groundnut stripping frame, maize sheller, naveen dibbler, bamboo hand hoe set, fertilizer broadcaster, wheel hoe, potato picker, saral khurpa, groundnut decorticator, cot bag, dibble, fertilizer trolley, improved cap and capron were introduced.

Ergonomic assessment of head load manager revealed that it was useful in relieving pressure on neck and back by shifting the load on heads to shoulder and back muscles.

Ensuring food and nutritional security: A base line study conducted to identify the food consumption pattern and nutrient intake of farm families, revealed that majority of children and adolescent girls have various grades of malnutrition. Iron deficiency anemia was prevalent among farmwomen and to address this iron rich product named as '*lehyam*' was formulated using underutilized green leafy vegetables like the leaves of amaranth, colocasia, kondhra, knoll khol, *bathua*, coriander, drumstick, phenugreek, mint, spinach, radish and curry leaves. The products are under trial and refinement. Nutrition education was imparted to women in 45 adopted villages covered by AICRP Centres in different states. Entrepreneurship development was promoted by

conducting training programmes on food processing and preservation and preparation of value added products from locally available foods. Nutrition gardens were established in 30 households from the adopted villages by each Centre.

Vocational skills among adolescent girls were promoted through training in crèche management, early childhood education, preparation of educational and play materials, nursery raising of vegetables and fruits, vermicompost preparation, identification of colour yielding medicinal plants and mushroom cultivation.

Utilization of under-utilized agro- and animal based-resources: Availability and prevalent practices of utilization of under-utilized agro- and animal- based fibre resources in different agro-climatic zones were accessed. This study included jute, pati doi, mesta, banana, coir, palmyra, babbar grass, paddy straw, hemp (Bast), cane, palm leaves, cotton (pod), moong, sunn, ambadi, linseed, dhencha, dadun, eri silk, muga silk, mulberry silk, deccani wool and fibre from goat and sheep hairs. All the fibers were used for textile purpose whereas, coir and palmyra were mainly used for ropes, floor mats, baskets, yarn, durriee, khes and bed sheets.

Natural dyes developed and standardized into natural dye colour concentrates. Natural dye printing procedure on silk was standardized. Preliminary tests were conducted to optimize the dye and mordant concentrations. Shade cards were developed and fastness test is in progress. Printed shade catalogues for silk samples by using the natural dye sources were developed for commercialization among artisans.

The degradable and non-degradable farm wastes such as sisal (*Agave mericana*), which are grown as edge plant around the field and is usually thrown as agricultural waste, were identified as good raw material for hand-made paper. Young men and women were imparted training on preparation of hand-made paper, envelopes, carry bags and big shopper bags from sisal fibre. Fibre was extracted from the plant by machine to ensure the quality of the fibre to suit the purpose of hand–made papermaking. The non-degradable farm waste such as polyethylene was utilized and value added products such as hand bags, rain coat, kids wear, diapers, bibs, baby sheets, baby-hood, refrigerator covers, table mats, apron, gloves and mattress were prepared by bonding process. Mode of pesticide application by women in different farming systems was studied, and protective clothing for each crop was designed.

Training modules were developed for alternate care of young children of agricultural labourers, quality learning environment for pre-schools and early intervention for prevention of developmental delays.

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Visioning, policy analysis and gender in agriculture

Training-cum-workshop on strengthening gender perspective in agricultural research and extension was organized for KVK professionals, wherein issues like gender concepts, gender in agriculture, gender analysis, work participation rate and importance of gender in agriculture were dealt with. Fifteen' years gender-wise data on students' enrolment for UG and PG courses on various disciplines in the Orissa University of Agriculture and Technology indicated an upward trend in girls' enrolment — in agricultural subjects it increased from 37% in 1993–94 to 58% in 2009–10, and similarly in UG courses in veterinary and animal husbandry it increased from 7.6% in 1994–95 to 37.3% in 2009–10.

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Research for Tribal and Hills Region

The Indian Council of Agricultural Research (ICAR) through its institutes located in North-West Himalayas, North-East Himalayas and Islands evolved technologies to meet the needs of tribal and hill farmers.

These technologies are intended to improve the socio-economic status of the target group, and will help them to acquire special skills through vocational training in traditional and non-traditional crops, agroforestry, apiculture, horticulture, animal husbandry, poultry and fisheries.

NORTH-WEST HIMALAYAS

The research carried out at the institute located at Almora in North-West Himalayas led to:

Varietal release: Ten varieties/hybrids of different crops were released for various agro-

Varieties released

Variety	Adaptation region/ Agro-ecology	Duration	Salient features
Vivek Maize Hybrid 33	Uttarakhand, Himachal Pradesh,Jammu and Kashmir (J&K) and NEH region	Extra-early (85-90 days in hills)	Outyielded HIM 129 and Vivek Maize Hybrid and showed tolerance to *Helminthosporium turcicum* leaf blight and *H. maydis* leaf blight
VL Madira 207	All over the country except Gujarat and Tamil Nadu	85-95 days	An improved plant type with high harvest index compared to VL Madira 29 and K 1. Exhibited resistant reaction to grain smut
VL Soya 59	Rainfed, timely sown areas of Uttarakhand hills, J & K and Himachal Pradesh	120-125 days	It has superior quality low linolenic acid and showed significant yield superiority to best check VLS 47. It showed moderate multiple resistance against pod blight (anthracnose) and target leaf spot, and moderate resistance to frog-eye leaf spot, in north-western hills
VL Soya 63	Rainfed, timely sown areas of Uttarakhand hills, J & K and Himachal Pradesh	115-120 days	It showed high multiple resistance against pod blight (anthracnose) and target leaf spot, and moderate resistance to frog-eye leaf spot in north-western hills
VLS 65 (Bhat)	Uttarakhand Hills	120-123 days	First Bhat (black soybean) strain developed by selection from the local germplasm of Uttarakhand hills, which can fulfils local Bhat requirement for Uttarakhand hills. It has moderate resistance against frog-eye leaf spot, pod blight

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Variety	Adaptation region/ Agro-ecology	Duration	Salient features
VL Gahat 15	Rainfed, timely sown areas of North and Central India	95-100 days	It has resistance to anthracnose and leaf spot diseases (< 10%) and shows better digestibility than checks AK 21, AK 42 and PHG 9
Vivek Matar 10	Zone I (J & K, Himachal Pradesh and Uttarakhand) and Zone IV (Punjab, Uttar Pradesh, Bihar and Jharkhand)	115-125 days	It has shown higher yield than national checks Arkel and VL 7 in Zone I and Zone IV. Also shows more pod length and seeds/pod and less pods/half kg than the check Arkel
VL Bean 2	Uttarakhand mid-hills	46-50 days	A high-yielding bush-type variety with soft string less and long flashy pods. It gave 21.29% higher yield than VL Bauni Bean 1
VL Moongphali 1	Rainfed, timely sown areas of Uttarakhand Hills	125-130 days	It shows yield superiority to best check Sulamit. Moderately resistant to tikka disease
VL Massor 129	Timely sown, rainfed conditions of Uttarakhand Hills	148-151 days	Significant yield superiority to checks VL 125, L 4076 and Pant L 05 under organic mode. It is moderately resistant to root rot and wilt diseases

climatic regions of the country.

Seed production: A total of 23.38 tonnes breeder seeds of 51 released varieties/inbred lines, 5.1 tonnes TL seeds of released varieties and 1.61 tonnes nucleus seeds of 42 released varieties was produced. Out of breeder seeds produced, 17.4 tonnes was supplied to different seed-producing agencies to take up further multiplication.

Registration of genetic stocks: Seven maize inbred lines were registered with National Bureau of Plant Genetic Resources for high tryptophan and lysine content. Marker-assisted selection was used to develop these lines, viz. VQL 3, VQL 5, VQL 8, VQL 12, VQL 16, VQL 17 and VQL 30.

SUCCESS STORY

Fodder production from dual-purpose wheat during winter under irrigated condition

Livestock is an integral part of hill farming. Cow, sheep, goat, buffalo and yak are the important livestock of hilly regions. Due to the peculiar geographical conditions and agro-ecological nature of such regions, food as well as fodder/feed security at local level is of utmost importance, particularly during winter months. Though quite a good number of fodder trees are available in these areas, they get severely affected by low temperature and frost during winters. Cultivated fodder also has very limited scope, as only 10% of the area is irrigated where vegetables and cereal crops get preference over fodder crops. Therefore, possibility of cultivation of fodder crops is negligible in hilly areas. Under such conditions, crop varieties offering both fodder and grains will be a viable solution. Wheat varieties serving the dual-purpose have been developed which provide green fodder at early stages of growth (particularly during winter months) and subsequently also provide grains. Farmers can cut the early vegetative crop for fodder and later, the crop grows to produce grains for food.

Sowing time: September last week to second fortnight of October
Seed rate: 100-120 kg/ha
Fertilizer: 120: 60: 40 (N: P_2O_5: K_2O) kg/ha.
Additional 20 kg/ha N after cut of green forage
Cutting time for green fodder: 70 to 90 days after sowing
Conditions: Irrigated conditions
Varieties: VL 616 and VL 829

Advantage: 4-6 tonnes/ha fodder production can be obtained during winter months without significant reduction in grain yield (4.0-4.5 tonnes/ha)

NORTH-EAST HIMALAYAS

Major achievements of the Institute located at Umiam in North-East Himalayas are:

Improved varieties of upland rice: Two new upland genotypes RCPL 1-115 and RCPL1-116 maturing in 145 days with good yield potential were developed. Both the genotypes are tolerant to acidic soils and brief moisture stress, and moderately tolerant to leaf and neck blast. Grains possess sufficient dormancy to withstand the effect of rain which frequently occurs at maturity stage.

RCPL 1-116, a variety of rice, is suitable for Mizoram, Nagaland and Manipur regions

Similarly, a cold-tolerant genotype developed by the Institute was recommended for release as NEH Megha Rice 3 by the State Seed Sub-Committee of Meghalaya. The genotype, maturing in 140-145 days with yield advantage, is for high altitude (up to 1,950 m) areas of Meghalaya. The genotype also meets the quality requirements of typical *japonica* rice.

Development of 4-row pre-germinated paddy seeder for hilly region: The paddy seeder has the advantage of line sowing in hilly areas with narrow terraces having widths up to 1 m. The main advantage of the paddy seeder is that it reduces the seed rate by almost half from about 125 kg/ha required for broadcasting in dry cultivation to about 60-80 kg/ha for line sowing using seeder. Two persons are needed in the field for carrying the machine and turning at the row end. It can cover up to 0.3-0.5 ha area in a day and the seed rate is about 60-80 kg/ha. By using this equipment, the cost of paddy cultivation can be reduced.

Large cardamon dryer: A batch-type tray dryer having about 600 kg capacity was designed and developed at this institute in collaboration with the other ICAR institute. The dryer was installed and evaluated at Sikkim Centre. It takes about 12 hr to bring down the moisture content of cardamon fruit from 625% (db) to 50% (db). A heat exchanger based on diesel fuel was designed and developed as source of energy to drying equipment. The best temperature for drying the cardamon fruit was 55-60 °C. Overall quality of the dried product was very good, without any loss in colour, flavour and aroma.

Semen preservation and artificial insemination in pigs: Semen evaluation methodology was standardized for fresh and preserved spermatozoa particularly, assessment of sperm membrane integrity, membrane permeability, mitochondrial membrane potential, DNA damage by various fluorescent staining methods.

For dissemination of superior germplasm and to develop upgraded pigs in a participatory mode through artificial insemination (AI) technology in field condition, 26 villages were selected and survey work was done. A total of 180 farmers were trained on scientific breeding, heat detection methods, reproductive management and awareness on artificial insemination in pig. Good quality semen was extended in BTS (BeltsVille Thawing Solution) media and preserved at 18°C up to 48 hr for insemination in field condition. A total of 189 pigs were inseminated (field demonstration) in different villages and obtained the pregnancy

SUCCESS STORY

Success of hatching turkey eggs by indigenous broody hen

Modern turkey varieties lack broodiness character and hence cannot hatch poults on their own. Indigenous broody hens available with farmers could successfully hatch out turkey eggs with a hatchability percentage of 85.78 ± 2.37 on total eggs set basis in 28 days. Although a local broody hen can hatch 12-15 chicks from their own eggs, they could ideally hatch 10 poults in one sitting since the eggs of turkey are bigger in size than chicken eggs. However, special care must be taken to prevent the mortality of young poults during first two to three weeks of age due to starve outs and infections.

Local broddy hen with freshly hatched out turkey poults

rate of 79.4% and farrowing rate of 77.8% with average litter size of 8.2.

For the first time in India, the Institute has produced piglets out of AI with frozen semen. Boar semen was successfully frozen using conventional method of freezing that does not involve costly equipment like programmable cell freezer. The motility of frozen-thawed semen ranged from 30 to 40% and a sow was inseminated with frozen-thawed semen, conceived in single insemination, and farrowed with 10 piglets including one mummified foetus. All the live born piglets are doing well. The average birth weight of piglet was 1.05 kg that ranged from 0.85 kg to 1.25 kg. The standardized technology shall have immense applicability in breed improvement programme of pigs and to produce superior germplasm pigs at farmer's field, even in remote areas.

Pathogenic organisms from livestock and their products: PCR-based protocols for rapid detection and confirmation of infectious bacterial pathogens of livestock and poultry in the North-eastern region were standardized. The organisms included *Escherichia coli*, *Salmonella* sp., *Listeria* sp., mesophilic *Aeromonas*, *Brucella*, *Campylobacter* sp., *Pasteurella* sp., *Clostridium perfringens* and *Vibrio* sp. The protocol for Capsular PCR Typing of *Pasteurella multocida* was standardized. *P. multocida* serogroup D was confirmed by PCR-based detection of *P. multocida* specific *dcbF* gene (657 bp) as an etiology of pig pneumonia. Spontaneous cases of swine abortion were investigated and confirmed as *Brucella* based on detection of 16S rRNA gene of *Brucella* sp. by PCR. These isolates were further confirmed as *Brucella suis* by PCR method targeting species specific IS*711* gene sequence. PCR-based detection of *Campylobacter jejuni* based on 16S rRNA, *fla*A and *hip*O gene was standardized. Several pathogenic genes were detected, namely *cdt*A, *cdt*B, *cdt*C, *iam*, *virB*11, *pld*A, *rac*R. A Pulse Field Gel Electrophoresis study for characterization of *C. jejuni* isolated from poultry showed the variation in the type of *C. jejuni* occurring in poultry. Western blotting protocol for identification of immunogenic proteins in *C. jejuni* was standardized. Immunogenic proteins could be identified with molecular weight between 50 and 75 kDa.

ISLANDS

Significant findings of the Institute located at Port Blair in Andaman and Nicobar Islands are:

Water resource development: A three-tier strategy was developed for water resource development, namely development of plastic film-lined tanks on the top of the hills, recharge structure-cum-well system in the mid-hills and

Lining of tank reinforced plastering on silpauline (*top*); finished lined tank (*bottom left*); check dam in Kaju Nallah watershed (*bottom right*)

development of open dug-wells in the valley areas. Such systems are very useful for utilization of water during dry periods. Lining of hill top tanks are being planned to be taken up both in South Andaman as well as Nicobar.

Rice: The Institute has released five varieties of rice, namely CARI Dhan 1, CARI Dhan 2, CARI Dhan 3, CARI Dhan 4 and CARI Dhan 5, through State Seed Sub Committee for A & N Islands. These varieties mature in 120,121,120,123 and 150 days respectively. Out of these, two varieties (CARI 4 and CARI 5) were specially developed for coastal salinity conditions and other three for normal soils.

Role of associated bacteria in bioactivity of marine sponges from Andaman

Two sponge specimens were collected by skin diving from North Bay which were subsequently identified as *Stylissa* sp. and *Iricinia* sp. Of the 62 strains isolated from sponges, eight isolates from *Stylissa* sp. showed significantly higher weighted inhibitory efficiency than the sponge itself, while none from *Iricinia* sp. had such property. Of the bacterial isolates associated with *Stylissa* sp., 21 (70%) produced antibiotics. Genomic DNA was isolated from the two isolates associated with *Iricinia* sp. which showed significant antibacterial activity than the sponge extract.

Iricinia sp

Stylissa sp

SUCCESS STORY

Composite fish farming with grass carp

Shri Periaswamy is a farmer of Indranagar village of Manglutan Panchayat of South Andaman having 2 hactares of land. In 2006, he had constructed a pond (0.08 ha) with the financial support of Department of Agriculture, A and N Administration for utilizing the water for agricultural and allied activities. He purchased some fish fingerlings from Department of Fisheries and reared them. After a year he could not harvest the fish due to poor body weight because of low fertility and high stocking of fishes. He had attended the training programme which helped him a lot in gaining confidence.

The KVK and Fishery Science Division team visited his pond and found that the fertility of the pond was very poor, as the pond was newly constructed and no organic manure was used by the farmer due to lack of knowledge. As per the advice of the experts, he applied lime and cowdung as per the recommended dose. After testing the water quality, he was issued 150 fingerlings including 20 grass carps from Division of Fisheries of the institute. He provided feed with GNC and rice bran 1:1 ratio @ 3% of the body weight of the fish. Sufficient amount of local grass and banana leaf was also provided daily for the grass carp. The KVK-CARI team took the harvested fishes and sold @ Rs 100/kg, by which he earned Rs 12,900 from the sale of 129 kg fish and received Rs 5,400 from 18 grass carp fishes. After seeing his interest and dedication, the Division of Fisheries of the Institute selected him as a best fish farmer and awarded him during Kisan Mela organized in February 2009.

Harvested fresh fish

Sweet potato: Two varieties, namely CARI Swarna (light pink skinned, orange fleshed) and CARI Aparna (light purple skinned, white fleshed) both sppreading type, have been released in the state. The varieties have high adaptability in hot humid tropical climatic conditions of Islands.

Coconut: Four varieties, namely CARI Annapurna, CARI Surya, CARI Omkar and CARI Chandan, have been proposed for release in the state.

Microbial diversity: A total of 483 bacteria, 117 *Trichoderma* spp, 32 *Ralstonia solanacearum* and 35 fungal pathogens were isolated and maintained in slants. Novel strains of bacteria were identified as *B. subtilis*, *B. pumilus*, *B. amyloliquefaciens* and *Enterobacter cloacae*. The 16S rDNA-RFLP analysis with *Msp* I and *Hae* III revealed greater diversity among the isolates. Of the total species isolated, *T. asperellum*, *T. erinaceum*, *T. ovalisporum* and *T. brevicompactum* were recorded for the first time from Andaman and Nicobar Islands. The survey and identification showed that the climate condition of the Islands is congenial for multiplication and spread of *Colletotrichum* spp. and found that *Colletotrichum* spp present in almost all crops as pathogenic as well non-pathogenic form.

Broodstock development and breeding of damsel fishes: Brooders of damsel fish species, namely *Amphiprion alkallopsos*, *Amphiprion ephippium* and *Premnas biaculeatus*, were collected from reefs and maintained in hatchery for the development of suitable breeding pair. The maroon damselfish, *Premnas biaculeatus*, could bred repeatedly five times in captivity.

Rotifers in Andaman waters: The distribution and abundance of rotifers, a potential feed for larvae of damsel fishes in Andaman, was explored by a survey from brackishwater areas in South Andaman. Species like *Brachionus plicatilis*, *B. rotundiformis*, *B. urceolaris*, *B. murrayi*, *B. calyciflorus*, *B. falcatus* and *Kellicotia* sp. were identified. The presence of *Brachionus plicatilis* species complex is a notable character of the rotifers present in Andaman waters.

Performance of crossbred ducks: Backyard duck rearing is an integral part of various farming systems in the islands, and to improve the egg production in local ducks, several crosses were attempted. Considering the growth performance, the Pekin × Chara-Chembelli crossbred showed better performance than all other crosses, and can be used as a meat-purpose duck under backyard condition.

Database on animal genetic resources in islands: The website is targeted to a wide range of users which includes department of Animal Husbandry and Veterinary Services, policy makers, scientists and public. The main page of the database comprises links to webpages of CARI, A & N Islands, Veterinary resources etc. ❑

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Organization and Management

DARE

The Department of Agricultural Research and Education (DARE) was established in the Ministry of Agriculture in December 1973. Subjects allotted to the DARE as per the Government of India (Allocation of Rules) are specified in Appendix I of DARE.

The Indian Council of Agricultural Research (ICAR) is an autonomous body under the Department of Agricultural Research and Education. The Secretary to the Government of India in the DARE functions as the Director-General of the ICAR. The Financial Advisor of the DARE is the Financial Advisor of the ICAR. Generally single-file system is followed between DARE and ICAR.

The Department has one more autonomous body, viz. the Central Agricultural University, Imphal under its administrative control. The University, which was established in 1993 has its jurisdiction over Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Sikkim and Tripura and is wholly financed by the Government of India.

The DARE has 17 Group A, 15 Group B, 12 Group C, and 6 Group D posts. The recruitment to the post in the Group A, B, C is being made centrally, either through the Department of Personnel and Training or through the Department of Agriculture and Co-operation, depending on the level of the post. The DARE makes direct recruitment only to Group D posts. Such recruitments are being made in accordance with the orders of the Government of India regarding reservations for Scheduled Castes, Scheduled Tribes, and Other Backward Classess. Presently, DARE has 6 Scheduled Castes and 1 Scheduled Tribes employees.

A detailed break up of the posts and names of the important functionaries is given in Appendix II of DARE. The financial requirement (Grant No. 2) includes budget estimates (BE) and revised estimates (RE) of DARE and ICAR (Plan and Non-Plan) 2008-2009 respectively and BE for 2009-10 (Plan and Non-Plan). The detailed break up of these financial figures is given in Appendix III of DARE.

ICAR

The Indian Council of Agricultural Research is an apex organization at the national level for promoting Science and Technology Programmes in the agricultural research and education.

The ICAR was set up on 16 July 1929, as the Registered Society under the Societies Registration Act 1860, on the recommendations of the Royal Commission of Agriculture. It was reorganized twice, in 1965 and 1973. The headquarters of the ICAR is located at Krishi Bhavan, New Delhi, and its other buildings are Krishi Anusandhan Bhavan I and II, and NASC Complex, New Delhi.

The Union Minister of Agriculture is the President of the ICAR. The Principal Executive Officer of the ICAR is the Director-General, who is also the Secretary to the Government of India in the Department of Agricultural Research and Education.

The General Body of the ICAR Society is the supreme authority of the ICAR, and the Minister for Agriculture, Government of India, heads it. Its members are the Ministers for Agriculture, Animal Husbandry and Fisheries, and the Senior Officers of the various state governments, representatives of Parliament, industry, education institutes, scientific organization and farmers (Appendix 1).

The Governing Body (Appendix 2) is the chief executive and decision-making authority of the ICAR. It is headed by the Director-General. It consists of eminent agricultural scientists,

educationists, legislators and representatives of the farmers. It is assisted by the Standing Finance Committee, Accreditation Board, Regional Committee, Policy and Planning Committee, several Scientific Panels, and Publications Committee. In the scientific matters, the Director-General is assisted by 8 Deputy Directors-General, one each for (*i*) Crop Sciences, (*ii*) Horticulture, (*iii*) Natural Resource Management, (*iv*) Agricultural Engineering, (*v*) Animal Sciences, (*vi*) Fisheries, (*vii*) Agricultural Education, and (*viii*) Agricultural Extension. The DDGs are responsible for the Institutes, National Research Centres, and the Projects Directorates belonging to their respective fields. The Senior Officers posted at the ICAR (Hq) are listed in Appendix 3 of the ICAR.

The ICAR receives funds from the Government of India and from the proceeds of the Agricultural Produce Cess.

The ICAR develops technologies and disseminates knowledge to farming community not only for increasing yields of crops and maintaining natural resources but also for elevating community's economics status.

The Research set-up of the ICAR includes 49 Institutes (Appendix 4), 6 National Bureaux (Appendix 5), 25 Project Directorates (Appendix 6), 17 National Research Centres (Appendix 7), and 78 All-India Co-ordinated Research Projects including Network Projects (Appendix 8).

The Directorate of Information and Publications of Agriculture is working independently with the approval of the Competent Authority. It also includes Media and Information Unit, ARIS Unit and Library. This integration of various units under DIPA provided organized strength and efficient use of human, financial and infrastructural resources for creating public awareness through dissemination of information globally by print media as well as electronic media.

DIPA is also working on projects funded by NAIP and increasing public awareness globally through ICAR website.

The ICAR promotes research, education and extension education in 44 State Agricultural Universities, 5 Deemed Universities, 1 Central Agricultural University for the North-Eastern Hills Region, and 4 Central Universities with agriculture faculty by giving financial assistance in different forms (Appendix 9).

For effective communication of research findings among farmers, the ICAR maintains an effective network of Krishi Vigyan Kendras and Trainers' and Training Centre along with Zonal Co-ordinating Units.

The total sanctioned as well as existing strength of the employees of the ICAR system, including scheduled castes, scheduled tribes and other backward classes, is given in Appendix 10.

Thus with an extensive network of research infrastructure, backed by an excellent team of scientists and other employees, the ICAR is making rapid strides in agricultural research, and provides support to the national efforts in achieving food security and self-sufficiency.

INTELLECTUAL PROPERTY AND TECHNOLOGY MANAGEMENT

The capacity building and Human Resource Development efforts made in the past two years have given dividends (number of ICAR institutes seeking IPR protection, number of alternate forms of IPR secured, and number of IPR grants to ICAR has risen). During 2009, ICAR received 1,048 IPR applications (385 patents, 635 plant varieties, 14 trademarks, 17 copyrights for software) from 42 ICAR institutes.

IP disclosure and grant of titles

Patents: Thirteen ICAR institutes filed a total of 55 patent applications [CIRCOT, Mumbai and CIFT, Kochi (13 each), NDRI, Karnal (7), CICR, Nagpur (6), CMFRI, Kochi (4), IARI, New Delhi (3), CPCRI, Kasaragod and CSWRI, Avikanagar (2 each), and CRIDA, Hyderabad; IGFRI, Jhansi; IVRI, Izatnagar; NIRJAFT, Kolkata and NRCMAP, Anand (1 each)]. Also, 2 patent applications earlier filed under the Patent Cooperation Treaty (PCT) entered into national phase in USA, France and Japan. The patents (55) were granted to ICAR.

Plant varieties: Applications for 28 varieties (23 extant and 5 new) of the notified genera/ crops were filed at the Plant Variety Registry; raising the cumulative total to 635 applications (577 extant and 58 new varieties). So far, 63 extant varieties have been registered and granted protection; and 301 applications have been published in the *Plant Variety Journal*. Applications submitted/ registered are illustrated.

Other forms of IPRs

Trademarks: ICAR institutes secured 4 Trademarks to distinguish the ICAR products and services offered by these institutes ('Vanaraja' and 'Gramapriya' for breeds by Project Directorate on Poultry, Hyderabad; 'CIFABROOD' for Carp Brood stock diet developed by CIFA, Bhubaneshwar; and 'IISR' by Indian Institute of Spices Research, Calicut).

Copyright: The copyrights (6) were registered by ICAR institutes to protect their softwares from unauthorized copying ('Software for design and layout of drip and sprinkler irrigation systems' and 'Decision support system for

Patents granted to ICAR, 2009

Patent Number	Granted on/ With effect from	Title	Inventors/ Institute
227533	13.1.09/4.4.01	Palmyrah fibre separating machine	I. Srinivasan, R. Sudhakar, K. Nagarajan/ CTRI, Rajahmundry
227536	13.1.2009/4.4.01	Additives for improved photostability of *Azadirachtin*-A	Prem Dureja, S. Johnson, S. Dhingra/ IARI, New Delhi
227691	16.1.09/23.12.05	Biofertilizer-cum-biofungicide/ biobactericide composition B5	V. Sunaina, V. Kishore/ CPRI, Shimla
231054	28.2.09/20.8.02	Seed-cum-fertilizer grain drilling machine	B.K. Dutt/ IARI, New Delhi
232467	17.3.09/12.11.03	The synergistic mineral mixture for increasing milk yield in cattle.	M. C. Sharma, N. Pathak, C. Joshi/ IVRI, Izatnagar
233742	2.4.09/12.4.06	Design and development of coconut deshelling machine	T. Vidhan Singh/ CPCRI, Kasaragod
233744	2.4.09/12.4.06	Development of a manually operated tender coconut punch and cutter	T. Vidhan Singh, K.G. Narayanaswami, M.V. Krishnan/ CPCRI, Kasaragod
234480	29.5.09/14.2.06	Biopesticidal formulation with improved shelflife and the process of preparation	Prem Dureja, B. S. Parmar/ IARI, New Delhi

farm machinery management for optimum selection and matching with power sources' by CIAE, Bhopal; and 4 data arrangement and analysis softwares developed at Directorate of Soybean Research, Indore).

Strengthening the IP and technology management mechanism

The premise of centralized planning and decentralized execution for intellectual property management in ICAR was strengthened; the 3-tier mechanism is operationalised with the establishment of 95 Institute Technology Management Units and further strengthened by establishing 5 Zonal Technology Management Centres at NIRJAFT, Kolkata for East zone; CIRCOT, Mumbai for West zone; IARI, New Delhi for North-I zone; IVRI, Izatnagar for North-II zone; and CIFT, Kochi for South zone. Decision-support system was provided, and thereby convergence streamlined, for the Zonal IP and Technology Management and Business Planning and Development activities; with the constitution of zonal level committees (ZITMCs). Assistant Director-General oversees facilitation, coordination and monitoring needs among the ZTM&BPD Units and the ITMUs from the ICAR headquarters.

Commercialization of technologies

Dissemination of ICAR technologies in partnership with public and private sectors is based on the principles of joint IPR ownerships and pre-decided licensing rights on mutually agreed terms as illustrated in the ICAR guidelines for IP management and technology transfer/ commercialization. In 2009, CIAE, Bhopal has licensed 36 technology products by entering into 11 Agreements with various companies. It has also entered into Research and Development partnership with public agencies and private companies for developing microwave energy-based pilot scale unit for production of edible grade soyflour, and straw reaper with rectangular container. Project Directorate on Poultry, Hyderabad has commercialized 2 chicken varieties, viz. Vanaraja™ and Gramapriya™. Vanaraja is a multicoloured dual purpose bird that attains 1.8 to 2.0 kg body weight at 12 weeks of age and lays 110 eggs in laying cycle under backyard conditions. Gramapriya is an egg type coloured bird, which lays 180-200 eggs in a laying cycle. These birds are well accepted across the country and are performing well in different agro-climatic regions. IARI, New Delhi and some other institutes have also entered into MoUs with private and public sector companies for commercialization of plant varieties/hybrids.

ADMINISTRATION

Filling up of vacant posts: A good number of vacant posts like Under-Secretaries, Senior Administrative Officers, Administrative Officers/ Finance and Accounts Officers/Section Officers / Private Secretaries / Assistants / Personal Assistants/ UDCs / Stenographers / Group 'D' posts were filled up.

Details of total number of employes in ICAR (headquarters) and its research institutes mentioning SC/ST/OBC are given in Appendix 10.

Financial upgradation granted under ACP Scheme: As per the Government of India instructions Financial Upgradation was granted to many eligible employees in various grades during this period, viz. SOs/AAOs/AF&AOs/ AD(OL)/Stenographers / LDC and Group 'D' employees.

Staff Welfare Fund Scheme

(i) As per the recommendations of the Managing Committee of ICAR Hqrs' Welfare Fund financial assistance of Rs 1,00,000 was extended to the family of 4 deceased employee of the ICAR Hqrs.

(ii) 42 Scholarships (Rs 2,500 each) were awarded to the meritorious wards of the Council's employees under Staff Welfare Fund Scheme.

Finance and Audit

Avoidable expenditure due to excess procurement: Indian Agricultural Research Institute purchased 3 Gas Liquid Choromotographs against the requirement of only 1. As such, the expenditure of Rs 2.592 millions on procurement of 2 additional Gas Liquid Choromotographs was avoidable (paragraph 9.1)

Avoidable expenditure due to failure to obtain separate electrical connection for staff quarters: Failure of National Dairy Research Institute to get separate electric connection for its staff quarters, resulted in avoidable expenditure of Rs 2.516 million from April 2001 to May 2008 due to payment of electricity charges at commercial rates for residential staff quarters (paragraph 9.1)

Councils' response: Action taken notes *vide* para at Sl. No. 2 above has already been furnished to Audit. In respect of paras at Sl. No. 1, the Action taken notes shall be furnished to Audit shortly.

The Budget Estimate (BE) and Revised Estimate (RE) of DARE and ICAR (Plan, Non-Plan) for 2008-09 are Rs 2,680.00 crore and Rs 2,982.64.00 crore, respectively, and BE for 2009-10 (Plan and Non-Plan) is Rs 3,314.77 crore.

PROGRESSIVE USE OF HINDI

DARE

The Department of Agricultural Research and Education has an Official Language Section for the compliance and implementation of the Official Language Policy of the Government of India.It consists of one post each of Assistant Director (Official Language), Junior Hindi Translator and Hindi Typist. Besides the Hindi translation of the Budget, compilation and preparation of the Annual Report of the Department etc. also take place. The functioning of this section also includes holding Hindi workshops, meetings, reports, organizing Hindi *Pakhwada* to encourage the employees for doing their official work in Hindi.

Items	Budget Estimates 2008–2009		Revised Estimates 2008–2009		Budget Estimates 2009–2010	
	Plan	Non-Plan	Plan	Non-Plan	Plan	Non-Plan
Major Head '3451'090 Secretary	-	175	-	282	-	374
Major Head '2415'80 General						
International Co-operation(010032) –India's membership Contribution to Commonwealth Agricultural Bureau	-	10	-	10	-	10
(020032) – India's membership Contribution to Consultative Group on International Agricultural Research	-	380	-	380	-	400
(030032) –Other Programmes	1100	-	1100	-	*2100	-
(040032) –India's contributions to Asia Pacific Association of Agricultural Institutions	-	5	-	5	-	5
(050032) – India's contributions to NACA	-	9	-	9	-	9
(060032) – India's contributions to CGPRT	-	5	-	5	-	5
(070032) – India's contributions to Seed Testing Association	-	2.25	-	2.25	-	2.25
(080032) –ISHS Belgium	-	0.75	-	0.75	-	0.75

*Includes Rs 20.00 crore for National Fund for Basic and Strategic Research in agriculture

ICAR

- During the period under report 6 Institutes/ Centres of the Council were notified in the Gazette of the Government of India thus raising the total number for notified Institution to 114 under rule 10(4) of the Official Language Rule 1976.
- Joint Official Language Committee of the DARE and the ICAR working under the chairmanship of the Special Secretary, DARE/ Secretary, ICAR met fourth time during the period under report. Similarly, Official Language Implementation Commitees constituted at mostly Institutes/Centres convened its meetings.
- Proceedings of the Official Language

Implementation Committee meetings held by the Institutes etc. as well as the quarterly progess reports regarding the use of official language Hindi received from various institutes at the ICAR Headquarters were reviewed and proper measures were suggested to overcome the shortcomings found threin.

- Roster has been maintained for imparting training in Hindi, Hindi typing and Hindi Stenography and officials were accordingly deputed for training during the year. This year 5 stenographers and 7 typists were nominated for Hindi stenography and typing respectively.
- This year was observed **'Hindi Year"** and **'Hindi Chetna Maas"** at ICAR(Hqrs) and many programmes were organized for staff to promote the progressive use of Hindi in official business. A message of Hon'ble Minister of Agriculture was issued on this occasion. The DG, ICAR also issued an appeal requesting the officers/staff to do their maximum official work in Hindi. Hindi Day/ Week/Fortnight/Month was also organized in different Institutes/Centres of ICAR.
- Hindi Workshops (4) were also organized during the reported period for officers/staff.
- Under the cash award scheme during 2008-09 cash awards will be given to 10 officials at Headquarters for doing this maximum offical wok in Hindi at ICAR (Hqrs).
- "Under the *RAJARSHRI TANDON RAJBHASHA PURASKAR*" following Institute were awarded for doing their maximum work in Hindi during 2008.
- The First Big Institutes Award has gone to Indian Agricultural Research Institute, Pusa, New Delhi and Second to National Dairy Research Institute, Karnal.
- The First Small Institutes Award of 'A' and 'B' Region has gone to Central Institute for Research on Goats, Makhdoom, Mathura and Second to National Bureau of Soil Survey and Land Use Planning, Nagpur.
- The First 'C' Region's Institute Award has gone to Central Research Institute on Dryland Agriculture, Hyderabad and Second to Central Marine Fisheries Research Institute, Kochi.
- The First *Ganesh Shankar Vidyarthi Utkrist Hindi Krishi Patrika Puraskar* has gone to Central Institute on Sub-tropical Horticulture, Bikaner; Second to Indian Institute of Horticultural Research, Bengaluru; and Consolation to Central Soil Salinity Research Institute, Karnal.
- Under this scheme Hindi publications brought out by various Institutions during 2008, were evaluated and the following publications got prizes.
- In accordance with the recommendations made by the Department of Official Language and the Parliamentary Committee on Official Language, to assess the progressive use of Hindi at the ICAR (Hqrs) as well as its institutes 17 Offices were inspected during 2009, and suggestions were given to improve the shortcomings. Second Sub-committee of the Parliamentary Official Language Committee inspected 3 Institutes/Centres of the Council during this year.
- The 11th issue of *RAJBHASHA ALOK* was released on the 15 July, 2009 on the occasion of ICAR Foundation Day.
- The Council and its institutes are organizing regular training programmes for farmers in Hindi and in other regional languages and remarkable progess has been made at Krishi Vigyan Kendras situated in Hindi speaking region in the use of Hindi and other regional languages in their day-to-day official work.
- Besides material regarding Parliament, Annual Plan Report, Review of Demands for Grants, General Body, Standing Finance Committee, Parliamentary Standing Committee on Agriculture, Annual General Meeting of the ICAR society and many other meetings were translated and got prepared bilingually. The Hon'ble Agriculture Minister and other higher officials delivered many of their speeches in Hindi. The drafts of speeches of Hon'ble Union Agriculture Minister and other higher offiicals of ICAR were prepared originally in Hindi also.

ICAR AWARD CEREMONY, 2009

The Union Minister of Renewable Energy, Dr Farooq Abdullah awarded 55 awardees under 12 categories at the NASC Complex, New Delhi. This comprised 3 institutions, 47 scientists, 3 farmers and 2 journalists; out of 47 scientists there are 9 women scientists, Appendix 11.

TECHNICAL COORDINATION

The Coordination work comprised financial support to 40 societies for publication of their scientific journals, 18 societies/Associations/Universities for holding National Seminars/Symposia/Conferences and 12 Societies/Association/Universities for holding International Seminars/Symposia/ Conferences. It also included work related to selection of Best Annual Report of Institutes, Preparation of ICAR International Training Calender for conducting training, replies to Parliament Questions, VIP references, IMC/RAC of

various Institutes of the ICAR, Deputation Report and queries under RTI Act regarding Awards. One Regional Committee meeting was organized during October 2009 and proposals for holding 3 more Regional Committee meetings have also been finalized for current financial year.

Monthly Cabinet Report containing major breakthroughs achieved in research and other related matters at various ICAR Institutes/NRCs Project Directorates was submitted to the Cabinet Secretariat, Government of India every month. Copies were also circulated to various Ministers and other related Departments.

Assistance of scientific nature was rendered to DST, DSIR, DAC and other Departments of the Government of India. The Coordination Unit assists in preparation of Memoranda of Understandings and formulation of Work Plans for technical cooperation between DARE and various collaborating patterns from abroad. Various MoUs with work plans between DARE (ICAR) and various countries were finalized. Besides this, the Directors' Conferences is to be organized by Coordination Unit during current financial year.

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Partnership and Linkages

The International Cooperation in ICAR/DARE has been operating through the Memoranda of Understandings/Work Plans signed with various countries/International organizations with ICAR/DARE as the Nodal Department and through participation of ICAR/DARE in the MoUs/Work Plans signed by the Department of Agriculture and Cooperation as the Nodal Department. Besides, Ministry of Science and Technology has developed Programme of co-operation with various countries and international organizations in which ICAR/DARE is the participating agency in agricultural research. The Joint Commissions/Working Groups constituted by the Ministry of External Affairs and the Ministry of Commerce have the component of agriculture/agricultural research. The Joint Commissions/Working Groups constituted by the Ministry of External Affairs and the Ministry of Commerce have the component of agriculture/agricultural research in which DARE participates directly or through the Department of Agriculture and Co-operation. India is donor member to CGIAR and contributes 0.75 US million $ under unrestricted funding of CG Institutes. The Scientists /Officers were sent on International deputation and training during 2009–10 funded by CG centers or covered. The Department is also organizing visits of foreign nationals under "*Ad hoc* Category". The Department also receives proposals for customized training courses for foreign nationals.

MEMORANDUM OF UNDERSTANDING

- Memorandum of Understanding was signed on 24 April, 2009 between the ICAR and Biodiversity International for Scientific and Technical Cooperation at NASC Complex, New Delhi.

COLLOBORATIVE PROJECTS

During 2009–10 a number of foreign collaborative projects were received and considered. However, following projects were approved for implementation by the various institutes of the ICAR.

Promoting sustainable livelihood development: With the aim to improve access to knowledge and technology for poor people whose livelihoods depend on natural resources the ICAR Research Complex for Eastern Region, Patna is implementing 'Promoting sustainable livelihood development' project. The sponsoring agency for this project is DFID, Ministry of External Affairs, United Kingdom for which GY Associates United Kingdom has been contracted to implement DFID Innovation Challenge Fund Project. Besides ICAR-RCER, Patna, 7 other organization are also involved in the project. The total budget for the project is UK £ 1,801,246 and the funds meant for the ICAR-RCER is UK £ 68, 871 for 2 years and 7 months i.e. from 5 November, 2008 to 30 June, 2011. There is no financial liability on the part of the institute/ICAR/DRE. However, the contribution of the institute will be in kind.

Conservation and sustainable use of cultivated and wild tropical fruit diversity: promoting sustainable livelihood, food security and ecosystem services: ICAR alongwith Bioversity International is participating in the above project along with are CISH, Lucknow, IIHR, Bengaluru, NRCC, Nagpur and NBPGR, New Delhi. The other foreign organizations participating in the project are:

(i) Indonesian Centre for Horticultural Research and Development Jakarta, Indonesia,
(ii) Malaysian Agricultural Research and Development Institute, Kuala Lumpur, and
(iii) Department of Agriculture, Chatuchak, Bangkok.

The project has been re-endorsed by the Ministry of Environment and Forest for 5 years ie from 1

January, 2009 to 31December, 2013. The total cost of the project is US$ 1,03,75,748 which includes cash funding from Global Environmental Facility through UNEP and co-financing from the 4 partner countries. "India's co-funding in cash and in-kind is US$ 19,09,041. The Global Environmental Facility funding is US$36,61,674 out of which ICAR will get US$ 9,43,465 for 5 years for undertaking activities in India."

Indo-Swiss collaboration in Biotechnology: With the aim to characterize the resistance gene(s) against fungal diseases, viz. rusts (leaf and stripe rusts), powdery mildew and terminal heat tolerance in wheat for mitigating the effects of climate change the Directorate of Wheat Research, Karnal participated in the Indo-Swiss collaboration in Biotechnology Project, "Molecular characterization and genetic enhancement of fungal disease-resistance and terminal heat tolerance in wheat" that was conveyed on 15 January, 2009. Besides other collaborative institutions in this project are Punjab Agricultural University, Ludhiana and Institute of Plant Biology, University of Zurich, Switzerland for 3 years w e f 9 March, 2009, the date the project is approved by Indo-Swiss collaboration in Biotechnology. The total cost of the project is Rs 6.95 millions out of which Swiss Agency for Development and cooperation, Switzerland component is Rs 2.450 millions and Department of Biotechnology is Rs 4.5 millions. However, the contribution of Indo-Swiss Directorate of Wheat Research is as time sharing of its scientific staff and other infrastructure facilities and the same has been quantified to the tune of Rs 0.75 million.

Sustainable management of marginal dryland: The Central Arid Zone Research Institute, Jodhpur is participating in the second phase of the UNESCO-MAB approved project Sustainable Management of Marginal Dryland. In all 12 countries are participating in the project for 5 years (2009–13) and the total estimated project budget is Rs US $ 8,608,5090: (*i*) Flemish Government of Belgium (US $ 1,480,050), (*ii*) Counterpart contributions by project sites (SUMMAD Member States, US $ 7,048,450 this includes in kind contribution of India to the tune of US $ 150,000), (*iii*) UNESCO-MAB (US $ 40,000) and (*iv*) UNU-INWEH (US $ 40,000). Collaborating agencies are UNESCO with its Man and the Biosphere Programme, the United Nations University International Network on Water, Environment and Health (UNU-INWEH) and Flemish Government of Belgium. India will be receiving US $ 96,000 from UNESCO and India's in kind contribution is US $ 150,000. The overall objective of the second phase of the project (2009–13) is to focus on building the capacity of the dryland researchers to transfer their scientific findings for use both by local communities and for policy.

Foreign National studies in India

Foreign Deputation cases of Scientists for Training/Fellowship/Scholarship/Associateship/ Position/Assignment were 42 and 176 foreign candidates from Iran, Sri Lanka, Ethiopia, Rwanda, Myanmar, Bhutan, Botswana, Iraq, Nepal, Vietnam and Nigeria etc. have been admitted for pursuing Ph.D/M.Sc/M.V.Sc/M.Tech/B.Sc/B.Tech/B.V.Sc and A.H degree programme and short-term training programme in the State Agricultural University/ Deemed Universities during 2009–10 upto 21 October, 2009.

CENTRAL AGRICULTURAL UNIVERSITY

The Central Agricultural University working under DARE, has started postgraduate programmes in the faculty of Veterinary Science, Fisheries and Horticulture leading to masters degree in the discipline of microbiology, aquaculture, fishery extension, fruit science and vegetable science respectively. The admission capacity of undergraduate and postgraduate programmes have been increased to 331 and 140 students respectively. The University at present has 902 students on roll for undergraduate and postgraduate programmes. The 137 students have completed the bachelors and 24 students postgraduate degree programme in 2009. The students from Central Agricultural University performed well in Junior Fellowship Examination conducted by ICAR during 2009. Students from CAU (21) have been selected for the award of Junior Research Fellowship. The 26 students from CAU have been admitted in National Institutes, viz. IARI, IVRI, NDRI, IASRI and CIFE. Another 68 students got admission for Postgraduate studies in different universities in the country.

To boost up the research in the region the ICAR has sanctioned 19 Centers of All India Co-ordinated Research Projects at different colleges of Central Agricultural University. In the AICRP (Voluntary Centre) on Tuber Crops (Other than Potato), 33 germplasms of sweet potato, 27 of colocasia, 25 of cassava and 3 of arrow root were collected. Most of them performed well under agro-climatic condition of Manipur.

Studies suggested that intercropping of maize with cowpea can yield 91.9 q fodder/ha and can overcome the fodder deficiency in areas that are suitable for maize-cowpea intercropping. The 4 different pathotypes of *Escherichia coli* (STEC/ EPEC/EHEC) were detected from the faeces of diarrhoeic and non-diarrhoeic piglets in Mizoram.

Presence of stx_1, stx_2, *eaeA*, *ehxA* and other putative virulence genes were detected from both diarrhoeic and healthy piglets. Common porcine pathogens under serogroup O8, O103, O108, O138, O141 and O147 were also isolated. On the basis of studies on bacterial contamination of boar semen, it was found that use of chloramphenicol and ciprofloxacin is more effective in checking the bacterial contamination than aminoglycosides. A location specific fish-based farming system is being developed at College of Fisheries, Lembucherra, Agartala, Tripura by harnessing runoff water and integration of existing farm practices (Agriculture, Horticulture, and Animal Husbandry) with Aquaculture. The efficacy of the model is being evaluated on farm as well as in the farmers' field. The University is actively engaged in extension education activities. The University has organized an exhibition for North-Eastern Hills Region and a National Seminar on 'Integrated Pest Management strategies to combat emerging pests in the current scenario of climate change' was organized at College of Horticulture and Forestry, Pasighat, Arunachal Pradesh at the exhibition.

The villages (10) have been linked with e-governance in the East Siang district under the College of Horticulture and Forestry, Pasighat. A National Seminar on 'Information and Communication Technology for Agriculture and Rural Development' was also organized at College of Horticulture and Forestry, Pasighat. Under the extension programme efforts are being made for producing quality seeds, planting material and fish seed. During 2009–2010, 65 tonnes of truthful seed of rice CAU R1 has been produced under farmers participatory seed production programme. This seed is being processed and will be made available to the farmers during the next *kharif*. More than 0.1 million grafts of virus free *Khasi* Mandrins are being prepared. The fingerlings (0.5 million) of Indian major carp and five thousands post larvae of fresh water prawn have been produced and being distributed to the farmers in Tripura. The university has established good infrastructural facility for the smooth functioning of education programme. Library building at College of Veterinary Science, Aizawl, Mizoram, administrative and academic block at College of Horticulture and Forestry, Pasighat, sports complex at College of Fisheries, Lembucherra, Agartala, Tripura and Guest House at College of Agricultural Engineering and Post-harvest Technologys, Ranipool (Sikkim) have been completed.

PROTOCOL ACTIVITIES

Delegations abroad

- Dr Suresh Kumar, Senior Scientist, IGFRI, Jhansi visited University of Missouri, College of Agriculture Food and Natural Resources, USA from 11 April to 25 May, 2009 for undergoing training on "Deployment in MiRNAs for enhancing abiotic stress tolerance" under the Indo-US AKI programme.
- Dr Manoj Kumar Yadav, Assistant Professor (Agril. Biotech), S.V. Patel University of Agriculture and Technology, Meerut visited University of Missouri-Columbia, USA from 11April to 23 May, 2009 for undergoing training programme under the project "Plant tissue culture transformation and molecular biology" under the Indo-US Norman Borlaug Fellowship AKI.
- Dr Rakesh Kumar, Scientist (SS), CIFT, Cochin visited Michigan State University from 1 May to 30 June 2009 for undergoing training in the field of "Gene Knowk out, Gene expression and regulation in food borne bacterial pathogens" under the Norman E. Borlaug Fellowship Programme, 2008 under Indo-US Knowledge Initiative in Agriculture.
- Dr P.K. Joshi, Director, NCAP, New Delhi visited Rio de Janeiro, Brazil from 14 to16 July, 2009 to attend the Working Group Meeting on Agriculture as a representative from DARE as part of the delegation led by Secretary (Agriculture).
- Dr Nihar Ranjan Sahoo, Assistant Food Microbiologist, Orissa visited Kansas State University, USA from 2 August to 12 September, 2009 under Norman E. Borlaug Fellowship Programme, 2008.
- Dr Suresh Pal, Head, Division of Agricultural Economics, IARI, New Delhi visited IFPRI, Washington, DC, USA from 15 September to 15 October, 2009 for the Norman Borlaug International Agricultural Science Technology Fellowship Programme, 2009 under Indo-US AKI in Agricultural Economics.
- Dr Anjani Kumar, Senior Scientist, NCAP, New Delhi visited USA to the Norman Borlaug International Agriculture Science Technology Fellowship Programme, 2008 under the Indo-US AKI in Agricultural Economics from 12 October to 26 November, 2009.
- Dr S.P. Tiwari, DDG(Edn.), ICAR visited Afghanistan from 29 September to 1 October, 2009 to explore the possibilities of establishing the Afghan University of Agriculture and Technology with Indian Assistance.
- Dr A.K. Misra, Project Director, CIRB, Meerut visited Afghanistan from 29 September to 1 October, 2009 to explore the possibilities of establishing the Afghan University of Agriculture and Technology with Indian Assistance.
- Dr S.L. Mehta, Vice-Chancellor, MPUAT, Udaipur visited Afghanistan from 29 September to 1 October, 2009 to explore the possibilities of establishing the Afghan University of Agriculture and Technology with Indian Assistance.
- Dr (Mrs) Lalita Batra, Principal Scientist and Dr P.K. Joshi, Principal Scientist, Central Soil Salinity Research Institute, Karnal, visited All-Russia Science Research Institute of Hydrotechnics and

Amelioration named A.N. Kostyakov; All-Russia Sciences Research Institute of Feed named V.R. Villiams, Lobnya and All-Russia Sciences Research Institute of Agro -and Forest- Amelioration, Volgograd from 18 to 31August, 2009 to study under ICAR-RAAS Work Plan for 2009–2010 for "Reclamation of Salt Affected Soils – Bio-ameloration for saline and alkaline soils".

Foreign deligations

- His Excellency Dr Marc Fortin, Assistant Deputy Minister of Research, Canada visited Indian Agricultural Research Institute and Indian Council of Agricultural Research (Hqrs.), New Delhi on 20 and 21August, 2009.
- His Excellency Mr Mizengo Kayanza Pinda (MP), Prime Minister of the United Republic of Tanzania visited Indian Agricultural Research Institute/ National Bureau of Plant Genetic Resources/ National Agricultural Science Museum, New Delhi on 14 September, 2009.
- Mr Ranjith Wijethilake, Secretary, Ministry of Agriculture Development and Agrarian Sciences, Sri Lanka visited Indian Council of Agricultural Research did observation visit from 13 July, 2009 for discussing the formulation of the Work Plan for 2010–11 thereafter the delegation visted at IASRI/NCAP/IARI/NRCPB/NBPGR/NARM, Pusa, New Delhi.
- Mr Parashuram Lal Karna, Director, Financial Administration and Mr Narendra Lakhe, Administrative Officer from Nepal Agricultural Research Council, Nepal visited National Academy of Agricultural Research Management, Hyderabad from 7 to 11 September, 2009 under the Work Plan for 2010–11.
- A 4-member delegation from Sri Lanka Council of Agricultural Research, Sri Lanka visited National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi from 21 to 27 September, 2009 to study in the field of Agricultural Risk Management and Extension' under the ICAR-CARP Work Plan for 2008–09.
- A 4-member delegation from Sri Lanka Council of Agricultural Research Council, Sri Lanka visited Central Sheep and Wool Research Institute, Avikanagar; Central Institute for Research on Goats, Makhdoom; Central Institute for Research on Buffaloes, Hisar; National Research Centre for Equines, Hisar; National Dairy Research Institute, Karnal; National Bureau of Animal Genetic Resources, Karnal; and Guru Angad Dev Veterinary and Animal Husbandry University, Ludhiana to study in 'Livestock Production Research and Development under the ICAR-CARP Work Plan for 2008–09.
- Dr Kosolapov Vladimir, Director and Dr Trofimov Ilya, Deputy Director, All-Russia Sciences Research Institute of Feed named V.R. Villiams, Academics of Russian Academy of Ecology Science, Moscow, Russia visited National Dairy Research Institute, Karnal; Central Institute for Research on Buffaloes, Hisar and Central Sheep and Wool Research Institute, Avikanagar from 10 to 21 June, 2009 to study "Animal Production, Health and Processing – Feed processing technology like complete feeds, feed block etc." under ICAR- RAAS Work Plan for 2009–2010.

Indian scientists on foreign assignments

The scientists were deputed in foreign countries and it includes visits under collaborative project of ICAR.

- Dr Shiv Kumar, Head, Division of Crop Improvement, IIPR, Kanpur was deputed as Lentil Breeder on Deputation basis at ICARDA, Aleppo, Syria.
- Dr M. S. Ramesha, Sr. Sci., Directorate of Rice Research, Hyderabad was deputed as 'Scientist-Rice Breeder' at IRRI, Philippines.
- Dr M. L. Jat, Sr. Sci., Directorate of Maize Research, Indian Agricultural Research Institute Pusa Campus, New Delhi was deputed for the position of 'Hub Manager- Haryana' at IRRI India Office under CSISA.
- Dr S.K. Bandyopadhyay, former Joint Director (Academic), IVRI, Izatnagar (presently on deputation as Animal Husbandry Commissioner to Department of AH, Dairying and Fy., Krishi Bhawan, New Delhi) was deputed for the position of 'Senior Technical Coordinator (P-5) Grade- I (Fixed Term)' at FAO OF THE United Nations, Hanoi, Vietnam.

Scientist to foreign countries on deputation funded by CG Centres

- Dr R. Viswanatahan Sr. Sci., Sugarcane Breeding Institute, Coimbatore visited Wageningen University, the Netherlands for Department of Biotechnology Overseas Associateship Award (Short-term), 2007–08 for 3 months up to 15 May, 2009.
- Dr M Kailasam, Sr. Sci., Central Institute of Brackishwater and Aquaculture, Chennai visited University of Tokyo, Japan for Department of Biotechnology Overseas Associateship Award (Short-term) 2007–08 for 6 months, i.e. up to second week of August, 2009.
- Dr Bhupinder Singh, Sr. Scientist, Nuclear Research Laboratory, IARI, New Delhi visited for DBT Overseas Associateship Award 2007–08 at Institute of Plant Nutrition, University of Hohenheim Stuttgart), Germany for 86 days i.e 17 March to 13 June, 2009. His local living cost, boarding lodging etc. was given by Host Academy in Germany-50% air fare by INSA- remaining 50% by the Scientist himself or DST or CSIR.
- Dr Dinesh Kumar, Sr. Sci., IARI, New Delhi visited New Castle Upon Tyne University, United Kingdom for UGC's sponsored commonwealth Academic Staff Fellowship, 2008 for 6 months from 01 February to 31 July 2009. He got Commonwealth Scholarship Commission, London, United Kingdom.
- Dr D.R. Malaviya, Pr. Scientist, IGFRI, Jhansi visited Wagga, Australor the study of Pasture Genentics and Improvement, E.H. Graham Centre for Agricultural Innovation (NSW Department of

Primary Industries and Charles Sturt University), Wagga between 25 March and 24 June, 2009 pertaining to DBT Overseas Associateship Award 2007–08.

- Dr Anil Kumar Nair, Sr. Scientist (Agronomy), IIHR, Bengaluru visited Egyptian International Centre for Agriculture from 15 February to 30 April, 2009
- Dr A.K. Samanta, Sr. Sci., NIANP, Bengaluru visited Department of Education, Science and Training, Government of Australia for availing Endeavour Research Fellowship, 2009 from 16 April to 15 October, 2009
- Dr (Mrs) G. Nirmala, Sr. Scientist, CRIDA, Hyderabad visited Host Institute in USA for Hubert H. Humphery Fellowship.
- Dr P. G. Patil, Scientist (SG), GTC Nagpur of CIRCOT and Dr V. Santhy, Scientist(SS), Seed Technology CICR, Nagpur visited EICA, Egypt for undergoing training course titled "Cotton Production and Technology" Organized by EICA, Giza, Egypt for approx. 2 months and 15 days (April-June 2009).
- Dr Ashish Saha, Sr. Sci., CIFA, Bhubaneshwar visited France for undergoing training under the area of 'Life Science' under DST's BOYSCAST Fellowship Award, 2008–09 for 12 months i.e. from 2nd week of May, 2009.
- Dr H.C. Prasanna, Sr. Scientist, IIVR, Varanasi visited Department of Plant Sciences, University of California, Davis, USA for "Crop Biotechnology" under DST's BOYSCAST Fellowship, 2008–09 for 12 months from any date in May before 31 May, 2009.
- Dr T. Mohapatra, Principal Scientist, NRCPB, New Delhi visited Li-Cor, INC, 4647 Superior Street, Lincoln, Nebraska, USA 68516 for TILLING application for LI-COR, 4300 DNA Analyser from 6 to 8 July, 2009
- Dr Anil Kumar, Principal Scientist, IGFRI, Jhansi visited University of Guelph, Canada for training under the area of 'Life Science'/Plant Genetic Resources under DST's BOYSCAST Fellowship Award, 2008–09 for 4 months w.e.f. 25 May, 2009
- Dr Pankaj Kaushal, Principal Scientist, CRRI, Cuttack visited Institute of Plant Genetic, Perugia-CNR, Italy for training on the subject titled "Agriculture Biotechnology" under DBT Overseas Associateship Award, 2007–08 for 6 months w.e.f 26 March, 2009.
- Dr K. Giridhar, Sr. Scientist, NIANP, Bengaluru visited University of New England, Armidale, Australia for availing 2009- Endeavour Research Fellowship Award for 6 months w.e.f 10 July 2009.
- Dr Tapas Kumar Das, Sr. Scientist, IARI, New Delhi visited EICA, Egypt for training on "Agricultural Sciences"Organized by EICA" for 2 months and 15 days i.e 1 April to 15 June, 2009.
- Dr E. Sreenivasa Rao, Sci.(SS), IIHR, Bengaluru visited AVRDC, P.O. Box 42 Shanhua, Taiwan, 74199 for "Molecular mapping and Molecular maker assisted Plant Breeding" under DST's BOYSCAST Fellowship 2008–09 for 12 months w.e.f 31 May, 2009.
- Dr M. Sankaran, Scientist, ICAR Research Complex for NEH Region, Umiam visited International Centre for Tropical Agriculture, Cali, Colombia for 'Molecular Marker Assisted Breeding in Cassava under DST's BOYSCAST Fellowship- 2008–09 for 12 months w.e.f 31 May, 2009.
- Dr Ashwin Ashok Raut, Sci.(SS), IVRI, Izatnagar visited Texas Tech University Health Science Centre, EI Paso Texas-79905, USA for 'Biotechnology (Animal Sciences) under DST's BOYSCAST Fellowship- 2008–09 for 12 months w.e.f any date in May before 31.5.2009.
- Dr G.R. Patil, Joint Director, NDRI, Karnal visited University of Texas at Austin, USA to participate in the Technology Commercialization Program-Indo-US Science and Technology forum (IUSSTF), Fulbright House, New Delhi for 16 days, i.e. from 15 to 30 May, 2009.
- Dr P. Naveen Kumar, Sci.(SS), IARI, New Delhi visited The Hebrew University of Jerusalem, P.O. Box 12, Rehovot 76100, Israel for modification of flower color in tuberose (Polianthes tuberose1) under DST's BOYSCAST Fellowship, 2008 for 12 months w.e.f any date in May before 31 May 2009.
- Dr Sultan Singh, Sr. Sci., IGFRI, Jhansi visited Institute of Animal Sciences, University of Bonn, Germany for INSA's International Scientific Collaboration and Exchange of Scientists Program 2009–2010 for 3 months w.e.f any date in September, 2009. The local living cost, boarding lodging etc. was given by Host Academy in Germany-50% air fare by INSA- remaining 50% by the Scientist himself.
- Dr A. Sahoo, Principal Scientist. IVRI, Izatnagar visited DEEWR, Government of Australia for availing, 2009 Endeavour Research Fellowship Award for 6 months w.e.f. November, 2009.
- Dr Samrath Lal Meena, Sci. (SS), CAZRI, Jodhpur visited University of Nottingham, UK for availing the Post-Doctoral Research in Agronomy under the National Overseas Scholarship for ST candidate sponsored by the Ministry of Tribal Affairs, Government of India for 18 months w.e.f 5 October, 2009.
- Dr A.S. Yadav and Dr Raj Narayan, Sr. Scientists, CARI, Izatnagar visited EICA, Giza, Egypt for 'Poultry Production and Health' organized by EICA, Giza, Egypt for 2 months, i.e. from 10 July to 17 September, 2009.
- Dr Souvik Ghosh, Scientist(SS), WTCER, Bhubaneshwar visited EICA, Giza, Egypt for training on 'Rural Development' organized by EICA, Giza, Egypt for 2 months and 7 days i.e from 10 July to 17 September, 2009.
- Dr Prikshayat Singh, Head, Division of Biochemistry, IARI, New Delhi visited Institute for Pflanzen- ernahrung, leibniz University of Hannover, Germany under INSA's International Collaboration/Exchange Program 2009–2010.
- Dr (Mrs) Prameela Krishan, Sr. Sci, CRRI, Cuttack visited USA for availing USEFI Fulbright Senior Research Fellowship Program 2009–2010 for 6

months w.e.f. 10 July, 2009.

- Dr A. Kumarsan, Sr. Sci, ICAR Research Complex for NEH Region, Umiam, Meghalaya visited Swedish University of Agrilcultural Sciences, Uppsala, Sweden for training on "Cryopreservation of semen" under DST's BOYSCAST Fellowship 2008–2009 for 12 months w.e.f any date September, 2009 to August 2010.
- Dr Dinesh Kumar, Sr. Sci, IARI, New Delhi visited University of Glasgow, United Kingdom under UGC sponsored Commonwealth Academic Staff Fellowship, 2009 for 6 months w.e.f 1 October, 2009.
- Dr Parimal Sinha, Sr. Sci, IARI, New Delhi visited University of Warwick, United Kingdom under UGC sponsored Commonwealth Academic Staff Fellowship, 2009 for 6 months w.e.f 6 November, 2009.
- Dr (Mrs) Nita Khandekar, Sr. Sci, IIHR, Bengaluru visited University of Reading, United Kingdom under UGC sponsored Commonwealth Academic Staff Fellowship, 2009 for 6 months w.e.f 28 September, 2009.
- Dr B.S. Chandel, Principal Scientist, NDRI, Karnal visited University of Reading United Kingdom under UGC sponsored Commonwealth Academic Staff Fellowship, 2009 for 6 months w.e.f 01 October, 2009.
- Dr S. K. Kaushik, Sr. Scientist(Plant Breeding), Division of Crop Science, CPRI, Shimla visited St. Louis, Missouri and Washington, DC for training on 'Eniviromental Risk Assessment (ERA)" in USA under US-India Agricultural Biotechnology Training Programme w.e.f 26 October, 2009.
- Dr Major Singh, Principal Scientist, IIVR, Varanasi visited Michigan State Univeristy, USA under 'Indo-US collaboration short-term programme '' sponsored by USTDA for 5 days w.e.f. 26 October, 2009.
- Dr B.C. Ghosh, Principal Scientist, Working in SRS, Bengaluru visited Victoria University, Melbourne, Australia for training on 'Bioactive peptides from Milk proteins and development of a drink/bevearage with this bioactive peptides for health promotion' under Endeavour Executive Award, 2009 sposored by Department of Education Emplooyees and Workplace Relations, Government of Australia for 4 months w.e.f November, 2009.
- Dr Satyanshu Kumar, Sr. Scientist, NRCPRM, Bharatpur visited Ogden College of Science and Technology, Western Kentucky University, USA for Post-Doctoral Fellowship in Research on Medicinal Application of Plant Extract by the Stipend of 30,000$ US paid to the Scientist for 9 months w.e.f. 02 March, 2009.
- Dr K. S. Roy, Scientist (SS), NIANP, Bengaluru visited University of Arizona, USA for training on 'Life Sciences' under DST's BOYSCAST Fellowship programme 2008–09 for 12 months w.e.f. any date in May, 2009.

Scientists to foreign countries on deputation

- Dr P.K. Joshi, Director, NCAP, New Delhi attended the 1st Meeting of CCCP Steering Committee ICSU from 29 to 30 April 2009 held at Paris, France.
- Dr G.P. Singh, Sr. Scientist, Division of Genetics IARI, New Delhi visited CIMMYT, Mexico for attending the training course on "Phenotype for physiological trait based breeding" from 13 April to 8 May 2009.
- Dr Masood Ali, Director, IIPR, Kanpur participated in Second Annual Tropical Legumes-I project meeting and Chickpea challenge initiative workshop from 16 to 21 April, 2009 held in Lilongwa, Malavi.
- Dr Praveen Kumar, Sr. Scientist attended training at Germany from 2 to 12 June, 2009 regarding Evaluation of Potato Genotypes to Drought Tolerance being organized by International Potato Centre, (CIP).
- Dr S.K. Sharma, Director, NBPGR attended the ALIS International Steering Committee meeting at Bioversity International (HQ) at Rome, from 18 to 20 May,2009.
- Dr H.P. Singh, DDG(Hort) visited Malaysia on deputation to participate in the Project Steering Committee Meeting of UNEP/GEF approved project on "Conservation and Sustainable use of Cultivated and wild tropical fruit diversity: Promoting Sustainable livelihoods, Food security and Eco-system health.". It was organized by Bioversity International from 14 to16 May,2009 at Serdang, Malaysia.
- Dr K.K. Vass, Director, CIFRI, Barrackpore visited Cairo, Egypt on deputation in connection with the final Wrap-up meeting of the CP-PN-34 Project from 3 to 8 May, 2009.
- The ICAR delegates (5) visited Vietnam on deputation to attend the viith Annual Meeting of the CURE Steering Committee held at Hanoi, Vietnam from 27 to 29 May, 2009.
- Dr S.K. Dutta, DDG(CS), visited Thailand on deputation to attend the XIII CORRA meeting at Bangakok, Thailand held from 29 to 30 October, 2009.
- Dr Masood Ali, Director, IIPR Kanpur and Dr Chellapilla Bhardwaj, Senior Scientist, IARI, New Delhi visited ICARDA to study in the field of pulses (Chickpea and Lentil) from 17 to 21 May, 2009.
- Dr S.K. Sharma, Director, NBPGR, visited Rome on deputation for participation in the Expert Consultation Meeting to finalize the Second State of World's Plant Genetic Resources for Food and Agriculture (SoW-2) from 9 to 11 June, 2009 at Bioversity International (HQ), Rome.
- Dr Suresh Pal visited Rome on deputation for attending the workshop organized by Standing Panel on Impact Assessment (SPIA) on 22 to 23 June, 2009.
- Dr C.S. Reddy, Principal Scientist, DRR, Hyderabad visited IRRI Philippines on deputation for the Joint Analysis of POS data for 1 month w.e.f. 15 September, 2009.
- Dr Rajendra Prasad, National Fellow, IASRI visited Tashkent, Uzbekistan on deputation New Delhi

from 1 to 5 June, 2009 to give a training course to the Biometrics Services Unit at ICARDA, Syria Staff in Tashkent, Uzbekistan.

- Dr H.P. Singh, DDG(Hort) visited China on deputation from 14 to 18 September,2009 for participation in ISHS-Pro Musa Symposium on "Global Perspectives on Asian Challenges".
- Dr R.K. Tyagi, Principal Scientist and Head Germplasm Conservation Division and Dr (Ms) Anuradha Aggarwal, Sr. Scientist, TC and CP Unit, NBPGR, New Delhi visited Belgium on deputation for attending training on "Technological and Management Aspects of Banana Crio Banking at Leuven, Belgium from 7 to 21 June,2009.
- Dr Sewa Ram, Principal Scientist, DWR, Karnal visited Mexico on deputation for participation in a course on "Wheat Chemistry and Quality Improvement from 3 to 28 August, 2009 at CIMMYT (Hqrs.) Mexico.
- Dr S.K. Chaturvedi, Principal Scientist, IIPR Kanpur visited Spain on deputation to attend training programme on "Marker Assisted Breeding Course from 29 June to 3 July, 2009 at Zaragoza, Spain.
- Shri K.P. Singh, Scientist (Sr. Scale), DMR, New Delhi visited Germany on deputation for training at Hohengein, Germany under BMZ funded ICAR–CIMMYT collaborative project (from 1 to 31July, 2009) now rescheduled from 15 September to 15 October, 2009.
- Dr N. Shobha Rani, Principal Scientist, visited China on deputation, DRR INGER National Co-ordinator to attend the INGER TAC Meeting at Hangzhou, China from 10 to 11 September, 2009.
- Dr S.K. Pandey, Director, Dr S.V. Singh, Principal Scientist, Dr Govindakrishnan, Principal Scientist and Dr Rajesh Rana, Sr. Scientist of CPRI Shimla visited Uzbekistan on deputation to attend Project Meeting in Tashkent, Uzbekistan from 17 to 19 September, 2009.
- Dr S.K. Luthra, Sr. Scientist, CPRI, Modipuram attended training on 'Germplasm evaluation for biotics stress' at International Potato Centre (CIP), Lima from 24 August to 18 September, 2009.
- Dr Raman Sundram, Scientist, Sr Scale, DRR visited Phillipines on deputation to participate in VIth International Rice Genetics Symposium RG6 held from 16 to 19 November,2009 at Manila, Philippines.
- Dr A.K. Sharma, PI Crop protection and Dr M. Prashar, both Principal Scientist, DWR, Karnal visited Kenya on deputation from 26 September to 7 October, 2009 for participation in "Standardisation of Stem Rust Noye taking and Evaluation of Germplasm".
- Dr Ravish Chatrath, Principal Scientist DWR, Karnal visited Kenya from 26 September to 7 October, 2009 for participation in "Standardisation of Stem Rust Noye taking and Evaluation of Germplasm".
- Dr Mangala Rai, Secretary, DARE and DG, ICAR visited Bamako, Mali on deputation to participate in the Governing Board and Committee Meeting of ICRISAT from 14 to 18 September, 2009.
- Dr Mangala Rai, Secretary, DARE and DG, ICAR visited Japan on deputation to attend the September, 2009 Board of Trustees Meeting of the International Rice Research Institute (IRRI) held at Tsukuba, Japan from 28 September to 2 October, 2009.
- Dr T.K. Adhya, Director, CRRI and Dr P.K. Sinha, Principal Scientist/Officer-incharge, Central Rainfed Upland Rice Research Station visited Philippines on deputation to participate in the Inception Workshop for the "CURE IFAD Project titled "Enabling Poor Rice Farmers to improve Livelihood and overcome poverty in South and South-East Asia through the Consortium for Unfavourable Rice Environment (CURE) at International Rice Research Institute (IRRI), Los Banos, Philippines from 26 to 27 August,2009.
- Dr Gurjit Singh Mangat, Rice Breeder, Department of Plant Breeding and Genetics visited Phillipines on deputation to attend a training course under CSISA- Collaborating Institutions at IRRI, Philippines from 24 August to 8 September,2009.
- Prof. K.C. Bansal, NRC on Plant Biotechnology, New Delhi visited Hawai and IJSA on deputation to Hawai and Honololu, USA for participation in ASBP Conference from 18 to 23 July, 2009.
- Dr J.C Dagar Head, Soil and Crop Management CSSRI, Karnal visited Kenya on deputation from 23 to 28 August, 2009 held at Nairobi, Kenya.
- Dr Achla Sharma, Assistant Plant Breeder PAU, Ludhiana visited Mexico on deputation to attend a coordinated training programme on Wheat Improvement and Durable Resistance of Rust Diseases to be held at CIMMYT (Headquarters), El Batan and Research Station in Toluca Mexico from 3 August to 2 October, 2009.
- Dr V.D. Patil, ADG(OP), ICAR; Dr Arvind Kumar, Director, Dr J.S. Chauhan, Principal Scientist, Dr Maharaj Singh, Sr. Scientist and Dr Pankaj Kumar Sharma, Sr. Scientist all from DRMR, Bharatpur visited Australia from 9 to 16 September, 2009 to attend the final meeting of ACIAR – ICAR Project "Oilseeds *Brassicas* Improvement in China, India and Australia" at University of Melbourne, Australia from 9 to 11 September, 2009 in conjunction with 16th Australian Research Assembly on *Brassicas* (ARAB) in Ballarat Australia 14 to 16 September, 2009.
- Dr Vinay Singh, Sr. Scientist and Dr Sukhwinder Singh, Sr. Scientist, CPRI Campus, Modipuram visited China on deputation for participation in a training/study Aeropphonic Technology for Seed Production at Chinese Academy of Agricultural Sciences (CAAS) in Beijing China organized by International Potato Centre (CIP) from 26 to 30 September, 2009 instead of 10 to 14 August, 2009.
- Dr R. Selvarajan, Sr Scientist NRCB visited Tanzania on deputation to attend the International Workshop on Banana Bunchy Top Disease (BPTD) and Banana Bacterial Wilt (BXW) from 24 to 29 August, 2009.
- Dr Ajit Kumar Verma, Scientist (SS) and Dr N.K. Chadha, Principal Scientist CIFE, Mumbai visited Australia on deputation to participate in the training at Australian Center for International Research

Project "Developing Aquaculture in Degraded Inland Areas in India and Australia" rescheduled from 14–19 September, 2009 to 18–27 September, 2009.

- Dr Dheeraj Singh, Training Organiser, KVK CAZRI; Pali, Rajasthan visited Kenya on deputation attend the 2nd World Congress on Agroforestry held at Nairobi, Kenya from 23 to 28 August, 2009.
- Dr A.K. Handa, Sr. Scientist, NRC on Forestry, Jhansi visited Kenya on deputation to attend the 2nd World Congress on Agroforestry held at Nairobi, Kenya from 23 to 28 August, 2009.
- Dr Rajesh Rana, Sr. Scientist, CPRI, Shimla visited Bangladesh on deputation to conduct a baseline survey under CIP CPRI Collaborative Project on "Enhanced Food and Income Security in South-West and Central Asia through Potato varieties from 29 August to 8 September, 2009.
- Dr B. Venkateswarlu, Director, CRIDA, Hyderabad visited Argentina on deputation participate in the International Scientific Conference, "Understanding Desertification and Land Degradation Trends":part of CST of the UNCCD in Buenos Aires, Argentina from 22 to 24 September, 2009.
- Dr M.M. Mustaffa, Director NRCB, Dr S. Uma, Principal Scientist, NRCB, Tiruchirapalli visited China to participate in the International Banana Symposium on "Global Perspective on Asian Challenges held at Guangzhou, China from 14 to 18 September, 2009.
- Dr (Ms) Sukada Mohandas, Principal Scientist, Division of Biotechnology of IIHR, Bengaluru visited China on deputation to participate in the international Banana Symposium on "Global Perspective on Asian Challenges" held at Guangzhou, China from 14 to18 September, 2009.
- Dr K.V. Ravishankar, Sr. Scientist, IIHR Bengaluru visited Guang Dong, China on deputation from 14 to 18 September, 2009 for presentation of Research Paper in the International Banana Symposium on "Global Perspective on Asian Challenges".
- Dr M Edward Raja, Principal Scientist, IIHR Bengaluru visited Guang Dong, China on deputation from 14 to 18 September, 2009 for presentation of Research Paper in the International Banana Symposium on "Global Perspective on Asian Challenges".
- Dr M.S. Saraswati, Sr. Scientist, NRCB, Trichy visited China on deputation to attend the international Banana Symposium on "Global Perspective on Asian Challenges held at Guangzhou, China from 14 to 18 September, 2009.
- Dr Ravis Chatrath and Dr Gyanendra Singh, both Principal Scientist of DWR, Karnal visited Nepal on deputation to participate in workshop on Wheat Breeding (Objective 4) of the project Cereal System Initiative for South Asia (CSISA) funded by BMGF, USAID and the World Bank from 10 to 13 September, 2009 at Kathmandu, Nepal.
- Dr G.P. Singh, Sr. Scientist (Plant Breeding), Division of Genetics, IARI, New Delhi visited Nepal on deputation to participate in workshop on Wheat Breeding (Objective 4) of the project Cereal System Initiative for South Asia (CSISA) funded by BMGF, USAID and the World Bank from 10 to 13 September, 2009 at Kathmandu, Nepal.
- Dr (Mrs) Indu Sharma, Sr. Plant Pathologist, PAU, Ludhiana visited Nepal on deputation to participate in workshop on Wheat Breeding of the project Cereal System Initiative for South Asia (CSISA) funded by BMGF, USAID and the World Bank from 10 to 13 September, 2009 at Kathmandu, Nepal.
- Dr A.N. Mishra, Principal Scientist and Head and Dr S.V. Sai Prasad Sr. Scientist, IARI Regional Station, Indore, participated in workshop on Wheat Breeding (Objective 4) of the project Cereal System Initiative for South Asia (CSISA) funded by BMGF, USAID and the World Bank from 10 to 13 September, 2009 at Kathmandu, Nepal.
- Dr R. Kalpana Sastry and Dr S.K. Soam, both Principal Scientists of NAARM, Hyderabad attended the Annual Meeting of National Partners Initiative at the Hague, Netherlands from 1 to 5 September, 2009.
- Dr Vijay Pal Bhadana, Sr. Scientist, DRR, Hyderabad visited IRRI on deputation to attend the 2009 Rice Breeding course held at IRRI, Philippines from 24 August to 8 September, 2009.
- Dr S.S. Raju, Sr. Scientist, NCAP New Delhi, Dr P. Shinoj, Scientist(Agril Economics), NCAP, New Delhi attended Annual Modeling Workshop of the project "Biofuels and the Poor" to be held at, IFPRI, Washington DC from 26 October to 3 November, 2009.
- Dr S.V Ngachan (Director ICAR Research Complex for NEH Region), Dr A.K. Tripathi (P.I and Sr. Scientist Agril. Economics) and Dr A. Pattnayak (PS Plant Breeding and Co-PI) participated in the terminal workshop of the project "Managing Rice Landscape in Marginal Uplands for Household Food Security and Environmental Sustainability" to be held at International Rice Research Institute at Los Banos, Philippines from 24 to 25 August, 2009.
- Dr A.K. Singh, DDG(NRM), ICAR Hqrs. visited on deputation to attend Second World Congress of Agroforestry from 23 to 28 August, 2009 held at Nairobi, Kenya.
- Dr R.K. Gupta, Principal Scientist, DWR, Karnal visited Australia from 5 to 12 September, 2009 for a study on "Wheat Quality and Sustainable Dryland Farming in South Asia under ACIAR project No.CIM/2006/094.
- Dr P.K. Joshi, Director, NCAP, New Delhi and Dr JVNS Prasad, Sr. Scientist, CRIDA, Hyderabad participated in a Centre Wide Science Meeting being organized by ICRAF from 31 August to 2 September 2009 at its Hqrs, Nairobi, Kenya.
- Dr Randhir Singh, PI and Principal Scientist, DWR, Karnal attended Annual Project Progress and Planning Meeting under ACIAR project No.CIM/2006/094 to be held from 27 September to 1 October, 2009 at ICARDA, Aleppo, Syria.
- Dr M Prashar, Principal Scientist, DWR, Shimla visited ICARDA Aleppo Syria from 1 to 7

September, 2009 for participating in the Borlaug Global Rust Initiative (BGRI) Coordination Meeting.

- Dr S.S. Banga, Sr. Scientist (Oilseeds), Department of Plant Breeding and Genetics attended the programme at Victoria and Sydney NSW from 9 to 30 September, 2009 under ACIAR Collaborative project CIM/1999/072.
- Dr P.K. Joshi, Director NCAP, New Delhi visited ICARDA, Aleppo, Syria from 20 to 22 October 2009 to participate in the 2nd Annual Science Week Workshop.
- Dr K.V. Prabhu, Head, Division of Genetics, IARI, New Delhi attended Review Meeting of Generation Challenge programme for 2009 from 20 to 23 September, 2009 at Bamako, Mali.
- Dr S.M. Balachandran, Principal Scientist, DRR attended a short -term course on " Environmental Risk Assessment of G.M Crops at Michigan State University, USA from 24 to 31 October, 2009 under the Indo-US Collaboration (USTDA Project).
- Dr P.K. Aggarwal, National Professor, IARI New Delhi visited Bangkok, Thailand to attend First Annual Review Meeting of the project of "Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience from 30 September to 1 October, 2009.
- Dr G G S N, Project Coordinator and Dr V U M Rao, Principal Scientist (both from Agriculture Meteorology), CRIDA Hyderabad visited Bangkok, Thailand from 30 September to 4 October, 2009 to attend first Annual Review Meeting of the project of "Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience and also to participate in the Training workshop as Resource Persons on Agro-climatic Analysis, which contains theory and hand on computer practicals.
- Dr S.K. Pandey, Director, CPRI, Shimla visited C I P, Lima Peru to present a paper in the 15 Triennial Symposium of the International Society for Tropical Root Crops (ISRTC) from 2 to 6 November, 2009.
- Dr M.S. Saharan, Sr. Scientist, DWR Karnal participated in "4th" Yellow Rust Conference" held in Antalya, Turkey from 10 to 12 October, 2009.
- Dr Birpal Singh, Joint Director, CPRI campus Modipuram participated in the Beijing Meeting at Bellagio, Italy from 16 to 20 November 2009.
- Dr A.K. Singh, Sr. Scientist (Nematology), DWR, Karnal attended 1st International Cereal Cyst Nematode Initiative Workshop at Antalya Turkey from 21 to 24 October, 2009.
- Dr B. Vimala, Principal Scientist, CTCRI, Thiruvananthapuram attended 15 Triennial Symposium of the International Society for Tropical Root Crops (ISRTC) held at Lima Peru from 2 to 6 November, 2009.
- Sh. B. Ganesh Kumar, Sr. Scientist, NCAP visited ICARDA, Syria from 25 October to 5 November, 2009 to attend a "Training course on 'Household survey Data collection, entry analysis, result interpretation and reporting and value chain analysis".
- Dr S.K. Naskar, Director,CTCRI, visited Lima, Peru on deputation for participation in the HP Sweet Potato Breeding Meeting, 2009 from 27 to 30 October and 2 to 6 November 2009 (excluding journey time) and the 15th International Symposium of the International Society for Tropical Root Crops (ISTRC).

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20

National Agricultural Innovation Project

The National Agricultural Innovation Project (NAIP) has made remarkable progress in approving and grounding 187 sub-projects (39 under Component-1, 51 under Component-2, 36 under Component-3 and 61 under Component-4) at a total outlay of about Rs 1,017 crore. These sub-projects have very diverse partnership such as ICAR Institutions and State Agricultural Universities, General Universities, IITs, IIMs, CSIR laboratories, other Central and State government departments, private sectors and NGOs. The project is being operated under following four components:

Component-1 (Strengthening ICAR as Catalyzing Agent of Management of Change in the Indian NARS)

A total of 39 projects have been approved. Under e-theses repository, more than 3,000 theses have been digitized and full text data uploaded (*http://www.hau.ernet.in*). The database access (password based) has been provided to all stakeholders. The 'Agropedia' has further diversified with many discussions online and is evincing increased interest with over 30,000 people from 165 countries visiting the site (*www.agropedia.net)*. aAQUA SMS and voice services are reaching over 10,000 farmers regularly.

Consortium for e-Resources in Agriculture (CeRA) continues to attract more users with cumulative hits on their website (*www.cera.jccc.in*) crossing the one million mark and 0.36 million downloads. The consortium is now providing access to additional 930 journals from four new publishers. The e–courses for degree programmes in Agriculture, Horticulture, Home Science, Fisheries, Diary Technology, Veterinary Science and Animal husbandry are being developed. The developed courses are being uploaded on *mms.tnau.ac.in,tau.tnau.ac.in* (Agriculture), *http://www.elearnvet.net* (Veterinary and Animal Sciences) and *www.elearnfish.net* (Fisheries). Five Business Planning and Development (BPD) projects are being implemented at IARI, CIRCOT, CIFT, IVRI and NIRJAFT. Five more BPD projects have recently been approved for CCSHAU, Hisar, JNKVV, Jabalpur, BAU, Ranchi, AAU, Anand and TNAU, Coimbatore. So far, 126 scientists have been deputed for international training.

Linking research and extension with farmers

Component-2 (Research on Production to Consumption Systems)

Cheaper concentrate mixture feed for livestock production: A simple feed technology was developed for the preparation of low-priced and balanced concentrate feed mixture utilizing ground feed ingredients available locally, namely *Prosopis juliflora* pods, *tumba* (*Citrullus colocynthis*) seed-cake, *guar* (*Cyamopsis tetragonoloba*) *korma*, *til* (*Sesamum indicum*) seed-cake, wheat bran, maize grain, common salt, mineral mixture etc. as per requirement and mixing them uniformly. The acceptability and palatability of formulated concentrate mixture fed to Tharparkar cattle was better than traditional control group, with no ill-effect on health. The experimental cattle

showed higher milk yield than the costlier concentrate mixture feed available in market. Farmer accepted this process technology for concentrate feed mixture owing to its low cost.

Propagation technology for industrial agroforestry: A clonal propagation technology was developed for mass multiplication of elite genetic resources particularly in *Casuarina junghuhniana*, which resulted in early harvest of three years against five years in practice.

Clonal mass multiplication

Standardization of processes for preparation of value-added products from seabuckthorn: A methodology was standardized for preparation of seabuckthorn-based value-added products, namely ready-to-serve squash, beverage (RTS), jam, syrup and fruit toffees with and without blending with different fruits. Acceptable blends of mango pulp were identified for the preparation of RTS, squash, syrup, fruit toffee and jam. The products were standardized taking into consideration FPO and International Standards.

Value-added extruded products from tuna red meat: The red meat collected from tuna was incorporated with cereal flour for the production of extruded snack product. The process parameters were standardized with different percentage of red meat with cereal flours by using twin screw extruder.

SILO feed from tuna processing waste: On an average 3,000 tonnes of tuna wastes is generated annually at Lakshadweep islands and fishermen bury the wastes in the beach itself creating serious environmental problems and health hazards. The effluent leaching from the decomposed wastes is a major threat to the pristine coral ecosystem of the islands. Hence, a technology was developed using waste generated during processing of tuna and converting it into a liquid protein source for animal feed preparation and developed fish feed under the brand name of SILO feed. It is a promising feed for cultivable fishes such as sea-bass, grouper and cobia.

Component-3 (Research on Sustainable Rural Livelihood Security)

Through 36 approved projects, 102 disadvantaged districts (out of 150 disadvantaged districts in 28 States of the country) are covered. The total number of targeted farmers /agricultural labourers includes 130,000. Baseline survey was conducted and location-specific integrated farming system, capacity building and social mobilization through formation of different SHGs were designed and implemented in target areas. The major interventions across all clusters included introduction of improved variety of crops, including horticultural crops and increase in productivity of livestock. Income-generating activities such as lac cultivation, mushroom cultivation, vermi-composting, tasar silk cultivation were introduced wherever it had potential. Natural resource management interventions such as water harvesting, conservation agriculture etc. are also important activities being carried out for sustainable livelihood. The other major activities included establishing infrastructure and deploying ICT equipment for site-specific knowledge empowerment through Village Resource Centres; strengthening existing community-based organizations (CIGs, SHGs and VOs) and enabling the new ones to participate in productive enterprises through capacity building; linkages established with concerned departments and agencies such as National Rural Employment Guarantee Scheme and National Bank for Agricultural and Rural Development. Some of the salient findings are:

- The project has been able to motivate people in these backward areas with large population of tribals and also characterized by diverse socio-economic conditions, inaccessible roads, adverse climates, violence and frequent bundhs. More than 48,000 farmers have already been covered under the programme for various interventions.
- Various consortiums under the project responded to drought situation by adopting suitable mitigation measures. Interventions like transplanted pigeonpea, fodder cultivation, growing of less water-consuming vegetables etc. were adopted with suitable advice to the farmers.
- The introduction of lac cultivation in states of Jharkhand, Chhattisgarh and Madhya Pradesh has proved to be major income-generating activity, particularly under rainfed/ dryland situations. As estimated, Rs 1-1.5 lakh can be generated from one hectare area in a year.
- The CRIDA, Hyderabad, BAIF, Pune, VPKAS, Almora and other consortia have developed number of farm ponds for water harvesting with suitable recommendations for multiple use of water. Introduction of HDPE pipes for better utilization of water has been widely accepted by the farmers.
- Apart from introduction of improved variety

of crops and livestock, the interventions like SRI method, zero tillage and vegetable cultivation with appropriate market linkages are being appreciated by the farmers as a source of livelihood.

- To ensure sustainability of the project the MPUAT, Udaipur, has been able to generate more than Rs one crore to be used by the participating farmers after the withdrawal of the project.

Component-4 (Basic and Strategic Research)

In all 61 sub-projects have been sanctioned.The last sub-project under the Component-4 was 'Bioprospecting of genes and allele mining for biotic stress tolerance' is the largest in NAIP (Rs 57 crore budget and 36 partners). It is a bold attempt to bring in a large number of scientists together to attempt a far-reaching initiative in basic and strategic research cutting across all species barriers (animals, microbes and plants). A few examples of the results are:

- A new micro-well chip platform (a fine example of micro engineering) was designed and fabricated and based on this a novel micro-well chip-based biosensor for high throughput analysis of ultra trace concentration of the potent pesticide Paraoxon methyl (lower limit of detection 5 ng^{L-1}) in low fat milk (0.5%) was developed. Indigenous specifications and manufacturing process of a composite material for Rubber dam application were developed for the first time in India.
- First prototype of sensor node with 3D Accelerometer was developed and tested on lame cows for gait and other types of remotely recorded movement detection.
- Nanowhiskers and nanofibrils prepared from cotton waste by mechanical process were used as fillers in preparation of starch biodegradable films that showed improved mechanical properties of films and thus usability.
- A new methodology for isolation and purification of microbial polysaccharides (potent in reducing water evaporation from soils) was developed.
- Isolates of nitrate-reducing microbes which have the desired characteristics of speeding up methane inhibition were isolated and appear to have a potential to be used as probiotics to mitigate methane emission for eco-friendly livestock production.
- About five technologies are at the patentable stage now. ❑

21

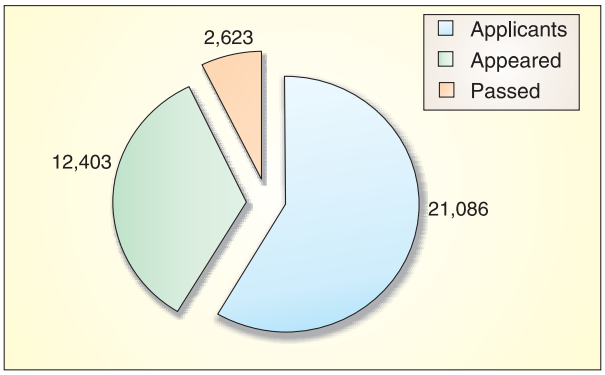
Selection and Assessment of Scientific Resource

The Agricultural Scientists Recruitment Board (ASRB), an independent recruitment body of ICAR, continues its efforts to revitalize the system of selection and assessment. The Board completed recruitment process for 275 direct selection positions. The Agricultural Research Service (ARS) – National Eligibility Test (NET) examination in 38 comprehended disciplines was held in 2009. The board is in the process of introducing on-line examination for ARS/NET preliminary examination. The progress made in the various mandated programmes of the Board is briefly described here.

ARS/NET examination

The ARS/NET examination was conducted by the Board at 33 centres in April 2009. A total of 12,403 (59%) candidates appeared in the examination out of 21,086 candidates who had applied for the same. Only 2,623 candidates cleared NET and therefore the success ratio for NET was 1:5.

The selection of scientist is vacancy based. A total of 952 candidates, who had obtained marks above the cut-off level, were called for ARS interview against 283 advertized vacancies.

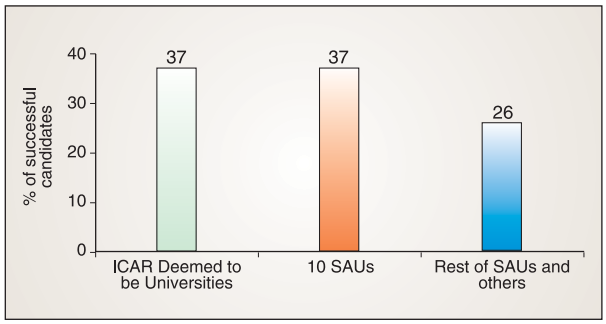


Details of NET Examination 2009

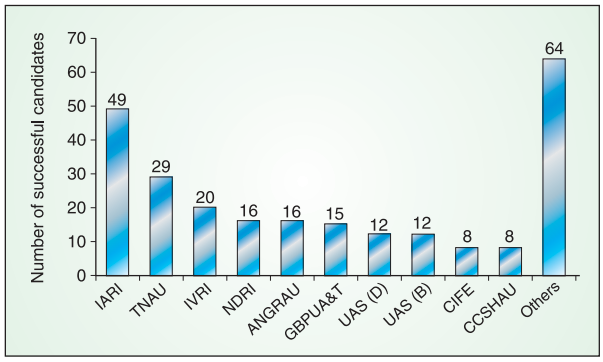
However, only 249 vacancies were filled. No candidate could qualify in Chemical Engineering and Electronics and Instrumentation disciplines.

The Board usually interviews/calls five candidates against each vacancy. But during the current year, the number of candidates who cleared written test was far below the target. In the discipline of Agricultural Physics, the number of vacancies and the number of candidates who cleared the written examination was almost equal, while in the discipline of Agricultural Statistics, it was even less than the number of vacancies. The number of successful female candidates was 50. Based on the analysis of the ARS results, some of the inferences drawn are:

- It appears that agricultural research system has become attractive to female candidates, as their number has increased during 2008-09. Out of 249 selected candidates, 20% were female.
- 12% selected candidates had Ph.D. degree and about the same number had job experience in temporary /permanent positions in other departments.
- Candidates belonging to OBC category outperformed general category, and claimed 28 seats of the general category. Candidates belonging to SC category also performed fairly well and claimed one seat of general category.
- State-wise distribution is skewed, as 87% ARS scientists came from just 10 states (Tamil Nadu, Karnataka, West Bengal, Kerala, Bihar, Uttar Pradesh, Rajasthan, Andhra Pradesh, Maharashtra, and Orissa). The status of Gujarat, Haryana, Punjab, Himachal Pradesh and Madhya Pradesh had very little representation in the list of successful ARS candidates.
- Ten top state agricultural universities/deemed-



Organization-wise performance in ARS Examination 2007–08



Performance of the top 10 SAUs/ICAR deemed-to-be universities in ARS Examination 2007–08

to-be universities contributed 74% of the successful ARS candidates. Of the successful candidates, 47% appeared in ARS examination for the first time.

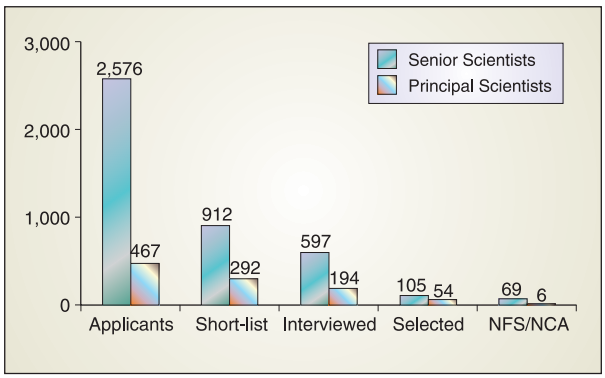
Limited departmental audit and account examination 2008

Limited departmental competitive examination for Audit and Account personnel was conducted by the Board during November 2008 at 11 centres, in which 195 candidates appeared. Only six candidates cleared the Audit and Account Examination and 114 candidates cleared varying number of papers ranging from 1 to 4. In any future examination, these candidates will not be required to appear in papers they have already cleared.

Direct selection

The Board completed the recruitment process for 275 posts during the year, for which more than 3,500 applications were received. After screening, 1,515 candidates were called for interview, but only 1,045 candidates attended the interview. These vacancies included 18 posts in the research management category (RMP), 45 in the middle-level cadre (Heads, Joint Director and Project Co-ordinators) and the remaining in the Senior/Principal Scientist categories. The Board made positive recommendations in 201 cases, and for the rest of the posts, no candidate was found suitable.

With an average of 3.8 candidates appearing in the interview per vacant position, the competition was not so tough. But the inter-category distribution of the available candidates was highly skewed.



Recruitment details for positions of principal/senior scientists (NFS, None found suitable; NCA, no candidates available)

Posts for which the Board has completed the recruitment process

Name of post(s)	No. of post (s)	No. of applications	Candidates called for interview	Candidates interviewed	Candidates selected	NFS/NCA*
Deputy Director-General	1	17	13	10	1	0
Assistant Director-General	4	78	30	20	4	0
Director of National Institute	3	86	41	34	3	0
Director	9	129	68	49	8	1
Project Director	2	44	23	17	2	0
Joint Director of National Institute	1	6	5	4	1	0
Joint Director	1	8	5	4	1	0
Head of Division	41	396	253	174	36	5
Project Co-ordinator	3	45	34	22	3	0
Principal Scientist	49	371	232	152	43	6
Senior Scientist	161	2,387	811	559	99	62
Total	275	3,567	1,515	1,045	201	74

*NFS, None found suitable; NCA, no candidate available

Availability of the candidates for the posts of principal scientists was very low, and about 33% of selections were based on 1-2 eligible candidates. It seems there is an acute shortage of candidates in the feeder cadre of Senior Scientist/Associate Professor. In spite of the relaxed qualifications for the post of senior scientists, about 39% positions remained vacant as no suitable candidates were available.

Right to Information Act -2005

During the year, Board received 47 cases, largely relating to the role of ASRB. The information sought concerned disclosures of name of experts, marks secured in the scorecard and interviews, procedures of screening for direct recruitment, and photocopy of application form and marks secured in the ARS/NET examination etc. Out of 47 cases only, four candidate filed appeal with CIC against the ASRB decision. All the cases were disposed off successfully to the satisfaction of all concerned.

Reforms

The Board had constituted a committee to revise the guidelines for assessment of scientists placed in Units of Zonal Co-ordinator and Project Co-ordinator. The proposal for conducting NET/ARS examinations online is under active consideration of the Board.

The qualifications for the post of senior scientists under alternate qualification has been modified. The candidates are now required to have a minimum of two papers with NAAS rating of 6 and above emanating out of post-doctoral research work or in any subsequent regular position. ❑

(A) DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION

APPENDIX I

THE GOVERNMENT OF INDIA (ALLOCATION OF BUSINESS) RULES
THE SECOND SCHEDULE
(RULE 3)

(A) Distribution of Subjects in the Department (*Vibhag*), Ministry of Agriculture (*Krishi Mantralaya*)

(B) Department of Agricultural Research and Education (*Krishi Anusandhan aur Shiksha Vibhag*)

Part I

The following subjects which fall within List I of the Seventh Schedule of the Constitution of India.

1. International co-operation in the field of agricultural research and education including relations with foreign and international agricultural research and educational institutions and organizations, including participation in international conferences, associations and other bodies dealing with agricultural research and education and follow-up of decisions of such international conferences, etc.
2. Fundamental, applied and operational research and higher education including co-ordination of such research and higher education in agriculture including agroforestry, animal husbandry, dairying and fisheries, including agricultural statistics, economics and marketing.
3. Co-ordination and determination of standards in institutions for higher education or research and scientific and technical institutions insofar as it relates to food and agriculture including animal husbandry, dairying and fisheries.
4. Cesses for financing to the Indian Council of Agricultural Research, and the commodity research programmes other than those relating to tea, coffee and rubber.
5. Sugarcane research.

Part II

For Union Territories the subjects mentioned in Part I above so far as they exist in regard to these territories and in addition the following subject which falls within List II of the Seventh Schedule of the Constitution of India.

6. Agricultural Education and Research.

Part III

General and consequential:

7. All matters relating to foreign aid received from foreign countries and International Organizations in sofar as agricultural research and education and allied subjects are concerned, including all matters relating to assistance afforded by India to foreign countries in the field of agricultural research and education and allied subjects.
8. Plant introduction and exploration.
9. All-India Soil and Land-Use Survey relating to research, training, correlation, classification, soil mapping and interpretation.
10. Financial assistance to state governments and agricultural universities in respect of agricultural research and educational schemes and programmes.
11. National Demonstrations.
12. Indian Council of Agricultural Research and its constituent research institutes, stations, laboratories and centres.
13. Offences against laws with respect to any of the subjects allotted to this department.
14. Enquiries and statistics for the purpose of any of the subjects allotted to this department.
15. Fees in respect of any of the subjects allotted to this department except fees taken in a court.

APPENDIX II

Total Number of Posts and Names of Important Functionaries

Group	Designation	Santioned strength
A	Secretary	1
A	Additional Secretary (DARE)/Secretary, ICAR	1
A	Financial Adviser and Additional Secretary	1
A	Director	2
A	Deputy Secretary	1
A	Joint Director	1
A	Senior Principal Private Secretary	1
A	Under Secretary	7
A	Principal Private Secretary	2
B	Assistant Director (Official Language)	1
B	Private Secretary	1
B	Section Officer	4
B	Assistant	4
B	Personal Assistant	4
C	Junior Hindi Translator	1
C	UDC-cum-Cashier	1
C	UDC	2
C	Steno Grade 'D'	5
C	UDC-Hindi Typist	1
C	Staff Car Driver	1
C	LDC	2
D	Daftry	1
D	Peon	5
	Total	50

Names of the Important Functionaries

Sl.No.	Name	Designations
1.	Dr Mangala Rai	Secretary, DARE and DG, ICAR
2.	Mr Rajiv Mehrishi	Additional Secretary, DARE and Secretary, ICAR
3.	Mr Chaman Kumar	Additional Secretary/Financial Adviser, DARE/ICAR
4.	Dr Ajai Kumar	Director
5.	Mr A Prabhakaran	Deputy Secretary
6.	Mr J N Banati	Senior Principal Private Secretary
7.	Mr M S Nayar	Under-Secretary
8.	Mr Roopak Chaudhuri	Under-Secretary
9.	Ms Alka Ahuja	Under-Secretary
10.	Ms Sumita Dasgupta	Under-Secretary
11.	Mr Madan Lal	Under-Secretary
12.	Mr V K Verma	Principal Private Secretary
13.	Mr S K Gupta	Principal Private Secretary

APPENDIX III

ACTIVITY PROGRAMME CLASSIFICATION

The Budget Estimates (BE) and Revised Estimates (RE) of DARE and ICAR (Plan, Non-Plan) for 2008–2009 are Rs 2680.00 crores and Rs 2982.64 crores respectively and BE for 2009–2010 (Plan and Non-Plan) is Rs 3314.77 crores. The detailed break-up of these financial figures are given below in Tables 1 and 2.

Department of Agricultural Research and Education (DARE): The details in respect of BE and RE for 2008–2009 and BE for 2009–2010 are given in Table 1. This excludes the payment to the ICAR.

Table 1 Budget estimates and revised estimates of DARE

(Rupees in lakhs)

Item		Budget Estimates 2008–2009		Revised Estimates 2008–2009		Budget Estimates 2009–2010	
		Plan	Non-Plan	Plan	Non-Plan	Plan	Non-Plan
Major Head '3451'		–	175	–	282	–	374
090	Secretariat						
Major Head '2415'							
80	-General International Co-operation						
(010032)	-India's membership contribution to Commonwealth Agricultural Bureau	–	10	–	10	–	10
(020032)	-India's membership contribution to Consultative Group on International Agricultural Research	–	380	–	380	–	400
(030032)	-Other Programmes	1100	–	1100	–	2100*	–
(040032)	-India's contribution to Asia Pacific Association of Agricultural Institutions	–	5	–	5	–	5
(050032)	-India's contribution to NACA	–	9	–	9	–	9
(060032)	-India's contribution to CGPRT	–	5	–	5	–	5
(070032)	-India's contribution to Seed Testing Association	–	2.25	–	2.25	–	2.25
(080032)	-ISHS Belgium	–	0.75	–	0.75	–	0.75

*Includes Rs 20 crore for National Fund for basic and strategic research in agriculture

Table 2 Details of Financial Outlay

Demand No. 2. Department of Agricultural Research and Education

(Rupees in crores)

	Major Head	2008–2009 Budget			2008–2009 Revised			2009–2010 Budget		
		Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total
A. Budget Allocation, net of recoveries										
Revenue		1760.00	920.00	2680.00	1760.00	1200.00	2960.00	1760.00	1481.40	3241.40
Capital		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		1760.00	920.00	2680.00	1760.00	1200.00	2960.00	1760.00	1481.40	3241.40
1. Secretariat - Economic Service Agricultural Research and Education Payments to ICAR	3451	0.00	1.75	1.75	0.00	2.82	2.82	0.00	3.74	3.74
2. Crop Husbandry										
2.1 Payments of net proceeds of cess under Agricultural Produce Cess Act, 1940	2415	0.00	14.00	14.00	0.00	10.56	10.56	0.00	10.00	10.00
2.2 Other Programmes of Crop Husbandry										
2.2.01 Crop Sciences	2415	315.00	220.92	535.12	303.50	287.41	590.91	300.00	352.30	652.30
2.2.02 Horticulture	2415	88.00	87.28	175.28	88.00	104.64	192.64	88.00	157.60	245.60
2.2.03 Agricultural Extension	2415	281.00	1.10	282.10	285.00	1.20	286.20	282.00	1.43	283.43
2.2.04.01 Agricultural Education	2415	350.00	7.20	357.20	372.64	8.13	380.77	418.37	11.80	430.17
2.2.04.02 Less amount met from social and infrastructure development fund	2415 Net	0.00 350.00	0.00 7.20	0.00 357.20	–22.64 350.00	0.00 8.13	–22.64 358.13	–73.37 345.00	0.00 11.80	–73.37 356.80
2.2.05 Economics, Statistics and Management	2415	4.00	13.90	17.90	4.00	18.39	22.39	4.00	18.60	22.60
2.2.06 Agricultural Engg.	2415	42.00	30.45	72.45	42.00	38.66	80.66	42.00	46.50	88.50
2.2.07 ICAR Hq Admn., including ASRB, DIPA, IPR Management	2415	21.00	235.58	256.58	32.50	318.00	350.50	35.00	332.55	367.55
2.2.08 National Agril. Innovation Project	2415	257.00	0.00	257.00	253.00	0.00	253.00	252.00*	0.00	252.00
Total other Programmes of Crop Husbandry		1358.00	596.43	1954.43	1358.00	776.43	2134.43	1348.00	920.78	2268.78
Total Crop Husbandry		1358.00	610.43	1968.43	1358.00	786.99	2144.99	1348.00	930.78	2278.78
3. Soil and Water Conservation										
3.01 Soil and Water Conservation Institutes	2415	4.00	13.46	17.46	5.00	17.62	22.62	5.00	22.67	27.67
3.02 Other NRM Instts. including Agroforestry Research	2415	86.00	82.54	168.54	85.00	110.65	195.65	85.00	166.74	251.74
Total-Soil & Water Conservation		90.00	96.00	186.00	90.00	128.27	218.27	90.00	189.41	279.41
4. Animal Husbandry	2415	80.00	141.05	221.05	80.00	185.96	265.96	80.00	242.15	322.15
5. Fisheries	2415	45.00	66.65	111.65	45.00	91.84	136.84	45.00	111.00	156.00

(Contd . . .)

	Major Head	2008–2009 Budget			2008–2009 Revised			2009–2010 Budget		
		Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total
6. Lump-sum provision for Projects/ Schemes for the benefit of North-Eastern Region and Sikkim	2552	176.00	0.00	176.00	176.00	0.00	176.00	176.00	0.00	176.00
Total-Payments to ICAR		1749.00	914.13	2663.13	1749.00	1193.06	2942.06	1739.00	1473.34	3212.34
7. Contribution to Commonwealth Agricultural Bureau, Consultative Group on International Agricultural Research and Association of Asia Pacific Agricultural Research Institutes	2415	11.00	4.12	15.12	11.00	4.12	15.12	21.00	4.32	25.32
Total-Agricultural Research and Education		1760.00	918.25	2678.25	1760.00	1197.18	2957.18	1760.00	1477.66	3237.66
Grand Total		1760.00	920.00	2680.00	1760.00	1200.00	2960.00	1760.00	1481.40	3241.40
C. Plan Outlay	Head of Div.	Budget support	IEBR	Total	Budget support	IEBR	Total	Budget support	IEBR	Total
1. Agricultural Research and Education	12415	1584.00	0.00	1584.00	1584.00	0.00	1584.00	1584.00	0.00	1584.00
2. North-Eastern Areas	22552	176.00	0.00	176.00	176.00	0.00	176.00	176.00	0.00	176.00
Total		1760.00	0.00	1760.00	1760.00	0.00	1760.00	1760.00	0.00	1760.00
D. Major Head-wise Totals	Total	1760.00	920.00	2680.00	1760.00	1200.00	2960.00	1760.00	1481.40	3241.40
	3451	0.00	1.75	1.75	0.00	2.82	2.82	0.00	3.74	3.74
	2552	176.00	0.00	176.00	176.00	0.00	176.00	176.00	0.00	176.00
	2415	1584.00	918.25	2502.25	1584.00	1197.18	2781.18	1584.00	1477.66	3061.66

(B) INDIAN COUNCIL OF AGRICULTURAL RESEARCH

APPENDIX 1

INDIAN COUNCIL OF AGRICULTURAL RESEARCH SOCIETY

The Society shall have the following *Ex-Officio* Members:

(i) *President of the Society*

1. Mr Sharad Pawar
   Minister of Agriculture
   Government of India, Krishi Bhavan
   New Delhi 110 001
2. Mr. Kanti Lal Bhuria
   Minister of State (Agriculture)
   Government of India, Krishi Bhavan
   New Delhi 110 114

(ii) *Union Ministers holding charge of Finance, Planning, Science and Technology, Education and Commerce (in case the Prime Minister is holding any of these portfolios, the Minister of State in the Ministry/ Department concerned)*

3. Mr S S Palanimanickam
   Minister of State (Revenue)
   Ministry of Finance, Government of India
   North Block, New Delhi 110 001
4. Mr V Narayansamy
   Minister of State for Planning
   Yojana Bhawan, Government of India
   New Delhi 110 001
5. Mr Kapil Sibal
   Minister of Science & Technology, and
   Human Resource Development
   Government of India, Shastri Bhawan
   New Delhi 110 001
6. Mr Arjun Singh
   Minister for Human Resources
   Government of India
   New Delhi 110 001
7. Mr Kamal Nath
   Minister of Commerce,Government of India
   Udyog Bhawan, New Delhi 110 001

(iv) *Other Ministers in the Union Ministry of Agriculture*

8. Mr Taslimuddin
   Minister of State for Animal Hisbandry, Dairying and Fisheries Krishi Bhawan, New Delhi 110 114

(v) *Ministers in the States/Incharge of Agriculture/Animal Husbandry/Fisheries*

Andhra Pradesh

9. Mr N Raghuveera Reddy
   Minister of Agriculture, Horticulture and Food
   Government of Andhra Pradesh
   Hyderabad
   (Andhra Pradesh) 500 022
10. Mr Budha Prasad Mandali
    Minister for Animal Husbandry, Fisheries and Dairy Development
    Government of Andhra Pradesh
    Hyderabad (Andhra Pradesh) 500 022

Arunachal Pradesh

11. Mr Tersong Gyurne
    Minister for Agriculture, Animal Husbandry and Horticulture
    Government of Arunachal Pradesh
    Itanagar (Arunachal Pradesh) 791 111
12. Mr Chowna Mein
    Minister of Fisheries
    Government of Arunachal Pradesh
    Itanagar (Arunachal Pradesh) 791 111

Assam

13. Ms Pramila Rani Brahma
    Minister for Agriculture, Government of Assam
    Janta Bhavan,
    Guwahati (Assam) 781 006
14. Mr Kharsingh Engti
    Minister for Veterinary and Animal Husbandry
    Hill Area Development
    Government of Assam, Janta Bhavan
    Guwahati (Assam) 781 006
15. Mr Nurjamal Sarkar
    Minister for Fisheries
    Government of Assam, Janta Bhavan
    Guwahati (Assam) 781 006
16. Minister for Horticulture
    Government of Assam, Janta Bhavan
    Guwahati (Assam) 781 006

Bihar

17. Mr Ram Narayan Mandal
    Minister for Animal Husbandry and Fisheries
    Government of Bihar
    Patna (Bihar) 800 015
18. Mr Nagmani
    Minister for Agriculture and Horticulture
    Government of Bihar
    Patna (Bihar) 800 015

Chhattisgarh

19. Minister for Agriculture and Animal Husbandry
    Government of Chhattisgarh, Sachivalaya
    Raipur
    (Chhattisgarh)

Delhi

20. Mr R K Chauhan
    Minister for Agriculture Development and Food
    Animal Husbandry & Fisheries
    National Capital Territory of Delhi
    New Delhi 110 012

Goa

21. Mr Antanasio Monserette
    Minister of Agriculture,
    Animal Husbandry and Horticulture
    Government of Goa, Panaji (Goa) 403 001
22. Mr Joaquim Braz Alemao
    Minister for Fisheries
    Government of Goa,
    Panaji (Goa) 403 001

Gujarat

23. Mr Dileep Sanghani
    Minister for Agriculture, Animal Husbandry,
    Fisheries and Cow Breeding
    Government of Gujarat
    Gandhinagar
    (Gujarat) 382 010
24. Minister for Horticulture
    Government of Gujarat
    Gandhinagar
    (Gujarat) 382 010

Haryana

25. Mr Harmohinder Singh Chatha
Minister for Agriculture, Horticulture,
Animal Husbandry, Dairying and Fisheries
Government of Haryana
Chandigarh (Haryana) 160 001

Himachal Pradesh

26. Mr P K Dhumal
Chief Minister and holding the charge of Agriculture, Animal husbandry and Fisheries
Government of Himachal Pradesh
Shimla (Himachal Pradesh) 171 001
27. Mr Narendra Bragla
Minister of State for Horticulture
Government of Himachal Pradesh
Shimla (Himachal Pradesh) 171 001

Jammu and Kashmir

28. Minister for Agriculture,
Horticulture and Fisheries
Government of Jammu and Kashmir
Srinagar (Jammu and Kashmir) 190 001
29. Minister of Animal Husbandry
Government of Jammu & Kashmir
Srinagar (Jammu & Kashmir) 190 001
30. Minister of Horticulture
Government of Jammu & Kashmir
Srinagar 190 001

Jharkhand

31. Mr Nalin Soren
Minister of Animal Husbandry, Horticulture and Fisheries
Government of Jharkhand
Ranchi (Jharkhand) 834 002

Karnataka

32. Mr Krishna Palemar
Minister of Fisheries
Government of Karnataka, Vidhan Soudha
Bangalore (Karnataka) 560 001
33. Dr Revunaik Belamagi
Minister for Animal Husbandry
Government of Karnataka, Vidhan Soudha
Bangalore (Karnataka) 560 001
34. Mr S K Belubbi
Minister for Horticulture
Government of Karnataka
Bangalore 560 001
35. Mr S A Ravindranath
Minister for Agriculture
Government of Karnataka, Vidhan Soudha
Bangalore (Karnataka) 560 001

Kerala

36. Mr Mullakkara Ratnakaran
Minister for Agriculture & Coir including Animal Husbandry and Horticulture
Government of Kerala
Thriuvananthapuram
(Kerala) 695 001
37. Mr S Sharma
Minister of Fisheries
Government of Kerala
Thiruvananthapuram (Kerala) 695 001

Madhya Pradesh

38. Dr Ramakrishna Kusmaria
Minister for Agriculture, Development, Animal Husbandry and Fisheries
Government of Madhya Pradesh
Bhopal (Madhya Pradesh) 423 006
39. Mr. Kailash Vijayvargiya
Minister for Horticulture
Government of Madhya Pradesh
Bhopal (Madhya Pradesh) 423 006

Maharashtra

40. Mr Balasaheb Thorat
Minister for Agriculture
Government of Maharashtra
Mumbai (Maharashtra) 400 032
41. Mr Ravi Seth Patil
Minister for Fisheries, Animal Husbandry and Dairy Development
Government of Maharashtra
Mumbai (Maharashtra) 400 032
42. Mr Vinay Vilasrao Kore
Minister for Horticulture and Non-conventional Energy
Government of Maharashtra
Mumbai (Maharashtra) 400 032

Manipur

43. Mr D D Thaissi
Minister of Animal Husbandry
Government of Manipur
Imphal (Manipur) 795 001
44. Mr N Loken Singh
Minister for Agriculture
Government of Manipur
Imphal (Manipur) 795 001
45. Mr T Phungza Thang Tonsingh
Minister for Horticulture
Government of Manipur
Imphal (Manipur) 795 001
46. Md Alauddin Khan
Minister of Fisheries
Government of Manipur
Imphal 795 001

Meghalaya

47. Mr E C B Bamon
Minister for Agriculture and Animal Husbandry & Veterinary
Government of Meghalaya
Meghalaya Secretariat
Shillong (Meghalaya) 793 001
48. Dr A Pariong
Minister for Horticulture
Government of Meghalaya, Meghalaya Secretariat (C)
Shillong (Meghalaya) 793 001

Mizoram

49. Mr H Liansailova
Minister for Agriculture, Horticulture and Fisheries
Government of Mizoram
Aizwal (Mizoram) 796 001
50. Mr N K Chakma
Minister for Animal Husbandry
Government of Mizoram
Aizwal (Mizoram) 796 001

Nagaland

51. Mr Neiphiu Rio
Chief Minister and holding charge of Horticulture and Fisheries
Government of Nagaland
Kohima (Nagaland) 797 001
52. Mr Chuben Murry
Minister for Agriculture
Government of Nagaland
Kohima (Nagaland) 797 001
53. Mr T R Zeliang
Minister for Animal Husbandry and Veterinary
Government of Nagaland
Kohima (Nagaland) 797 001

Orissa

54. Mr Surinder Nath Nayak
Minister for Agriculture and Horticulture
Government of Orissa
Bhubaneshwar (Orissa) 751 001
55. Mr Golak Bihari Naik
Minister for Fisheries and Animal Resources Development
Government of Orissa
Bhubaneshwar (Orissa) 751 001

Puducherry

56. Mr V Vaithilingam
Chief Minister holding charge of Agriculture, and Horticulture
Government of Puducherry
Pondicherry 605 001
57. Mr T Malladi Krishna Rao
Minister of Fisheries
Government of Pondicherry
Pondicherry 605 001
58. Mr T A Namawwirayom
Minister of Animal Husbandry
Govt. of Puducherry
Puducherry 605 001

Punjab

59. Mr Sucha Singh Lamgha
Minister of Agriculture
Government of Punjab
Chandigarh (Punjab) 160 001
60. Mr G S Ranike
Minister of Animal Husbandry, Fisheries and Dairy Development
Government of Punjab
Chandigarh (Punjab) 160 001
61.
Minister of Horticulture
Government of Punjab
Chandigarh (Punjab) 160 001

Rajasthan

62. Mr Harji Bam Burdak
Minister for Agriculture, Animal Husbandry and Horticulture
Government of Rajasthan
Jaipur (Rajasthan) 302 005

Sikkim

63. Mr Somnath Poudyal
Minister for Agriculture Development and Horticulture
Government of Sikkim
Secretariat, Gangtok (Sikkim) 737 101
64. Ms Kalawati Subba
Minister for Animal Husbandry and Fisheries
Government of Sikkim
Secretariat, Gangtok (Sikkim) 737 001

Tamil Nadu

65. Mr Veera Pandi S Arumugam
Minister for Agriculture and Horticulture
Government of Tamil Nadu
Chennai, (Tamil Nadu) 600 009
66. Mr K P P Sami
Minister for Fisheries
Government of Tamil Nadu
Chennai (Tamil Nadu) 600 009
67. Mr P N Palanisamy
Minister for Animal Husbandry
Government of Tamil Nadu
Chennai (Tamil Nadu) 600 009

Tripura

68. Mr Aghore Debbarma
Minister for Agriculture, Animal Husbandry and Horticulture
Civil Secretariat, Government of Tripura
Agartala (Tripura) 799 001
69. Mr Khagentra Jamatia
Minister for Fisheries
Government of Tripura
Agartala (Tripura) 799 001

Uttarakhand

70. Mr Trivendra Singh Rawat
Minister for Agriculture, Fisheries and Animal Husbandry
Government of Uttarakhand
Dehradun (Uttranchal)
Uttarakhand
71. Mr Ajay Tamta
Minister of Horticulture
Government of Uttarakhand
Dehradun

Uttar Pradesh

72. Mr Lakshmi Narayan
Minister for Agriculture
Government of Uttar Pradesh
Lucknow (Uttar Pradesh) 226 001
73. Dr Awadhpal Singh Yadav
Minister for Animal Husbandry
Government of Uttar Pradesh
Lucknow (Uttar Pradesh) 226 001
74. Mr Narayan Singh
Minister for Horticulture
Government of Uttar Pradesh
Lucknow (Uttar Pradesh) 226 001
75. Mr Dharm Raj Nishad
Minister of Fisheries
Government of Uttar Pradesh
Lucknow (Uttar Pradesh) 226 001

West Bengal

76. Mr Naren De
Minister for Agriculture
Government of West Bengal Writers' Building
Kolkata (West Bengal) 700 001
77. Mr Anisur Rahman
Minister for Animal Resources Development
Government of West Bengal
Kolkata, (West Bengal) 700 001
78. Mr Kironmoy Nanda
Minister for Fisheries
Government of West Bengal
Kolkata (West Bengal) 700 001
79. Minister for Horticulture
Government of West Bengal
Writers Building
Kolkata (West Bengal) 700 001

(vi) *Member of Planning Commission, Incharge of Agriculture*

80. Mr Abhijit Sen
Member (Agriculture), Planning Commission
Yojana Bhavan
New Delhi

(vii) *Six members of Parliament (Four elected by Lok Sabha and two elected by Rajya Sabha)*

81. Mr Praveen Rashtrapal 02.04.2012
Member of Parliament (RS)
Bikhemani Chambers, Shahpur
Ahmedabad, Gujarat 380 081 and
93–94, South Avenue,New Delhi 110011

82. Mr Sharad Anantrao Joshi — 04.07.2010
Member of Parliament (RS)
Angar Mala, Village Ambethan, Taluk khed,
Distt Pune and
12-A Meena Bagh,
New Delhi 110 001

83. Mr Mahdevrao Shivankar — Till the expiry of term in the Lok Sabha
Member of Parliament (LS),
Amgaon, Distt. Gondia 441 902
Maharashtra, and B-603, MS Flats,
BKS Marg, New Delhi 110 001

84. Mr K Manvendra Singh, — -do-
Member of Parliament (LS)
Amagarh House, Dampier Nagar, Mathura,
Uttar Pradesh and 20, Willingdon Crescent,
New Delhi 110 001

85. Mr Kishan Singh Sangwan — -do
Member of Parliament (LS)
H. No. 563, Ward No. 4, Tehsil Road,
Gohana, Sonepat 131 001 Haryana and
18, Dr Rajendra Prasad Road,
New Delhi 110 001.

86. Mr V K Thummar — -do-
Member of Parliament (LS)
Amrut Complex, Station Road,
Amreli 365 601 Gujarat and
7, H C Mathur Lane, New Delhi 110 001

(viii) *Director-General, ICAR*

87. Dr Mangala Rai
Director-General, ICAR
Krishi Bhavan, New Delhi 110 001

(ix) *All Secretaries in the Ministry of Agriculture*

88. Mr T Nanda Kumar
Secretary (Agriculture and Co-operation)
Ministry of Agriculture, Department of Agriculture,
Krishi Bhavan,New Delhi 110 001

89. Ms N Gokulram
Secretary (ADF)
Krishi Bhavan,
New Delhi 110 114

(x) *Secretary, Planning Commission*

90. Mr Sabas Pani
Secretary, Planning Commission
Yojana Bhavan, New Delhi 110 001

(xi) *Secretary, Department of Biotechnology*

91. Mr M K Bhan
Secretary
Department of Biotechnology
CGO Complex, New Delhi 110 003

(xii) Director-General, Council of Scientific and Industrial Research, Anusandhan Bhawan, New Delhi 110 001

92. Prof S K Brahmachari
Director General
Council of Science and Industrial Research
Anusandhan Bhawan, New Delhi 110 001

(xiii) *Chairman, University Grants Commission*

93. Dr S K Thorat
Chairman, University Grants Commission
Bahadur Shah Zafar Marg, New Delhi

(xiv) *Chairman, Atomic Energy Commission (or Director, Bhabha Atomic Research Centre, if nominated by the Chairman, Atomic Energy Commission)*

94. Mr Anil Khakodkar
Chairman, Atomic Energy Commission and Secretary to the Government of India
Department of Atomic Energy
Anushakti Bhavan, Chhatrapati Shivaji
Maharaj Marg, Mumbai 400 039

(xv) *Member, Finance (Secretary/Additional Secretary in the Ministry of Finance), Government of India, Alternate Member—Financial Adviser (DARE/ICAR)*

95. Ms Rita Menon
Special Secretary to the Government of India
Ministry of Finance, Department of Expenditure
New Delhi 110 001

(xvi) *Four Vice-Chancellors of the Agricultural Universities nominated by the President*

96. Dr Vijay Mehta — 9.4.2010
Vice-Chancellor
Dr Balasaheb Sawant Konkan
Krishi Vidyapeeth, Dapoli
Ratnagiri, Maharashtra 415 712

97. Dr N N Singh — 09.4.2010
Vice-Chancellor
Birsa Agricultural University
Ranchi 834 006
Jharkhand

98. Dr P Raghava Reddy — 07.02.2011
Vice-Chancellor
Acharya N.G. Ranga Agricultural University
Rajendra Nagar, Hyderabad 500 030
Andhra Pradesh

99. Dr R K Samanta — 29.07.2011
Vice-Chancellor
Bidhan Chandra Krishi Vishwavidyalaya
District Nadia 741 252
West Bengal

(xvii) *Five technical representatives, namely Agricultural Commissioner, Horticultural Commissioner, Animal Husbandry Commissioner, Fisheries Development Commissioner from the Union Ministry of Agriculture and Inspector-General of Forests, Government of India*

100. Dr N B Singh
Agricultural Commissioner — Ex-officio
Department of Agriculture and Co-operation
Krishi Bhavan, New Delhi 110 001

101. Dr S K Pattanaik — Ex-officio
Horticultural Commissioner, Department of Agriculture,
Krishi Bhavan, New Delhi 110 001

102. Dr S K Bandyopadhyay
Animal Husbandry
Commissioner, Department of Agriculture
Krishi Bhawan, New Delhi

103. Mr M K R Nair — Ex-officio
Fisheries Development Commissioner
Department of Agriculture, Krishi Bhavan
New Delhi 110 001

104. Mr N K Joshi — Ex-officio
Inspector-General of Forests,
Government of India
Department of Environment and Forests
CGO Complex, Lodi Road, New Delhi 110 003

(xviii) Fifteen scientists from within and outside the Council, including one from the Indian Council of Medical Research nominated by the President

105. Dr M V Gupta — 9.4.2010
C- 502, Aditya Elite
B.S. Maktha, Somajiguda
H.No. 6-3-1119, Hyderabad 500 016
(Andhra Pradesh)

106 Dr T J Pandian — 9.4.2010
Former National Professor
Madurai Kamaraj University
9, Old Natham Road
Madurai- 625 014
(Tamil Nadu)

107 Prof Sudhir K Sapori 9.4.2010
Head, Plant Molecular Biology
International Centre for Genetic
Engineering and Biotechnology,
Near JNU Campus, Aruna Asaf Ali Road,
New Delhi 110 067

108 Dr N Panda 9.4.2010
Plot No. 62/63, Opp. Unit 8,
Boy's Singh School
P.O. Baramunda,
Bhubaneshwar 751 003 (Orissa)

109. Dr N N Goswami 9.4.2010
JD 20D, Pitampura,
Delhi- 110 088

110. Dr T C Thakur 9.4.2010
National Professor
College of Technology
GB Pant University of
Agriculture & Technology
Pantnagar 263 145
Distt. Udham Singh Nagar (Uttarakhand)

111. Dr Gyanendra Singh 9.4.2010
Vice-Chancellor
Mahatama Gandhi Chitrakoot Gramodaya
Vishwavidyalaya
Chitrakoot Distt. Satna 485 331
(Madhya Pradesh)

112. Dr M Mahadevappa 9.4.2010
Former-Chairman
Madapura, Cha. Nagar, Tq and
DT, Kasaba Hobli 571 303
(Karnataka)

113. Dr J B Chowdhary 01.07.2010
906, Sumeru Towers
Kaushambi, Ghaziabad

114. Dr C D Mayee 9.4.2010
Chairman
Agricultural Scientists Recruitment Board
New Delhi 110 012

115. Dr Asis Datta 9.4.2010
Former Vice-Chancellor
Jawaharlal Nehru University & Director,
NIPGR
Aruna Asaf Ali Margt, JNU Campus
Post Box No. 10531, New Delhi 110 067

116. Dr K Pradhan 9.4.2010
Former Vice-Chancellor
Orissa University of Agriculture & Technology
C 24/HIG, Housing Board Colony
Baramunda, Bhubaneshwar (Orissa) 751 003

117. Dr S S Acharya 9.4.2010
Honorary Professor
33, Shahi Complex, Sector 11
Udaipur (Rajasthan) 313 002

118. Mr J N L Srivastava
Former Secretary
Department of Agriculture and Cooperation
Government of India
Kothi No. 316, Sector 17-A
Gurgaon 122 001 (Haryana)

Representative of ICMR

119. Dr G S Toteja 08.10.2009
Scientist F
Division of Reproductive Health and Nutrition
Indian Council of Medical Research
Ansari Nagar, PB 4911, New Delhi 110 029

(xix) *Three representatives of Commerce and Industry nominated by the President*

120. Mr Gokul Patnaik 06.05.2010
Chairman
Global Agri. Systems Pvt. Ltd.
K-13 A, Hauz Khas Enclave, New Delhi 110 016

121. Mr M Manickam 06.05.2010
Vice-Chairman & Managing Director
M/s. Shakti Sugars Limited
180, Race Course Road
Post Box No. 3775
Coimbatore 641 018 and 149 Vasant Enclave
New Delhi 110 057

122. Ms Megha Borase 06.05.2010
President
Flower Growers Association
20/4, Kulkarni Baug Opp. B Y K College
Nasik 422 005 Maharashtra

(xx) *One farmer from each region mentioned in Rule 60(a) and four representatives of rural interest nominated by the President*

123. Prof D P Tripathi 08.06.2011
C-9/9782 Vasant Kunj
New Delhi 110 070

124. Mr Anand Thakur 08.06.2011
At Post Vangaon, Tal. Dhanu
District Thane
Maharashtra

125. Ms Usha Barwale Zehr 08.06.2011
Maharashtra Hybrid Seeds
Company Limited
Post Box No. 76
Jalna 431 203, Maharashtra

126. Mr Sudhir Kumar Bhargava 08.06.2011
Agroman Systems Pvt. Ltd.
25/2, Tardeo AC Market
Tardeo, Mumbai 400 034

127. Ms Rinchin Droma 08.06.2011
Rungkhung P.O. Dirang
West Kameng Dist. 790 101
Arunachal Pradesh

128. Ms Asha Kashyap 08.06.2011
Village - Pawar
Panchayat- Thadi
Post Office - Shoghi
Block-Mashobra, District Shimla 173 219

129. Vacant

130. Vacant

(xxi) *Four representatives of Rural Interest*

131. Mr Sopan Kanchan 08.06.2011
Irrigation Colony
At & Post Office: Uruli Kanchan
District: Pune 412 202

132. Dr Chanda Nimbkar 08.06.2011
Director
Animal Husbandry Division
Nimbkar Agricultural Research Instt.
P.O. Box. 23, Phaltan
Maharashtra 415 523

133. Mr D S Ananth Kumar 08.06.2011
Planter
Sathya Sai Estate, Mahadev Pet,
Madikeri, Coorg District, Karnataka

134. Vacant

(xxi) *Four Directors of the ICAR Research Institutes, nominated by the President*

138. Dr O M Bambawale 9.4.2010
Director
National Centre for Integrated Pest Management
LBS Building Pusa Campus
New Delhi 110 012

139. Dr K A Singh 9.4.2010
Director
Indian Grassland & Fodder Research Institute
Jhansi 238 003 (Uttat Pradesh)

140. Dr B P Singh 31.01.2010
Director
Central Avian Research Institute
Izatnagar 243 122 (Uttar Pradesh)

141. Dr K K Vass 9.4.2010
Director
Central Inland Fisheries
Research Institute, Barrackpore
Kolkata 743 101(West Bengal)

(xxii) *Secretary, Indian Council of Agricultural Research*

142. Mr A K Upadhyay
Member-Secretary, ICAR
Krishi Bhavan, New Delhi 110 014

APPENDIX 2

GOVERNING BODY

Chairman

1. Dr Mangala Rai
   Director-General
   Indian Council of Agricultural Research
   Krishi Bhavan, New Delhi 110 001

Ex-officio Members

Member-Finance

2. Ms Rita Menon
   Special Secretary to the Government of India
   Ministry of Finance, Department of Expenditure
   New Delhi 110 001

Secretary, Planning Commission

3. Mr Subas Pani
   Secretary
   Planning Commission
   Yojna Bhavan, New Delhi 110 001

Secretary, Agriculture

4. Mr T Nanda Kumar
   Secretary (Agriculture and Coop),
   Government of India
   Ministry of Agriculture, Department of
   Agriculture, Krishi Bhavan, New Delhi 110 114

Chairman, University Grants Commission

5. Dr S K Thorat
   Chairman
   University Grants Commission
   Bahadur Shah Zafar Marg, New Delhi 110 002

Secretary, Animal Husbandry, Fisheries and Dairying

6. Mr N Gokulram
   Secretary (ADF)
   Department of Animal Husbandry and Dairying & Fisheries
   Krishi Bhavan, New Delhi 110 114

Secretary, Department of Biotechnology

7. Mr M K Bhan
   Secretary
   Department of Biotechnology
   CGO Complex, New Delhi 110 002

Director-General Council of Scientitic and Industrial Research

8. Prof S K Brahmachari
   Director-General
   Council of Scientist and Industrial Research
   Anusandhan Bhawan, Rafi Marg, New Delhi 110 001

Members

Four scientists (including one Management Expert) who are not employees of the ICAR and are nominated by the President

Management Expert

9. Mr J N L Srivastava
   Former Secretary, DOAC
   Government of India
   Kothi No. 316, Sector 17 A
   Gurgaon (Haryana) 122 001

Scientists

10. Dr T J Pandian — 09.04.2010
    Former ICAr National Professor
    Kamaraj University
    9, Old Natham Road,
    Madurai (Tamil Nadu) 625 014

11. Dr C D Mayee — 09.04.2010
    Chairman
    Agricultural Scientists Recruitment
    Board, Pusa,
    New Delhi 110 012

12. Dr Asis Datta — 0.9.04.2010
    Former Vice-Chancellor
    Jawaharlal Nehru University & Director,
    NCPGR
    Aruna Asaf Ali Marg
    JNU Campus, POst Boxt No. 10531
    NEW Delhi 110 067

Three Vice-Chancellors (nominated by the President)

13. Dr P Raghava Reddy — 7.02.2011
    Vice-Chancellor
    Acharya N G Ranga Agricultural University
    Hyderabad 500 030

14. Dr R K Samanta — 29.07.2011
    Vice-Chancellor
    Bidhan Chandra Krishi Vishwa Vidyalaya
    Mohanpur
    West Bengal

15. Dr Vijay Mehta — 09.04.2010
    Vice-Chancellor
    Dr Balasaheb Sawant Konkan
    Vidyapeeth, Dapoli
    Maharashtra 415 712

Three Members of Parliament (Two from Lok Sabha and one from Rajya Sabha) nominated by the President

16. Mr Mahdevrao Shivankar — 16.08.2009
    Member of Parliament (Lok Sabha)
    Amgaon, Gundia 441 902 and
    B 603, MS Flats, B K S Marg
    New Delhi 110 001

17. Mr Manvendra Singh — 16.08.2009
    Member of Parliament (Lok Sabha)
    Amgarmala House, Dambiev Nagar
    Mathura and
    20, Willigdon Cresent
    New Delhi 110 001

18. Mr Sharad Anantrao Joshi — 19.06.2009
    Member of Parliament (Rajya Sabha)
    Angarmala, Vill. Ambethom, Taluk Khed,
    Distt. Pune and
    12 A, Meena Bagh, New Delhi 110 001

Three Farmers/Representatives of rural areas nominated by the President

19. Prof. D P Tripathi — 08.06.2011
    C-9/9782 Vasant Kunj
    New Delhi 110 070

20. Dr Chandra Nimbkar — 08.06.2011
    Director
    Animal Husbandry Division
    Nimbkar Agricultural Research Institute
    P O Box 23, Phaltan
    Maharashtra 415 523

21. Mr Sudhir Kumar Bhargava — 08.06.2011
    Director
    Agroman Systems Pvt Ltd.
    25/2, Tardeo A C Market
    Tardeo, Mumbai 400 034
    Maharashtra

Three Directors of Research Institutes of the Council nominated by the President

22. Dr O M Bambawale 09.04.2010
Director
National Centre for Integrated Pest Management
LBS Building, Pusa Campus
New Delhi 110 012

23. Dr B P Singh 31.01.2010
Director
Central Avian Research Institute
Izatnagar 243 122
Uttar Pradesh

24. Dr K K Vass 09.04.2010
Director
Central Inland Fisheries
Research Institute, Barrackpore
Kolkata 743 101 (West Bengal)

Member-Secretary

25. Mr A K Upadhyay
Special Secretary (DARE) and Secretary
Indian Council of Agricultural Research
Krishi Bhawan
New Delhi 110 001

APPENDIX 3

SENIOR OFFICERS AT THE HEADQUARTERS OF THE ICAR

1. Dr Mangala Rai
Director-General, ICAR and
Secretary to the Government of India
Department of Agricultural Research and Education

2. Mr Rajiv Mehrishi
Secretary, ICAR and
Additional Secretary to Government of India
Department of Agricultural Research and Education

Deputy Directors-General

1. Dr S Ayyappan (Fisheries and I/c Animal Sciences)
2. Dr A K Singh (Natural Resource Management)
3. Dr H P Singh (Horticulture)
4. Dr S K Datta (Crop Sciences)
5. Dr K D Kokate (Agricultural Extension)
6. Dr M M Pandey (Agricultural Engineering)
7. Dr Arvind Kumar (Education)

Assistant Directors-General

Crop Science

1. Dr K C Jain (Commercial Crops)
2. Dr S N Shukla (Food and Fodder Crops)
3. Dr T P Rajendran (Plant Protection)
4. Dr N D Jambhale (Seeds)
5. Dr V D Patil (OP)
6. Dr S Mauria (IP&TM)

Horticulture

1. Dr S Rajan (Hort I)
2. Dr U C Srivastava (Horticulture II)

Natural Resource Management

1. Dr A K Gogoi (Agronomy)
2. Dr P D Sharma (Soils)

Engineering

1. Dr S K Tandon (Engineering and PE)

Animal Sciences

1. Dr Lal Krishna (Animal Health)
2. Dr C S Prasad (ANP)

Fisheries

1. Dr V V Sugunan (Inland Fisheries)
2. Dr Madan Mohan (Marine Fisheries)

Education

1. Dr R K Mittal (EQAR)
2. Dr C Deva Kumar (EPS)
3. Dr S D Sharma (HRD)

Extension

1. Dr A K Mehta (Agril. Extn.)
2. Dr V Venkateasubramanian (AE)

ARIS

1. Dr T P Trivedi

Co-ordination

1. Dr N B Singh

Principal Scientists

Crop Science

1. Dr A K Sharma (Food Crops)
2. Dr C P Singh (Seeds)
3. Dr Sudhir Kochhar (PB)
4. Dr Sanjeev Saxena (Policy and IPR)
5. Dr G N Mishra

Horticulture

1. Dr S K Malhotra
2. Dr P S Saroj

Natural Resource Management

1. Dr R K Batta (IWM)
2. Dr P P Biswas (Soil)

Education

Nil

Fisheries

1. Dr Anil Agarwal (M F)
2. Dr Usha Moza (I F)

Animal Sciences

1. Dr Ranjan Gupta
2. Dr Vineet Bhasin

ARIS Unit

1. Dr D K Aggarwal

Extension

1. Dr A M Narula

Engineering

1. Dr S Ganesan

Others

1. Dr D B S Sehra (ES&M)
2. Dr Ravindra Kumar (Awards)

National Agricultural Innovation Project

1. Dr M M Pandey, National Director I/c
2. Dr R K Goel, National Coordinator
3. Dr A P Srivastava, National Coordinator
4. Dr N T Yaduraju, National Coordinator
5. Dr A Bandhopadhyay, National Coordinator

Administration

Directors

1. Mr K K Bajpai, Director (P)
2. Mr Ravindra Pattar, Director (F)
3. Mr H C Joshi, Director (OL)
4. Mr V P Kothiyal, Director (Works)
5. Mr Devendra Kumar, Director (F), NAIP

Deputy Secretaries

1. Mr Sanjay Gupta
2. Mr H L Meena

3. Mr J Ravi
4. Mr A C Ghosh
5. Ms Shashi Prabha Razdan
6. Mr S K Mitra
7. Mr B N Rao
8. Mr K C Joshi

Agricultural Scientists' Recruitment Board

1. Dr C D Mayee, Chairman
2. Dr N K Tyagi, Member
3. Dr M J Modayil, Member
4. Mr N S Randhawa, Secretary
5. Mr C Muralidharan, Controller of Examination

Directorate of Information and Publications of Agriculture

1. Dr T P Trivedi, Project Director
2. Mr V K Bharti, Chief Production Officer
3. Dr Kuldeep Sharma, Editor (Hindi) and Unit Incharge
4. Dr R P Sharma, Editor (English) and Unit Incharge
5. Mr B C Majumder, Artist and Unit Incharge
6. Mr Hans Raj, Information System Officer
7. Mr S K Joshi, Business Manager
8. Dr B N Chattopadhya, CNO
9. Dr P Vishaki, Librarian, Krishi Bhavan
10. Mr Anil Sharma, Public Relations Officer

APPENDIX 4

ICAR INSTITUTES AND THEIR DIRECTORS

National Institutes

1. Dr H S Gupta
   Indian Agricultural Research Institute
   New Delhi 110 012
2. Dr M C Sharma
   Indian Veterinary Research Institute
   Izatnagar (Uttar Pradesh) 243 122
3. Dr A K Srivastava
   National Dairy Research Institute
   Karnal (Haryana) 132 001
4. Dr Dilip Kumar
   Central Institute of Fisheries Education
   Jaiprakash Road, Seven Bungalow (Versova)
   Mumbai (Maharashtra) 400 061
5. Dr P K Joshi
   National Academy of Agricultural Research and Management, Rajendranagar
   (Andhra Pradesh) 500 030

Agricultural Sciences

6. Dr R C Srivastava
   Central Agricultural Research Institute
   Andaman and Nicobar Group of Islands
   P B 181 Port Blair
   (Andamans & Nicobar Islands) 744 101
7. Dr N V Patil
   Central Arid Zone Research Institute
   Jodhpur (Rajasthan) 342 003
8. Dr Pitam Chandra
   Central Institute of Agricultural Engineering
   Berasia Road, Nabi Bagh,
   Bhopal (Madhya Prdesh) 462 038
9. Dr T A More
   Central Institute of Arid Horticulture
   Bikaner (Rajasthan) 334 006
10. Dr K R Kranti
    Central Institute for Cotton Research
    ICAR Housing Complex, Central Bazar Road
    Bajaj Nagar,Nagpur (Maharashtra) 440 010
11. Dr H Ravi Shankar
    Central Institute for Sub-tropical Horticulture
    Rehmankhera, PO Kakori
    Lucknow (Uttar Pradesh) 227 107
12. Dr Nazeer Ahmed
    Central Institute of Temperate Horticulture
    Old Air Field
    Rangreth (Jammu and Kashmir) 190 007
13. Dr R T Patil
    Central Institute of Post-Harvest Engineering and Technology, Ludhiana (Punjab) 141 004
14. Dr S Sreenivasan
    Central Institute for Research on Cotton Technology
    PB 16640, Adenwala Road, Matunga
    Mumbai (Maharashtra) 400 019
15. Dr George V Thomas
    Central Plantation Crops Research Institute
    Kasaragod (Kerala) 671 124
16. Dr S K Pandey
    Central Potato Research Institute
    Shimla (Himachal Pradesh) 171 001
17. Dr B Venkateswarlu
    Central Research Institute for Dryland Agriculture
    Santoshnagar, P O Saidabad
    Hyderabad (Andhra Pradesh) 500 059
18. Dr B S Mahapatra
    Central Research Institute for Jute and Allied Fibres
    Barrackpore, Distt 24 Paraganas
    (West Bengal) 700 120
19. Dr T K Adhya
    Central Rice Research Institute
    Cuttack (Orissa) 753 006
20. Dr Gurbachan Singh
    Central Soil Salinity Research Institute
    Zarifa Farm, Kachwa Road
    Karnal (Haryana) 132 001
21. Dr V N Sharda
    Central Soil and Water Conservation Research and Training Institute, 218 Kaulagarh Road
    Dehradun (Uttaranchal) 248 195
22. Dr V Krishnamurthy
    Central Tobacco Research Institute
    Rajahmundry (Andhra Pradesh) 533 105
23. Dr S K Naskar
    Central Tuber Crops Research Institute, PB 3502
    Sreekariyam, Thiruvananthapuram (Kerala) 695 017
24. Dr V S Korikanthimath
    ICAR Research Complex for Goa,
    Ela, Old Goa (Goa) 403 402
25. Dr M A Khan
    ICAR Research Complex for Eastern Region
    Patna (Bihar) 800 014
26. Dr S V Ngachan
    ICAR Research Complex for North-Eastern Region
    Umiam (Meghalaya) 793 103
27. Dr V K Bhatia
    Indian Agricultural Statistics Research Institute
    Library Avenue, Pusa Campus
    New Delhi 110 012

28. Dr K A Singh
Indian Grassland and Fodder Research Institute
Pahuj Dam, Gwalior-Jhansi Road
Jhansi (Uttar Pradesh) 284 003
29. Dr A S Sidhu
Indian Institute of Horticultural Research
P.O. Hassaraghatta Lake
Bangalore (Karnataka) 560 089
30. Dr N Nadarajan
Indian Institute of Pulses Research
Kanpur (Uttar Pradesh) 208 024
31. Dr A Subba Rao
Indian Institute of Soil Science
Nabi Bagh, Bhopal (Madhya Pradesh) 462 038
32. Dr V A Parthasarathy
Indian Institute of Spices Research
P B 1701, P O Marikunnu
Kozhikode (Kerala) 673 012
33. Dr R L Yadav
Indian Institute of Sugarcane Research
P O Dilkusha
Lucknow (Uttar Pradesh) 226 002
34. Dr Bangali Baboo
Indian Institute of Natural Resins and Gums
Namkum, Ranchi (Jharkhand) 834 010
35. Dr Mathura Rai
Indian Institute of Vegetable Research
P.B. 01, P.O. Jakhini
Shahanshapur, Varanasi (Uttar Pradesh) 221 305
36. Dr K K Satpathy
National Institute of Research on Jute and
Allied Fibre Technology
12 Reagent Park
Calcutta (West Bengal) 700 040
37. Dr K P R Vittal
National Institute of Abiotic Stress Management
Malegaon, Baramati, Pune, (Maharashtra) 413 115
38. Dr N Vijayan Nair
Sugarcane Breeding Institute
Coimbatore (Tamil Nadu) 641 007
39. Dr J C Bhatt
Vivekananda Parvatiya Krishi Anusandhan Sansthan
Almora (Uttar Pradesh) 263 601

Animal Sciences and Fisheries

40. Dr B P Singh
Central Avian Research Institute
Izatnagar (Uttar Pradesh) 243 122
41. Dr R K Sethi
Central Institute for Research on Buffaloes
Sirsa Road, Hisar (Haryana) 125 001
42. Dr S K Jindal
Central Institute for Research on Goats
Makhdoom, Mathura, (Uttar Pradesh) 281 122
43. Dr K K Vass
Central Inland Fisheries Research Institute
Barrackpore (West Bengal) 743 101
44. Dr A G Ponniah
Central Institute of Brackishwater Aquaculture
75 Santhome High Road
R A Puram, Chennai (Tamil Nadu) 600 028
45. Dr B Meena Kumari
Central Institute of Fisheries Technology
Willingdon Island, P O Matsyapuri
Cochin (Kerala) 682 029
46. Dr A E Eknath
Central Institute of Freshwater Aquaculture
Kausalyaganga, Bhubaneshwar (Orissa) 751 002
47. Dr G Syda Rao
Central Marine Fisheries Research Institute
P B 1603, Tatapuram, Kochi (Kerala) 682 018
48. Dr S A Karim
Central Sheep and Wool Research Institute
Avikanagar, District Tonk
Via Jaipur (Rajasthan) 304 501
49. Dr K T Sampath
National Institute of Animal Nutrition and Physiology
Adugodi, Bangalore
(Karnataka) 560 030

APPENDIX 5

NATIONAL BUREAUX AND THEIR DIRECTORS

Agricultural Sciences

1. Dr R J Rabindra
National Bureau of Agriculturally Important Insects
PB 2491, H A Farm
Hebbal
Bengaluru (Karnataka) 560 024
2. Prof D K Arora
National Bureau of Agriculturally Important
Micro-organisms
PB No. 6, Kusmaur
Mau Nath Bhanjan
Uttar Pradesh 275 101
3. Dr S K Sharma
National Bureau of Plant Genetic Resources
FCI Building, Pusa
New Delhi 110 012
4. Dr Dipak Sarkar
National Bureau of Soil Survey and
Land Use Planning
P B 426, Shankar Nagar, Amravati Road
Nagpur (Maharashtra) 440 010

Animal Sciences

5. Dr B K Joshi
National Bureau of Animal Genetic Resources
PB 129, Karnal (Haryana) 132 001
6. Dr W S Lakra
National Bureau of Fish Genetic Resources
Radhaswami Bhavan, 351/28,
Dariya Pur,
Talkatora Road
PO Dilkusha
Lucknow (Uttar Pradesh) 226 002

APPENDIX 6

PROJECT DIRECTORATES AND THEIR DIRECTORS

Agricultural Sciences

1. Dr B Gangwar
   Project Directorate of Farming Systems Research
   Modipuram
   Meerut (Uttar Pradesh) 250 110
2. Dr J B Mishra
   Directorate of Groundnut Research
   Ivnagar Road, Timbawadi
   PB 5, Junagadh
   (Gujarat) 362 001
3. Dr T P Trivedi
   Directorate of Information and Publications of Agriculture
   KABI, Pusa,
   New Delhi 110 012
4. Dr Sain Dass
   Project Directorate of Maize Research
   Cummings Laboratory
   Indian Agricultural Research Institute,
   Pusa
   New Delhi 110 012
5. Dr M Kochu Babu
   Directorate of Oilpalm Research
   Pedavegi (Andhra Pradesh) 534 450
6. Dr D M Hegde
   Directorate of Oilseeds Research
   Hyderabad (Andhra Pradesh) 500 030
7. Director Incharge
   Directorate of Rapeseed-Mustard Research
   P B 41, Bharatpur
   (Rajasthan) 321 303
8. Dr B C Viraktamath
   Directorate of Rice Research
   Hyderabad (Andhra Pradesh) 500 030
9. Dr A B Mandal
   Directorate of Seed Research
   Kusmaur, Mau Nath Bhanjan
   (Uttar Pradesh) 275 101
10. Dr N Seetharama
    Directorate of Sorghum Research
    Rajendranagar
    Hyderabad (Andhra Pradesh) 500 030
11. Dr S K Srivastava
    Directorate of Soybean Research
    Bhawerkua Farm, Khandwa Road,
    Indore (Madhya Pradesh) 452 017
12. Dr S S Singh
    Directorate of Wheat Research
    P B 158, Kunjpura Road, Karnal (Haryana) 132 001
13. Dr J G Varshney
    Directorate of Weed Science Research
    Maharajpur, Adhartal
    Jabalpur (Madhya Pradesh) 482 004
14. Dr Ashwani Kumar
    Directorate of Water Management
    Chandrasekharpur,
    Bhubaneshwar (Orissa) 751 023
15. Dr (Ms) Krishna Srinath
    Directorate of Research on Women in Agriculture
    1199, Jagamara
    Bhubaneshwar (Orissa) 751 030
16. Dr M Gopalakrishna Bhat
    Directorate of Cashew Research
    Kamminje, Puttur (Karnataka) 574 202
17. Dr K P Singh
    Directorate of Floricultural Research
    IARI Campus, Pusa
    New Delhi 110 012
18. Dr Satyabrata Maiti
    Directorate of Medicinal and
    Aromatic Plants Research
    Boriavi Seed Farm,Boriavi
    Anand (Gujarat) 387 310
19. Dr Manjit Singh
    Project Directorate of Mushroom Research
    Chambaghat,
    Solan (Himachal Pradesh) 173 213
20. Dr K E Lawande
    Project Directorate on Onion and Garlic Research
    Rajguru Nagar
    Pune, (Maharashtra) 410 505

Animal Sciences

21. Dr K Prabhudas
    Project Directorate on Animal Disease Monitoring and Surveillance
    Hebbal, Bangalore (Karnataka) 560 024
22. Dr A K Misra
    Project Directorate on Cattle
    Grass Farm Road, PB 17
    Meerut (Uttar Pradesh) 250 001
23. Dr B Pattanaik
    Project Directorate on Foot and Mouth Diseases
    IVRI Campus, Mukteshwar
    Kumaon (Uttaranchal) 263 138
24. Dr R P Sharma
    Project Directorate on Poultry
    Rajendranagar
    Hyderabad (Andhra Pradesh) 500 030
25. Dr P C Mahanta
    Directorate of Cold Water Fisheries Research
    Nainital (Uttarakhand) 263 136

APPENDIX 7

NATIONAL RESEARCH CENTRES AND THEIR DIRECTORS

Agricultural Sciences

1. Dr S K Dhyani
   National Research Centre for Agroforestry
   IGFRI Campus, Pahuj Dam, Gwalior-Jhansi Road
   Jhansi (Uttar Pradesh) 284 003
2. Dr M M Mustaffa
   National Research Centre for Banana
   Thogamalai Main Road, Thayanur Post
   Thiruchirapalli (Tamil Nadu) 620 102

3. Dr V J Shivankar
National Research Centre for Citrus
PB 464, P.O. Shankar Nagar,
Nagpur (Maharashtra) 440 010
4. Dr P G Adsule
National Research Centre for Grapes
PB No. 3, Manjri Farm Post
Pune (Maharashtra) 412 307
5. Dr O M Bambawale
National Research Centre for Integrated Pest Management
Lal Bahadur Shastri Building
IARI, Hillside Road,
Pusa
New Delhi 110 012
6. Dr K K Kumar
National Research Centre for Litchi
Manchi House
Muzaffarpur (Bihar) 842 002
7. Dr R P Medhi
National Research Centre for Orchids
Pakyang (Sikkim) 737 106
8. Dr P Ananda Kumar
National Research Centre for Plant Biotechnology
Indian Agricultural Research Institute
Pusa, New Delhi 110 012
9. Dr Vilas T Jadhav
National Research Centre on Pomegranate
C/o Centre on Rabi Sorghum
NH 9 Bye Pass
Shelgi, Solapur (Maharashtra) 413 006
10. Dr M M Anwar
National Research Centre for Seed Spices
Tabiji, Ajmer (Rajasthan) 305 206

Animal Sciences and Fisheries

11. Dr K M L Pathak
National Research Centre on Camel
Jorbeer, PB 07
Bikaner (Rajasthan) 334 001
12. Dr R K Singh
National Research Centre for Equines
Sirsa Road, Hisar (Haryana) 125 001
13. Dr N Kondaiah
National Research Centre on Meat and Meat Products
CRIDA Campus, Santosnagar
Hyderabad (Andhra Pradesh) 500 059
14. Dr Chandan Rajkhowa
National Research Centre for Mithun
ICAR Research Complex
Jharnapani, Medziphema (Nagaland) 797 106
15. Dr Anubrata Das
National Research Centre for Pigs
Panjabari Road, 6th Mile, Guwahati (Assam) 785 037
16. Dr P Chakravarty
National Research Centre on Yak
West Kemeng, Dirang (Arunachal Pradesh) 790 101

General

17. Dr B C Barah
National Centre for Agricultural Economics and Policy Research
Library Avenue, Pusa, New Delhi 110 012

APPENDIX 8

A. ALL-INDIA CO-ORDINATED RESEARCH PROJECTS AND PROJECT/NETWORK CO-ORDINATORS

Crop Sciences

1. Dr B Mallik
Network Co-ordinator (Acarology)
UAS
GKVK, Hebbal, Bangalore (Karnataka) 560 065
2. Dr D Kumar
Network Coordinator (Arid Legumes)
CAZRI
Jodhpur (Rajasthan) 342 003
3. Dr R J Rabindra
Project Co-ordinator (Biological Control)
National Bureau of Agriculturally Important Insects
Hebbal, Bangalore (Karnataka) 560 024
4. Dr D M Hegde
Project Co-ordinator (Castor, Sunflower and Safflower)
Directorate of Oilseeds Research
Rajendranagar, Hyderabad (Andhra Pradesh) 500 030
5. Dr N Gopala Krishan
Project Co-ordinator (Cotton Improvement)
CICR Research Station, PO Lawley Road,
Coimbatore
(Tamil Nadu) 641 003
6. Dr N P Singh
Project Co-ordinator (Chickpea)
Indian Institute of Pulses Research
Kalyanpur, Kanpur (Uttar Pradesh) 208 024
7. Dr S A Faruqui
Project Co-ordinator (Forage Crops)
Indian Grassland and Fodder Research Institute
PO Pahuj Dam, Jhansi-Gwalior Road
Jhansi (Uttar Pradesh) 284 003
8. Dr J B Misra
Project Coordinator (Groundnut)
Directorate of Groundnut Research
Junagarh
(Gujarat) 362 001
9. Dr Dilip Monga
Project Co-ordinator (Honeybees and Pollinators)
Division of Entomology
CCS Haryana Agricultural University
Hisar (Haryana) 125 004
10. M K Sinha
Network Co-ordinator (Jute and Allied fibres)
Central Research Institute for Jute and Allied Fibres
Barrackpore (West Bengal) 700 120
11. Dr R L Srivastava
Project Co-ordinator (Linseed)
CSA University of Agriculture and Technology
Kanpur
(Uttar Pradesh) 208 002
12. Dr Sain Dass
Project Co-ordinator (Maize)
Directorate of Maize Research
New Delhi 110 012
13. Dr B B Singh
Project Co-ordinator (MULLARP)
Indian Institute of Pulses Research
Kalyanpur, Kanpur
(Uttar Pradesh) 208 024
14. Dr A B Mandal
Project Co-ordinator (National Seed Project)
Directorate of Seed Research
Kusmour, Mau (Uttar Pradesh) 275 101

15. Dr R K Jain
Project Co-ordinator (Nematodes)
Division of Nematology
Indian Agricultural Research Institute, Pusa
New Delhi 110 012
16. Dr V Vasudeva Rao
Network Co-ordinator (Ornithology)
ANGRAU, Rajendranagar
Hyderabad (Andhra Pradesh) 500 030
17. Dr I S Khairwal
Network Co-ordinator (Pearl Millet)
Agricultural Research Station, RAU, Mandore
Jodhpur (Rajasthan) 342 304
18. Dr K K Sharma
Network Coordinator (Pesticide Residues)
Division of Agricultural Chemicals, LBS Building
Indian Agricultural Research Institute, Pusa
New Delhi 110 012
19. Dr N D Majumdar
Project Co-ordinator (Pigeonpea)
Indian Institute of Pulses Research
Kalyanpur, Kanpur (Uttar Pradesh) 208 024
20. Dr A R G Ranganatha
Project Co-ordinator (Sesame and Niger)
JNKVV, Jabalpur (Madhya Pradesh) 482 004
21. Dr N Seetharama
Project Co-ordinator (Sorghum)
Directorate for Sorghum Research
Rajendranagar, Hyderabad (Andhra Pradesh) 500 030
22. Dr M V Channabyre Gowda
Project Co-ordinator (Small Millets)
University of Agricultural Sciences
GKVK Campus, Bangalore (Karnataka) 560 065
23. Dr S K Srivastava
Project Co-ordinator (Soybean)
Directorate of Soybean Research
Indore (MP) 452 017
24. Dr O K Sinha
Project Co-ordinator (Sugarcane)
Indian Institute of Sugarcane Research
Lucknow (Uttar Pradesh) 226 002
25. Dr B C Viraktamath
Project Coordinator (Rice)
Directorate of Rice Research
Hyderabad, Andhra Pradesh 500 030
26. Project Co-ordinator (Rapeseed Mustard)
Directorate of Rapeseed-Mustard Research
Sewar, Bharatpur (Rajasthan) 321 303
27. Dr R S Tripathi
Network Co-ordinator (Rodent Control)
CAZRI, Jodhpur (Rajasthan) 342 003
28. Dr V Krishnamurthy
Network Co-ordinator (Tobacco)
CTRI, Rajamundry (Andhra Pradesh) 533 105
29. Dr R P Dua
Network Co-ordinator (Under-utilized crops)
NBPGR, Pusa, New Delhi 110 012
30. Dr S S Singh
Project Co-ordinator (Wheat and Barley)
Directorate of Wheat Research
Karnal (Haryana) 132 001
31. Dr Y S Mathur
Network Co-ordinator (White Grubs and other soil anthropods)
Agricultural Research Station, RAU
Jaipur (Rajasthan) 302 018

Horticulture

32. Dr T A More
Project Coordinator (Arid Zone Fruits)
Centeral Institute of Arid Horticulture
Bikaner (Rajasthan) 334 006
33. Dr Satyabrata Maiti
Project Co-ordinator (Medicinal
Aromatic Plants and Betelvine)
Directorate of Medicinal and Aromatic Plants
Anand (Gujarat) 387 310
34. Dr Gopala Krishna Bhat
Project Co-ordinator (Cashew)
Directorate for Cashew Research
Puttur
(Karnataka) 574 202
35. Dr Krishan Pal Singh
Project Co-ordinator (Floriculture)
Directorate of Floricultural Research
Indian Agricultural Research Institute, Pusa
New Delhi 110 012
36. Dr Manjit Singh
Project Coordinator (Mushrooms)
Directorate of Mushroom Research
Chambaghat, Solan (Himachal Pradesh) 173 213
37. Dr K E Lawande
Network Co-ordinator (Onion and Garlic)
Project Directorate on Onion and Garlic Research
Rajgurunagar, Pune (Maharashtra) 410 505
38. Dr S Arulraj
Project Co-ordinator (Palms)
Central Plantation Crops Research Institute
Kasaragod (Kerala) 671 124
39. Dr P S Naik
Project Co-ordinator (Potato Improvement)
Central Potato Research Institute
Shimla (Himachal Pradesh) 171 001
40. Dr A K Misra
Project Co-ordinator (Subtropical Fruits)
Central Institute for Subtropical Horticulture
Rahmankhera, Lucknow (Uttar Pradesh) 227 107
41. Dr M Anandraj
Project Co-ordinator (Spices)
Indian Institute of Spices Research
PB 170, Marikunnu, Calicut (Kerala) 673 012
42. Dr A S Sidhu
Project Co-ordinator (Tropical Fruits)
Indian Institute of Horticultural Research
Hessarghatta Lake Post
Bangalore (Karnataka) 560 089
43. Dr M S Palaniswami
Project Co-ordinator (Tuber Crops), Regional Station,
Central Tuber Crops Research Institute
Thiruvananthapuram (Kerala) 695 017
44. Dr Mathura Rai
Project Co-ordinator (Vegetables)
Indian Institute of Vegetable Research
Varanasi (Uttar Pradesh) 221 005

Natural Resource Management

45. Dr G G S N Rao
Project Co-ordinator (Agricultural Meteorology)
CRIDA Campus
Santoshnagar
Hyderabad (Andhra Pradesh) 500 059
46. Dr D L N Rao
Network Co-ordinator
(Soil biodiversity and biofertilizer)
Indian Institute of Soil Science
Bhopal (Madhya Pradesh) 462 038
47. Dr S K Dhyani
Project Co-ordinator (Agroforestry)
National Research Centre on Agroforestry
Jhansi
(Uttar Pradesh) 284 003
48. Dr B Gangwar
Project Co-ordinator (Integrated Farming System)
Project Directorate of Farming Systems Research
Modipuram, Meerut (Uttar Pradesh) 250 110

49. Dr P K Mishra
Project Co-ordinator (Dryland Agriculture)
CRIDA Campus, Santoshnagar
Hyderabad (Andhra Pradesh) 500 059
50. Dr Bangali Baboo
Project Co-ordinator (Harvesting, processing and value-addition of natural resins and gums)
Indian Institute of Natural Resins and Gums
Namkum, Ranchi (Jharkhand) 834 010
51. Dr Muneshwar Singh
Project Co-ordinator (Long-term Fertilizer Experiments)
Indian Institute of Soil Science
Bhopal
(Madhya Pradesh) 462 038
52. Dr S K Gupta
Project Co-ordinator (Management of Salt-affected Soils and Saline Water in Agriculture)
Central Soil Salinity Research Institute
Karnal
(Haryana) 132 001
53. Dr Mahavir Singh
Project Co-ordinator (Micronutrients and Secondary Nutrients and Pollutant Elements in Soils and Plants)
Indian Institute of Soil Science
Bhopal
(Madhya Pradesh) 462 038
54. Dr Ashwani Kumar
Project Co-ordinator (Optimization of Ground Water Utilization)
Directorate of Water Management
Khurda, Bhubaneshwar
(Orissa) 751 023
55. Dr Y Muralidharudu
Project Co-ordinator (Soil Test and Crop Response)
Indian Institute of Soil Science
Bhopal (Madhya Pradesh) 462 038
56. Dr Ashwani Kumar
Project Co-ordinator (Water Management)
Directorate of Water Management
Bhubaneshwar (Orissa) 751 023
57. Dr J G Vashney
Project Co-ordinator (Weed Control)
Directorate of Weed Science Research
Adhartal
Jabalpur (Madhya Pradesh) 482 004

Engineering and Technology

58. Dr P R Bhatnagar
Project Co-ordinator (Application of Plastic in Agriculture)
Central Institute of Post-harvest Technology
Ludhiana (Punjab) 141 004
59. Dr L P Gite
Project Co-ordinator (Ergonomics and Safety in Agriculture)
Central Institute of Agricultural Engineering
Bhopal (Madhya Pradesh) 462 038
60. Dr Surendra Singh
Project Co-ordinator (Farm Implements and Machinery)
Central Institute of Agricultural Engineering
Bhopal (Madhya Pradesh) 462 038
61. Dr S K Nanda
Project Co-ordinator (Post-Harvest Technology)
Central Institute of Post-Harvest Technology
Ludhiana (Punjab) 141 004
62. Dr M Shyam
Project Co-ordinator (Renewable Sources of Energy for and Agriculture and Agro-based Industries)
Central Institute of Agricultural Engineering
Bhopal
(Madhya Pradesh) 462 038
63. Dr Deepak Chaudhuri
Project Co-ordinator (Utilization of Animal Energy with Enhanced System Efficiency)
Central Institute of Agricultural Engineering
(Madhya Pradesh) 462 038

Animal Sciences

64. Dr K Prabhudas
Project Co-ordinator (ADMAS)
Project Directorate on Animal Disease Monitoring and Surveillance
Hebbal, Bangalore (Karnataka) 560 024
65. Dr Rishendra Verma
Network Co-ordinator (Blue tongue)
IVRI
Izatnagar (Uttar Pradesh) 243 122
66. Dr R K Sethi
Network Co-ordinator (Buffalo improvement)
CIRB
Hisar (Haryana) 125 001
67. Dr A K Misra
Project Co-ordinator (Cattle)
Project Directorate on Cattle
Meerut (Uttar Pradesh) 250 002
68. Dr K T Sampath
Project Co-ordinator (Improvement of Feed Resources and Nutrient Utilization in Raising Animal Production and Outreach Programme on Methane Emission)
NIANP
Audugodi, Bangalore (Karnataka) 560 030
69. Dr B Pattnaik
Project Co-ordinator (FMD)
Project Directorate on Foot and Mouth Diseases
IVRI Campus
Mukteshwar (Uttar Pradesh) 263 138
70. Dr S K Jindal
Project Co-ordinator (Goats)
Central Institute for Research on Goat
Mathura (Uttar Pradesh) 281 122
71. Dr Rishendra Verma
Network Co-ordinator (Haemmrrhagic Septicaemia)
IVRI, Izatnagar 243 122
72. Dr J K Malik
Network Co-ordinator (Gastro-intestinal parasitism)
IVRI, Izatnagar (Uttar Pradesh) 243 122
73. Dr Anuprata Das
Project Co-ordinator (Pigs)
NRC on Pigs
Guwahati (Asom) 781 037
74. Dr R P Sharma
Project Co-ordinator (Poultry Breeding)
Project Directorate on Poultry
Rajendranagar
Hyderabad (Andhra Pradesh) 500 030
75. Dr B K Joshi
Network Co-ordinator (Animal Genetic Resources)
NBAGR
Karnal (Haryana) 132 001
76. Dr G R Patil
Network Co-ordinator (Process Upgradation of indigenous milk for industrial application)
NDRI, Karnal (Haryana) 132 001
77. Dr A L Arora
Network Co-ordinator (Sheep Breeding)
CSWRI
Avikanagar (Rajasthan) 304 501

Education

78. Dr Krishna Srinath
Project Co-ordinator (Home Science)
Directorate of Research on Women in Agriculture
Bhubaneshwar (Orissa) 751 001

APPENDIX 9

AGRICULTURAL UNIVERSITIES AND THEIR VICE-CHANCELLORS

1. Dr P Raghava Reddy
   Acharya N G Ranga Agricultural University
   Rajendranagar,
   Hyderabad (Andhra Pradesh) 500 030
2. Dr S D Shikamany
   Andhra Pradesh Horticulture University
   Tadepalligudam (Andhra Pradesh) 534 101
3. Dr M C Varshneya
   Anand Agricultural University
   Anand (Gujarat) 388 110
4. Dr K M Bajarbaruah
   Assam Agricultural University, Jorhat
   (Assam) 785 013
5. Dr S K Sanyal
   Bidhan Chandra Krishi Vishwa Vidyalaya
   Mohanpur, Nadia (West Bengal) 741 252
6. Dr N N Singh
   Birsa Agricultural University
   Ranchi (Jharkhand) 834 006
7. Dr G C Tewari
   Chandra Shekhar Azad University of Agriculture and Technology,
   Kanpur (Uttar Pradesh) 208 002
8. Dr K S Khokhar
   Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana) 125 004
9. Dr Tej Partap
   Ch Sarwan Kumar Krishi Vishwavidyalaya
   Palampur (Himachal Pradesh) 176 062
10. Dr Vijay B Mehta
    Dr Balaesahib Sawant Konkan Krishi Vidyapeeth
    Dapoli (Maharashtra) 415 712
11. Dr V M Mayande
    Dr Panjabrao Deshmukh Krishi Vidyapeeth
    Akola (Maharashtra) 444 104
12. Dr K R Dhiman
    Dr Yashwant Singh Parmar University of Horticulture and Forestry
    Nauni, Distt Solan (Himachal Pradesh) 173 230
13. Dr B S Bisht
    Govind Ballabh Pant University of Agriculture and Technology
    Pantnagar (Uttaranchal) 263 145
14. Dr V K Taneja
    Guru Angad Dev Veterinary and Animal Sciences University
    PAU Campus, Ludhiana, Punjab 141 004
15. Mr M P Pandey
    Indira Gandhi Krishi Vishwavidyalaya
    Raipur (Chhatisgarh) 492 012
16. Dr Gautam Kalloo
    Jawaharlal Nehru Krishi Vishwa Vidyalaya
    Jabalpur, (Madhya Pradesh) 482 004
17. Dr N C Patel
    Junagarh Agricultural University
    Junagarh (Gujarat) 362 001
18. Dr Suresh S Honnappagol
    Karnataka Veterinary, Animal and Fisheries Sciences University
    Bidar (Karnataka) 585 401
19. Dr K R Viswambharan
    Kerala Agricultural University
    Vellanikara, Distt Trichur (Kerala) 680 656
20. Dr Arun S Ninawe
    Maharashtra Animal Sciences and Fisheries University
    Nagpur (Maharashtra) 440 006
21. Dr R B Deshmukh
    Mahatma Phule Krishi Vidyapeeth
    Rahuri (Maharashtra) 413 722
22. Dr S S Kadam
    Marathwada Agricultural University
    Parbhani
    (Maharashtra) 431 402
23. Dr Basant Ram
    Narendra Dev University of Agriculture and Technology
    Faizabad (Uttar Pradesh) 224 229
24. Dr H C Pathak
    Navsari Agricultural University
    Navsari (Gujarat) 396 450
25. Dr D P Ray
    Orissa University of Agriculture and Technology
    Bhubaneshwar (Orissa) 751 003
26. Dr Manjit Singh Kang
    Punjab Agricultural University
    Ludhiana (Punjab) 141 004
27. Dr S S Chahal
    Maharana Pratap University of Agriculture and Technology
    Udaipur (Rajasthan) 313 001
28. Dr Pranab Narain
    Rajasthan Agriculture University
    Bikaner (Rajasthan) 334 006
29. Prof Vijay Singh Tomar
    Rajmata Vijayaraje Scindia
    Krishi Vishwa Vidyalaya,
    Gwalior (Madhya Pradesh) 474 002
30. Dr M L Chaudhary
    Rajendra Agricultural University
    Samastipur, Pusa (Bihar) 848 125
31. Dr R C Maheshwari
    SD Agricultural University
    Dantiwada (Gujarat) 385 506
32. Vice-Chancellor
    Sardar Ballabh Bhai Patel University of Agriculture and Technology
    Modipuram, Meerut (Uttar Pradesh) 250 110
33. Dr Anwar Alam
    Sher-E-Kashmir University of Agricultural Sciences and Technology
    Srinagar (Jammu and Kashmir) 191 121
34. Dr B Mishra
    Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu
    45-B, Gandhinagar, PB 37
    Jammu (Jammu and Kashmir) 180 009
35. Dr DVG Krishna Mohan
    Sri Venkateswara Veterinary University
    Tirupati (Andhra Pradesh) 517 502
36. Dr P M Boopathi
    Tamil Nadu Agricultural University
    Coimbatore (Tamil Nadu) 641 003
37. Dr P Thangaraju
    Tamil Nadu Veterinary and Animal Sciences University, Chennai (Tamil Nadu) 600 051
38. Dr P G Chengappa
    University of Agricultural Sciences, GKVK
    Bangalore (Karnataka) 560 065
39. Dr H S Vijaya Kumar
    University of Agricultural Sciences
    Dharwad (Karnataka) 580 005
40. Dr B V Patil
    University of Agricultural Sciences
    Raichur (Karnataka) 584 101

41. Dr S B Dandin
University of Horticultural Sciences
Bagalkot (Karnataka) 587 102
42. Dr G C Tiwari
UP Deen Dayal Upadhyaya Veterinary and Animal Science University
Mathura (Uttar Pradesh) 281 001
43. Dr Asit Kumar Das
Uttar Banga Krishi Vishwavidyalaya
Pundibari, Cooch, Bihar (West Bengal) 736 165
44. Dr C S Chakrabarti
West Bengal University of Animal and Fishery Sciences, 68KB Sarani
Kolkata (West Bengal) 700 037

Central Agricultural University

1. Dr S N Puri
Central Agricultural University
Imphal (Manipur) 795 004

Central Universities (with Agriculture Faculty)

1. Dr P K Abdul Azis
Aligarh Muslim University
Aligarh (Uttar Pradesh) 202 002
2. Professor D P Singh
Banaras Hindu University
Varanasi (Uttar Pradesh) 221 005
3. Professor Rajat Kumar Roy
Upacharya, Visva Bharati
Sriniketan (West Bengal) 731 236
4. Prof R K Roy
Viswa Bharti, Palli Bhavana
Shantiniketan (West Bengal) 731 236
5. Vice-Chancellor
Nagaland University
Medziphema (Nagaland) 797 106

Deemed-to-be Universities

1. Dr H S Gupta
Indian Agricultural Research Institute
Pusa,
New Delhi 110 012
2. Dr M C Sharma
Indian Veterinary Research Institute
Izatnagar
(Uttar Pradesh) 243 122
3. Dr A K Srivastava
National Dairy Research Institute
Karnal
(Haryana) 132 001
4. Dr Dilip Kumar
Central Institute of Fisheries Education
Jaiprakash Road,
Seven Bungalows, Versova
Mumbai (Maharashtra) 400 061
5. Dr R B Lal
Sam Higginbottom Institute of Agriculture, Technology and Sciences
Allahabad
(Uttar Pradesh) 211 007

APPENDIX 10

Total number of employees in the ICAR and its research institutes and number of Scheduled Castes, Scheduled Tribes and Other Backward Classes

	Total posts sanctioned	Total employees in position	Total SC among them	Per cent to total employees	Total ST among them	Per cent to total employees	Total OBC among them	Per cent to total employees
1. Scientific Post								
Scientist	3881	3094	435	14.25	98	3.96	364	11.76
Senior Scientist	1651	598	68	10.86	13	2.00	67	11.20
Prinicipal Scientist	741	481	72	14.96	07	3.74	37	7.69
RMP Scientist	156	142	05	3.52	03	2.11	10	6.33
Total	6429	4315	580	13.44	121	2.80	478	11.07
2. Technical Posts								
Category I	3842	3143	625	16.26	328	8.53	379	9.86
Category II	2665	2433	418	15.70	144	5.40	283	10.61
Category III	756	659	134	17.72	37	4.89	64	8.46
Total	7263	6235	1177	16.20	509	7.00	726	9.99
3. Administration Posts								
(a) Directors/Dy.Secretaries Under Secretaries/ Sr. Admn. Officers/ Sr. Accounts Officers/ Admn. Officer/ F&AO/Legal, PA	181	164	24	14.63	12	7.31	7.00	4.26
(b) Asstt. Fin. & Accounts Officer/Accounts Officer Section Officer/Hindi Officer/Desk Officer	658	560	83	14.82	45	8.03	25	4.46
(c) Assistants, UDC/PA AD (OL)/PS/ SO/DO/JA/	4246	3595	641	17.83	268	7.45	313	8.70
Total	5095	4319	728	14.29	325	6.37	345	6.77
4. Supporting skilled Staff (Grade I, II, III, IV)	9352	7950	2287	28.76	581	7.30	855	10.75
5. Supporting staff								
(Safiwala)	98	98	82	83.67				
Auxillary post dying cadre	21	17	5	29.00				

APPENDIX 11

AWARDS

AWARD	AWARDEES
Sardar Patel Outstanding Institution Award (2008)	*ICAR Institutes* (i) Central Rice Research Institute, Cuttack, Orissa (ii) Directorate of Oilseeds Research, Hyderabad, Andhra Pradesh
Jawaharlal Nehru Award for Outstanding Post-graduate Agricultural Research (2008)	*Crop Sciences and Crop Improvement* (i) Dr Rakesh Singh, IARI, New Delhi (ii) Dr G Velu, TNAU, Coimbatore, Tamil Nadu *Biotechnology* (i) Dr K Rekha Devi, Central Institute of Fisheries Education, Kochi, Kerala (ii) Dr Dipnarayan Saha, Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand *Plant Protection including Microbiology* (i) Dr C N Lakshinaryana Reddy, UAS, Bengaluru, Karnataka (ii) Dr Vidya Mulimani, UAS, Dharwad, Karnataka *Soil Science, Natural Resource Management and Agronomy* (i) Dr C Naryanaswamy, UAS, GKVK, Bengaluru, Karnataka (ii) Dr Partha Pratim Adhikary, CSWCRTI, RC, Datia, Madhya Pradesh *Horticulture* (i) Dr Amjad Masood Husaini, Jamia Hamdard, New Delhi (ii) Dr S Shyamalamma, UAS, GKVK, Bengaluru, Karnataka *Engineering and Technology* (i) Dr Anil Bhardwaj, PAU, Ludhiana, Punjab (ii) Dr S Balasubramanian, PAU, Ludhiana, Punjab *Animal Production and Veterinary Sciences* (i) Dr R Laha, ICAR Research Complex for NEH Region, Umiam, Meghalaya (ii) Dr Aruna Kumari, Gangineni, College of Veterinary Science, Rajendranagar, Hyderabad, Andhra Pradesh (iii) Dr Rajendran Thomas, National Research Centre on Pig, Guwahati, Asom *Fisheries* (i) Dr Leema Jose, Cochin University of Science and Technology, Cochin, Kerala *Social Sciences including Home Science, Extension and Economics* (i) Dr Swamikannu Nedumaran, TNAU, Coimbatore, Tamil Nadu (ii) Dr Seema Bathla, JNU, New Delhi
N.G. Ranga Farmer Award for Diversified Agriculture (2008)	(i) Mr Shashi Kumar, Janakpuri, Buniyadganj, Gaya, Bihar
Panjabrao Deshmukh Women Agricultural Scientist Award (2008)	(i) Dr N Sadhya Kranti, CICR, Nagpur, Maharashtra (ii) Dr S Uma, NRC for Banana, Tiruchirapalli, Tamil Nadu
Vasantrao Naik Award for Research Applications in Dryland Agriculture (2008)	(i) Dr Manivannan Sandrasekaran, ICAR Research Complex for Goa, Goa

Chaudhary Devi Lal Outstanding AICRP Award (2008)	(i) AICRP on Arid Legumes CAZRI, Jodhpur, Rajasthan
Chaudhary Charan Singh Award for Excellence in Journalism in Agricultural Research & Development (2008)	(i) Dr Dilip Kumar Yadav, Mathura, Uttar Pradesh (ii) Mr Som Dutt, DIPA, ICAR, New Delhi
Lal Bahadur Shastri Young Scientist Award for the Biennium (2007–08)	(i) Dr Pradeep Sharma, DWR, Karnal, Haryana (ii) Dr Anirban Roy, CRIJAF, Kolkata, West Bengal (iii) Dr Sanjay Mothkur Thimma Reddy UAS, Hebbal, Karnataka (iv) Dr K A Gopinath, CRIDA, Hyderabad, Andhra Pradesh (v) Dr V B Patel, IARI, Pusa, New Delhi (vi) Dr Mohammed Shafiq Alam, PAU, Ludhiana, Punjab (vii) Dr Amlan Kumar Patra West Bengal University of Animal and Fishery Sciences Kolkata, West Bengal (viii) Dr Sameer Shrivastava, IVRI, Izatnagar, Uttar Pradesh (ix) Dr Suresh A Kurup, CSWRI, Avikanagar, Rajasthan
Jagjivan Ram Kisan Puraskar (2008)	*Crop Production* (i) Mr G Nagarathnam Naidu Dilsukh Nagar, Hyderabad, Andhra Pradesh *Livestock, Poultry, Fish Farming* (i) Mr Veera Kempanna, Chikkaballapur, Karnataka
Hari Om Ashram Trust Award for the Biennium (2007–08)	*Crop Sciences* (i) Dr Shailaja Hittalmani UAS, GKVK, Bengaluru, Karnataka *Horticulture* (i) Dr R S Marwah, CPRS, Jalandhar, Punjab *Resource Management* (i) Dr Gouranga Kar Water Tech. Centre for Eastern Region Bhubaneshwar, Orissa *Animal Sciences* (i) Dr W S Lakra, NBFGR, Lucknow, Uttar Pradesh
Rafi Ahmed Kidwai Award for the Biennium (2007–08)	*Crop Sciences* (i) Dr K C Bansal, NRC on Plant Biotechnology IARI Campus, Pusa, New Delhi (ii) Dr S K Rao, JNKVV, Jabalpur, Madhya Pradesh *Resource Sciences* (i) Dr P S Minhas, PAU, Ludhiana, Punjab *Engineering and Technology* (i) Dr Sushil Kumar Kamra, CSSRI, Karnal, Haryana *Animal Sciences* (i) Dr Gaya Prasad, CCSHAU, Hisar, Haryana
Swami Sahajanand Saraswati Extenion Scientist/ Worker Award for the Biennium (2007–08)	*Agricultural Extension for Livestock Production* (i) Dr Shalander Kumar CRIDA, Hyderabad, Andhra Pradesh *Agricultural Extension for Crop Production* (i) Dr P Jeyakumar, NCIPM, IARI Campus, New Delhi *Agricultural Extension for Resource Management* (i) Dr K Narayana Gowda UAS, GKVK, Bengaluru, Karnataka
National Krishi Vigyan Kendra Award (2008)	(i) KVK, DDRI, Satna, Madhya Pradesh (ii) MYRADA, KVK, Erode, Tamil Nadu (iii) KVK (North Goa), ICAR Research Complex for Goa Ela, Old Goa

APPENDIX 12

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Summary of Audit Observations
(C&AG Report for the year ended March 2008)
(Union Government, Scientific Departments, No. CA 16 of 2008–09)

1. Avoidable expenditure due to excess procurement

Indian Agricultural Research Institute purchased three Gas Liquid Choromotographs (GCs) against the requirement of only one. As such, the expenditure of Rs 25.92 lakh on procurement of two additional GCs was avoidable

(Paragraph 9.1.)

2. Avoidable expenditure due to failure to obtain separate electrical connection for staff quarters

Failure of National Dairy Research Institute to get separate electric connection for its staff quarters, resulted in avoidable expenditure of Rs 25.16 lakh from April 2001 to May 2008 due to payment of electricity charges at commercial rates for residential staff quarters.

(Paragraph 9.2)

Council's response

Action taken notes in respect of paras at Sl No. 2, has already been furnished to Audit. In respect of paras at Sl No. 1 above, the action taken notes shall be furnished to Audit shortly.

Acronyms

AAU	:	Assam Agricultural University
AI	:	Artificial Insemination
AICRP	:	All-India Co-ordinated Research Project
AINP	:	All-India Network Project
AKI	:	Agricultural Knowledge Initiative
ANGRAU	:	Acharya NG Ranga Agricultural University
ARIC	:	Agricultural Research Information Centre
ARIS	:	Agricultural Research Information System
ARS	:	Agricultural Research Service
ASRB	:	Agricultural Scientists Recruitment Board
AU	:	Agricultural University
AUTM	:	Association of Universities for Technology Management
BBF	:	Broad Bed and Furrow
BE	:	Budget Estimate
BHU	:	Banaras Hindu University
BPD	:	Business Planning Development
BTV	:	Bluetongue Virus
CAU	:	Central Agricultural University
CAZRI	:	Central Arid Zone Research Institute
CCSHAU	:	Chaudhary Charan Singh Haryana Agricultural University
CGIAR	:	Consultative Group on International Agricultural Research
CIAE	:	Central Institute of Agricultural Engineering
CIBA	:	Central Institute of Brackishwater Aquaculture
CICR	:	Central Institute for Cotton Research
CIFA	:	Central Institute of Freshwater Aquaculture
CIFE	:	Central Institute of Fisheries Education
CIFRI	:	Central Inland Fisheries Research Institute
CIMMYT	:	Centro International de Mejormento de Maize Trigo
CIPHET	:	Central Institute of Post-harvest Engineering and Technology
CIRCOT	:	Central Institute for Research on Cotton Technology
CMFRI	:	Central Marine Fisheries Research Institute
CMS	:	Cytoplasmic Male Sterile
CP	:	Crude Protein
CPCRI	:	Central Plantation Crops Research Institute
CRIDA	:	Central Research Institute for Dryland Agriculture
CRIJAF	:	Central Research Institute for Jute and Allied Fibres
CRRI	:	Central Rice Research Institute
CTCRI	:	Central Tuber Crops Research Institute
CTMC	:	Central Technology Management Committee
CTRI	:	Central Tobacco Research Institute
DARE	:	Department of Agricultural Research and Education
DAS	:	Days After Sowing
DBT	:	Department of Biotechnology
DDG	:	Deputy Director-General
DG	:	Director-General
DIPA	:	Directorate of Information and Publications of Agriculture
DRWA	:	Directorate of Research on Women in Agriculture
DU	:	Deemed-to-be University
DWR	:	Directorate of Wheat Research
EIA	:	Enzyme Immuno Assay
ELISA	:	Enzyme-linked Immunosorbent Assay
EPN	:	Entomopathogenic Nematode
ETL	:	Economic Threshold Level
FAO	:	Food and Agriculture Organization
FMD	:	Foot-and-Mouth Disease
FSH	:	Follicle-stimulating Hormone
FYM	:	Farmyard Manure
GBPUAT	:	Govind Ballabh Pant University of Agriculture and Technology
GCMS	:	Gas Chromatography Mass Spectrometry
GIS	:	Geographical Information System
GPA	:	Global Plan of Action
GPS	:	Global Positioning System
GRD	:	General Recommended Dose
HAPA	:	Hybridization-supplemented Apomixis Components Partitioning Approach
HDPE	:	High Density Polyethylene
HPTLC	:	High Performance Thin Layer Chromatography
HRD	:	Human Resource Development
HTMA	:	Hair Tissue Mineral Analysis
IARI	:	Indian Agricultural Research Institute
IASRI	:	Indian Agricultural Statistics Research Institute
ICAR	:	Indian Council of Agricultural Research
ICARDA	:	International Centre for Agricultural Research in Dry Areas
ICRISAT	:	International Crops Research Institute for Semi-Arid Tropics
ICT	:	Information and Communication Technologies
IFS	:	Integrated Farming System
IGFRI	:	Indian Grassland and Fodder Research Institute
IGKVV	:	Indira Gandhi Krishi Vishwa Vidyalaya
IIHR	:	Indian Institute of Horticultural Research
IINRG	:	Indian Institute of Natural Resins and Gums
IISR	:	Indian Institute of Sugarcane Research
IPGRI	:	International Plant Genetic Resources Institute
IPM	:	Integrated Pest Management
IPR	:	Intellectual Property Right
IRRI	:	International Rice Research Institute
IVDMD	:	*In-vitro* Dry Matter Digestibility
IVF	:	*In-vitro* Fertilization
IVRI	:	Indian Veterinary Research Institute
JAU	:	Junagarh Agricultural University
JNKVV	:	Jawaharlal Nehru Krishi Vishwa Vidyalaya
LDPE	:	Low Density Polyethylene
MAP	:	Modified Atmosphere Packaging
MAS	:	Molecular Marker-assisted Selection
MNFB	:	Multi-nutrient Feed Block
MoU	:	Memorandum of Understanding
MPAUT	:	Maharana Pratap University of

		Agriculture and Technology
MR	:	Moderately Resistant
MW	:	Molecular Weight
NA	:	Nutrient Agar
NAARM	:	National Academy of Agricultural Research and Management
NAIP	:	National Agricultural Innovation Project
NARC	:	Nepal Agricultural Research Council
NARD	:	National Agricultural Research Database
NARS	:	National Agricultural Research System
NBAGR	:	National Bureau of Animal Genetic Resources
NBAIM	:	National Bureau of Agriculturally Important Microorganisms
NBFGR	:	National Bureau of Fish Genetic Resources
NBPGR	:	National Bureau of Plant Genetic Resources
NCAP	:	National Centre for Agricultural Economics and Policy Planning
NDRI	:	National Dairy Research Institute
NET	:	National Eligibility Test
NGOs	:	Non-Government Organizations
NHCP	:	National Herbarium of Cultivated Plants
NIANP	:	National Institute of Animal Nutrition and Physiology
NIRJAFT	:	National Institute of Research on Jute and Allied Fibre Technology
NISAGENET	:	National Information System on Agricultural Education Network
NISM	:	National Information Sharing Mechanism
NRC	:	National Research Centre
NSKE	:	Neem Seed Kernel Extract
OBCs	:	Other Backward Classes
OL	:	Other Languages
OMP	:	Outer Membrane Protein
OUAT	:	Orissa University of Agriculture and Technology
PAGE	:	Polyacrylamide Gel Electrophoresis
PAU	:	Punjab Agricultural University
PCR	:	Polymerase Chain Reaction
PD_ADMAS	:	Project Directorate on Animal Disease Monitoring and Surveillance
PG	:	Post-graduate
PPVFR	:	Protection of Plant Varieties and Farmers' Right
PTO	:	Power Take Off
PVP	:	Polyvinyl Pyrrolidone
RAPD	:	Random Amplified Polymorphic DNA
RAU	:	Rajendra Agricultural University/ Rajasthan Agriculture University
RDF	:	Recommended Dose of Fertilizer
RDN	:	Rumen Degradable Nitrogen
RE	:	Revised Estimate
RFLP	:	Restricted Fragment Length Polymorphism
RH	:	Relative Humidity
RTV	:	Rice Tungro Virus
SAC	:	Space Application Centre
SAUs	:	State Agricultural Universities
SBI	:	Sugarcane Breeding Institute
SCC	:	Somatic Cell Count
SHGs	:	Self-help Groups
SLTL	:	Soil Loss Tolerance Limit
SNP	:	Single Nucleotide Polymorphism
SOC	:	Soil Organic Carbon
SRF	:	Senior Research Fellowship
SRI	:	System of Rice Intensification
SSD	:	Super Saturated Designs
SSNM	:	Site-specific Nutrient Management
SSP	:	Single Superphosphate
SSRs	:	Simple Sequence Repeats
SVVU	:	Sri Venkateswara Veterinary University
TANUVAS	:	Tamil Nadu University of Veterinary and Animal Sciences
TDN	:	Total Digestible Nutrient
TLCV	:	Tomato Leaf Curl Virus
TNAU	:	Tamil Nadu Agricultural University
TSS	:	Total Soluble Solids/Sugars
TVCSC	:	Teaching Veterinary Clinical Service Complex
UAS	:	University of Agricultural Sciences
UG	:	Under-graduate
UGC	:	University Grants Commission
UTM	:	Uterine Milk Protein
VAM	:	Vesicular-arbuscular Mycorrhiza
VPKAS	:	Vivekananda Parvatiya Krishi Anusandhan Sansthan
WBNV	:	Watermelon Bud Necrosis Virus

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