Overview

The year 2003–2004 received normal monsoon in over 90% of the country. Fortunately, during the year there was no major incidence of drought, disease or insect pests. As a result of favourable weather conditions and timely and adequate availability of inputs such as seeds, fertilizers, pesticides, feeds, vaccines, medicines etc., our foodgrains production is estimated to be 210.78 million tonnes.

The Indian Council of Agricultural Research, as the national apex organization for agricultural research and education, is strongly emphasizing the role of collective and synergistic efforts to increase the food production, through enhancements of productivity and input use efficiency, in view of our rising population and mounting concern to safeguard the natural resources. An overview of the Council's achievements in agricultural research, education and frontline extension during 2003–2004 and the initiatives taken to sustain the enhanced agricultural productivity and profitability is presented here.

Under *Crop Improvement and Management* germplasm being basic and essential, 11,889 accessions of crops and their wild relatives were collected through 186 explorations in different parts of the country. Besides, 33,092 accessions of diverse crops from various countries including 25 of transgenic crops, were introduced. Accessions numbering 45,093 were processed for quarantine clearance. The National Seed Genebank has been enriched with 20,453 accessions and over 200 phyto-sanitary certificates have been issued for export material. More than 600 varieties and elite germplasm lines of 15 crops have been fingerprinted. Also, marker has been identified to determine rate of ripening in tomato.

During the year, 19 varieties and one hybrid in rice, seven varieties in wheat, one variety in barley, 11 cultivars in maize, two hybrids in sorghum, three open-pollinated varieties and one hybrid in pearl millet have been released for their commercial cultivation in food crops for various agro-ecologies. Rice variety Nidhi was found suitable for direct seeding under puddle conditions. Besides, 10 varieties of wheat, two varieties of barley, five hybrids of pearl millet and one variety of proso millet have been identified for release. One variety of foxtail millet has been notified for cultivation in Rajasthan. In forage crops, five varieties, one each in cowpea, tall fescue grass, setaria grass, pearl millet and berseem have been released for cultivation.

Among pulses three varieties of pigeonpea, two varieties each of chickpea and urdbean and one variety each of fieldpea and lentil have been released/identified for cultivation. Two varieties of arid legumes could be identified for pre-release seed multiplication. In oilseeds, two varieties each of groundnut and rapeseed-mustard, four of sesame, and one variety each of niger, soybean, sunflower, safflower and linseed have been released/identified for cultivation. A stem-rot-resistant groundnut genotype (CS 19) of interspecific origin was developed for the first time. In commercial crops, six varieties/hybrids of cotton and five varieties of sugarcane have been released/notified/identified for commercial cultivation. One variety of tobacco has also been recommended for release.

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The national test guidelines were framed for Distinctness, Uniformity and Stability (DUS) testing for all major crops. An atlas was prepared for quality parameters of wheat. Other major achievements in the crop sector include: production of 3,067 tonnes of breeder seed of different crops, popularization of rice–chickpea system over rice–wheat system for higher economical returns, effective control of Karnal bunt on wheat with two foliar sprays of *Trichoderma viride,* standardization of simplified growth-room screening technique for studying *Botrytis* grey-rot in detached spike of castor and development of Expert System BIORICE for biocontrol of rice pest.

In *Improvement and Management of Horticultural Crops*, 15 accessions of guava and seven wine varieties and four natural mutants of grape were added to gene bank. The traps consisting of ethyl alcohol, methyl eugenol and malathion in a 6 : 4 : 1 ratio soaked in plywood could manage fruit-fly effectively in mango. In banana, a novel technique to feed bunches through distal end has been developed to increase bunch weight. Packaging technology for banana was standardized for export purpose. Two hybrids of rough lemon × Troyer Citrange were found promising rootstocks for *Phytophthora* resistance. Embryo-rescue technique was standardized in grape. During one year production cycle Metwin 2 software could save 11 sprays in disease management in grape cultivation. Besides, improvement in shelf-life of grapes was noted with pre-harvest treatment of chitosan alone or in combination with *Trichoderma*. In papaya, adoption of plant density of 555 trees/ha resulted in 48% more yield. Litchi Rose Scented gave high yield with good-fruit quality.

In arid zone fruits, major accomplishments include collection of 12 new frost-resistant genotypes of *aonla* from mid-hills region of Himachal Pradesh, introduction of six varieties of pomegranate and three varieties of fig, and recommendation of two varieties (Kaithali and Gola) of *ber* and one variety (APK 1) of pomegranate for commercial cultivation in rainfed Vertisols in Arupukkotai region. Collection of apricot selection Suka, having red cheeks, was a major finding in temperate fruits.

In vegetable crops, one variety and two hybrids of tomato and two varieties of garlic have been released for cultivation. One variety and one hybrid of chilli; one variety each of cowpea, pea and French bean; two varieties of okra; one hybrid each of tomato, capsicum, bitter-gourd and cauliflower; and two hybrids of brinjal were identified for release. Eight new varieties of vegetables have been released by the Delhi State Variety Release Committee. Other major accomplishments include: standardization of technology producing quality tomato and capsicum and discovery of a new species of begomo virus causing leaf curl in tomato. In potato, four hybrids have been recommended for release and 20 accessions added to germplasm. In tropical tuber crops, 65 new accessions/collections have been added to germplasm.

In cassava, two triploid clones with higher extractable starch have been identified for industrial use. In mushroom, 21 new wild mushroom species have been collected. Oyster mushroom could be successfully grown on wheat straw, rice straw and on leaves and stalk of maize. A cryoperservation technique for preservation of *Volvariella* and *Morchella* cultures has been developed.

Six varieties of rose and five of gladiolus have been released. About 450 species belonging to 93 genera of orchids have been collected. The concerted research efforts resulted in release of two high-yielding and high-quality ginger varieties (IISR Mahima and IISR Rejatha) and one nutmeg clonal selection (IISR Viswashree) for cultivation in Kerala and addition of accessions of ginger, cardamom, turmeric, *Garcinia, Cinnamomum* and of nine seed spices to germplasm.

In *Natural Resource Management,* soil resource

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atlases of 24 districts for sustainable land use, and soil erosion maps of Rajasthan, Madhya Pradesh and Chhattisgarh have been brought out, besides identification of important benchmark soil series in four districts of Assam. Sustainable cropping system in rice fallows of Brahmaputra valley of Jorhat, Assam, and critical areas for prioritized land treatments in watersheds have been identified. Mixed biofertilizer formulations consisting of nitrogen-fixing organisms and phosphate-solubilizing bacteria (PSB) proved superior to individual inoculants.

The water resource development proved beneficial for cyclone-affected farmers of coastal Orissa. Other salient achievements under water management had been improvement in yield and quality of banana under drip irrigation and usefulness of fish pond-cum-reservoir for economized and multiple uses of water. The research conducted in saline coastal soils led to the maintenance of rice and wheat yields even at 50% NPK when used in conjunction with farmyard manure (FYM) or green manuring, development of technologies for skimming and recharging freshwater in saline groundwater regions, identification of causes and remedial measures for resodification of reclaimed soils in Uttar Pradesh, development of organic practices for rice-based cropping systems in saline coastal soils and reclamation of alkali Vertisols under rainfed condition.

Conservation furrow plots could store 4–37% additional soil moisture and resulted in higher bean and seed yield of castor and pigeonpea. Tolerance of sorghum to biotic stress could be enhanced through genetic manipulation. Development of a new technique of growing mat-type nursery for rice transplanters, improvement in nitrogen and phosphorus-use efficiency through inclusion of forage cowpea in rice–wheat system and enhancement in yield, soil organic carbon and available P and K with soil application of ferrous sulphate, zinc sulphate and urea along with *Aspergillus awamorae* and *Trichoderma viride* in rice–wheat system are the salient features of crop production research.

A low-cost passive cool chamber has been developed for short-duration preservation of vegetables and fruits. Spraying 2,4-D @ 1.5–2.0 kg/ha, glyphosate @ 1.5 kg/ha on actively growing plants or new shoots of *Ipomoea carnea*, the most problematic weed, proved effective in its control. An integrated management package for lantana has been developed. In agroforestry research, 80% success with *in-situ* veneer grafting in August–September and 25% success with chip budding in August was recorded when these were done on 2 or 3 years old plants of *chironjee*. High survival, increased tree height, canopy diameter, dry leaf fodder and fuel wood of *Albizia procera* were noticed during seventh year in natural grassland. In neem, 276 accessions were collected from eight states. On-line computerized database was also developed for system of agroforestry in India. A website named 'Crop-Weather Outlook' has been developed under AICRPAM and operates from the Central Research Institute for Dryland Agriculture, Hyderabad. The site provides useful information on crop-weather conditions in the country.

Under *Livestock and Poultry Improvement and Management,* database on Indian livestock resources, infrastructure, animal production, products and utilization has been made available in a single user-friendly package. Polymorphism of growth hormone gene in Karan Fries cattle and Murrah buffalo was revealed for the first time in developing a strategy for genetic selection of dairy bulls. Immune competence of purelines of poultry was profiled, primarily for breeding purposes. Buffalo ovary-released protein was identified as a marker for oestrous and pregnancy detection. Genetic distance measures revealed that Nali and Chokla sheep are genetically closer, while Garole sheep is a distinct population. Since Nicobari and

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Kashmir Favorolla poultry populations showed recent genetic bottleneck, these require their special conservation efforts. For the first time, neighbour-joining tree of Indian goat breeds with wild goats could be constructed.

Aseel and Kadakanath poultry breeds were utilized to develop CARI-Nirbheek and CARI-Shyama for backyard poultry. A preliminary attempt was made to grow embryonic stem cells in buffalo. Double window embryo culture system for production of turkey embryos was developed for first time in the world. This technique could be used for transgenesis, production of chimeric birds and production of pharmaceutical proteins with egg gene promoters. The technique will help in conserving rare and endangered poultry species.

The Frieswal cows recorded 3,570 kg milk yield in 300 days with peak yield of 14.27 kg and lactation length 315 days. Average milk yield of Murrah buffaloes was 2,928 kg. Genetic improvement studies are in progress in Hariana, Gir, Ongole and Tharparker breeds. In sheep, Chokla, Marwari and Magra are being studied for carpet wool production and Madras Red, Ganjam, Muzaffarnagari, Nellore and Deccani for mutton production. In Barbari and Jamunapari goats, genetic improvement and sire evaluation are in progress. The National Research Centre on Pigs was established at Rain, Guwahati, Assam. The Caribro-Tropicana birds ranked third in 19th Random Sample Poultry Performance Test (RSPPT), Gurgaon, showing 1,750 g body weight by 7 weeks of age. The CARI layer bird strain achieved top position in hen-housed egg production at 31st RSPPT, Hessaraghatta, Bangalore. The CARIBRO-Dhanraj birds could achieve 1,875 g body weight at 7 weeks of age.

Complete nucleotide (nt) sequence of foot-and-mouth disease virus Asia 1 vaccine strain (IND 491/97) was determined. The National Animal Disease Referral Expert System was evolved for monitoring and forecasting animal diseases. Immunized kids showed reduction in growth of *Theileria annulata*. Molecular techniques could be developed to unravel mysteries of disease outbreak in natural conditions. Low volume saponified *hemorrhagic septicemia* vaccine for cattle and buffalo was prepared and is under trial in a large number of cattle. Primer for identification of gastro-intestinal parasites was developed for the first time. In pigs, diagnostic test was developed for porcine reproductive and respiratory syndrome (PRSS). An indigenous killed vaccine using EHV-1 strain was developed, showing better immune response than commercially available vaccine. PCR-ELISA was developed for differential diagnosis of capri-pox virus. PCR was found to be the test of choice in surveillance and monitoring of camel surra or trypanosomiasis. Non-isotropic DNA probe was developed for detection of swine fever. A primer pair was synthesized for using in duck plague virus detection by PCR. Diagnostic kits were developed for rinderpest and peste des petits ruminants (PPR) and live attenuated vaccine for PPR. Recombinant antigen-based diagnostics could be developed for detection of bovine viral diarrhoea virus.

The potential dry-matter availability of animal feed resources increased in Karnataka. Grain : straw ratio was found useful in determining dry fodder availability. Cellulase gene from *Ruminococus albus* could be cloned in *Escherichia coli*. Feeding of chaffed maize improved the body weight in crossbred calves. *Orphinomyces* sp.(C 14) proved a better ruminal fungal isolate in improving nutritive value of wheat straw-based diet. Ragi straw was found to be a better source of dry matter, crude protein and fibre than paddy straw. A technology was developed for preparation of chelate minerals. Nutritional remedies were suggested for sustainable cattle milk production.

Citric acid and neem bark powders were used to prevent fungal infestation of stored feeds. Substitution of barley by *Prosopis juliflora* in sheep diet proved satisfactory. Feed pellets for feeding

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goats were prepared using leaves of *subabul*, neem, *ber*, *peepul*, siris, mulberry and *desi babul*. Milk replacer containing 24% crude protein was found economical than mother's milk for finisher goat kids. Approximately 15 species of rumen ciliates have been identified in mithun.

The nutrient requirement was updated for various avian species. Methionine-supplemented red sorghum diet improved the growth in birds. Feed supplement zeosil plus could counter the adverse effects of aflatoxin. The measured feeding of metabolizable energy in grower phase regulated body weight gain and helped in achieving optimum performance. Krishibro chicks performed normal even with low lysine diets. Dietary supplementation of natural agents minimized production losses due to aflatoxin in feeds and improved cellular immune response, dressing yields and liver fat content. Recommendation of reduced Ca and P in birds' diet resulted in decreased feed cost without affecting the growth or bone mineralization. Sesame and sunflower protein-meal resulted in lean broiler meat.

A laboratory procedure was evolved to accurately predict fertility of bulls in making selection procedure more effective. Improvement in cryopreservation method of semen could reduce rejection rate of ejaculates by 20%. Milk progesterone profile successfully demonstrated the reproduction status in buffalo and it was utilized for timely remedy of reproductive disorder in animal. Estrus synchronization in Malpura ewes resulted in 75% ovulation. The scientific management practices resulted in reduced calf mortality in loose housing system. Artificial insemination (AI) and pregnancy diagnosis could be perfected in equines. Yaks were successfully induced into heat. Enzyme immuno assay was evolved for determination of growth hormone in mithun. Antibiotics reduced the bacterial count in foam of quails. Birds immunized against vaso active intestinal peptide showed higher egg production.

Whey-based *jaljeera* drink was standardized and its dried form was also developed. Inulin @ 3% resulted in better growth and acid production in symbiotic yogurt preparation. Immuno-modulatory property of *dahi* stimulates immune system and protects against enteric infection. Twin-screw plasticizer was developed for production of ghee-based butter. A model was evolved for pore membrane formation by class IIa bacteriocins from gram-positive lactic acid bacteria. Low fat/sugar-free frozen dessert could be developed for diabetic patients. Energy auditing was done for identifying potential for improvement in energy efficiency in model dairy plant. Assays were standardized for detection of antibiotic residues in milk. A process was standardized for soft cheese preparation from camel milk. Customer response to chevon pickle indicated that it has good market potential.

In *Fish Production and Processing,* marine fish landings improved by 13.5% over previous year. Under inland sector, a multimatrix index of fish assemblages has been developed for fish species in river Hooghly. Hilsa continued to be a major component, contributing 10.4% of total yield from Hooghly estuary. The GIS was developed on water bodies for eight districts of Bihar and a digital map was prepared for six districts of Rajasthan.

In culture fisheries, important research achievements during the year have been seed production in *Macrobrachium rosenbergii* using underground saline water with necessary ionic amendments at Rohtak, Haryana, breeding of *Labeo fimbriatus* using a portable hatchery at Bangalore and *in-vitro* cell culture of freshwater pearl mussel. Research efforts in the field of coldwater fisheries led to development of natural lake as conservation site for the threatened mahseer species *Tor putitora*, evolvement of eye ova of rainbow trout under warmer conditions for the first time, and advancement in maturing period of grass and silver carps with harmone treatment and raising water temperature at high altitude. The work conducted under brackishwater aquaculture led to

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successful testing of shrimp feed in a farmer's pond, development of a latex agglutination kit for the detection of white spot virus in shrimps and preparation of immune index to assess the health status of tiger shrimp.

In mariculture, natural spawning of groupers *Epinephelus tauvina* and *E. polyphekadion* could be observed under captive conditions. In five species of damsel fishes, viz. filamentous tail black damsel, yellow tail damsel, blue damsel, peacock damsel and Indian dascyllus, broodstocks were successfully developed. Identification of molecular markers and natural genetic variation in important fish species, karyological characterization of fish species endemic to Western Ghats, development of sperm cryopreservation protocols for *Ompok malabricus*, and diagnostic capability of PCR in detecting exotic pathogens for fish quarantine are some salient accomplishments in fish genetic resources.

In *Agricultural Engineering and Technology*, a number of implements such as lug-wheel puddler, seven-row till-plant machine, pneumatic planter for vegetables, two-row vegetable transplanter, zero-till seed-cum-fertilizer drill for wheat, MPKV multi-crop planter, semi-automatic potato planter and flail-type forage harvester-cum-chopper were developed as tractor-operated machines. Zero-till drill machine, orchard sprayer, OUAT groundnut digger and chipper shredder for cotton-stalks and other agricultural waste were the implements fabricated under power-tiller-operated machinery. In case of self-propelled machinery, two-row cultivator for *biasi* operation, riding type (10-row) rice seeder and power weeders were developed. Likewise, CIAE planter for groundnut, maize, pigeonpea, sorghum and other oilseed and pulse crops under animal-drawn machinery, and indigenous seed counter, high-capacity pigeonpea thresher, maize dehusker-cum-sheller and ANGRAU sugarcane leaf stripper under stationery machinery were developed.

A strength measurement set-up for agricultural workers and anti-vibration devices for comfort of power-tiller and tractor operators were evolved. A low-cost and energy-saving fruit and vegetable preservator has been fabricated that increases shelf-life by 7–12 days and reduces handling damages. In post-harvest engineering technology, prototype of cleaner to arrest dust emission in *dal* mills, process for making fermented banana beverage, double stage filtration system for sugarcane juice and electronic thermometer for striking point in jaggery making have been developed. The technology of making ginger- and vanilla- flavoured chips of coconut has been transferred to coconut entrepreneurs.

The work carried out under cotton technology led to the development of light-weight cotton-gin which can be operated by remote as well. For the first time, coir-cotton composite yarn has been developed through friction spinning technology for industrial uses. In lac technology, successful propagation of *Flemingia semialata* – a recently identified potential bushy host, identification of rare variants of *Butea monosperma* and development of water-thinnable coating compositions for cementitious surfaces were the important findings. Salient achievements in jute technology include successful blending of coir with jute and of sisal with jute, besides the development of bagasse-based gasifier, improved cook stove for low pollution and roof integrated unglazed solar-air heater and solar refrigerator. Pantnagar adjustable collar harness and Allahabad harness have been modified to provide comfort to the animals during work. Technologies of soy-processing, manu-facturing package for serrated sickle etc. have been transferred to users. For commercialization, 31 technologies have been assigned by the ICAR to the National Research Development Corporation.

Under *Agricultural Human Resource Develop-ment*, Model Course Curricula and Syllabi of 8 UG and 44 PG programmes were developed and provided to all agricultural universities along with academic regulations, and majority of SAUs

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and Deemed Universities (DUs) have implemented these courses.

During the year, 127 students from 22 foreign countries were admitted in various degree programmes in ICAR-DUs/SAUs. In Centres of Advanced Studies and Summer/Winter Schools/ Short Courses, 4,250 scientists/faculty members were trained in diverse subjects of agricultural and allied fields. For the award of National Talent Scholarships (NTS), 218 candidates were recommended on the basis of their merit. Junior Research Fellowships were awarded to 438 candidates and Senior Research Fellowships to 202 candidates.

The women and rural girls were trained in scientific child-care and also to undertake activities such as candle preparation, mushroom cultivation etc. As a part of its HRD activities, the National Academy of Agricultural Research and Management organized 36 programmes through which 828 scientists were trained with respect to agricultural research and education management.

In *Social Sciences and Policies*, a study has shown that the demand for livestock products has increased with improved rural income, indicating a need for faster growth in production of livestock products. Coping mechanism was evolved to reduce the impact of climate-induced natural disasters. Integrated technology package was prepared for food security in tribal, backward and hilly areas and initial impacts were assessed. A new mechanism - deficiency price payment - was suggested, and it has to be developed to protect farmers' income. Dissemination of available technology needs more attention in future, as farmers are realizing significant economic benefits by adopting them and support to the extension system will yield heavy returns.

Technology Assessment, Refinement and Transfer is accomplished through Krishi Vigyan Kendras (KVKs), Institution-Village Linkage Programme (IVLP) and Agricultural Technology Information Centres (ATICs). There are 376 KVKs, 70 IVLP Centres, and 44 ATICs. The ATICs provided technological products, diagnostic services and technology information to farmers and end-users. During the year, 19,880 training programmes were organized benefiting 470,000 farmers and farm women, 110,000 rural youth and 60,911 participants. *Kisan melas, gosthies* (discussion forum), advisory services, film shows, diagnostic services, etc. were arranged to accelerate the process of dissemination of technologies.

The production potential of newly released technologies in oilseeds, pulses and other crops were demonstrated through front-line demonstrations. The KVKs identified more than 330 technologies for on-farm testing to assess their impact on location-specific basis in different farming systems. Also quality seed/planting material of cereals, pulses, oilseeds, vegetables, fruits and spices, and livestock strains were produced by KVKs and provided to farmers.

The TTCs organized 216 training courses, benefiting more than 4,100 participants. From the inception of Mission Mode Project, more than 4,000 ITKs have been documented and three publications have been brought out in the form of *Inventory of ITK in Agriculture*. Validation and promotion of IPM technologies were carried out in selected crops in different agro-ecological regions.

Eight projects have been initiated nearly on all aspects of role of *Women in Agriculture*. The Krishi Vigyan Kendras trained nearly 200,000 farm women, girls and women extension workers. Innovative marketing outlets were developed for self-help groups. Cafeteria for women in agriculture was developed and offered to states to guide the development of new programmes for women in agriculture. Five components of the *All-India Co-ordinated Research Project on Home Science* moved towards empowerment of rural women and their main achievements are : mobilization of self-help groups and creation of learning environment,

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strengthening empowerment process, and assessment of empowerment gains for women.

In agricultural research planned especially for *Tribal and Hill Regions*, nine varieties (wheat 2, barley 1, maize 1, pea 2, toria 1, tomato 1 and okra 1) of crops were released and one variety each of wheat, finger millet and amaranth identified at the Vivekananda Parvatiya Krishi Anusandhan Shala, Almora, for release in North-western/ Uttaranchal hills. Identification of eight rice genotypes for multiple-disease tolerance, isolation of a new strain of bacterium (*Yersinia* sp.) from infected white-grub larvae and development of Vivek thresher-cum-pearler for *mandua* and *madira* had been the other significant findings.

The work conducted at the ICAR Research Complex for NEH Region, Umiam, led to development of 10 guava hybrids for cultivation in mid-hills of North-eastern hills region. Rich contents of vitamins and minerals were found in young shoots of edible bamboo. A methodology was developed for boar semen preservation. Dies and fixtures were developed for fabrication of wheel hand hoe, octagonal maize sheller and other tools.

At the Central Agricultural Research Institute, Port Blair, a protocol was developed in rice varieties compatible for other *indica* varieties for developing transgenic plants with economically important genes. Five varieties of rice could be identified for large-scale cultivation under humid tropics of Bay Islands. Cultivation of capsicum, beans and tomato was found economically viable under protected conditions. Other achievements were the successful control of mastitis, enteritis and hump sore in cattles development of synthetic layer suitable for backyard farming in Bay Islands, standardization of dairy calves management for hot and humid climate, successful breeding of clawn fish (*Amphiprion percula*) in captivity and first time breeding of *A. sandarocinos* on formulated feed.

In organization and management of the *National Agricultural Technology Project*, major thrust has been put now by the Council for commercialization of technologies. The National Centre for Agricultural Economics and Policy Planning (NCAP) in consultation with PIU has selected 14 technologies of national significance for impact assessment. A software *Nitriguide* has been developed for assessing the food intake in the Indian context. The National Academy of Agricultural Research and Management(NAARM) has launched a web site *http://naarm.ernet.in* for getting information on Indian agriculture.

Research on production systems resulted in 40–50% additional yield of oilseed crops owing to water-harvesting and drought-mitigation technologies and 75–90% increase in income of tribal farmers by crop diversification. Further, new *arboreum* cotton varieties were identified for dryland areas under rainfed agro-ecosystem. The research conducted under irrigated agro-ecosystem led to the release of multi-cut sorghum hybrid and variety with enhanced nutritional quality, increase in income through zero-tillage technology in wheat, development of direct sensitive micro-filter plate enzyme-immuno-assay method for the first time for estimation of oxytocin, LH, GH, FSH and PGFM and 3–4 times increase in productivity and production of fish reservoir with proper stocking of bigger-size fingerlings. In case of coastal agro-ecosystem, the major findings were popularization of backyard poultry for landless and marginal farmers, development of technology for tissue-cultured pearls that can manipulate colour, hue and luster, process for manufacturing of shell-bead nucleus using indigenous materials and machinery and sero-diagnostic kit for early diagnosis of basal stem rot pathogen of coconut. Control of *khejri* drying and development of skin fibroblast cell technology for livestock germplasm conservation under arid agro-ecosystem and development of cost-effective technology for treatment of choes (rainy-season torrents) under hill and mountain ecosystem were the other achievements.

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In mission mode research, five special explorations were made in different inaccessible areas and areas not surveyed earlier. Standard descriptors were prepared for fruit and medicinal and aromatic plants. Quality seeds of crops and planting material of fruit and vegetable crops, improved sheep, poultry, pigs, quality seeds for freshwater aquaculture were supplied to farmers in tribal, backward and hilly areas in 15 states. Thirty-seven hybrids of crops having improved quality, yield and disease resistance were released. Commercialization of technology for pouch processing for fish curry preparation, prototype fabrication of 44 agricultural implements, development of equipment and technology for direct sprouted rice seeding that could save 70–75% in labour, 85–90% in operational energy and 80–85% in operation cost and empowerment of women in tribal, backward and hilly areas with implements to reduce drudgeries in farm operations, were the other accomplishments.

Under Team of Excellence (ToE), 30 genes of eight groups of viruses and citrus viroid were cloned, sequenced and deposited in genebank. Transgenic to tomato leaf curl virus incorporating *Rep* gene of virus was generated. Immunity was developed in buffaloes using antibodies against bursal diseases and infectious bronchitis. Other achievements under ToE include development of royal jelly extractor, mapping of pearl mussel resources in different agro-ecological regions of the country, preparation of a holistic quality management programme for production and processing of wholesome meat and establishment of three Referral Laboratories for quality assurance of plant, animal and fishery products.

In competitive grants programme, novel abiotic stress-responsive genes were identified and characterized in rice. Rare and high-valued medicinal plant species in north-eastern India were propagated on large scale using tissue-culture technology. Molecular markers for natural disease resistance in Nicobari fowl were identified. Technologies were developed for aquaculture, breeding and hatchery production of marine ornamental fishes. The other significant findings were standardization of techniques for off-season chrysanthemum flowering in plastic greenhouse-cum-rain shelter, preparation of computer models for optimal allocation of water and water-table management in the existing irrigation projects, and standardization of process for product development, value-addition and waste utilization in banana and plantains.

To improve working environment and to make research effective, efficient and relevant, the ICAR has taken several initiatives under *Organization* and *Management*. Significant progress was made in adjustment of outstanding advances, compliance of Audit paras, Reconciliation of Bank Account and Maintenance of Asset Registers at ICAR institutes. The Budget Estimates (BE) and Revised Estimates (RE) of the DARE and ICAR (Plan and Non-Plan) for 2002–2003 were Rs 14,988 million and Rs 14,488 million respectively. The BE for 2003–2004 (Plan and Non-Plan) is Rs 15,109.2 million.

The ICAR announced 44 awards in 12 categories to honour 33 scientists and their nine associates, four extension workers, innovative farmers, agricultural journalists, and three institutions, during the year. Financial assistance was also provided to 47 scientific societies and academic universities for publication of journals and for seminars/symposia/conferences.

The DARE and ICAR have been operating *Partnership and Linkages* in agricultural research and education at the national and international level through the Memoranda of Understanding (MoUs)/Work Plans/Projects/Training Courses/Exchange Visits etc. One MoU and three Work Plans were signed between the ICAR and France and Sri Lanka, Cuba and Iran for scientific and technical co-operation in field of agriculture and education. Under International linkages nine

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projects have been approved/initiated. A number of delegations led by Presidents of Republic of Mozambique, Republic of Guyana, and Prime Ministers of Laos, People's Democratic Republic and Lesotho visited India. An Indo-French seminar 'To identify priority areas for collaborative research, germplasm exchange, study visits, training' was also held at New Delhi.

The Directorate of Information and Publications of Agriculture (DIPA) brought out 50 publications in English and 10 in Hindi besides regular research monthly journals/magazines. Special issues/accent numbers of periodicals were also brought out on the occasions/themes of World Food Day, ICAR Foundation Day, etc. Recently, the DIPA has entered into e-publishing and developed five CDs - DARE/ ICAR Annual Report 2002–2003, All-India Co-ordinated Research Project Database, ICAR Telephone Directory, Terminated ICAR Ad-hoc Research Projects and ICAR Institutes' Research Project Information. The DIPA earned Rs 4.78 million through sale of its publications, advertisements etc., and participated in various exhibitions and displayed its publications.

In tune with recognition of the role of science and technology in overall national perspective, the ICAR established a National Agricultural Science Museum. This will be opened to farmers, scientists and the general public very soon.

Publicity and Public Relations Unit issued materials of current importance to various newspapers, agricultural and current affairs magazines and electronic media to cover the achievements of the Council in agricultural research, extension and education at national and regional levels. The video films prepared on the activities and achievements of the Council are being distributed to ICAR institutes, KVKs, Extension Directorates of SAUs and others for wider dissemination of information for technology led growth in agriculture and allied sectors.

(Mangala Rai)
Secretary (DARE) & DG, ICAR

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2. Salient Achievements

Crop Improvement and Management

PLANT GENETIC RESOURCES

Germplasm Collection, Introduction and Supply

A collection of 11,889 accessions could be added through 186 explorations, which include cereals and pseudocereals (2,080), oilseeds (855), vegetables (1,867), horticultural crops (881), medicinal and aromatic plants (1,894), spices (779) and other crops (792). Besides, 33,092 accessions of diverse crops from various countries (including 25 samples of transgenic crops) and 59,000 samples of different international trials have been introduced; and 12,041 accessions have been exported and 11,659 samples of crops have been supplied to different research stations in India.

Plant Quarantine

Accessions, numbering 45,093 received under germplasm exchange, have been processed for quarantine clearance. A mandatory hot-water treatment was given mainly to paddy (18,597 accessions), prophylactic fumigation was given to trial materials introduced (59,000 accessions), and 10% tri-sodium orthophosphate treatment was given to chilies, tobacco and tomato (87 accessions). Important

- Accessions totalling to 33,092 of diverse crops from various countries and 59,000 samples of different international trials have been introduced in the country.
- Under germplasm exchange, 45,093 accessions have been processed for quarantine clearance.
- Added accessions 20,453 of orthodox seed species including cereals, millets, forages, oilseeds etc to the National Seed Genebank for long-term conservation at –20°C and 11,517 to medium-term storage at 5°C.
- Maintained *in-vitro* cultures of 1,366 accessions.
- Characterized, evaluated and maintained 7,588 accessions of different crops.
- Identified promising accessions of *Brassica juncea, B. campestris* var. *toria*, *B. campestris* var. yellow sarson and *B. napus* with oil percentage >47%, of urdbean with protein >26% and of pea with protein >30% and of *Mucuna pruriens* with L-DOPA ranging from 2.46 to 5.64%.
- Fingerprinted more than 600 varieties and elite germplasm lines of 15 crops using a variety of molecular profiling techniques.
- Sorghum material with high genetic variability found.
- AFLP profile of exotic cotton and Indian cotton *Gossypium hirsutum* varieties revealed their common gene pool.
- Studies on banana confirm the hypothesis that India is a part of the centre of diversity of banana.
- Marker ACC oxidase isoform I (ACO 1) identified in tomato that determines rate of tomato ripening.
- Accomplished cloning of fruit specific promoters *Le Exp 1* and *ACS 4*.

(a) *Oryza sativa* (Jacanica trait), a tall landrace from Nagaland
(b) *Oryza rufipogon* collected from the Western Ghats
(c) *Oryza meyeriana* var. *granulata* from the Western Ghats
(d) Primitive maize (*Zea mays*) variety collected from Sikkim Himalayas

(a) Komal dhan. A soft-rice, collected from Majuli island of Assam, (b) Landraces of cowpea, collected from Kerala, (c) Variability in citrus species, collected from Arunachal Pradesh

NATP for PGR

Plant biodiversity. Accessions, totalling, 74,754, comprising crop landraces, local cultivars, trait specific materials, wild relatives of crops, lesser known species and wild economic plants have been collected.

Seed-health testing for pest-free conservation. Important interceptions include *insects-Callosobruchus analis* in *Vigna radiata, C. phaseoli* in *Lablab purpureus, Conicobruchus albopubens* in *Cyamopsis tetragonoloba, Specularius* sp. in *V. unguiculata, Spermophagus pygopubens* in *Abelmoschus, Systole* sp. in *Coriandrum sativum;* and pathogens-*Drechslera oryzae, D. sorghicola* and *Ustilaginoidea virens* in *Oryza sativa, Fusarium solani* in *Pisum sativum* and *F. solani, F. semitectum* and *Rhizoctonia solani* in *Phaseolus vulgaris*.

Integrated approach to control stem necrosis disease of groundnut. Fifty accessions of advanced groundnut breeding lines have been tested by sap inoculation of tobacco streak virus (TSV). None were found resistant. Three isolates of TSV from groundnut, sunflower and marigold have been sap inoculated on to a set of differential hosts. Groundnut isolates have showed differences in host-reaction severity.

Genetic evaluation and improvement of Sesbania *and* Crotalaria *for green manuring*. Evaluation of 86 accessions of *Sesbania* and 17 of *Crotalaria* at 8 locations for various traits has resulted in identification in *Sesbania* Ses-H 9, Ses-Pant 10 and *Crotalaria* Crota-ND 3, Crota-NBPGR 1. Based on the three years' performance for green-manuring traits, *Sesbania* Pant Dhaincha 1, DH 1 and *Crotalaria* Narendra Sanai 1 have been identified by the Variety Identification Committee for release at the national level.

PGR management and related policy issues

- Critical technical inputs were provided on the Biological Diversity Act 2002.
- Technical inputs were prepared for draft for the International Standards for Phytosanitary Measures (ISPM-11).
- Proforma have been developed for documentation of farmers' varieties and extant varieties.

interceptions are: *insects-Araecerus* sp. in *Zea mays* and *Bruchidius* sp. in *Trifolium alexandrium*; *fungi-Peronospora manschurica* (a fungus not yet reported from India) in *Glycine max*, *Colletotrichum capsici* in chili; *viruses*-7 in *Phaseolus vulgaris*; and *nematodes-Meloidogyne* sp. and *Pratylenchus* sp. in *Malus*, *Prunus* and *Pyrus* from the USA. Two hundred and four phytosanitary certificates have been issued for export materials.

Germplasm Conservation

Accessions, totalling to 20,453 of orthodox seed species, including cereals (8,466), millets (2,709), forages (838), pseudocereals (658), grain-legumes (2,395), oilseeds (2,200), fibre crops (649), vegetables (2,015), fruits (42), medicinal and aromatic plants (184), narcotics (4), spices (2), released varieties (174) and genetic stocks (117), are added to the National Seed Genebank for long-term conservation at –20°C; and 11,517 accessions have been added to medium-term storage at 5°C as reference samples. Cryostored 410 accessions comprise fruits and nuts (148), agroforestry species (90), legumes (55), vegetables (37), medicinal and aromatic plants (10) and others (70); and pollens of mango (30). Accessions 1,366 in number of the 47 genera belonging to 121 species, mainly *Allium sativum* (10), *Curcuma* (24), *Fragaria* (10), *Ipomoea batatas* (20), *Morus* (32) and *Musa* (20) have been maintained as *in vitro* cultures, and 179 new accessions of various vegetatively propagated species have been added to *in-vitro* genebank.

Germplasm Characterization, Evaluation and Maintenance

In *rabi* 2002-03, 7,588 accessions of different crops

(a) High-yielding sorghum developed through selection from a landrace in Maharashtra, (b) Early-maturing guar (*Cyamopsis tetragonoloba*) accession grown at the NBPGR Regional Station, Jodhpur, (c) Characterization of lentil germplasm at the NBPGR Regional Station, Bhowali

IPR-related activities

IPR Cell at the ICAR has filed 101 patent applications. And during 2003-04, 24 applications have been filed. This includes also for securing patent rights in foreign countries under the Patent Cooperation Treaty. Steps have also been accelerated for commercialization of ICAR technologies. So far, 31 technologies have been assigned by the ICAR to the National Research Development Corporation (NRDC) for commercialization.

have been characterized, evaluated and maintained.

Maize, pearl millet, cowpea, urdbean, brinjal, bottle-gourd, ridge-gourd, sponge-gourd, aloe, mucuna, vetiver, sesbania and sunnhemp 4,187 accessions have been sown/planted at the NBPGR Headquarters and 20,276 at various regional stations for seed increase, characterization, preliminary evaluation and maintenance in *kharif* 2003.

Rapeseed-mustard (708), safflower (501), wheat (76), pea (185), walnut (10), urdbean (300) and cowpea (95), totalling to 1,875 accessions, have been analyzed for respective quality traits like total oil, and protein and fatty acid profiles. Promising accessions of *Brassica juncea*, *B. campestris* var. *toria*, *B. campestris* var. yellow sarson and *B. napus* with oil percentage >47%; of urdbean with >26% protein and of pea with >30% protein; and of *Mucuna pruriens* (6 samples) with L-DOPA ranging from 2.46 to 5.64% have been identified.

DNA Fingerprinting

More than 600 varieties and elite germplasm lines of 15 crops have been fingerprinted using a variety of molecular profiling techniques.

Cereals and millets. Fingerprinting 38 varieties/parental lines of sorghum using sequence tagged microsatellite sites (STMS) markers has revealed on an average 5.8 alleles per locus for 8 selected STMS loci and

Molecular markers reveal wide genetic diversity in banana

Recent reports in the international press had raised alarm about the possible extinction of edible banana due to its susceptibility to black sigatoka and Panama diseases. The National Research Centre on DNA Fingerprinting, New Delhi, has analysed molecular diversity of 220 traditional varieties of banana, grown in different regions of India. The study has revealed that varieties comprise 5 different genomic groups, *viz.* AA, AB, ABB, AAB and AAA; and in each group, high amount of genetic diversity exists. These results confirm hypothesis that India is the part of the centre of diversity of banana, and the country harbours extensive genetic variations in this crop. The wide genetic diversity existing in farmers' fields ensures that there is no immediate threat of extinction of banana in India.

Electronic database of plant genetic resources

A software has been developed, and the data of about 2.5 lakh accessions are being maintained in the genebank converted into database format by adopting standard codes for facilitating smooth retrieval of information on the genetic resources. About 50,000 entries of the newly collected germplasm have also been entered in the database.

a diversity index of 0.226-0.800. This indicates high genetic diversity in the material. In 54 selected barley varieties, 10 STMS primers have revealed diversity index of 0.037-0.614.

Pulses and oilseeds. Pigeonpea (31) profiled with 15 amplified fragment length polymorphism (AFLP) primers has revealed 82% polymorphism and chickpea has showed 93% polymorphism. Among safflower, soybean, sesame and niger, AFLP diversity in safflower has been found very low, and in sesame, it is higher, which may be attributed to liberal use of indigenous landraces in its breeding programmes.

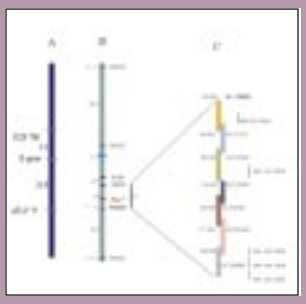
Fibre crops. AFLP profile of cotton (30) has revealed that exotic and Indian *Gossypium hirsutum* varieties are from common gene-pool.

Plant Biotechnology

Selections BIO 169-2000, BIO 64-2001 and BIO 54-2001 of mustard have showed significant yield superiority with 18.8, 17.1 and 15.1% yield advantage over the best check, Pusa Jai Kisan. CMS of (*Diplotaxis catholica*) *Brassica juncea* derived through somatic hybridization has indicated duplicated *coxI* gene in this system. RNA blots

Magnaporthe grisea resistance helped mapping *Pi k^h* gene on rice chromosome 11

The *indica* rice line Tetep possesses durable resistance to *Magnaporthe grisea* population of the north-western Himalayan



Integrated linkage map of gene Pikh derived from RAPD, AFLP (A) and CAPS, RAPD and STMS (B) Markers and putative physical location (C) of R-gene on rice chromosome

region of India. It has been used in mapping *Pi k^h* gene with AFLP and RAPD markers. This gene has now been mapped within 2.1 cM on the rice chromosome 11.

Summary status of Genebank Genes predicted in the rice genome sequences at the IARI

Total rice genome sequences submitted in the Genebank	6734077 bp
Total number of genes predicted	984
Genes showing 100% match with existing genes	154
Putative genes	39
Unknown genes	78
Hypothetical genes	411

Effects of protease inhibitors on *Helicoverpa armigera* larvae growth

Helicoverpa armigera larvae, when reared on the artificial diet supplemented with protease inhibitors of different crops, *viz*. Pigeonpea Protease Inhibitor (PPI), Mungbean Protease Inhibitor (MPI) and Chickpea Protease Inhibitor (ChPI); have showed reduced growth rate in terms of body weight and number of days required for pupation. Cloning cDNA and genes of these inhibitors is continuing. The plasmid DNA from these clones has been isolated, and presence of an insert DNA of 4-5kb in mungbean and cowpea and of 2 kb in chickpea has been observed.

Marker for tomato ripening identified

To determine rate of ripening in tomato, a marker has been identified as ACC oxidase isoform 1 (ACO1), which has showed a direct relationship with ripening in 3 tomato cultivars.

prepared from leaf and flower-bud tissues of male sterile, fertile and euplasmic lines of *B. juncea* have been probed with mitochondrial *coxI* gene probe. In leaf tissues of all the 3 lines, a transcript of 2kb hybridized to probe, and their flower buds have showed variable *coxI* transcript size.

*LeExp*1 cDNA has also been cloned from tomato for developing its transgenics with delayed ripening. Cloning of fruit-specific promoters *LeExp*1 and ACS4 has been accomplished.

FOOD CROPS

Rice

Crop improvement: In rice, 19 varieties and one hybrid have been released.

Crop production. Rice variety Nidhi has been found most suitable for direct seeding under puddle conditions using sprouted seeds at 125 kg of seeds/ha along with Butachlor at 1.5 kg a.i./ha and one spot weeding.

Planting one or two seedlings of rice hybrids/hill at 20

Hybrid rice technology

In advanced variety trials, 4 hybrids, MPH 5401, PRH 122, HRI 126 and PAC 89001 have showed promise. Two CMS lines, DRR 2A and DRR 3A, have been registered with the NBPGR, New Delhi.

It is estimated that around 2 lakh hectares were planted with hybrid rice in the country during 2002, mainly in the eastern Uttar Pradesh, Bihar, Chhattisgarh, Jharkhand, Haryana, Punjab and Maharashtra.

- Registered 2 CMS rice lines DRR 2A and DRR 3A with the NBPGR.
- Planted 0.2 million hectares with hybrid rice in the country, mainly in the eastern Uttar Pradesh, Bihar, Chhattisgarh, Jharkhand, Haryana, Punjab and Maharashtra.
- Identified SSR markers RM 316, RM 219 and RM 444, located on the short-arm of chromosome 9, as more tightly linked markers with the gall-midge resistance gene *Gm I*.
- In rice released Dhanrasi, RH 204 as Central releases and GR 8, Dandi, Shah Sarang, Lam Puch as State releases.
- Rice Nidhi found most suitable for direct seeding under puddle conditions.
- White-ear damage by yellow stem-borer significantly lowered on main crop rice RP 4-14, wherein trap crop Pusa Basmati I was planted with it in 9:1 ratio in east-west direction as compared to plots with the sole main crop.
- For sheath-rot management fluorescent *Pseudomonas* S-cag-6 found most effective when seeds and seedlings were treated with it, followed by a foliar spray of 0.1% Carbendazim.

Developed database on rice for linked SSR markers for gall-midge

Three SSR markers RM316, RM219 and RM444, located on the short arm of the chromosome 9, have been identified as more tightly linked markers with gall-midge resistance gene *Gm1* with a linkage distance of 8 cM, 4.9 cM and 6.0 cM. The linkage distances and orientation of these markers with respect to *Gm1* have been validated in $BC_1F_{2:3}$ population of cross Swarna/W1263//Swarna. A database of marker allele sizes in base pair (bp) has been developed for the linked SSR markers in a set of gall-midge resistant and susceptible genotypes of rice.

Fluorescent *Pseudomonas* isolates for controlling sheath-rot in rice

Three isolates of fluorescent *Pseudomonas* C-1, S-cag-2 and S-cag-6 have been evaluated in the field for management of sheath-rot disease. The antagonistic bacterium S-cag-6 has been found the most effective one when seed and seedlings were treated with it, followed by one foliar spray coupled with one spray of 0.1% Carbendazim.

Rice varieties released

Variety/Designation/ IET No.	Days to 50% flowering	Grain type	Ecosystem	Yield range (tonnes/ha)	Reaction to pests/diseases	Recommended state/region
			Central Releases			
Dhanrasi IET 15358	115-120	SB	Shallow lowland	5.5-6.5	R-BL; MR-BLB, RTV, ShR	Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu
RH 204 IET 16442 (Hybrid)	90-95	LS	Irrigated	6.0-6.5	R-Lbl	Andhra Pradesh, Karnataka, Tamil Nadu, Haryana, Rajasthan
			State Releases			
GR 8	75-80	-	Rainfed upland	-	-	Gujarat
Dandi IET 14906	-	-	Irrigated, salt tolerant	-	R-BLB, BL; MR- WBPH	Gujarat
Shah Sarang 1 IET 14620	115	SB	Rainfed/ irrigated lowland	-	MR-BL	Meghalaya
Lam Puch 1 IET 15057	113	SB	Rainfed/ irrigated lowland	-	MR-BL	Meghalaya
Bha Lum 1 IET 16486	94	LB	Rainfed upland	-	R-BL	Meghalaya
Bha Lum 2 IET 16487	95	LB	Rainfed upland	-	R-BL	Meghalaya
Gouri IET 15923 KAUM 38-4-1 (MR 1)	85-90	SB	Irrigated	5.0	R-ShR, Stack-burn, BS; MR-ShBl	Peat soils of Kuttanad district of Kerala
IET 15376 R 636-405	90-100	MSl	Irrigated	4.0	R-GM1	Chhattisgarh, Madhya Pradesh
IET 14400 CN 846-30-3-1	140-150	LS	Shallow water	4.5	-	West Bengal
Bhudeb IET 14496 (CN 1035-61)	120-125	LS	Semi-deep water	4.5-5.0	R-BPH, Bl, BLB; MR-ShBl, ShR	West Bengal
Sweta IET 14735 rpp 7-23-1-2-3	100-105	SB	Irrigated	5.0	MR-WBPH, BL, BS, ShBl, ShR; MS- BLB, RTV	Irrigated areas of Kerala
IET 16075 SYE 14-9-8	100-105	SB	Irrigated	4.5-5.0	MR-WBPH, BPH, BL, BLB	Vidarbha areas of Maharashtra
Varsha IET 16709	85-90	SB	Irrigated/ lowland	4.5-5.0	-	Kerala
Chingam	70-75	MB	Irrigated upland	3.5-4.0	-	Kerala
Dhanu	120-130	SB	Irrigated boro	4.5-5.0	-	Kerala
Kunjukunju-Varna	75-80	LB	Irrigated lowland	6.0-6.5	-	Kerala
Kunjukunju-Priya	75-80	LB	Irrigated lowland	6.0-6.5	-	Kerala
Pant Dhan 15 IET 14132	110-115	LS	Basmati area	3-4	MR-NBl, Lbl	Uttaranchal

BL-Blast; BLB-Bacterial Blight; BPH-Brown Planthopper; BS-Brown Spot; GM-Gall Midge; Lbl-Leaf Blight; LB-Long Bold; LS-Long Slender; MB-Medium Bold; MR-Moderately Resistant; MS-Moderately Susceptible; MSl-Medium Slender; NBl-Neck Blast; R-Resistant; RTV-Rice Tungro Virus; SB-Short Bold; ShBl- Sheath Blight; ShR- Sheath Rot; WBPH- White Backed Planthopper.

× 10cm or 20 × 20cm has recorded comparable grain yields. And for seed production of hybrid DRRH 1, planting 'A' line at 15 × 15cm and 'R' line at 15 × 15cm or at 30 × 10cm has recorded higher seed yields.

Rice cultures IET 15392, IET 12067, IET 15353 and IET 14336 have recorded higher P-use efficiency and grain yields under low to moderate (10–30 kg P_2O_5/ha) as well as at higher P-levels (40-60 kg P_2O_5/ha).

A ten-year study has showed that grain yield of *kharif* rice (variety, Krishnahamsa) increased significantly (6.0-6.2 tonnes/ha) as against control (4.98 tonnes/ha) by growing green manure during pre-*kharif* and incorporating crop in the soil prior to land preparation for *kharif*. Even *rabi* crops grown subsequently in these plots performed significantly compared to control.

Crop protection: In field experiements Pusa Basmati 1 rice variety, known to attract yellow stem-borer (YSB) moths, has been used as the trap crop and variety RP 4-14 as the main crop, grown during *rabi* and *kharif* 2002 in different row ratios and planted in east-west or north-south directions. White-ear damage by YSB was significantly lower in the main crop in plots wherein trap crop was planted in 9:1 ratio with it and planted in east-west direction as compared to plots with sole main crop; besides the higher yield of the main crop.

Recent monitoring of stem-borer species at 15 locations in the country has revealed that in north-western parts, yellow stem-borer (YSB) populations were higher, followed by white stem-borer (WSB) and pink stem-borer (PSB). At Pantnagar, striped stem-borer (SSB) was also observed. In southern parts, YSB was the only species present in Andhra Pradesh, and besides this PSB was observed in Tamil Nadu. In eastern parts, dark-headed borer (DHB) was observed in addition to other three species. In hills, WSB was higher than PSB and YSB. Thus, stem-borer species composition is probably influenced by the suitability of the local rice varieties and other crops grown in the area.

Weather-based forewarning studies have indicated significance of maximum temperature, crop age and morning humidity for leaf blast severity and crop age and maximum/minimum temperatures for neck blast.

Wheat and Barley

Crop improvement: Seven wheat and one barley varieties have been released for commercial cultivation.

Ten wheat and two barley varieties have been identified for release.

Diversification/intensification of rice-wheat system: Replacing rice with soybean/pigeonpea and wheat with mustard, followed by mungbean, can diversify rice-wheat system and can improve soil health.

Vegetable pea (as green pod), mustard and mungbean have recorded up to 34.0, 20.4 and 11.8% higher yields as compared to flat planting; indicating utility of bed planting for diversification/intensification of rice-wheat

- Released wheat VL 829, HS 420, HS 375, DBW 14, NW 2036, MP 4010 and HI 1500
- Improved soil health, with replacement of rice with soybean/pigeonpea and wheat with mustard, followed by mungbean.
- For wheat rotary tillage proved better than zero tillage, followed by FIRBS, followed by conventional practice.
- Attack of various rusts on PBW 343 signals that effective life of the variety may not be very long from now onwards.
- One of the major diseases of wheat, powdery mildew, caused by *Erysiphe graminis,* found favour under the FIRBS, due to the change in microclimate.
- Achieved effective control of Karnal bunt through 2 foliar sprays of *Trichoderma viride,* before ear-head emergence and at its emergence.
- Prepared an atlas for various quality parameters for wheat.

Wheat and barley varieties for commercial cultivation

Varieties	Production conditions	Area of adaptability
Wheat		
VL 829	Rainfed, early sown	Hills of Jammu and Kashmir, Himachal Pradesh, Uttaranchal and Sikkim
HS 420	Irrigated, late sown	Hills of Jammu and Kashmir, Himachal Pradesh, Uttaranchal and Sikkim
HS 375	Rainfed, summer sown	Snow-bound areas of north-western hills
DBW 14	Irrigated, late sown	Eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Orissa and Assam
NW 2036	Irrigated, late sown	Eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Orissa and Assam
MP 4010	Irrigated, late sown	Gujarat, Madhya Pradesh, Chhattisgarh, Kota and Udaipur (Rajasthan), and Bundelkhand region (Uttar Pradesh)
HI 1500	Rainfed, timely sown	Gujarat, Madhya Pradesh, Chhattisgarh, Kota and Udaipur (Rajasthan) and Bundelkhand region (Uttar Pradesh)
Barley		
BHS 352	Rainfed, timely sown	Hills of Jammu and Kashmir, Himachal Pradesh, Uttaranchal and Sikkim

Hybrid wheat

Among 23 entries in pilot trial (19 hybrids + two 'checks' i.e. PBW 343 and HD 2687 at two seed rates 50 kg/ha and 100 kg/ha each), only one hybrid HM 01150 has exhibited 15.06% standard heterosis

DBW 14 wheat. It has been released for commercial cultivation for irrigated, late sown areas of eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Orissa and Assam.

PBW 502 wheat. This has been identified for release for irrigated, timely sown areas of Punjab, Haryana, western Uttar Pradesh, Delhi and parts of Rajasthan.

system with better returns. Nodule formation and root dry matter in mungbean under bed-planting system have been found higher as compared to flat-planting system.

HD 2687, PBW 343, BW 1485, DL 1266 and CBW 23 wheat under zero, rotary, FIRBS and conventional tillage options have indicated varietal differences in yield. HD

Wheat and barley varieties identified for release

Varieties	Production conditions	Area of adaptability	Developed by
Wheat			
VL 832	Rainfed, timely sown, high altitude	Hills of Jammu and Kashmir, Himachal Pradesh, Uttranchal and Sikkim	VPKAS, Almora
HPW 155	Rainfed, timely sown, high altitude	Hills of Jammu and Kashmir, Himachal Pradesh, Uttranchal and Sikkim	HPKV, Palampur
PBW 502	Irrigated, timely sown	Punjab, Haryana, western Uttar Pradesh, Delhi and parts of Rajasthan	PAU, Ludhiana
HD 2824	Irrigated, timely sown	Eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Orissa and Assam	IARI, New Delhi
MACS 6145	Rainfed, timely sown	Eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Orissa and Assam	ARI, Pune
Raj 4037	Irrigated, timely sown	Madhya Pradesh, Chhattisgarh and Gujarat	RAU, Durgapura
GW 1189 (Durum)	Irrigated, timely sown	Maharashtra, Karnataka, and parts of Andhra Pradesh and Tamil Nadu	GAU, Vijapur
NIDW 295 (Durum)	Irrigated, timely sown	Maharashtra, Karnataka, and parts of Andhra Pradesh and Tamil Nadu	MPKV, Niphad
UP 2565	Irrigated, late sown	Maharashtra, Karnataka, and parts of Andhra Pradesh and Tamil Nadu	GBPAU&T, Pantnagar
HD 2833	Irrigated, late sown	Maharashtra, Karnataka, and parts of Andhra Pradesh and Tamil Nadu	IARI, New Delhi
Barley			
RD 2624	Timely sown, rainfed	Punjab, Haryana, western Uttar Pradesh, Delhi and Rajasthan	RAU, Durgapura
NDB 1173	Saline/alkaline soils	Salt-affected regions in India	NDUAT, Faizabad

Sound IPM strategy for wheat

This year, the IPM module was validated in 5 acres of land in two villages, namely Darar and Taraori in Karnal. The seed treatment with a combination of reduced dosage of Vitavax 75WP (at 1.25g/kg of seed) plus *Trichoderma viride* at 4g/kg of seed (commercial product), followed by broadcast in insecticide (Endosulfan)-treated soil at 15 days after sowing and one spray of Confidor 200 SL on border rows were the only management activities in the IPM plots. The wheat yield gain was in the range of 12.40 to 14.56% in the experimental fields and 8.7 to 14.58% at the farmers' fields. Pest incidence data have indicated that target pest, termite, was lower in the IPM plots compared to non-IPM plots. Also, incidences of foliar aphids and loose smut were lower in the IPM plots.

2687, PBW 343 and BW 1485 were at a par in yield in zero tillage and conventional tillage, and were significantly superior to others. In rotary tillage, HD 2687 and PBW 343 were at a par and significantly superior to others. In FIRBS, DL 1266 produced the highest yield and was significantly better than others, exceptilng HD 2687, which showed higher grains/ear-head. In general, rotary tillage has been better among all tillage systems, followed by conventional practice.

Crop protection: No serious outbreak or epidemic of any pest has been reported during the season. Brown rust has been recorded on the dominant PBW 343 in various locations in Punjab; the disease had developed late in the season. Hence, losses are expected to be negligible. This year, yellow rust has been recorded in the SAARC disease-trap nursery, planted in Pakistan at Islamabad, and in traces at Humle in Nepal. This is the signal that effective life of PBW 343 may not be very long from now onwards.

HD 2824 wheat. This has been identified for release in irrigated, timely sown areas of eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Orissa and Assam. It has given an average yield of 4.6 tonnes/ha with a potential of 6.5 tonnes/ha. It has excelled over popular variety PBW 343 by a margin of 5–14%.

HD 2833 wheat. It is found suitable for irrigated, late-sown areas of Maharashtra, Karnataka, parts of Andhra Pradesh and Tamil Nadu. This variety has exhibited high degree of resistance to black and brown rusts in older plants.

Pest problems in rice – wheat cropping system in a system's perspective

The continuous rotation of rice and wheat, year after year, has influenced pest situation with the introduction of several new tillage techniques in the recent years.

Powdery mildew, caused by *Erysiphe graminis*, is one of the major diseases of wheat, and is influenced by tillage practices due to the change in the microclimate. This disease has been found to be favoured under the FIRBS. The Per Cent Disease Index (PDI) under the FIRBS, zero tillage (ZT) and conventional (CT) has been calculated to be 58.22, 42.44 and 12.44 in 2002-03.

Termite is a very important pest of wheat in loose soils in the North-Western Plains Zone. The damage due to termites is highly influenced by tillage system. During 2002-03 crop season, the termite damage under the FIRBS, CT and ZT has been 1.63, 1.01 and 0.24 tillers/m^2.

Multiple disease/pest resistants wheat genotypes

Resistant to three rusts + Moderately resistant (MR) to Leaf Blight (LB) + Flag Smut (FS): HPW 185

MR to LB + Karnal Bunt (KB) + FS: HW 3082, DWR 1006 (d), PDW 215 (d) and TL 2877 (T)

Resistant (R) to KB + FS: HI 8591 (d), Raj 6557 (d), MACS 3127 (d) and DWR 247

MR to LB + KB + FS + Powdery Mildew (PM): TL 2908 (T), TL 2910 (T), TL 2788 (T), TL 2908 (T) and COLOTANA

R to KB + PM + FS: HI 8550 (d)

Resistant to stem and leaf rust +
R to KB: PBW 486 and LOK 42
R to KB + FS: GW 1172

Resistant to leaf and stripe rust + R to KB + PM + FS: WH 896 and HD 4687

Resistant to three rusts + Loose smut (LS) + FS + KB: HD 4672 (D) and HI 8498 (d)

Resistant to Root Aphids + Brown Wheat Mite + Shoot Fly + Powdery Mildew: SONORA Pm 3

Resistant to Root Aphids + Brown Wheat Mite + Three Rusts+ Karnal Bunt: HI 8498 (d)

Resistant to Brown Wheat Mite + Shoot Fly +Three Rusts+ KB + LB + PM + FS: TL 2877 (T) and TL 2908 (T)

Genetic variations for yield and its components in fixed breeding populations of wheat

To find out variability generated for various yield component lines, the fixed generation breeding materials were distributed in 6 distinct groups through Metroglyph analysis for various traits. These materials have been shared with other wheat-breeding centres in the country, and are being utilized in the hybridization programme.

Genetic background	Yield/plot (kg)	Tillers (metres)	Grains (spike)	Thousand grains (weight)	Spikelets (spike)	Spike (length)	Harvest index	Biological yield
Synthetics								
Range	1.788-2.356	116-158	42.6-73.4	35.7-56.9	16.8-23.4	9-13.7	0.29-0.39	5.2-6.4
Mean	2.011	133	55.7	41.9	21.2	11.5	0.34	5.7
Buitre								
Range	1.528-3.426	49-135	59-97	31.6-46.7	19.8-25	10.8-15.2	0.27-0.46	4.5-7.4
Mean	2.005	88.7	75.1	38.8	21.9	13.0	0.35	5.7
PBW 343	2.385	145	61.4	41.0	18.8	9.7	0.38	6.25
SE (±)	58	5	2.0	0.6	0.3	0.2	0.007	0.10

Epidemiological studies to manage Karnal bunt (KB): An effective control of KB (0.33% incidence) could be achieved through 2 foliar sprays of *Trichoderma viride* at different crop growth stages; one spray before ear-head emergence and the second at the ear-head emergence. And foliar sprays of Tilt 25 EC at 0.1% at these growth stages gave cent-per-cent control. This is in comparison to 0.13% disease incidence with Tilt 25 EC at 0.1% spray at the later stage, which is the present-day recommendation for disease control. Hence, by adopting epidemiological approach, an effective management of the Karnal bunt disease could be achieved through *T.viride*. Spraying has to be done at different growth stages, by coinciding sprays with movement of *Tilletia indica* from soil to target part i.e., ear-head.

Wheat genotypes rich in nutritional quality

Attribute	Value	Genotypes
Triticum aestivum		
Protein	≥14.5%	Lok 45 (C), PBW 525, PBW 530, CBW 25, NW 2083, UAS 269
ß-carotene	≥4.2ppm	HS 240 (C), VL 849, VL 864, VL 865, UP 2625, HD 2859, HW 5023
Iron	≥75ppm	NW 1014 (C), HUW 533 (C), NIAW 34 (C), HW 1085 (C), HW 2044 (C), PBW 521
Zinc	≥50ppm	PBW 373 (C), NW 2036 (C), K 8027 (C), GW 322 (C), PBW 522
T.durum		
Protein	≥14.0%	MACS 2846 (C), UAS 1023, MPO 1152
ß-carotene	≥6.0ppm	PDW 233 (C), WH 896 (C), HI 8627, GW 1189, NIDW 295
Iron	≥75ppm	HD 4701, UAS 1023
Zinc	≥45ppm	HD 4701, NIDW 309, UAS 2024,

Wheat genotypes for end-products

Products	Released varieties	Final year entries
Chapati	PBW 175, C 306, K 9107, NW 1014, C 306, GW 322, Lok 1, HW 2004, HI 1500	PBW 509, Raj 4037, HD 2833
Bread	VL 738, K 9107, Lok 1, HI 977	HS 431, HUW 549
Biscuit	Sonalika, VL 829, UP 2425, PBW 498, PBW 175	HS 436
Pasta	PBW 34, PDW 233, WH 896, Raj 1555,	GW 1189

Quality: Attempts have been made to classify and grade Indian wheats on the basis of the quality analysis of the harvested produce that reaches different '*mandis*'. Out of 2002 wheat-grain samples collected from 108 places, covering eleven wheat-growing states, 32% samples belong to internationally accepted overall

grade 1. An atlas has been prepared for various quality parameters, and following classes have been proposed: (i) Indian medium hard wheat (IMHW) for chapati and other related products, (ii) Indian hard wheat (IHW) for bread, (iii) Indian soft wheat (ISW) for biscuit, (iv) Indian durum wheat (IDUW) for pasta and traditional products, and (v) Indian dicoccum wheat (IDIW) for traditional and pasta products.

For improving wheat quality for chapati and bread, systematic crosses were made using a large number of Indian germplasm lines, 16 Australian, 5 Argentinean and 3 Canadian lines. Some of the superior crosses for bread quality are K 9107/PBW 435, K 68/WH 542, WH 542/Terra (F_6 generation); WH 147/K 9107, UP 2338/WR 849, HUW 524/GW 273, GW 273/WH 157, WH 542/HI977, HUW 524/HI 1123 (F_4 generation), VL 796/K 9107 and K 9107/PBW 435//WH 542/Terra (F_2 generation). Similarly, for chapati, some of the superior crosses are: Raj 1482/WH 542, HI 1077/PBW 343, Hyb 633/UP 2338, NP 4/WH 291, C 306/K 9107, PBW 343/WH 147 (F_6 generation); C 306/GW 273, UP 2338/C 306, BW 11/HD 2687 (F_4 generation) and NP4/HD 2687 and CBW 09/GW 273 (F_2 generation).

Maize

Crop improvement: Eleven maize cultivars have been released for various agroclimatic regions.

Two single cross hybrids i.e. CML 175 × CML 176 and CML 142 × CML 150 and one three-way hybrid (CML 142 × CML 150) × CML 186 have given extremely good performance in *kharif* as well as in *rabi*. Considering increasing popularity of baby-corn in the country, maize cultivars, VL 42, Pusa Hybrid -1, -2, -3 and Parkash have been identified for production of baby-corn.

- Released 11 maize cultivars–Pratap Composite Makka 4, Pusa Early Hybrid 5, Pragati, Deccan Hyb. 115
- Two single-cross maize hybrids and 1 three-way hybrid gave extremely good performance in *kharif* as well as in *rabi*.
- Identified maize VL 42, Pusa Hybrid 1, Pusa Hybrid 2 and Pusa Hybrid 3 and Parkash for production of baby-corn; which is becoming popular in the country.

Maize varieties/hybrids released

Variety/Hybrid	Maturity	Grain colour	Area adaptation
Pratap Composite Makka 4 (EC 1108)	Early (80 –85 days)	White semi-flint	Jammu and Kashmir, Himachal Pradesh, Hills of Uttaranchal, Hills of West Bengal, North-east Region
Pusa Early Hybrid 5 (AH 421) (Single-cross hybrid)	Early (80 –85 days)	Yellow orange semi-flint	Delhi, Haryana, Punjab and Uttar Pradesh
Pragati (D 994) (Composite)	Early (80 –85 days)	Orange semi-flint	Eastern Uttar Pradesh, Bihar, Assam, Orissa, West Bengal and Jharkhand
Deccan Hyb. 115 (BH 2187) (Single-cross hybrid)	Early (80 –85 days)	Orange flint	Eastern Uttar Pradesh, Bihar, Assam, Orissa, West Bengal, Jharkhand, Jammu and Kashmir, Himachal Pradesh, Hills of Uttaranchal, Hills of West Bengal, North-east Region, Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra for *kharif*
PRO 345 (4644) (Hybrid)	Medium (90 days)	Orange semi-flint	Eastern Uttar Pradesh, Bihar, Assam, Orissa, West Bengal and Jharkhand
JKMH 68-2 (Hybrid)	Full season (100-110 days)	Orange-yellow flint	Jammu and Kashmir, Himachal Pradesh, Hills of Uttaranchal, Hills of West Bengal, North-east Region, Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra for *kharif*
BIO 9682 (Hybrid)	Medium season	Orange-yellow flint	Delhi, Haryana, Punjab and Uttar Pradesh
Pratap Maize Hybrid 1	Early	White semi-flint	Rajasthan
Vivek Comp. Maize 11	Early	Orange flint	Uttaranchal
Comp. Girija	Medium	Orange flint	Himachal Pradesh
Comp. Sharadhamani	Medium	Orange flint	Uttar Pradesh

Maize resistant germplasm against insect-pest *Chilo partellus*

Full-season maturity		Medium maturity		Early maturity		Extra early maturity		Quality protein maize	
R	M	R	M	R	M	R	M	R	M
BH 1015 BH 1620	17	-	17	BISCO 2032	11	-	4	HQPM-3 JHQPM 24 JHQPM 84 XP 0103 CML 142 × CML 150	27

R-Resistant line, M-no. of moderately resistant lines

PEEHM 5 (AH421) maize. This is an early variety released for Delhi, Haryana, Punjab and Uttar Pradesh. It is yellow-orange semi-flint type. This has an average yield of 5 tonnes/ha and it has potential of 6 tonnes/ha.

Crop production: Irrespective of cultivars for *kharif* maize, N dose of 120 kg for full and medium maturity groups and 80-100 kg N for early and extra-early material have been found optimum.

Crop protection: Many maize genotypes have been found resistant to biotic stresses

Sorghum

Crop improvement: DSH 4 (SB 401A × SPV 570), a *rabi* season sorghum hybrid, has been released and recommended for cultivation in northern Karnataka. Its

Maize genotypes resistant to biotic stresses

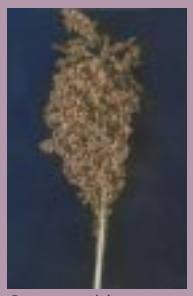
Diseases	Genotypes
A. Full-season maturity group	
MLB, TLB, BSDM, PFSR, CR	BH 2528, PRO 359, F 1562, BIO 92327, NECH 110, BISCO 851, PAC 7005
B. Medium maturity group	
MLB, TLB, BSDM, ESR, CR	BISCO 1102, X 1280 A, HKH 1191, PRO 349, PRO 345, NECH 113, X 2003, JKMH 1080, PAC 70009, AH 1121, BIO 92218, X 46172
C. Early maturity group	
MLB, TLB, PFSR, BSDM	X 2185, X 2002, AH 10411, BISCO 2434, JH 3851, PAC 70001, Seed Tech 1202, BIO 92136
D. Extra early	
MLB	BISCO 2051, AH 421

MLB- Maydis leaf blight; TLB- Turcicum leaf blight; BSDM- Brown stripe downy mildew, PFSR- Post-flowering stalk rot; CR- Common rust; ESR- Eriwinia stalk rot

DSH 4 sorghum is a *rabi* season hybrid between SB 401A and SPV 570. This has been released for cultivation in northern Karnataka. Its duration is 115-120 days with an yield potential of 3.0-3.5 tonnes of grains/ha and 6.0 tonnes of fodder/ha.

Occurrence and increased severity of biotic stresses in sorghum

A new sub-race of Sorghum



Grain-mold resistant sorghum germplasm

It is the first report on the occurrence of *Sorghum bicolor* ssp. *bicolor* race *guinea* sub-race *conspicuum* from the explorations made in the Ganga Basin and Bundelkhand regions of Uttar Pradesh. This sub-race possesses unique characteristic of gaping glumes, which may prove beneficial in resistance breeding programmes to grain-mold infection during *kharif*.

Cost of production (per litre) of ethanol from sugarcane and sweet-sorghum

Particulars	Sweet-sorghum (Rs/litres)	Sugarcane molasses (Rs/litres)
Manpower	0.50	0.25
Steam	1.00	1.00
Electricity	1.00	1.00
Yeast	0.10	0.10
Management/ Administration	0.10	0.25
Pollution control measures	Nil	0.25
Raw material	10.41	6.40[1]-9.70[2]
Total	13.11	9.25 – 12.55

1-Imputed cost in case of industries' own production. 2- Cost in case of market purchase of molasses

- To avoid the complexity in analysis, the investments were not considered.
- For raw material cost, molasses at Rs 1,600/tonne and sweet-sorghum stalks at Rs 500/tonne, that existed during the survey period, has been considered.
- While considering the output of alcohol, in case of sweet-sorghum, the quantity obtained in the laboratory analysis of 48 litres/tonne has been considered as against the actual yield of 18 litres/tonne in the pilot run (they could not run to full capacity and time).

duration is 115-120 days with a yield potential of 3.0-3.5 tonnes of grains/ha and 6.0 tonnes of fodder/ha.

Another hybrid, SPH 837 (AKMS 14A × SU 556), has been recommended for *kharif* in sandy-silt loam (light soils), and moderate to low rainfall (<550 mm) areas of Rajasthan. Its duration is 85-90 days that makes it escape terminal drought.

Crop production: Sweet-sorghum has the ability to rapidly accumulate sugars during and after crop maturity,

Economical alcohol production from sweet-sorghum

Pilot study was conducted in collaboration with Renuka Sugar Factory, near Belgaum, for alcohol production from sweet-sorghum variety SSV 84. The juice of 47,000 litres with 18% brix was extracted from 100 tonnes of stalks. This was diluted to 60,000 litres with 12% brix, and mixed with yeast, *Saccharomyces cerevisiae* in fermentor for ethanol production (95% alcohol), and was distilled to obtain rectified spirit. The bagasse contains 46.5% and 2.6% of moisture and sugar, which could be successfully used for cogeneration of electricity (approx. 2,086ca energy from green cane/tonne). Ash produced due to combustion of bagasse, fermentation sludge, and water-treatment compost was mixed together and sold at Rs 250 per tonne. The leftover fermentation contains sugars that contribute to 6.4% brix; since fermentation was for a limited period of 30 hr. The recovery can still be higher, if fermentation is allowed for more time, and a more efficient yeast strain is used. With further refinement, cost of ethanol production can be reduced. It is worthwhile to note that, in addition to sweet-talk, more than 1.0 tonne of grains/ha is also available.

and this is very much comparable with sugarcane due to its short duration (120 days). It can produce a green-cane yield of 40-50 tonnes/ha, of 15-23% brix and 40-50% juice extractability. With sweet-sorghum, it is possible to extend crushing season, so that the same machinery can be used for a longer period.

Crop protection: Increased severity and widespread occurrence of corn planthopper (*Peregrinus maydis* Ashm.) in parts of Karnataka and western Maharashtra and significant infection of long smut (*Tolysporium ehrenbergii*) in Gujarat have been recorded. Similarly, there has been an increase in infection of maize mosaic and maize stripe viruses transmitted by *Peregrinus maydis;* to an extent of 10-15% in Karnataka.

Pearl Millet

Crop improvement: Five hybrids of pearl millet have been identified for release at the national level, and three pollinated varieties and a hybrid have been released at the state level.

Crop production: The crop sequence of pearl millet after legumes has resulted in higher pearl millet equivalent yield (PMEY) as compared to pearl millet after fallow, pearl millet after sesame and pearl millet after pearl millet.

- Pearl millet hybrid MH 946 responded as the best hybrid to terminal drought during *kharif* and summer.
- Pearl millet hybrids MH 1001, MH 1109, MH 1169 and MH 1179 exhibited multiple resistance against downy mildew and smut.

Pearl millet varieties released

Hybrids/ Varieties	Area of recommendation	Mean grain yield (tonnes/ha)	Salient features
	Central Releases		
GHB 577	Rajasthan, Haryana, Gujarat, Uttar Pradesh, Madhya Pradesh, Punjab and Delhi	3.10	Medium maturity, downy-mildew resistant
RHB 127	Rajasthan, Haryana, Gujarat, Uttar Pradesh, Madhya Pradesh, Punjab and Delhi	2.91	Early maturing, downy-mildew resistant, bristled hybrid
SAMH 166	Maharashtra, Andhra Pradesh, Tamil Nadu and Karnataka	3.00	Late maturing, high-grain yield, downy-mildew resistant
Hybrids for summer cultivation			
PB 180	Gujarat, Maharashtra, Tamil Nadu and parts of Rajasthan	4.00	Late maturing, high grain and fodder yields
	State Releases		
HC 10	Haryana	2.24	Medium maturity, high grain yield, resistant to diseases
PPC 6	Maharashtra	2.67	Late maturing, moderately resistant to downy mildew
PCB 164	Punjab	2.15	High yield, dual purpose
HHB 117	Haryana	–	High grain and fodder yields, remains green till maturity

Application of 50-75% of the recommended N through inorganic source and 25-50% through vermi-compost has recorded considerably higher PMEY over 100% recommended N through urea in succeeding wheat, sunflower and soybean crops.

Crop protection: Pearl millet hybrid MH 946 has responded as the best hybrid to terminal drought during *kharif* and summer. Hybrid MH 1021 (GHB 577) has showed complete resistance to downy-mildew disease. And MH 1001, MH 1109, MH 1169 and MH 1179 hybrids have exhibited multiple résistance against downy mildew and smut.

SMALL MILLETS

Crop improvement: Foxtail millet variety SR 51 (Pratap Kangni 1), maturing in 65-70 days and yielding about 1.8-2.0 tonnes/ha, has been notified for cultivation in Rajasthan. Proso-millet variety GPU 21, maturing in

- Fingermillet+field-pea intercropped in 8:1 ratio found suitable and profitable in Karnataka and Tamil Nadu.
- Fungicide 'Saaf' at 0.2% showed its effectiveness in controlling blast in fingermillet.
- *Cercospora* leaf spot incidence lowered in fingermillet plots receiving farmyard manure instead of inorganic fertilizers alone.

GPU 21 proso-millet. This variety maturing in 65-70 days has been identified for Karnataka and Tamil Nadu.

Fingermillet + field-pea in 8:1 ratio has been widely accepted profitable intercropping system for augmenting legume production.

65-70 days, has been identified for Karnataka and Tamil Nadu.

Crop production: Fingermillet + field-bean (8:1) intercropping system has been found suitable and profitable in Karnataka and Tamil Nadu. Kodo millet and pigeonpea intercropping in 4:2 has been found more profitable than farmers' intercropping practice of kodo millet and urdbean in Madhya Pradesh.

Crop protection: The fungicide 'Saaf' (Carbendazim + Mancozeb) at 0.2 % has showed its effectiveness in controlling blast in fingermillet.

Incidence of *Cercospora* leaf-spot had significantly lowered in fingermillet plots receiving farmyard manure compared to plots receiving inorganic fertilizers alone.

UNDERUTILIZED CROPS

Crop improvement: One variety in grain-amaranth and 3 varieties in ricebean have been identified.

- Identified one variety of grain-amaranth and 3 of rice-bean.
- Most appropriate cropping system in Tamil Nadu is grain-amaranth and pigeonpea. It gives a cost : benefit ratio of 1:89.

Quality: Highest protein contents have been observed in amaranth Akola local (14.6%), faba bean HB 123 (19.9%), ricebean RBL 33 6 (20.5%), kalingada GK 1 (52.5%), winged-bean EC 38955 (35.8%) and jatropha Hansraj (47.9%). Maximum oil percentages have been seen observed in amaranth SKNA 20 (10.8%), kalingada SKNK 2 (49.3%), winged-bean IC 26945 (20.7%), jatropha Hansraj (48.9%) and *Simarouba* Mettupalayam Selection (61.1%).

Germplasm collection of underutilized crops

Plant	Collection
'kankoda' (Spine-gourd)	*64*
Amaranth	*47*
Buckwheat	*10*
Chenopods	*3*
Job's tear	*1*
Ricebean	*19*
Adzuki bean	*6*
Perilla	*10*
Jatropha	*2*
Citrullus colocynthis	*1*

Crop production and protection: Grain-amaranth-pigeonpea is the most appropriate cropping system in Tamil Nadu. It gives a cost:benefit ratio of 1: 89, and pre-emergent application of Alachlor at 1.5 kg a.i./ha has been effective for controlling weeds in buckwheat.

Underutilized crop varieties identified

Crop	Seed yield (tonnes/ha)	Salient features	Area of adoption
Grain-amaranth PRA 9401	1.99	High-yielding, medium maturity	North-western hills
Ricebean BRS 1	1.62	Medium maturity, dark-green seeds	North-western Hills
RBL 35	1.09	Early maturing	All plains zone
RBL 50	1.23	Green seeded	All plains zone

FORAGE CROPS

Crop improvement: Five varieties, one each in cowpea, tall fescue grass, *Setaria* grass, pearl millet and berseem have been released for cultivation at the central/state level.

- Released five varieties of forage crops, one each in cowpea, tall fescue grass, setaria grass, pearl millet and berseem, for cultivation.

OILSEEDS

Groundnut

Crop improvement: TG 37 A is an early-maturing (104 days), Spanish-bunch groundnut variety having wider adaptability. This has been identified for *kharif* in Uttar Pradesh, Rajasthan, Punjab and Haryana. During *kharif*,

- Identified TG 37 A, an early-maturing, Spanish-bunch groundnut variety for *kharif* with wider adaptability.
- CS 19 groundnut, a stem-rot-resistant genotype of interspecific origin, developed for the first time.
- In rainfed areas, groundnut + sesame gave the highest water-use efficiency of 5.41 kg/ha/mm, followed by groundnut + castor and groundnut + pearl millet.
- For screening high temperature tolerance in groundnut, specific leaf area is one parameter; genotypes with low SLA have high temperature stress tolerance.
- Groundnut genotypes CS 19 and PBS 12032 showed multiple disease resistance.

Forage crops varieties released

Forage crops	Variety	Adaptation region/ Agro-ecology	Green forage (tonnes/ha)	Duration	Salient features
		Central Release			
Cowpea	UPC 607	Subtropical to tropical plains of North-west Zone comprising Uttaranchal, northern Uttar Pradesh, *tarai* belt, Punjab, Haryana and Rajasthan	35-40	Medium late (140-150 days) (seed to seed)	Better dry matter digestibility than recent releases, UPC 5286 and UPC 287; resistant to anthracnose, mosaic virus, collar/ root rot, bacterial blight, aphids, defoliators and semi-loopers; better seed yield; a dual-purpose material with white testa
		State Releases			
Tall fescue grass (*Festuca arundinacea*)	Hima 4	Temperate grasslands and orchards in Himachal Pradesh	30-40 (in 2-3 cuts)	Early (230-250 days)	Resistant to cold, frost and lodging, disease-free
Setaria grass (*Setaria anceps*)	Setaria 92	Subtropical grasslands and pastures between 300 and 1,400m above sea level in Himachal Pradesh	25-30 (in 3-4 cuts)	Late	Very thin tillers, tolerant to drought, cold and frost,disease-free
Pearl millet	FBC 16	Plains of Punjab	70-80	–	Multicut, resistant to major diseases, high voluntary dry matter intake and low concentration of oxalates
Berseem	BL 42	Plains of Punjab	85	–	Superior nutritional quality and seed yield (0.4 tonne/ha)

pod and kernel yields realized were 1,993 and 1,272 kg/ha. The variety has also been identified for *rabi*/summer cultivation in Orissa, West Bengal and North-eastern Hill region. GPBD 4 is an early-maturing (104 days), foliar diseases (late leaf spot, rust) resistant variety identified for late-sown areas of Tamil Nadu, Andhra Pradesh, Karnataka, Kerala and southern Maharashtra during *kharif*. Its pod and kernel yields realized were 1,983 and 1,336 kg/ha.

For the first time, a stem-rot-resistant groundnut genotype (CS 19) of interspecific origin has been developed.

Crop production: Pod yield of groundnut (1,889 kg/ha) has been found maximum in sequential cropping of groundnut-wheat-mungbean. Inter Row Water Harvesting (IRWH) could increase pod yield by 15% over traditional method of planting, without moisture conservation (1,192 kg/ha). The highest water-use efficiency (WUE) of 4.16 kg/ha/mm has been recorded in the IRWH and the lowest of 3.96 kg/ha/mm in control (without moisture conservation treatment).

In groundnut-based intercropping system in rainfed areas, groundnut+sesame intercropping gave the highest WUE of 5.41 kg/ha/mm, followed by groundnut+castor (4.42 kg/ha/mm). And groundnut+pearl millet recorded the lowest WUE (3.47 kg/ha/mm).

Groundnut genotypes NRCG 7085-1, 6820, 6919, MOR 161 and ICGHNG 88448 have been found as Ca-efficient and NRCG 7085-1, 1308, 6155, PBS 13, PBS 18057, 20016, MOR 204, PBS 11037, 20016, 20057 and MOR 139 have been found as P-efficient.

At Hanumangarh, high temperature stress tolerance genotype screening has indicated that genotypes with low specific leaf area (SLA) gave higher yield; SLA can be used as a parameter for high temperature tolerance screening.

Crop protection: Two groundnut genotypes CS 19 and PBS 12032 have showed multiple disease resistance (early leaf spot, late leaf spot, rust) in fields.

Seed treatment with *Trichoderma harzianum* at 4g/kg of seed and soil application of castor-cake have given fairly good control of aflaroot, collar rot and stem rot diseases, and have also resulted in highest pod yield of 1,457 kg/ha.

For control of stem rot, seed treatment with Captan (2g/kg), followed by soil solarization + seed treatment with *Trichoderma harzianum* at 4g/kg of seeds has been found effective.

Rapeseed-mustard

Crop improvement: Two varieties have been identified for release.

- In rapeseed-mustard CS 614-4-1-4 and JD 6 have been identified.
- Developed a new CMS (*canarianse*) promising system in mustard.
- Plant extracts of *Parthenium, Datura, Eucalyptus, Azadirachta* and *Calotropis* when used as spray on rapeseed have been effective in reducing severity of *Alternaria* blight.

CMS (*mori*) and its restorer are being transferred into 500 of F_1–BC_6 and 37 of BC_1–BC_4 genotypes through backcrossing in Indian mustard. CMS (*mori*) -based experimental hybrids, 94 in number, have been developed and evaluated to study the level of restoration and yield. A promising new CMS system (*canarianse*) has been developed in mustard. In yellow sarson, hybrid-seed production technology for GMS-based YSMS 8163 hybrid has been standardized.

Rapeseed-mustard varieties identified

Variety	Areas of adoption	Developed by
CS 614-4-1-4	Salt-affected soils of Indo-Gangetic plains and waterlogged saline soils of semi-arid regions	CSSRI, Karnal
JD 6	An early-maturing genotype, suited for rainfed agro eco-system, ZoneV (Orissa, West Bengal, Bihar, Jharkhand, Chhattisgarh and Assam)	IARI, New Delhi

Promising strains possessing low erucic acid and high oleic acid (up to 55 %) in Indian mustard (*Brassica juncea*) and having oleic acid up to 72% in *B. campestris* var. *toria* have been identified. Two double low strains of Indian mustard, Heera and NUDH-YJ 5, received from the NDDB, have been registered at the NBPGR, New Delhi.

Crop production: For pearl millet–mustard crop sequence, application of 80 kg N + 30 kg P_2O_5/ha along with 10 tonnes of FYM + 40kg S + 25kg $ZnSO_4$ per hectare to mustard has been recommended for southern parts of Haryana.

Thiourea (0.1%) spray at flower initiation along with basal application of 40 kg S/ha through gypsum has been found remunerative in north-western parts of Rajasthan. For north Gujarat, 40kg S/ha through gypsum has been recommended for increasing mustard productivity.

Crop protection: Plant extracts of *Parthenium, Datura, Eucalyptus, Azadirachta* and *Calotropis* when used as spray have been found effective in reducing severity of *Alternaria* blight disease. Aqueous solution (2%) of garlic (*Allium sativum*) when applied at 45 and 75 days after sowing has also been found to reduce infestation of *Alternaria* blight in mustard.

And seed treatment and foliar spray (2%) of garlic (*Allium sativum*) bulb extract at 45 and 75 days after sowing has been effective in reducing *Sclerotinia* rot also.

Sesame

Crop improvement: Four new varieties have been identified for release.

- Identified Gujarat Til 10, Prachi, Chandana and Thilarani sesame for release
- Entry KMR 44 of sesame found free from leaf roller/capsule borer and Shekhar moderately resistant to *Macrophomina* stem/root rot.

Gujarat Til 10. A black-seeded, high-yielding variety, developed by the GAU, Amreli, has been released in Gujarat for cultivation in *kharif*. It matures in 105 days, contains 47.5% oil and gives an average yield of 750 kg/ha.

Prachi (ORM 17). This a deep-black-seeded, high-yielding variety with high degree of tolerance to major diseases and pests has been recommended for Orissa.

Chandana (JCS 94). A high-yielding variety with sandalwood-coloured seed, tolerance to major pests and diseases and suitable for all seasons has been released for Andhra Pradesh.

Thilarani. A high-yielding variety, characterized by dark-brown-coloured seed with high oil content (51%), early maturity (80 days), yield ability of 680 kg/ha and suitability for cultivation in *rabi* has been released for Kerala.

Crop production: Highest sesame equivalent yield (1,524 kg/ha) has been recorded in sesame+cotton (3:1) intercropping system at Amreli with 100:50% recommended fertilizer dose to main: intercrop as per the area occupied by the crops.

Highest seed yield and net returns could be recorded with 50% N through urea+50% N through castor-cake at Jalgaon; 50% N through urea+50% N through 'Thumba' cake+P at Mandore; 50% N through urea+50% N through FYM+P at Nagpur and 50% N through urea+*Azospirillum*+*Azotobacter*+PSB+half P at Tikamgarh.

Sulphur at 45 kg/ha, through gypsum at Nagpur, Vridhachalam and Tikamgarh and through single super phosphate at Jabalpur recorded highest sesame seed yields and highest net returns.

Sesame+mungbean (2:2) at Jabalpur and

sesame+soybean (2:2) at Powerkheda, sesame + groundnut at Mandore and sesame+cotton (3:1) at Amreli have been remunerative sesame intercropping systems.

Two hand weedings at 15 and 30 days after sowings produced maximum seed yields at Amreli, Jalgaon, Powerkheda, Vridhachalam and Kayankulam.

Highest seed yields at a par with recommended chemical fertilizers could be recorded with FYM at 2.5 tonnes/ha+neem-cake at 250 kg/ha at Amreli and with FYM 3.75 tonnes/ha+neem-cake at 900 kg/ha + wood-ash 75 kg/ha+bone-meal 75kg/ha+ELS 20 kg/ha+PSB 5 kg/ha + *Azotobacter* 5 kg/ha+*Trichoderma viride* (0.04%) seed treatment+neem oil (2.0%) spray thrice at 15, 30 and 45 days after sowing or/Azadriachtin (0.03%) at 30 DAS) at Jabalpur, Vridhachalam and Jalgaon.

Crop protection: On sesame, leaf roller/capsule borer (*Antigastra catalaunalis*) and gall-fly (*Asphondylia sesami*) are the major insect pests and *Macrophomina* stem/root rot, *Phytophthora* blight, phyllody and powdery mildew are the main diseases. Entry KMR 44 has been found free from leaf roller/capsule borer and sesame Shekhar moderately resistant to *Macrophomina* stem/root rot disease.

Seed treatment with Carbendazim 50 WP (0.1%) + Thiram (0.4%) or *Trichoderma viride* (0.4%) or *T. harzianum* (0.4%) or cowdung ash (0.04%) reduced incidence of *Macrophomina* stem/root rot.

Seed treatment with Thiram (0.2%)+Carbendazim 50 WP (0.1%) + spray of Macozeb (0.25%) + Endosulfan (0.07%) at 30-40 and 45-55 days after sowing minimized incidence of leaf-roller/capsule borer, powdery mildew. *Alternaria* leaft spot and phyllody and *Macrophomina* stem/root rot disease at Nagpur and Vridhachalam.

Niger

Crop improvement: NRS-96-1 a high-yielding, early-maturing (94 days) variety developed at Varanasi has been released for Gujarat. This has recorded 37% higher seed yield in Rajasthan, Gujarat and Maharashtra over IGP 76, the national check.

- Developed at Varanasi NRS 96-1, an early-maturing niger, released for Gujarat.

JNS 14, BNS 8 and NJS 17 are found high yielding in advanced stage of testing. Two hundred twenty-nine new collections have been made in three explorations in Jharkhand, Madhya Pradesh and Karnataka under the NATP.

Over 1.5 tonnes of breeder seed of 7 varieties have been produced against the indent of 0.73 tonnes.

Crop production: Niger+Frenchbean (4:2) at 20 cm spacing gave highest niger equivalent yield of 945 kg/ha at Semiliguda.

Sulphur at 30kg/ha recorded highest seed yields when supplemented through gypsum/single super phosphate.

Maximum seed yields were recorded with N 40 kg/ha+P 20 kg/ha (SSP)+ P 20 kg/ha + PSB at Igatpuri and Kanke, and with N 40+ P 20 (DAP) + P 20 + PSB at Semiliguda. However, highest seed yield of 631 kg/ha could be obtained with N 20+P 20 (DAP) + PSB at Chhindwara.

At Igatpuri, maximum yield was recorded with natural inputs FYM at 2.5 tonnes/ha +neem-cake at 400 kg/ha+wood-ash at 50kg/ha+bone-meal at 50kg/ha+PSB at 5 kg/ha+*Azotobacter* at 5 kg/ha+15 kg S/ha (ELS)+ *Trichoderma viride* seed treatment (0.04%).

Soybean

Crop improvement: Soybean MAUS 81, developed by the Marathwada Agricultural University, Parbhani, has been identified for the Central Zone, comprising Madhya Pradesh, Gujarat, Rajasthan and parts of Maharashtra. It is early maturing (93 days variety), tolerates moisture stress and shows resistance to bacterial pustule, yellow mosaic virus and *Rhizoctonia* aerial blight; and also to insect-pests like stem-fly, girdle beetle and green semilooper.

- Soybean MAUS 81 identified for Central Zone is an early-maturing variety.
- Soybean LSb1, MACS 58, MACS 330 and Shilajeet showed higher level of oleic acid; a monosaturated fatty acid.
- Inclusion of maize in soybean-based intercropping system has showed beneficial effect on the system's efficiency in terms of productivity, energy and cost.
- In soybean, phosphorus as single superphosphate gave 16.2% higher yield than phosphocompost.
- Soybean breeding lines D_3P_8 and D_5P_{11} are identified as promising for resistance against *Spodoptera litura*.

LSb 1, MACS 58, MACS 330 and Shilajeet soybean have showed comparatively higher level of oleic acid; a monounsaturated fatty acid.

PK 1029, PK 1024, Co 2, Hardee, HIMSO 1563, MACS 124, Bragg and JS 335 were screened with RAPD markers that generated 295 bands. Out of these bands, 202 are found polymorphic.

Crop production: Inclusion of maize either in soybean-wheat crop rotation or in soybean-based intercropping system has showed beneficial effect on the system's efficiency in terms of productivity, energy and cost.

Integration of nutrients, using inorganic (50% recommended dose of fertilizer-RDF) and organic carriers, i.e. poultry manure and FYM, have produced comparable soybean equivalent yield, and has been found equally remunerative to 100% RDF alone.

At flowering stage of soybean, additional 20 kg N/ha increased seed yield to 10.7% over basal application of 20

SUCCESS STORY

Participatory soybean seed production – under TAR-IVLP Project

The NRC on Soybean adopted Bhagora village under the IVLP programme and had 6 interventions on production of quality seeds of improved soybean varieties. As a first step, the TAR-IVLP team assessed seed requirement of the soybean-farmers in the village. About 0.42 tonne/ha of MAUS 47, 0.8 tonne of NRC 12 and 0.16 tonne of NRC 37, 0.48 tonne of NRC 2 were provided to select farmers in 2001 and 2002. Since it was a participatory programme, farmers met cost of other critical inputs.

The core team of TAR-IVLP trained farmers in intercropping system and seed-production techniques along with other aspects of production technology.

In spite of the uneven distribution and deficit rainfall (around 70%) during 2001 (786.4 mm in 21 days) and 2002 (675.6 mm in 19 days), farmers could realize average seed yield of 1.16-3.11 tonnes/ha depending on the variety. The farmers were motivated to exchange quality seed with fellow-farmers. During subsequent year (2002), the seeds of newly released varieties produced by them were made available to other farmers of the adopted village on the cost basis. Some farmers sold soybean-seed at Rs 50/kg (against about Rs 18/kg for certified seed) to neighbouring farming community. The efforts made have not only saturated adopted village with quality seed of improved varieties but seeds could be supplied to nearby villages also. Farmers have been able to raise their income by selling soybean as seed. Thus, seed production of soybean by adopting farmers' participatory approach on the seed-village concept became a successful effort to spread the use of good quality seeds.

kg N/ha. Maximum seed yield was noted in JS 335 with $N_{20}+S_{40}$ kg/ha.

Phosphorus through single superphosphate gave 16.2% higher yield than phosphocompost. Among varieties, JS 335 outyielded PK 416, PK 1029 and Ahilya 4.

Crop protection. Breeding lines D_3P_8 and D_5P_{11} for resistance against *Spodoptera litura* have been identified as promising on the basis of the leaf consumption in laboratory (no-choice test).

Bacillus thuriengiensis and Monocrotophos, an fungicide, gave good protection against defoliators, stem-borers and foliar diseases and also resulted in higher yields.

Chlorpyriphos 20 EC at 1.5 litres/ha, Ethofenprox 5 EC, Methomyl 40 SP at 1.0 kg/ha and Quinalphos 25 EC at 1.5 litres/ha gave good insect control; Chlorpyriphos was most cost-effective.

Studies have indicated that self-sown and *rabi*/summer-sown soybean acted as the primary source of rust inoculum for *kharif*-sown crop. There may be little or no role of collateral host, if any, in initiation of the rust in India.

Sunflower

Crop improvement: DRSF 108 has been identified and recommended for cultivation in rainfed areas for *kharif* in sunflower-growing areas of the country. The variety has high seed yield potential of 1.0-1.2 tonnes/ha with high oil content of 40-45%.

- Sunflower DRSF 108 identified and recommended for cultivation in rainfed areas in *kharif*.
- Sorghum as a border crop around sunflower and seed treatment with Imidochoprid at 5 g/kg of seed + Confidor 200 SL 0.01% spray at 15, 30, 45 days after sowing reduced significantly sunflower necrosis disease incidence.

Four inbreds have been developed through inter- and intra-specific hybridization that are diverse with respect to duration (74-88 days), seed yield (14-35 g/plant), autogamy (67-84%) and oil content (26.6–39%), besides possessing resistance to *Alternaria* blight and necrosis diseases.

Among new populations, PKVSF 27, TS 82-8-1/3 and TS 22-7-2/5 at Akola; GAUSUF 31, GAUSUF 48 and GAUSUF 52 at Amreli; TNHAP 89, TNHAP 19 and TNHAP 3 at Coimbatore; NDSV 4 and NDSV 6 at Nandyal; and SP 3 at Raichur have showed promise.

Crop production: In Marathwada region, in soybean-sunflower cropping system on Vertisols, it is possible and profitable to substitute 50% P for sunflower by seed treatment with phosphorus-solubilizing bacteria and application of 5 tonnes of FYM/ha, when preceding soybean is supplied with the recommended P.

Sunflower yields were highest when both sorghum and sunflower in sequence were fertilized with 150% RDF, followed by NPK + FYM-NPK and NPK-NPK+B. FYM along with NPK resulted in build-up of soil N and P in the system. Similar response was recorded for the sunflower productivity as in the Vertisols in mungbean-sunflower sequence.

Crop protection: Sorghum as a border crop around sunflower and seed treatment with Imidochoprid at 5g/kg of seed + Confidor 200 SL 0.01% spray at 15, 30, 45 days after sowing significantly reduced sunflower necrosis disease incidence and increased sunflower seed yield.

Sunflower necrosis virus (tobacco streak virus) for the first time has also been found infecting safflower.

Safflower

Crop improvement: Phule Kusum (JLSF 414) has been identified and recommended for release for both rainfed and irrigated safflower-growing areas of the country.

Mitochondrial diversity study in the safflower and its wild species was made using a PCR technique, based on the repetitive elements developed, and perfected at the DOR, Hyderabad, which had higher throughput than the RAPD analysis.

- Safflower Phule Kusum (JLSF 414) identified and recommended for release for both rainfed and irrigated safflower-growing areas of the country.
- Safflower seeds treated with *Trichoderma harzianum* and/or *T. viride* showed lesser wilt incidence on the crop.

The high-yielding, wilt-resistant advanced breeding lines of safflower 96-520 and 96-519-2 have been found tolerant to aphids in late-sown areas.

Wilt resistant hybrids DSH 172 and DSH 173 developed at the DOR, Hyderabad, have yielded 65 and 27% higher seed yield and 84 and 38 % higher oil content than the check hybrid DSH 129. The wilt-resistant hybrid DSH 174 has been found on a par with DSH 129 in yield, but gave 20% higher oil yield.

Carthamus oxycantha has been identified as the donor of sterile cytoplasm in the progenies of *C. oxycantha* × *C. tinctorius*.

Crop production/protection: Integrated nutrient management in the mungbean-safflower at Annigeri in rainfed areas has indicated the need for applying100% NP to both the crops. Part substitution with seed treatment with *Azotobacter/Azospirillum* and phosphorus-solubilizing bacteria was not found possible. Similar results are indicated in soybean-safflower sequence at Indore and Phaltan in irrigated areas and chickpea-safflower at Sholapur in rainfed areas. However, at Parbhani, in soybean-safflower sequence in irrigated areas, 50% NP in safflower was substituted by *Azotobactor/Azospirillum* and phosphorus-solubilizing bacteria.

Safflower seeds when treated with *Trichoderma harzianum* and/or *T. viride* have showed lesser wilt incidence in safflower.

Castor

Crop improvement: Castor RG 109 and RG 724 have been found resistant to *Fusarium* wilt and *Macrophomina* root rot; RG 2752 to wilt and grey rot; RG 1468 and RG 1624 to wilt and nematode; RG 1608, RG 1624 and RG 2719 to wilt complex; and castor RG 111, RG 224, RG 2727, RG 2730 and RG 2732 have showed resistance to wilt and tolerance to moisture stress.

- Castor RG 109 and RG 724 found resistant to *Fusarium* wilt and *Macrophomina* root rot; RG 2752 to wilt and grey rot; RG 1468 and RG 1624 to wilt and nematode; RG 1608, RG 1624 and RG 2719 to wilt complex; RG 111, RG 224, RG 2727, RG 2730 and RG 2732 to wilt and tolerant to moisture stress.
- Castor DPC 16 identified and stabilized as a new pistillate line.
- Standardized a simplified growth-room screening technique for studying *Botrytis* grey-rot in detached spikes of castor.

Developed insect-resistant castor transgenics

Transformation of castor with constructs harbouring insect-resistance gene (s) *Cry 1E* (c) and *Cry 1Aa* has been done through particle-gun bombardment and *Agrobacterium*-mediated methods. Molecular analysis using gene-specific primers for *Gus, Hpt* and *Cry 1Aa* have confirmed presence of genes. Insect bioassays of 15 primary transgenics have showed mortality of castor semilooper larvae within 1 day in 1 plant, within 2 days in 3 plants and in 4 days in 1 plant.

DPC 16 has been identified and stabilized as the new pistillate line.

Crop production: For higher returns of castor, precede *rabi* castor in north Gujarat by mungbean, fodder sorghum or sunnhemp for green manuring, besides applying 80 kg N/ha to *rabi* crops.

Crop protection: Farmyard manure and neem-cake applications and seed treatment with *Trichoderma viride* have recorded lowest wilt incidence in castor.

A simplified growth-room screening technique has been standardized for studying *Botrytis* grey-rot in detached spikes of castor.

Among 77 isolates of *Bacillus thuringiensis*, 54 strains had both *Cry1* and *Cry2* genes, 3 strains had only *Cry1* gene, 10 strains had only *Cry2* and 10 strains had none. Specific primers have been designed to characterize *Cry 1* genes in DOR-1 local isolate.

Mass multiplication of improved strains of *Trichoderma* has indicated that formulation prepared from biomass obtained through shaker-culture method has been found to retain shelf-life (up to 9 months) of *T.viride* (TV-N); stored in refrigerator. Seed treatment with Carbendazim + *Trichoderma* at 10 g/kg of seed+ soil application of *Trichoderma* has been found most effective in managing castor wilt.

Linseed

Crop improvement: KL 224 linseed has been identified for Haryana, Punjab, Himachal Pradesh and Jammu and Kashmir.

A catalogue of 2,053 accessions documented for 22 descriptors has been published.

Promising resistant/tolerant cultures of linseed against wilt are GS 362 and H 22; and against *Alternaria* blight are EC384154, H 8, H 10, H 15, H 34, H 43 and JRF 1.

- Linseed KL 224, yielding 511 kg/ha, identified for Haryana, Punjab, Himachal Pradesh and Jammu and Kashmir. It has showed moderate resistance to *Alternaria* blight and powdery mildew.
- At Raipur and Sagar rainfed areas, soybean-linseed crop sequence with 100% recommended dose of fertilizers to linseed has been adjudged very remunerative.

SUCCESS STORY

Water-harvesting technique for soybean cultivation

Mr Bhagat Singh has 9 hectares of land along with tractor and other agricultural resources for cultivation. His five family members are involved in the agricultural activity with him. He was producing soybean, potato, garlic, onion and chickpea in the limited area only due to severe water crisis during *rabi* till the year 2001. The technical support provided by the IVLP members has helped him not only in increasing cultivable area but also gross income from Rs 315,720/ha/yr to Rs 645, 700/ha/yr.

To limit run-off from canal, which is running along with the boundary of his farmland, he staked gunny-bags filled with sand/soil/pebbles at specified locations (*bori* bandh). The water collected in the canal was drained in open-wells through underground pipeline. In addition, all four bore-wells in farmland were interlinked and in turn linked with the collected water. In case of excess collection, he pumped water to bore-wells facilitated with percolation arrangement around them. For facilitating percolation in each bore-well, he had dug up to 5-metre in depth with 3-metre in diameter. First 2 metres were filled with 40-mm size boulders, followed by 20-mm size in another 2-metre. The top one metre space was filled with coarse-sand. A casing pipe of 4-metre length having small holes and wrapped using coconut rope was inserted into bore-well to filter rain-water. The water levels in the bore-wells got recharged quickly with these efforts and water availability in the bore-wells could extend from February to May. The total expenditure was Rs 70,000 for this facility.

Mr Bhagat Singh was having soybean cultivation in about 4.5 hectares and groundnut in 2 hectares during *kharif* and potato (2ha), garlic (0.5ha) and chickpea (6ha) during *rabi*. After establishment of this system, the area under potato has been increased from 2 hectares to 7 hactares and, accordingly, farm income has increased. An account of benefit accrued is as follows.

Benefits accrued from water-harvesting system

		Before the project initiation			After the project initiation			
Season	Crop	Area (ha)	Yield (tonnes/ha)	Gross income (Rs/ha)	Crop	Area (ha)	Yield (tonnes/ha)	Gross income (Rs/ha)
Kharif	Soybean	4.5	1.6	26,045	Soybean	4.5	2.6	52,000
	Groundnut	2.0	5.0	45,000	Groundnut	2.0	5.5	55,000
Rabi	Potato	2.0	14.5	126,875	Potato	7.0	23.4	245,700
	Garlic	0.5	6.8	108,800	Garlic	0.5	12.6	189,000
	Chickpea	6.0	0.6	9,000	Onion	0.5	26.0	104,000
	Total			315,720				645,700

In the process of water harvesting by Shri Bhagat Singh, the bore-wells numbering 20 of adjacent farmers also got recharged. Other farmers in Bhagora village were fascinated by this innovative approach and vowed to adopt in the next season.

Linseed variety identified

Variety	Average seed yield (kg/ha)	Days to maturity	Salient features
KL 224	511 (*Utera*)	171-203	Erect, purplish-blue flowers, brown seeds, has resistance to rust and powdery mildew and moderate susceptibility to wilt, moderate resistance to *Alternaria* blight and powdery mildew and moderate susceptibility to wilt. It has oil content of 39.70%

Crop production: Soybean-linseed crop sequence with 100% recommended dose of fertilizers (RDF) to linseed has been adjudged remunerative at Raipur and Sagar in rainfed areas. At Kanke, urdbean–linseed/Paddy–linseed cropping sequence with 100% RDF to linseed has been the best.

At Nagpur, in rainfed areas, linseed+chickpea (9:2) with 100% RDF to main crop and no fertilizer to intercrop has been the best.

Crop protection: For managing linseed wilt, seed treatment with *Trichoderma harzianum* at 4g/kg of seed has been most effective.

Two fortnightly applications of Imidacloprid 200 SL at 100 ml/ha have been found effective and economical for bud-fly management in irrigated as well as rainfed areas. Linseed germplasm lines CI 1956, EC 1392, EC 1424, EC 41636, ES 1474, ES 1476, GS 4, GS 192, RL 99-19, LMS 1-23 and LMS 49-2 K have showed promise against bud-fly.

PULSES

Chickpea

Crop improvement: Haryana Channa 3 (HK 98-155), a kabuli chickpea variety, has been developed from a single cross ICCV 2 × Surutato 77, and has been identified for Haryana, Punjab, Delhi, parts of Rajasthan and western Uttar Pradesh. It is characterized by plants of spreading, medium-tall nature with white flowers and dark-green broad leaves. It matures in 145 days and its average yield is 18-19 tonnes/ha. Its seeds are white-beige and seed weight is 25g/100 seeds.

- Developed Haryana Channa 3, a kabuli chickpea variety, from a single cross. It has been identified for Haryana, Punjab, Delhi, parts of Rajasthan and western Uttar Pradesh.
- Rice-chickpea system proved economical, giving higher returns of Rs 10,260/ha over rice-wheat system, and is gaining popularity.

And variety Anvita (RSG 931) has also been developed from a single cross RSG 44 × RSG 524. It is identified for rainfed areas of Haryana, Punjab, Delhi, parts of Rajasthan and western Uttar Pradesh. It has semi-erect nature with profuse branching and matures in 130-140 days with an average yield of 1.6-1.7 tonnes/ha, and has 100 seeds weight of 14.5g with moderate resistance to dry root-rot.

Crop production: Rice-chickpea (kabuli) system is gaining popularity. It is economical and has produced higher returns of Rs 10,260/ha over rice-wheat system. Rice-chickpea (*desi*) cropping system has been found almost equal in returns to rice-wheat system.

Crop protection: Entries FG 11, FG 712, H 99-117 and BCP 15 have been found resistant or moderately resistant against wilt.

Wilt incidence could be reduced significantly by seed treatment with *Trichoderma viride* + vitavax in chickpea sown in mixed and intercropped with linseed.

Under advanced stage screening, promising cultivar, BG 1053, has received minimum pod-borer damage.

Pigeonpea

Crop improvement: Three varieties have been released for commercial cultivation.

- Released pigeonpea Pusa 992, MA 6 and GAUT 00IE for commercial cultivation.
- Ridge planting of pigeonpea under recommended fertility increased its yield up to 32% over flat planting in the North-Eastern Plains Zone.
- Pigeonpea early genotype Pusa 2001 and medium-duration genotype KM 163 showed multiple tolerance to pod-fly and pod-borer.

Pigeonpea varieties released

Variety	Adoption region	Yield (kg/ha)	Duration (days)	Other salient features
Pusa 992	North-Western Plains Zone	2,400	119-162	Medium-bold seeds, six days earlier than UPAS 120
MA 6	North-Western Plains Zone	2,281	248-267	Resistant to pod-fly and pod-borer
GAUT 001E	Central Zone	2,610	140-150	Yield advantage (44%) over best check UPAS 120

Twenty-nine promising pigeonpea lines with a minimum of 5% yield advantage have been identified from different co-ordinated varietal trials and have been advanced to next stage.

Crop production: Intercropping of pigeonpea with mungbean/urdbean/soybean has proved superior to sorghum or pearl millet across the zones, and spray of 2% urea at 15 and 45 days after harvest of intercrop increased pigeonpea yield.

Application of 15 kg zinc sulphate/ha along with the recommended dose of fertilizers (20-18-27-20 NPKS) increased pigeonpea productivity up to 28%. *Rhizobium*, new strains, *viz*. A 5 A 7, RAU 10, BPR 9804 and 9806 have showed promising results. *Rhizobium*, PSB and compost (2.5 tonnes/ha) application reduced 50% on the cost of fertilizers.

Ridge planting of pigeonpea under the recommended fertility increased yield up to 32% over flat planting in the North-Eastern Plains Zone.

Crop protection: Early genotype Pusa 2001 and medium-duration genotype KM 163 have showed multiple tolerance to pod-fly and pod-borer. Pigeonpea MAL 13, RA 6, JKM 1, JKM 169, KPL 143 and KPL 44 have been identified as resistant to *Fusarium* wilt.

KPL 43, PP 16 K, PP 17 K, PPKL 6 and PSMR 2006 K have been identified as exhibiting multiple resistance to wilt and sterility mosaic and tolerance to *Phytophthora* blight. Sowing pigeonpea on ridges reduced *Phytophthora* blight incidence by 50% as compared to flat sowing. Blight incidence on ridges was only 44% compared to 82% in the flat sowing.

MAL 9 has been found resistant to pigeonpea cyst nematode (*Heterodera cajani*) and Pusa (B) 35 has exhibited tolerance to both cyst and root-knot nematodes. Wilt resistant lines KPL 43 and GPS 33 have also showed resistance to root-knot nematode.

Soil application of Carbofuran (3) at 2kg a.i./ha and seed treatment with Monocrotophos at 0.1% for 6 hours increased pigeonpea yield by 38.9 and 18.6% over control in root-knot nematode-infested fields.

MULLARP (Mungbean, Urdbean, Lentil, Lathyrus and Rajmash)

Crop improvement: Four new varieties have been identified for release.

Urdbean NDU 99-2. Developed from a cross of T 9 × PDU 102, this has showed consistent superiority in yield performance (12%) and in resistance to yellow mosaic virus (YMV); it is identified for Hill Zone for *kharif*.

- Identified urdbean NDU 99-2, KU 96-3, fieldpea IPF 99-25 and lentil KLS 218 for release.
- Recommended row ratio of 4:4, 4:3, 4:2 for urdbean+ragi intercropping in rainfed areas.
- Lentil *Rhizobium* strain LR 31-97 proved promising with superior yield over check strain LB 4.
- Mungbean MH 98-1 showed resistance to YMV across locations, BPMR 145 against powdery mildew in multilocations and PDM 96-262 against yellow mosaic virus and *Colletotrichum* leaf spot.

Urdbean KU 96-3. Developed from a cross of PU 19 × NP 21 with an advantage of 19% over the best check TPU 4 in the Central Zone, it has showed resistance to YMV; it is identified for the Central Zone (*kharif*).

Fieldpea IPF 99-25. This tall-type fieldpea has been developed through pedigree selection from a cross PDPD 8 × Pant P 5. It has yield superiority of 23.5% over the check variety in the Central Zone and has also high level of resistance to powdery mildew; it has been released and notified for the Central Zone.

Lentil KLS 218. This small-seeded variety has a yield advantage of 27% over the best check in the North-Eastern Plains Zone and is fairly tolerant to rust; it is identified for the North-Eastern Plains Zone.

Crop production: Early pigeonpea + mungbean (1:2) with 1.42 land-equivalent ratio have performed well in South Zone with mungbean contributing to the most.

Soil mulch and 2% KCl spray have been recommended for mid-season drought management in urdbean. Intercropping urdbean + ragi with increased urdbean row (4:3, 4:4 or 4:2) has been recommended in the rainfed areas.

Sprouted seeds of lentil sown 15 days before harvest of rice increased lentil yield by 30% in the North-Eastern Plains Zone (NEPZ). A plant population of 0.66 million per hectare (15 × 10 cm) was needed for best yields (1,867 kg/ha) in the extra early fieldpea in the NEPZ.

Lentil *Rhizobium* strain LR 31-97 has been promising with superior yield over check strain LB 4. Fonoxa propethyl at 56 g/ha (post-emergence) applied 28 days after sowing increased yield by 24.9% in urdbean.

Crop protection: Mungbean MH 98-1 has showed resistance to YMV across locations, BPMR 145 has showed multilocation resistance against powdery mildew, and PDM 96-262 has been found promising against yellow mosaic virus (YMV) and *Colletotrichum* leaf spot (CLS).

Lamda Cyhalothrin (Karate 0.04%) alone and in combination with NSKE (5%) and Thiodicarb (0.04%) has proved effective against sucking pests and pod-borer in mungbean and urdbean.

Urdbean genotype KU 96-3 has showed broad-based resistance to YMV; KU 99 and TU 99-51 against CLS. Lentil genotypes IPL 406, IPL 405, L 4650, L 4618, IPL 306, L 184-8, LH 2K-27, L 4649 and L 4619 have showed resistance against rust.

And fieldpea KPMR 641, KPMR 615 and KPMR 640 has showed broad-based resistance to powdery mildew.

Seed treatment with *Trichoderma viride* has reduced wilt incidence in fieldpea by 50%. Mungbean genotype TM 2000-2 has showed broad-based resistance against powdery mildew.

Arid Legumes

Crop improvement: Following varieties of arid legumes have been identified for pre-release.

Guar strain RGM 112. Three years' multilocation testing has established its average grain yield potential of 1,508 kg/ha, being 22.0% higher over the better check RGC 1002 (1,234 kg/ha). This strain put forths flowers in 35 days and matures in 92 days.

- Identified *Guar* RGM 112 and Mothbean CZM 45 for pre-release.
- In rainfed monocrop situation, guar–guar at Hisar (Rs 21,960/ha) and *bajra*–urdbean at Gwalior (Rs 18,606/ha) proved remunerative cropping systems.

Mothbean strain CZM 45. Across three years' multilocation testing, it has yielded up to 571.5 kg/ha, being 27.7% higher over the check CAZRI Moth 1 (447.5 kg/ha). Having tendency to escape YMV infection, it tends to flower in 34-35 and matures in 68-70 days. It has high grain-protein (25.0%) and appears suitable for both short and long range rainfall situations.

Guar strain HGS 870. It is characterized with maximum gum content (31.78%), endosperm (39.50%) and appreciably good viscosity (5166 cP) profile.

Cowpea strain GC 9040 has maintained higher crude protein (25.24%) and minimum tannin content (0.18 mg/g), and cowpea V 240 required minimum cooking time (13.8 min.). Horsegram strain AK 42 possesses maximum crude protein (31.6%).

Crop production: In rainfed monocrop situation, guar–guar at Hisar (Rs 21,960/ha) and *bajra*–urdbean at Gwalior (Rs 18,606/ha) have proved most remunerative cropping systems.

At Hisar, Bawal, Durgapura and Gwalior, one spray in guar with 0.5% $ZnSO_4$ at 25 or 45 DAS gave 8.98 kg of grains/ha compared to 6.92 kg/ha in control, particularly in Zn-deficient soils.

Trials at Sardar Krushinagar, Pattambi and Durgapura have showed that maximum grain yield (619 kg/ha) of cowpea could be obtained with 2 sprays of 0.5% $FeSO_4$ at 25 and 45 DAS; 26% higher with Rs 1,952 kg/ha additional returns over control (491 kg/ha).

Crop protection: Guar RGC 1074 and HGS 891 have showed less than 3.0% infection against bacterial leaf blight (BLB), and cowpea TC 99-1, DCP 5, DCP 6 and KBC 3 have showed less than 3.0% infection against cowpea yellow mosaic virus; hence may be rated as tolerant.

Seed treatment (1 g/kg) with streptocycline along with 3 sprays (150 ppm) at an interval of 15 days was most effective in reducing BLB intensity and increasing yield of guar considerably. Cowpea seed treatment with Carbendazim at 2 g/kg of seed was found effective in reducing seedling mortality percentage due to root rot besides increasing grain yield.

COMMERCIAL CROPS

Cotton

Crop improvement: Six varieties/hybrids have been released/notified for commercial cultivation.

Long staple diploids for better fibre properties for North Zone (having tolerance to leaf curl virus) and for dryland areas have been developed at Dharwad and Parbhani for multilocation testing.

- Cotton NH 545, LD 694, RBDV 7, PA 255, PKVHy 5 and PKVDH 1 released/notified for commercial cultivation.
- Registered *Gossypium hirsutum* genotype CNH 123, resistant to cotton leaf curl virus, and *G. arboreum* genotype 30838, resistant to grey mildew, with the NBPGR, New Delhi.
- In cotton–wheat sequential cropping, incorporation of wheat straw and cotton-crop residue after harvest improved productivity of both.

Gossypium hirsutum genotype CNH 123 (INGR No. 02021) resistant to cotton leaf curl virus has been registered with the NBPGR, New Delhi.

One *Gossypium hirsutum* genotype CNH 123 (INGR No. 02021) resistant to cotton leaf curl virus and one *G. arboreum* genotype 30838 (INGR No. 02020) resistant to grey mildew have been registered with the NBPGR, New Delhi. Also GMS line with LRA 5166 background has been registered (INGR No. 02012) with the NBPGR, New Delhi.

Crop production: In irrigated areas in the North Zone, significant increase in seed yield and quality parameters could be observed in varieties when crop was sown at 120 cm × 90 cm and sprayed with DAP 2% at 45 DAS, $MgSO_4$ 1% at 50 DAS, boron 0.1% at 60 DAS and $ZnSO_4$ 2% at 75 DAS.

In cotton-wheat sequential cropping system, incorporation of wheat straw and cotton-crop residue (stalks and leaves) after harvest has improved productivity of wheat and cotton both.

In summer cotton at Coimbatore, seed yield increase due to drip in cv. Surabhi ranged from 28.9 to 61.5%. The water-use efficiency (WUE) ranged from 8.8 to 15.8 kg/ha/cm in drip irrigation, and it was only 4 kg/ha/cm under flood irrigation.

Crop protection: The IPM modules have recorded less pest incidence and significant higher seed-cotton yield than the conventional pest management. Important packages of IPM modules are: seed treatment with

Cotton varieties/hybrids released/notified

Variety/hybrid	Developed by	Kind	Area of notification/cultivation
NH 545	MAU, Nanded	*G.hirsutum*	Marathwada
LD 694	PAU, Ludhiana	*G.arboreum*	Punjab
RBDV 7 (*Pratap Kapi-1*)	ARS, MPUAT, Banswara	*G. herbaceum*	South Rajasthan
PA255 (*Turrab*)	MAU, Parbhani	*G.arboreum*	Marathwada
PKVHy 5	PDKV, Akola	CMS based intra-*hirsutum* hybrid	Vidharba
PKVDH 1 (AKDH 7)	PDKV, Akola	intra-*hirsutum* hybrid	Vidharba

SUCCESS STORY

Yield improvement of cotton through moisture-management practices in rainfed areas

Ten farmers each on upper, middle, lower and bottom toposequences were selected at Thugaon micro-watershed in Amaravati (Maharashtra) for managing and conserving rainwater in different toposequences for yield maximization of rainfed cotton.

Improvement in crop/seed production

Ridge-and-furrow system enabled increase in sorghum and seed-cotton yield by 1.0 and 0.3 tonne/ha over flat bed, and 1.5 and 0.5 tonnes/ha over farmers' practice in upper toposequence. Sowing of cotton on contours has been beneficial, compared to moisture conservation in flat-bed method.

Intercropping mungbean resulted in increased seed-cotton yield by 0.2 tonne over sole cotton, besides increasing moisture conservation when cotton was also grown on contours.

Recycling rainwater harvested in farm-pond or recharged well or 'Nallah' was effective in increasing seed-cotton yield by 0.5 tonne/ha in upper and 0.8 tonne/ha over farmers' practice in lower to bottom toposequences. Stored water in water-harvesting pond increased seed-cotton yield as high as 2.25 tonnes/ha in the bottom toposequence.

Excess moisture management in cotton

Ridge-and-furrow and broad bed and sunken-bed system in bottom toposequence helped to drain-out excess rainwater and improved seed-cotton yield by 0.4-0.6 tonne/ha.

Ridge-and-furrow system in rainfed cotton

Improvement in quality parameters in cotton

Soil-moisture management practices results showed that ginning percentage was higher in middle and lower toposequences, and lower in upper and valley bottom.

Gross monetary returns (Rs/ha)

Intercropping sorghum with cotton is not advisable to avoid problems in cross-intercultural operations after knee-height stage. However, strip cropping of sorghum with cotton is profitable than cotton alone on upper toposequences. Soil-moisture conservation through ridge-and-furrow system and one protective irrigation increased gross yield and gross returns with additional income of Rs 13,000 in upper plains, Rs 7,000 in the middle plains and Rs 25,000 in the lower plains over farmers' practice.

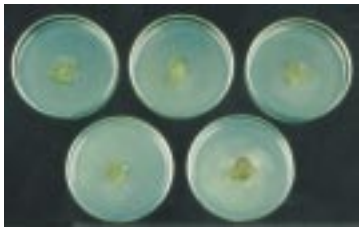
Technological impact

Ridge-and-furrow system is considered best among all moisture-conservation practices.

Intercropping mungbean, soybean and sorghum as a strip crop in cotton is being adopted by farmers to reduce run-off and improve soil moisture, and has facilitated increase in area under double-cropping system.

Imidachloprid or Thiamethoxam, raising castor or okra or marigold as trap-crop, release of egg parasitoid *Trichogramma chilonis*, spraying neem principles or its formulations, erecting bird perches, monitoring moth activities through pheromone traps, detopping terminal shoots when the crop is 100 days old and mechanical collection and destruction of egg masses and visible larvae of pests.

Location-specific IPM/IRM modules for eco-friendly and sustainable cotton production in 33 farmers' fields have helped reduce mean number of insecticidal sprays from 5.12 to 2.16 and plant protection cost from Rs 5,120 to Rs 2,160/ha over 'Control' village. In irrigated areas in the North Zone, neem-seed kernel extract (5%) along with insecticides reduced insect-pests and cost without significantly affecting yield. Though yield has been more in farmers' spray practice, its C:B ratio at 1:1.49 is lesser than IPM module (1:1.70) in the station trials.



New synthetic medium has been developed and a new technique of inoculation for healthy leaf tissues of cotton has been identified for obtaining sporulating pathogenic culture of grey-mildew pathogen *Ramularia*.

The IPM participatory farmers obtained average cotton-seed yield of 1.78 tonnes/ha compared to 1.62 tonnes/ha by non-IPM farmers under large-scale (50 acre plots) demonstration of IPM technologies in Pannihari village in Sirsa district. The C:B ratio in IPM farmers (1:3.15) was more than non-IPM farmers (1:2.62).

New synthetic medium has been developed and a new technique of inoculation for healthy leaf tissues has been identified for obtaining sporulating pathogenic culture of grey-mildew pathogen *Ramularia areola* Atk.

Sugarcane

Crop improvement: Five sugarcane varieties have been identified for commercial cultivation.

Thirty-one promising clones of sugarcane have been identified, of which 16 belong to early group and 15 belong to mid-late; 14 clones have showed high sucrose of more than 20% at harvest. Another 14 clones have showed cane yield of more than 100 tonnes/ha. In Co 0303, Co 0114, Co 0313, Co 0315, Co 0322 and Co 0323 clones

A photoperiodic facility at the SBI is being utilized to artificially induce flowering in non-flowering parents, delaying flowering in early-flowering parents and advancing flowering in late-flowering parents.

combined high yield of above 100 tonnes/ha and sucrose of above 20% have been noticed.

Nine accessions of *Saccharum spontaneum*, *Erianthus arundinaceus* and other related grasses have been collected during Andaman-Nicobar islands explorations that represent new variability.

Five cytotypes of *Saccharum spontaneum* (2n= 48 to 66) have been identified based on the cytological studies of 37 new accessions from Tamil Nadu, Andhra Pradesh, Arunachal Pradesh and Orissa.

A photoperiodic facility is being utilized to artificially induce flowering in non-flowering parents, delaying flowering in early-flowering parents and advancing flowering in late-flowering parents. Thus, several crosses between non-flowering and non-synchronous flowering parents have been made possible. This would help in development of improved sugarcane varieties.

- Identified sugarcane Co 94008, Cos 95255, Co Pant 93227, Co Se 96234 and Co Se 96436 for commercial cultivation.
- Identified 5 cytotypes of *Saccharum spontaneum* (2n=48 to 66) based on the cytological studies of 37 new accessions.
- Developed in the sugarcane institute a photoperiodic facility to induce artificially flowering in non-flowering parents and to cross early-flowering and late-flowering parents by delaying and advancing flowering.
- Designed an innovative overlapping cropping system for wheat-sugarcane sequential system to enhance sugarcane productivity.
- Autumn-sugarcane intercropped with 2 rows of maize and *rajmash* produced cane equivalent yield of 134.7 and 108.6 tonnes respectively and proved highly remunerative.
- In sugarcane, a dual-row planting system through mechanized cultivation has been developed to improve cane yield.
- Developed a laboratory-rearing technique for mass multiplication of sugarcane black-bug, *Dimorphopterus gibbus*.

Crop production: For multiple ratooning, integration of stubble shaving, gap filling, trash mulching and cultivation in alternate rows with use of Phorate (15 kg/ha) may be adopted to sustain higher cane ratoon yields. Keeping ratoon beyond third year does not appear to be economical.

Erianthus arundinaceus. This has been collected during Andaman-Nicobar islands explorations, and represents new variability.

Sugarcane varieties identified

Variety	Adaptation zone	Maturity group	Cane yield (tonnes/ha)	Sucrose (%)	Reaction to red rot
Co 94008 (*Shyama*)	Peninsular	Early	119.76	18.31	Moderately resistant
CoS 95255 (*Rachna*)	North West	Early	70.49	17.49	Moderately resistant
CoPant 93227	North West	Mid-late	75.38	17.30	Resistant
CoSe 96234 (*Rashmi*)	North Central	Early	64.11	17.94	Moderately resistant
CoSe 96436 (*Jalpari*)	North Central	Mid-late	67.12	17.73	Moderately resistant

In sugarcane keeping ratoon beyond third year is not economical. But fourth ratoon could be sustained with trash mulching and gap filling.

To enhance productivity of sugarcane in wheat-sugarcane sequential system, an innovative overlapping cropping system has been designed. This accommodates 3 rows of wheat in November on raised beds and sugarcane in 80-cm apart furrows in February (optimum time of sugarcane planting in subtropical India) in the Furrow Irrigated Raised Beds (FIRB) system. Sugarcane registered 30% higher cane yield as compared to wheat–sugarcane sequential system without reduction in wheat yield. In this system, irrigation is applied only in furrows, requiring less volume of water, which works out to be a 20% water-saving.

Autumn-sugarcane intercropped with 2 rows of maize and *rajmash* (Frenchbean) produced cane equivalent yield of 134.7 and 108.6 tonnes/ha and these proved highly remunerative sugarcane-based intercropping system.

To further improve cane yield under wide rows, 'dual-row planting', through mechanized cultivation, has been developed. In this, broad furrows are formed at the spacing of 150 cm, and in the middle of the furrows, sugarcane setts are planted in two rows with a spacing of 30-cm. The dual-row system gave a cane yield of 136.3 tonnes/ha compared to 126.7 tonnes/ha recorded in the single-row system.

An Integrated Nutrient Supply System (INSS) for sugarcane consisting of organics to supply 25% of the

Raised beds are formed for wheat in wheat-sugarcane sequential system. On this, an innovative overlapping cropping system has been designed to enhance productivity of sugarcane. In raised beds 3 rows of wheat are accommodated in November and sugarcane is grown in furrows 80-cm apart in February. Sugarcane stand remains after wheat harvest (*bottom*).

Sugarcane intercroppings
Sugarcane + rajmash; Sugarcane + potato

recommended dose of N, chemical fertilizers to supply 50% of the recommended dose of NPK, *Azospirillum* and phosphobacteria each at 10 kg/ha in 2 equal split doses at 30 and 60 DAP and *dhaincha* as an intercrop on the top of the ridges and its *in-situ* incorporation at 45 DAP has been developed. This system recorded a cane yield of 141.0 tonnes/ha; which is 16.0% higher compared to recommended practice.

Dual-row planting in sugarcane through mechanized cultivation has been developed.

Sugarcane transgenics developed

Transgenics of Co 86032 and CoC 92061 with gene encoding for 'aprotinin' have showed varying levels of resistance to top-borer, and are now being multiplied for further evaluation against pests. CoC 671 calli have been transformed with genes encoding for Chitinase, ß-Glucanase and DM-Amp1 in an attempt for gene pyramiding.

Crop protection: For effective mass multiplication of *Trichogramma chilonis* parasitoid (sugarcane strain), response of the tricocards of different colours (white, orange, yellow, red and green) were studied in laboratory, as phytophagous insects are known to perceive intensity, hue and saturation of colours. The study indicates that white or green colour is most favourable for mass multiplication of the parasitoid.

Raising *dhaincha* as an intercrop as the component of the integrated nutrient supply system in sugarcane.

A laboratory rearing technique for mass multiplication of sugarcane black-bug, *Dimorphopterus gibbus*

Sustainable sugarcane production

For organic sugarcane production, 5-year cropping sequence was sugarcane (plant) – sugarcane (ratoon) – fingermillet – cotton – sugarcane (plant) – sugarcane (ratoon). In the initial 3 years, applied 100% recommended N through organics plus biofertilizers produced comparable yields of crops with the recommended dose of nutrients only through the inorganic fertilizers. In subsequent years, application of 100% of recommended N through organics plus biofertilizers was better than continuous application of inorganic fertilizers only. On the completion of the 5-year sequence, bulk density, organic-carbon and microbial status of the soil improved favourably under the organic system. Results indicate feasibility of obtaining sustainable sugarcane production through organics.

SUCCESS STORY

National Sugarcane Varietal Improvement Programme

At the SBI, varietal improvement work is carried out in two modes (i) sharing of "Co" varieties to all research stations (ii) through supply of hybrid seed from crosses made at the SBI for raising seedlings at the location concerned for selection and release of location-specific varieties.

The varieties evolved at the SBI in collaboration with the State Agricultural Universities through Fluff Supply programme occupy almost entire area under sugarcane cultivation in the country. A total of 279 sugarcane varieties were developed with the support of this programme and recommended for commercial cultivation in different states. Due to the impact of the superior varieties evolved, the country is today, one of the largest producers of sugar in the world, currently producing 18.5 million tonnes of sugar from 800 million tonnes of cane harvested from 4.28 million hectares of land. The estimated contribution to National GDP per year is around Rs 22,500 crore at an average cost of Rs 750 per tonne of cane. Presently, sugar on hand is 12.5 million tonnes, which is equivalent to 8 months of consumption in the country. If today India has produced 18.5 million tonnes of sugar, a major share in this successful venture goes for varietal improvement programmes catalyzed by the Institute.

The varieties evolved from this Institute have not only been accepted for cultivation in the country but are also valued in foreign countries. Varieties bred at Coimbatore are now being used in 28 other countries either for commercial cultivation or as parents.

Resistant sugarcane varieties

Varieties	Resistance against
Co 97014 and Co 97015	Red rot, smut
CoJ 99192, CoPant 99214, CoS 96275 and CoS 97264	Moderately resistant against red rot
Co 97014, Co 97016, Co 96017, CoPant 99214, CoS 96269, CoS 96275 and CoS 97264	Resistant against smut

(Fabricius), has been developed. This is based on the natural substrate. There are two main components of insect-rearing (i) egg-laying bags (ii) paper-cone for nymphal development. With this technology, insect population in the laboratory can be maintained indefinitely without any deterioration in insect vigour, fertility and sex ratio. Thus technique can be further employed for mass multiplication of its egg parasitoid, *Eumicrosoma* sp., and for evaluation of insecticides against black bug and release of bug or parasitoid in field.

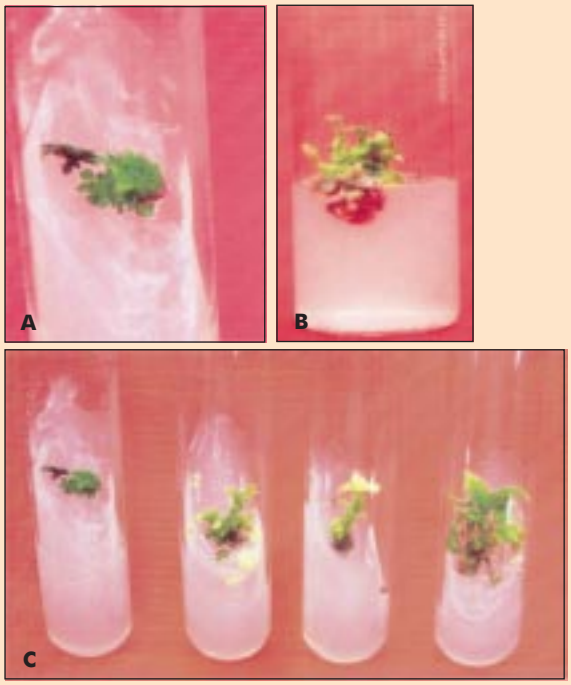
Jute and Allied Fibres

Crop improvement: Accessions of wild species of *Corchorus* collected from East Africa and other parts of the globe have been evaluated for resistance to different biotic stresses in the field. Accessions of different species, *C. aestuans*, *C. fascicularis*, *C. pseudo-olitorius* and *C. trilocularis*, have showed resistance for yellow mite, stem weevil and stem rot.

Crop production: Soil-test-based fertilizer application has led to attaining fibre yield of 2.0 and 2.5 tonnes/ha in Katihar (Bihar), Bahraich (Uttar Pradesh) and Nagaon (Assam).

In-vitro raised jute-plants transferred to field

Shoot-tip explants raised *in vitro* from jute (*Corchorus capsularis* L. cv JRC 212) have been used to produce multiple shoots. Modified MS medium containing BAP (1 mg/litre) and NAA (0.1 mg/litre) has been found best for induction of multiple shoots within 3 weeks of repeated subculturing in the same medium. The regenerated plantlets have been transferred to the field after hardening.



A. Induction and growth of shoot-buds from shoot-tip callus of Jute JRC 212

B. Regenerated shoots on modified MS medium with 1 mg/litre BAP and 0.1 mg/litre NAA.

C. Elongation of shoots after repeated subculturing in the same medium

Bast fibre portable extractor machine developed

Bast-fibre portable extractor machine has been developed, and demonstrated successfully to farmers and govt officials. It takes much less time (4-5 days compared to 21 days in conventional method) and is much less labour(1-2)-consuming. And the extraction produces quality fibres.

Crop protection: Natural products (seeds and organic matter from jute leaf) have been found suitable as the base material for making biocide with *Trichoderma viride*. The mature culture of *T. viride* was finally mixed with kaolin in seeds at 15g/100g of seed and packed with labelling for controlling major diseases of crops.

IPM practices *versus* farmers' practices in farmers' fields at Coochbehar (West Bengal) gave 2.63 tonnes/ha of fibre yield with IPM practices against 1.51 tonnes/ha with farmers' practices in *olitorius* jute.

Tobacco

Crop improvement: A *Jati*-tobacco variety Manasi with a yield potential of 1,600-1,700 kg/ha has been recommended for release for cultivation in the *Jati*-tobacco (*Chama* type)-growing areas of North Bengal.

- Recommended a jati-tobacco variety Manasi with a yield potential of 1,600-1,700 kg/ha for cultivation in jati-tobacco-growing areas of North Bengal.
- Generated molecular markers for 20 *Nicotiana* spp. and 78 released tobacco varieties.
- Thirty-eight derivatives of crosses involving *Beinhart 1000-1* and *L. 1128* (SR), found promising as resistant donors in tobacco against brown-spot disease.
- Maize+soybean (*kharif*), followed by chickpea (*rabi*) found remunerative against monocrop of FCV tobacco in the Northern black soils.
- In tobacco, production of seedlings in plastic trays is promising as eco-friendly, non-chemical approach; this has potentiality to replace conventional nursery management and can create revolution in seedlings production.
- In FCV tobacco and *rustica* tobacco, tagetes (single whorl), tagetes (multi whorl), chickpea and zinnia showed promise as trap crops for bud-worms.
- Phyton T found effective against black-shank disease in tobacco nursery.

Molecular (RAPD and AFLP) markers have been generated for 20 *Nicotiana* species and for 78 released tobacco varieties.

Advanced breeding lines JS 73, JS 78, JS 115, JS 119, JS 125 and JS 126 have recorded low tar values (around 20 mg/cigarette) in the Northern light soils (NLS) of Andhra Pradesh.

Among 7 natu selections evaluated in the Central black soils of Andhra Pradesh, selections II-1872 and II-1876 outyielded check varieties and exhibited resistance against *Spodoptera litura* under natural conditions.

Thirty-eight derivatives of crosses involving *Beinhart 1000-1* and *L.1128* (SR) have been found promising as resistant donors against brown-spot disease.

Two country-cheroot tobacco selections HV.97-7 and HV.97-10 tested in growers' fields in the cheroot tract of Tamil Nadu have showed promise, recording higher yields. HV.97-10 recorded maximum quality score of 33 out of 40, followed by HV.97-7 with 31 compared to 27 of the check pure-line variety.

Crop production: Maize + soybean (*kharif*), followed by chickpea (*rabi*) recorded highest net income of Rs 25,860 /ha with a C:B ratio of 1: 2.06 as against mono-crop of FCV tobacco in the Northern black soils with Rs 16,070/ha net income and 1:1.49 C:B ratio.

In soybean–FCV tobacco sequence, dual inoculation of soybean with *Rhizobium* + phosphorus solubilizing bacteria improved succeeding tobacco leaf yields by 16.3%, 27.07 % and 12.91% in cured, bright and grade out-turn in the Northern black soils of Andhra Pradesh.

In Tamil Nadu, chewing tobacco + beetroot recorded a higher net return of Rs 74,245 /ha, with a C:B ratio of 1: 3.09, followed by the sole crop of chewing tobacco. Also, ragi in *kharif* and chewing tobacco in *rabi* recorded higher net return of Rs 67,747/ha.

Highest net return of Rs 49,901 could be achieved when *Motihari* tobacco was intercropped with one row of garlic in every alternate row of tobacco under recommended dose of fertilizer for tobacco + 50% N for intercrops. The same treatment schedule with two rows in every alternate row of tobacco has also fetched higher net return of Rs 49,776.

A new eco-friendly, non-chemical approach viz. production of seedlings in plastic trays is found very promising method with potential to replace conventional nursery management and may create revolution in the seedlings production.

Crop protection: Application of glyphosate at 1.5 kg a.i/ha along with ammonium sulphate at 10 g/ litre of spray solution, 3 weeks prior to tobacco sowing on foliage of weeds, effectively controlled all weeds, including nutsedge in tobacco nursery. In combination with 'APSA', an adjuvant, glyphosate at 1.25 kg a.i / ha was equally effective in weed suppression. These two treatments recorded better weed-control efficiency than soil solarization.

IPM module with cultural, biological and need-based application of insecticides as components gave C.B ratios of 1: 1.52 to 1:1.60 in IPM plots as against 1:1.46 to 1: 1.56 in farmer's method.

In FCV tobacco and *rustica* tobacco, tagetes (single whorl), tagetes (multiwhorl), chickpea and zinnia were promising trap crops for bud-worms in terms of trapping ability, reduction of infestation and natural enemy activity.

Fumigation of tobacco stacks with magnesium phosphide plates (Degesch plates) at a dose of 1g/m^3 with 5 days exposure is sufficient to cause cent per cent mortality of all stages (including eggs) of cigarette beetle, *Lasioderma serricorne*, and it was superior to aluminum phosphide as is evidenced by quick release of phosphine. Aeration of fumigated stacks for 72 hr resulted in safe level of phosphine i.e. <1ppm.

Kocide (Copper hydroxide) at 0.2% applied at the time

of planting along with water and followed up with drench around plant at 30 and 45 DAT is found a better fungicide than Carbendazim (Bavistin) and Thiophanate Methyl (Topsin M) for effective control of *Fusarium* wilt in FCV tobacco field-crop. The disease was controlled to the extent of 88.3 to 93.8%.

Phyton T, a plant nutrient containing inorganic salt of phosphorus (40% phosphoric acid + 36% potassium phosphonate), has showed 100% inhibition of growth of *Phytophthora parasitica* var. *nicotianae* in *in vitro* and has been found effective against black-shank disease in nursery.

Contaf (Hexaconazole) and companion (Carbendazim + Mancozeb) controlled both phases (leaf and stem infection) of anthracnose in nursery effectively besides controlling frog-eye disease.

SEED PRODUCTION AND TECHNOLOGY

Breeder Seed Production

During 2002-03, a total of 3,067.10 tonnes of breeder seeds have been produced; major quantities belong to oilseeds (1,243.07 tonnes) and cereals (1,112.59 tonnes), followed by pulses (657.33 tonnes), forages (40.27 tonnes) and fibre crops (13.84 tonnes). Besides, additional breeder seeds were also produced against the indent of state level varieties.

- Produced a total of 3,067.10 tonnes of breeder seeds.
- Closer spacing of 45 cm between rows with 120kg N + 60 P_2O_5 kg/ha gave highest seed yield in male and female parental lines of maize hybrid.
- Variety characterization of wheat, paddy maize, sorghum, pigeonpea, chickpea etc. harmonized with the National Test Guidelines for DUS of these crops; which is to be done under the Protection of Plant Varieties and Farmers' Rights Act 2001.

Sieve sizes recommended for grading screen

Crop	Sieve size
Sunflower TCSH 1 and KBSH 44	2.5mm
CO 3	4.5mm
Delinted cotton (MCU 5)	4.5mm
Pearl millet (H 77/83-2)	1.8mm (oblong)
Berseem (Mescavi)	1.1mm (oblong)

Seed Technology

Hybrid seed technology: Flowering in sorghum hybrids CSH 16 and CSH 17 during *rabi* has showed that parents of these achieve better synchrony in Rahuri area, which is thus suited for hybrid-seed production.

Closer spacing of 45 cm between rows combined with application of 120 kgN + 60 kg $P_2 0_5$/ha gave highest seed yield in male and female parental lines of maize hybrid.

Spray of growth regulator T1BA at 25.5ppm at the button stage on 'A' line of sunflower significantly enhanced seed yield. Sunflower pollen could be stored up to 36 hours in ambient conditions in the earthen pots filled with water. Commercial seed production of sunflower hybrid around Bangalore and Jamnagar has been found profitable (C: B ratio at Bangalore is 1:1.86; and at Jamnagar it is 1:1.88).

Diagnostic characterization: Variety characterization of 14 major field crops (wheat, paddy, maize, sorghum, pearl millet, chickpea, pigeonpea, mungbean, urdbean, soybean, groundnut, sunflower, castor and cotton) has now been harmonized with the National Test Guidelines for the DUS of these crops, which is to be done under the 'Protection of Plant Varieties and Farmers' Rights Act 2001'. The data is being compiled for digitalization and publication.

Seed storage. Validity period for groundnut-seed certification for 9 months has been found appropriate if stored in the favourable environment. However, conditions of high relative humidity with high temperature prevailing at Bhubaneshwar limits its validity to 6 months only.

Studies on the large-scale seed storage have confirmed that HDPE interwoven, non-laminated bags may be used for bulk-seed storage as the substitute to jute-canvas bag, provided seeds are dried properly (moisture content not exceeding 10% at the time of packing). Packing less than the capacity of bag helps in proper stacking of bags.

Information collected from the State Seed Testing Laboratories (STLs) of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra and Tamil Nadu for 3 consecutive years has clearly revealed that germination status of cotton-hybrid seed is fairly high (more than 70% in majority of the samples). Germination of cotton-hybrid seeds from private seed industry has been still higher (above 90%). Therefore, it is strongly recommended that Minimum Seed Certification Standards for germination of cotton-hybrid seed should be upgraded from 65 to 70%. This will not affect availability of hybrid cotton-seed but will help in providing better quality seeds to farmers.

Seed health: Loose smut of wheat caused by *Ustilago segatum* var. *tritici* can be managed by seed treatment with *Glyocladium virens* at 4 plates/kg + 0.125 g/kg Vitavax in place of the recommended dose of Vitavax only at 0.250 g/kg to reduce chemical pollution.

Seed Processing: Delinted cotton seed (MCU 12, Surabahi and AKA 5), paddy (IR 20, ASD 18, ADT 36, Pusa 44 and PNR 381), chickpea (HC 1), fieldpea (HFP 4), soybean (Soya Harit), maize (Early composite), safflower (Bhima) and sunflower (TCSH 1, KBSH 44) must be processed by multi-stage seed processing by at least two machines comprising seed-cleaner-cum-grader and

specific-gravity separator. However, in large-seed processing plants, pre-cleaner must invariably be installed.

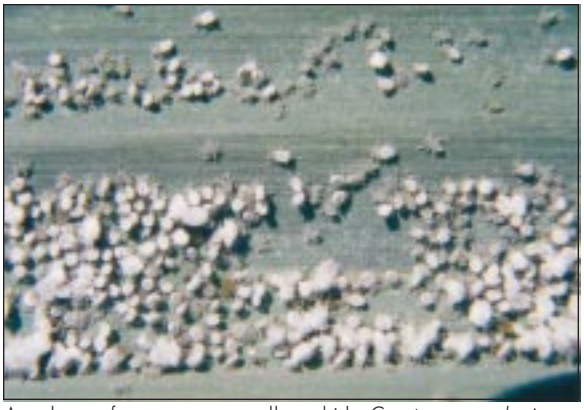
Specific gravity separator to meet certification standards can upgrade marginal seed-lots of mungbean (Kopargaon and TAP 7) to around 65% germination lots. Shade drying or mechanical drying at 45°C air temperature is suitable for maintaining seed quality in groundnut pods and mungbean seeds.

PLANT PROTECTION

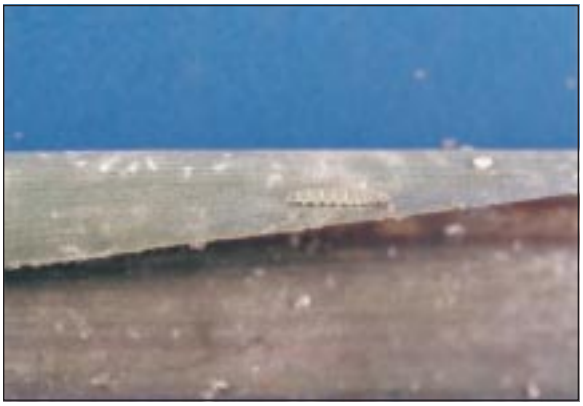
Biological Control

Natural enemies of sugarcane woolly aphid: Surveys in northern districts of Karnataka and western Maharashtra for natural enemies of the sugarcane woolly aphid, *Ceratovacuna lanigera*, have revealed *Dipha aphidivora* (Pyralidae), *Dideopsis aegrota* (Syrphidae), *Cheilomenes sexmaculata*, *Anisolemnia dilatata* and *Synonycha grandis* (Coccinellidae) being predating on aphid. *Dipha aphidivora* has been observed in large numbers in Kolhapur. Mass production technologies are being standardized for their adoption by farmers in the area.

Rearing/culturing techniques and studies on natural enemies: A rearing protocol to produce predatory mite *Amblyseius longispinosus* in large numbers has been standardized. First instar nymphs of the spiralling whitefly *Aleurodicus dispersus* have been found most suitable for parasitization by aphelinid parasitoid, *Encarsia guadeloupae*. A pest: parasitoid ratio of 1:5 of *Spodoptera litura* larvae to *Campoletis chlorideae* adults could produce 80.57% parasitism, and 1:15 ratio 81.95% parasitism. The pest population was reduced by 79.64 and 81.10%.



A colony of sugarcane woolly aphids *Ceratovacuna lanigera*



Dipha aphidivora Meyrick—a promising predator of *Ceratovacuna lanigera*

- Mass production technologies for natural enemies of sugarcane woolly aphid are being standardized for farmers' adoption
- Standardized a protocol to produce predatory mite *Amblyseius longispinosus*.
- Isolated nucleopolyhedrosis viruses of *Trichoplusia ni, Spodoptera exigua, Crocidolomia binotalis, opisina arenosella, Chilo infuscatellus, Chrysoperla carnea* and *Cadra cautella* and of a neogregarine protozoan pathogen *Mattesia dispar* from *Cadra cautella*.
- Developed a rapid and cheap production method using vermiculite for *Steinernema carpocapsae* and *Heterorhabditis indica*.

Behavioural studies on natural enemies: Parasitization of *Helicoverpa armigera* eggs by *Trichogramma chilonis* was more on Arka Alok and Pusa Ruby tomato varieties.

Artificial diet for host-insects and natural enemies: The parasitoids *Goniozus nephantidis*, *Brachymeria nephantidis* and *B. nosatoi* could complete their development successfully on diet-reared hosts.

Improved strains of natural enemies: Field trials conducted in Tamil Nadu (cotton) and Haryana (sugarcane) with high temperature tolerant strains of *Trichogramma chilonis* have recorded higher parasitism by these strains on pest eggs besides reduction in pest incidence compared to locally reared laboratory strain. Field trials conducted in Gujarat, Tamil Nadu and Karnataka to evaluate efficacy of multiple insecticide tolerant strain against cotton bollworms in comparison with normal laboratory strain of *T. chilonis* have revealed higher parasitism of bollworm eggs, lesser boll damage and higher yield in all trials than the normal strain.

Studies on entomopathogenic viruses and fungi: Nucleopolyhedrosis viruses of *Trichoplusia ni*, *Spodoptera exigua*, *Crocidolomia binotalis*, *Opisina arenosella*, *Chilo infuscatellus*, *Chrysoperla carnea* and *Cadra cautella* and of a neogregarine protozoan pathogen, *Mattesia dispar* from *Cadra cautella* have been isolated. Conidial spore production of *Nomuraea rileyi* has been cheap; it was maximum with 5% yeast granules as yeast source. The best liquid medium for conidial production of *N. rileyi* has been rice extract (5%) + yeast granules (5%). The need to add UV protectants (Congo Red, Ranipal) in the new wettable dust powder formulation of *Bacillus thuringiensis* has been established; as increased mortality of *Helicoverpa armigera* has been observed despite exposure of formulation to UV.

Fungal and bacterial antagonists: Seed biopriming

with a suspension of *Trichoderma* powder (10g TH + 10g FYM powder + 5g gum arabica in 50 ml water for 1 kg of seed) has resulted in rapid and uniform seedling emergence and better seedling growth and protection against seed-and-soil borne diseases in rice, wheat, chickpea, lentil, pigeonpea, tomato, brinjal, capsicum, cabbage, cauliflower and chilli especially in 'Usar' soil in Uttaranchal. Farmers have adopted production of *T. harzianum* in their fields, by colonizing antagonists in the FYM.

Entomopathogenic nematodes: A rapid and cheap mass production method using vermiculite has been developed for *Steinernema carpocapsae* and *Heterorhabditis indica*. *Heterorhabditis* isolates are more effective than *Steinernema* isolates against whitegrub, *Holotrichia lepidophora*.

Biological control of plant parasitic nematodes. Pochonia chlamydosporium produced in corn meal agar (CMA) medium has been better than water agar medium in inhibiting hatching of nematode eggs and also in its parasitizing ability. Microplot experiments carried out in root-knot nematode infested farmers' fields of tomato to evaluate combinations of talc formulation of *Paecilomyces lilacinus* and organic amendments have revealed that egg mass parasitization and reduction in nematode population was maximum with vermicompost, followed by neem-cake, farm compost and pelletized organic manure.

Biological suppression of crop pests: Commercial crops. Demonstrations for biocontrol of sugarcane borers have been conducted at Pravaranagar, Maharashtra, by releasing *T. chilonis* at 50,000/ha at 10 days' interval. These showed reduced incidence of early shoot borer.

Evaluating performance of bio-intensive integrated pest management practices in the management of cotton pests in Andhra Pradesh, Maharshtra, Tamil Nadu and Gujarat have resulted in decrease in jassids and whiteflies population, increase in natural enemies like coccinellids, spiders and lacewing; and higher 'kapas' yield than in farmers' practice and untreated control. *N. rileyi* formulation in aqueous suspension and oil in water emulsion at $5x10^{11}$ spores/ha has been as effective as Endosulfan (0.07%) in reducing incidence of *H. armigera* in cotton.

Pulse crops. Bio-intensive pest management trials in pigeonpea with special reference to pod-borer complex in Andhra Pradesh have showed that alternate sprays of *Ha*NPV and NSKE (*Ha*NPV-NSKE-*Ha*NPV-NSKE) have fared better in suppressing *Helicoverpa armigera* as well as pod-wasp and pod-fly with least pod damage. Similar trials in Tamil Nadu, but with *Bt*-*Ha*NPV alteration have showed lesser *H. armigera* larval population besides damage to pods by pod-wasp and other pod-borers was the lowest.

Vegetable crops. In cabbage, neem-seed powder and *Bt* in combination with *Trichogrammatoidea bactrae* have recorded lesser population of *Plutella xylostella* than *T. bactrae* alone on crop in Bangalore. Three sprays of *Bt* at 2kg/ha at weekly intervals starting from initiation of flowering have been effective against brinjal fruit borer (*Leucinodes orbonalis*), recording minimum fruit infestation (4.49%) and maximum marketable fruit yield (14.99 tonnes) in Pune.

Release of *Copidosoma koehleri* at 1 mummy/4kg tubers and *Chelonus blackburni* at 2 adults/kg tubers at 15 days' interval has been the most effective method of releasing parasitoids in local storage devices to control potato tuber-moth.

Honey Bee Research

Bee management: Double bee strength colonies with 1 or 2 queen bees of *Apis mellifera* have yielded more than even cumulative honey production from combination of 2 single strength colonies each with single queen.

For dearth period feeding of *A. mellifera* L. colonies, the diets based on brewer's yeast and parched chickpea (brewer's yeast 42% + parched chickpea 4% + skimmed milk powder 4% + sugar 25% + water 25%) with or without pollen were consumed most and could result in better growth of colonies.

In Orissa to ensure optimum bee strength before honey flow season (February-May), supply of pollen substitutes to bee colonies during December-January is felt imperative.

- Double bee strength colonies with 1 or 2 queen bees of *Apis mellifera* yielded honey more than even cumulative honey production from combination of 2 single strength colonies each with a single queen.
- For optimum pollination in litchi with *Apis mellifera,* 20-25 bee colonies per hectare are required.
- Combs treatment with Delfin, a Bt formulation, at 7% (0.7 g/hive) gave 93-97% control of wax moth, *Galleria mellonella*.
- Semen of yellow or black drones stored at room temperature for 60 days can be used for instrumental insemination of honeybee queens.

Hive products

For royal jelly production in *Apis mellifera*, cell acceptance was highest in 20 bee-frame strength colonies and lowest in 10 bee-frame strength colonies. The positions (top, middle or bottom) of cell bars did not result in any significant difference. Both these variables did not affect royal jelly production on per cell basis.

In an experiment on the production of propolis from *Apis mellifera* colonies by different methods, plastic screen alone, screen + sticks (to increase penetration of light) and scrapping, it has been found that propolis collection was maximum by scrapping, followed by screen + sticks, and lowest in use of screen alone.

Drone rearing for instrumental insemination of queen bees

Data on the number of spermatozoa in semen of yellow (3.49 × 10^6 sperms per drone) and black drones (3.09 × 10^6 sperms per drone) of *Apis mellifera* have revealed non-significant differences in their sperm count. Semen of drones stored at room temperature for 60 days can be used for instrumental insemination of honeybee queens.

Bee pollination: Apis mellifera and syrphid fly were the predominant visitors on radish. Intensity of visit of the insect on the crop was higher in forenoon and that of *A. mellifera* was in noon. Rate of foraging was higher for pollen foragers (*A. mellifera*) than nectar foragers. Three visits of *A. mellifera* bee resulted in significantly highest number of seeds per pod.

A. mellifera constituted the major proportion of total bee species visiting the flowers of sesame (51.9%) and sunflower (56.2%). Crop yield enhancement due to overall bee pollination was also noticed to the tune of 79.0, 55.0, 10.5 and 33.0% in sunflower, sesame, mustard and niger. While finding colony requirement for proper pollination with *A. mellifera* in litchi, it has been observed 20-25 colonies per hectare are optimum.

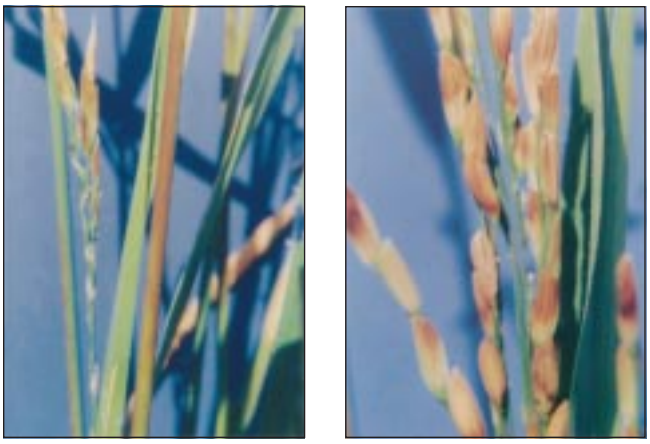
Diseases and enemies: A. mellifera apiaries in Punjab have revealed very low (1.65%) incidence of European foulbrood (EFB) – a bacterial disease caused by *Melissococcus plutonius*. This bacterial pathogen has been isolated and cultured. Out of 5 bacterial isolates, 3 have been identified as *M. plutonius*, *Lactobacillus eurydice* and *Paenibacillus alvei*. Significantly positive association has been found between migration of honey bee colonies and incidence of EFB. Shook swarm coupled with brood alone or brood + pollen combs have resulted in disappearance of EFB.

Treatment of combs with Delfin, a Bt formulation, at 7% (0.7 g/hive) gave 93-97% control of wax moth (*Galleria mellonella* L.).

Agricultural Acarology

Mite Infestation: Rice. Rice sheath mite *Steneotarsonemus spinki* Smiley (Tarsonemidae) has caused significant damage to rice crop in many districts of Karnataka and South Gujarat, both during *kharif* and summer. As many as 10-48 mites on leaf sheath and 0.5 to 1.5 mites (per 5 grains) on developing grains have been recorded in Karnataka. During *kharif* 2002, extensive damage by spidermite *Oligonychus oryzae* (Tetranychidae) on the crop was observed in Raichur and Bellary in Karnataka, in Navasari inGujarat.

- Weed plants *Chenopodium album, Amaranthus viridis, Trianthema monogyna, Euphorbia hirta* in the vicinity of cucurbitaccous plants supported multiplication as well as spread of *Tetranychus urticae*.
- Reported for the first time, eriophyid mite (*Cisaberoptus kenyae*) on Dussehri mango in Punjab and *Schizotetranychus baltazari* on citrus in Arsikere, Karnataka.
- Insecticides Monocrotophos, Cypermethrin Fenvalerate, Deltamethrin caused resurgence of yellow mite on chilli in Navasari (Gujarat).



Damage of *Steneotarsonemus spinki* on rice leaf sheath (*left*) Discolouration of glumes due to damage by *Steneotarsonemus spinki (right)*

Wheat. Rainfed wheat (PBW 175, PBW 299) and late-sown, irrigated wheat (PBW 373) in Ropar, Anandpur Sahib, Ballowal Saunkhri and Hoshiarpur have been found moderately infested (30-35 mites/plant) by brown wheat mite, *Petrobia latens*, during March. In Gujarat, sorghum mite, *Oligonychus indicus*, which appeared during second fortnight of August, gradually attained peak of attack by the first fortnight of November and then declined. Both predatory insects and mites were also active during this period.

Cucurbitaceous and other field crops. *Tetranychus urticae* infestation on cucurbitaceous crops, particularly on summer squash, ash gourd, bottle gourd and muskmelon, has been severe in parts of Ludhiana, of which muskmelon had high mite infestation of 325 mites/leaf. Survival of this mite on a number of weed plants *Chenopodium album*, *Amaranthus viridis*, *Trianthema monogyna*, *Euphorbia hirta* and *Polypogon monspeliensis*, in the vicinity of the crops showed that these weeds supported multiplication as well as spread of *T. urticae* on to cultivated crops.

Sugarcane. Ratoon sugarcane (COJ 83) has been found severely infested by *Oligonychus* sp. (33-475 mites/leaf) in Laddowal in Punjab, and profuse webbing and reddening of infested leaves was seen during June-July. Occurrence of this mite has also been noticed on regular sugarcane crop in Mandya (Karnataka) due to extended dry weather.

Horticultural crops. Eriophyid mite (*Cisaberoptus kenyae*) has been reported for the first time on 'Dussehri' variety of mango in Punjab, so also *Schizotetranychus baltazari* on citrus in Arsikere, Karnataka.

Chilli. In Kalyani, damage by yellow mite, *Polyphagotarsonemus latus* accounted for a yield loss of 28.6% or Rs 3,261/ha during 2002.

Resurgence of yellow mite in chilli

Monocrotophos, Cypermethrin, Fenvalerate and Deltamethrin caused resurgence of yellow mite *Polyphagotarsonemus latus* on chilli in Navasari, Gujarat. Evaluation of certain newer molecules against this mite in Karnataka has showed moderate efficacy of Bifenthrin, Fenpropathrin and Milbemectin only up to 7 days after application, compared to effectiveness of Dicofol up to 10-14 days. In Coimbatore, application of Diafenthiuron 50 WP (0.09%) caused 74- 93% reduction in chilli mite population in 15 days; followed by Fenpyroximate (0.006%) and Buprofezin (0.03%); these treatments helped realizing higher fruit yields. In Varanasi, Abamectin (0.028%) and Dicofol (0.05%) effectively controlled spidermite infestation on brinjal, and Fenpyroximate 5 SC (0.006%) was superior on okra mite in Coimbatore, recording maximum fruit yield, followed by Diafenthiuron 50 SC (0.09%).

Coconut. Coconut mite *Aceria guerreronis* has been observed to infest nuts of palmyra, *Borassus flabellifer*, and mite feeding caused reddish-brown patches on the inner side of the bracts. Unlike coconut, no significant feeding marks have been seen either on the outer surface of the nuts or on the developing tissues underneath the perianth.

Survival of coconut mite: Eriophyid mite vector, *Aceria cajani*, has been observed surviving on voluntary or stray pigeonpea plants, sterility mosaic infested stubbles or ratoons in Navasari, Gujarat, and also on the weed, *Atylosia scarabaeides*, in Bangalore.

Activity of predatory mites: Significant activity of predatory mites *Amblyseius longispinosus*, *A. alstoniae* and *Phytoseius roseus* on various crops has been observed in different parts of Punjab. *A. longispinosus* suppressed the population of spidermite *T. urticae* on roses in a polyhouse near Bangalore.

Host resistance: Cotton varieties GK 151 and LD 327 have been relatively more infested by spidermites (3.4-4.1 mites/leaf), and LD 327 was least preferred (0.2 mites/ leaf). Brinjal varieties, Punjab Neelam (16.8 mites/leaf) and Punjab Barsat (18.8 mites/leaf) are found more susceptible to *T. urticae* damage, and BH 1 with 3.2 mites/leaf has been fairly tolerant. Among okra varieties, Pusa A 4 and VR0 6 have been found heavily infested (76-97 mites/2 cm^2 leaf area), and Varsha Upahar (12 mites/2 cm^2 leaf area) was least infested. In Karnataka, coconut like West Coast Tall × Choughat Dwarf Orange, West Coast Tall × Gangabondam, West Coast Tall × Malaysian Dwarf Yellow, Gangabondam × Fiji, Gangabondam × Philippine Ordinary and Gangabondam × Lakshadweep Ordinary have consistently showed low mite damage.

Pesticide Residues Management

A safe waiting period of 30 days has been found adequate for Imidacloprid (200 SL) on apple when applied at 20 and 40 ml/4 litres. Residues of Imidacloprid (600 FS) in cottonseed, lint and soil are found below detectable limit at harvest when applied 9, 12, 18 and 24 ml/kg of seed dressing. And Spinosad (45 SC) were below detectable limit in cottonseed, lint and oil 50, 75 and 150 g a.i./ha. Similarly, no residues of b-Cypermethrin (5 EC) have been detected in any portion of cotton crop when applied at 15, 20 and 40 g a.i./ha. Residues of Chlorpyriphos (20 EC) on paddy were from below detectable limit to 1.70 ppm in grain, husk and straw at the application rate of 375g a.i./ha 30 days before crop harvest.

- A safe waiting period of 30 days found adequate for Imidacloprid (200 SL) on apple when applied at 20 and 40 ml/4 litres.
- Detected the commonly used pesticides in 64% of the vegetable samples (592) and 46% of the fruit samples (359). Only 9% vegetable samples contained residues above maximum residue limit (MRL), and none of the fruit samples contained above the MRL.

Residues of different commonly used pesticides were detected in 64% of vegetable samples (592) and 46% of fruits samples (359). And only 9% vegetable samples contained residues above maximum residue limit (MRL) values, compared to 12% reported in 2001. It was satisfying to note that none of the fruit samples contained pesticide residues above prescribed MRL value. Out of 214 butter samples collected all over the country, residues of DDT and HCH were detected in 66 % samples. The average level of these organo-chlorine pesticides has been found lower than the level detected in 2001. HCH residues were detected in 56 and 62% of vegetarian and non-vegetarian diet samples DDT contamination was detected only in 27% of vegetarian diet samples and 20% non-vegetarian diet samples. In animal feed and fodder samples (400) also, residues of OC pesticides were detected in 34% samples. Repeated observation have indicated without any doubt that pesticide residues from vegetables can be easily removed up to 50-100% by simple decontamination processes like washing, pealing and cooking before consumption.

Whitegrub Management

Whitegrub (*Holotrichia consanguinea*) management through beetle control by spraying insecticides (Chlorpyriphos 20 EC, 0.05% a.i. or Quinalphos 25 EC, 0.05% a.i. or Carbaryl, 0.2% a.i.) on host trees, followed by pheromone chemical (methoxy benzene) at 15 ml/3 pieces of sponge (each 5cm × 5cm) per tree for 3 successive days has been found very effective. Technology

- Chlorpyriphos 20 EC at 400 g ai/ha alone or in combination with Nicast (organic manure) 500 kg/ha at the time of second earthing in June found effective in protecting potato-crop from whitegrub at Palampur (Himachal Pradesh).

has been further improved to economize on pheromone. Pheromone chemical dose has been reduced to 1.5 ml/3 pieces of sponge (each 5cm × 5cm) per tree.

Field performance of M. anisopliae *against whitegrub: M. anisopliae* formulation at 1×10^{14} conidia/ha at 4 soil depths (10, 15, 20 cm and normal sowing depth has reduced plant mortality (56.5–61.2% protection) along with 40-44% higher mean pod yield in groundnut as compared to plots-sown without bioagent formulation. Enhanced crop protection and pod yield were obtained in 10 and 15 cm depths as compared to normal sowing depth.

Post-sown treatment in potato against whitegrub

Chlorpyriphos 20 EC at 400 g a.i./ha alone or in combination with Nicast (organic manure) 500 kg/ha at the time of second earthing up in June has been very effective for protecting potato-crop from whitegrub (*Holotrichia coriacae*) at Palampur (Himachal Pradesh).

Nematode Management

White-tip and root-knot nematodes: Rice. Paddy seed soaking in Carbosulfan 25 EC at 0.1% for 12 hours has been effective on farmers' fields in reducing root-knot nematode infestation and increasing grain yield by 78 and

- Paddy seed soaking in Carbosulfan 25 EC at 0.1% for 12 hours effectively reduced root-knot infestation; 78% in Karnataka, 13% in Assam and 64% in Orissa in farmers' fields.
- Root-knot nematode disease in groundnut reduced up to 40% by applying castor-cake at 1,000 kg/ha + neem oil at 5 litres/ha + Carbofuran.

26% in Karnataka, 13 and 18% in Assam, and 64 and 30% in Orissa.

Pulses. Seed soaking with Carbosulfan 25 EC at 0.1% for 6 hours or seed-dressing treatment with Carbosulfan 25 ST at 3% w/w in chickpea, cowpea, mungbean, pigeonpea and urdbean managed plant parasitic nematodes *Meloidogyne incognita*, *Heterodera cajani*, *Rotylenchulus reniformis* and *Pratylenchus thornei* infecting these crops and increased their yield by 15.7–38% over control.

Oilseeds and fibre crops. Root-knot nematode disease in groundnut could be reduced up to 40% by applying castor-cake at 1,000 kg/ha + neem oil at 5 litre/ha + Carbofuran at 1 kg a.i./ha and this increased yield by 46.7% over control with a cost benefit ratio of 1:1.47.

Root-knot nematode (*Meloidogyne incognita*) and reniform nematode (*Rotylenchulus reniformis*) infection could be controlled on cotton by soaking seeds in Carbosulfan at 500 ppm for 6 hours + soil application of Carbofuran at 1kg a.i./ha. This resulted in 19.6% increase in yield over control.

Vegetable and fruit crops. Root-knot nematode infection in brinjal, tomato and chilli could be reduced by deep summer ploughing and solarization of main field transplanted with seedlings raised on nursery-beds treated with Carbofuran at 0.3 a.i. w/w. Integration with neem cake at 200 kg/ha at places where solarization is not possible further improved efficacy.

Meloidogyne incognita, *M. javanica*, *Radopholus similis*, *Pratylenchus* spp. and *Helicotylenchus* spp. on banana were managed with highest cost:benefit ratio of 1:2.24 by paring of suckers + hot water treatment at 55°C for 20 minutes + Carbofuran (3G) at 16.6 g/pit + neem-cake at 1 kg/pit.

Agricultural Ornithology

For the first time, ashy wren warbler (*Prinia socialis*) has been observed resting in cotton-crop and feeding nestlings with available larvae in the cropped area. Due to erratic rainfall and delayed agricultural operations, breeding performance of rose-ringed parakeet has been affected, and it registered low (68.5%) reproductive success.

- For the first time ashy wren warbler (*Prinia socialis*) observed resting in cotton-crop and feeding nestlings with available larvae in the cropped area.
- Occurrence of house-sparrows reduced significantly in South Zone and Krishna Godavari Zone with a flock range of 4-11 birds.
- Observed for the first time Ruff (*Philomachus pugnax*) in Jamnagar, a coastal district of Gujarat, feeding on harvested earheads of pearl millet.

In Gujarat, within 5-km radius of a roost of rose-ringed parakeet of about 4,000 individuals, together with rock pigeon and ring dove, 22% damage to groundnut was observed during sowing to sprouting stage.

Migratory short-toed lark (*Calandrella cinerea*) and calendar larks (*Melanocorypha calandra*) caused heavy damage to wheat during sowing; to the extent that some farmers were compelled to re-sow their fields in Gujarat.

Ruff (*Philomachus pugnax*) has been observed in Jamnagar, a coastal district of Gujarat, for the first time feeding on harvested earheads of pearl millet, which were kept in field for drying. Sindh Jungle sprarrow (*Passer*

Status of house-sparrows

A survey was undertaken for house-sparrows in five different agroclimatic zones. Out of 184 villages, sporadic populations of house-sparrows, were found in 60 villages. The occurrence of house-sparrows, has significantly reduced in South Zone and Krishna Godavari Zone with a flock range of 4-11 birds. Occurrence is mainly restricted to village habitats. The main reason for decline of these species is attributed to loss of preferred habitat and other changes in the socio-economic conditions in rural areas.

pyrrhonotus) has been recorded feeding on the berry of *Salvadora* spp. for the first time from central Gujarat.

Rodent Control

Rodent surveys: Except for extreme arid tracts, *Bandicota bengalensis* has been predominant in all agroclimatic regions of the country. Its population during the year was generally higher in fodder, sugarcane, rice and wheat crops near sugarcane fields; rice crops near vegetable fields. Other major rodent species associated with *B. bengalensis* are *Tatera indica* and *Millardia meltada* (Gujarat and Karnataka); *Mus booduga* (Andhra Pradesh, Assam and Himachal Pradesh), *T. indica* and *Mus* sp. (Punjab), and in arid regions, major rodent species complex comprised *Meriones hurrianae – Tatera indica* and *Millardia meltada*.

- Except for extreme arid tracts, *Bandicota bengalensis* predominates all agroclimatic regions of the country
- Indigenous traps *Butta* and *Tanjore* Kitty traps evaluated in Godavari delta recorded a trap index of 0.028-0.04 and 0.013-0.015 for *Bandicota bengalensis* and *Mus booduga* in rice fields.
- Jojoba seed-cake powder with pearl millet flour at 10 and 20% concentration(w/w) recorded repellency index of 84.2 and 93.4% in *Tatera indica*.
- Rodent population was higher in zero-tilled fields as compared to conventionally tilled wheat field in Punjab.

Behavioural ecology: A significant increase in pre-copulatory behaviour was noticed in male and female partners during all stages of oestrous and met-oestrous stage of *Bandicota bengalensis*. Urinary pheromones were involved in such intra-specific communications. Addition of fresh burrow sand at 25% in plain baits significantly enhanced food consumption by *B. bengalensis*. Two breeding peaks of lesser bandicoots at October-November and March-April were noticed in West Godawari Delta in Andhra Pradesh. Population growth estimates have revealed that bandicoots breed 2.6-2.3 times/season, with an annual productivity of 65 and 61/females in *kharif* and *rabi*. Rodent population was higher in zero-tilled fields as compared to conventionally tilled wheat field in Punjab.

Management strategies: Mechanical control. Indigenous traps, *Butta* and *Tanjore* kitty traps, evaluated in Godavari delta have recorded a trap index of 0.028-0.04 and 0.013-0.015 for *B. bengalensis* and *M. booduga* from rice fields.

Botanicals. Jojoba seed-cake powder mixed with pearl millet flour at 10 and 20% concentration (w/w) has recorded a repellency index of 84.2 and 93.4% in *Tatera indica*. Similarly, aqueous leaf, kernel and pulp extracts of *Melia azedarach* and *Datura stramonium* have been found effective in reducing food consumption by rodents from 2.6-45%.

Chemosterilants. Administration of 50-100 mg/kg of body weight of epi-chlorohydrin resulted in reduction of weights of reproductive organs and accessory sex glands in *Rattus rattus*.

Control of poison shy rodents. Difethialone (0.002%) in pearl millet baits resulted cent-per-cent mortality of zinc-phosphide-induced bait-shy population of *Tatera indica* and *Rattus rattus*.

Field evaluation of rodenticides. Single application of second generation anticoagulants *viz.* bromadiolone (0.005%), brodifacoum (0.005%) and difethialone (0.0025%) have resulted in over 70% rodent control from a pest complex of *M. hurrianae-T. indica-R. meltada* up to 120 days in wheat-cumin-mustard cropping system in western Rajasthan. Similarly, single baiting with Coumatetralyl (0.0375%) placed in tyre-bait station yielded 75-89% and 67-84% rodent control in rice and wheat,. Difethialone (0.0025%), Bromadiolone (0.005%) and Coumatetralyl (0.0375%) baiting recorded over 80% control in groundnut, wheat, cotton and sugarcane in Gujarat.

Social engineering activity on rodent control. In Punjab and Rajasthan, adoption of rodent management technology has been higher in *rabi* than in *kharif* crops. As a result, a yield loss of 49.4 kg/ha and 89.8 kg/ha could be saved in *kharif* and *rabi*. Similarly, in Gujarat, adopted villages recorded lowest crop damage in groundnut (1.7-3.3%) and wheat (0.73-1.1%) with over 75% reduction in rodent pest infestation. In Karnataka

Rodent problem in NEH regions with special reference to bamboo flowering

In Manipur, four districts have been identified for abundant bamboo flowering; where about 27,000 hectares are likely to suffer due to rodent menace; coinciding with bamboo flowering. The predominant rodent species in bamboo-growing areas of Manipur are *Rattus rattus bullocki, R. manipulus, R.r. brunnusculus* and *Bandicota bengalensis*. In Assam's Karbi Anglong district, 570 hectares under jhoom rice were damaged by rodents in Khonbamon and Singhason areas. All 641 farm-families of the region were badly affected by rodent menace during the year. Sudden proliferation of rodent population has been assessed as the attribute of bamboo flowering.

also, rodent damage could be prevented to the tune of 58-78% in different crops in adopted villages.

Integrated Pest Management

IPM technology has been validated on farmers' fields for mungbean–safflower cropping system in 3 watershed villages around Parbhani, Maharashtra. The package comprised timely sowing undertaken during first week of October, seed treatment with Carbendazim at 2g/kg of seed, and border spraying with Dimethoate at 0.05% on 4 rows on each side under 180-cm across the plot on both sides. First application of NSKE at 5% and second with Dimethoate at 0.05% for aphids, and installing bird perches and pheromone traps for *Helicoverpa* proved effective and remunerative as compared to farmers' practice. The cost:benefit ratio in IPM and FP has been 1:7.1 and 1:5.1.

❑

Improvement and Management of Horticultural Crops

FRUIT CROPS

Mango

Eight mango accessions were added to field gene bank. Molecular characterization of 45 mango accessions following IPGRI descriptors has been completed and 20 mango hybrids were evaluated for fruit characters. Mango hybrids, 28-7 and 29-6, showed good fruit quality with more than 70% pulp recovery. Under IPGRI, ADB-TFT assisted Project, 125accessions of mango were added to field gene bank, and 194 accessions were documented and characterized.

Twenty accessions were collected, and characterization and documentation of 60 accessions were performed. Hybridization was performed in 28 cross combinations. Germplasm characterization of 254 mango accessions for 54 descriptor list has been published by CISH, Lucknow. Mango Bangalora produced heavy fruits (380 g) and highest yield (95.28kg/tree) at Sabour, while Neelum gave maximum fruit yield (41.62kg/tree) followed by Suvarnrekha (36.78kg/tree) at Sangareddy. At Sabour, Mallika showed superiority over other varieties in yield, average fruit weight and TSS content (52.15kg/tree, 507.39g, and 21.50° Brix). Mango Neeleshan produced maximum number of fruits (374) and yield (72.15kg/tree) at Sangareddy.

- Twenty accessions of mango were collected.
- Germplasm Information System was developed at IIHR, Bangalore.
- Traps consisting of ethyl alcohol, methyl eugenol and malathion in a 6:4:1 ratio soaked in plywood of 5 cm × 5 cm × 5 cm could manage fruit fly effectively.

Germplasm Information System was developed at IIHR, Bangalore, for computerization of central accession register of different horticultural crops. Separate database design structures were developed to store and retrieve information on fruit crops at IIHR, Bangalore.

In a rootstock trial of 22-year-old study employing 8 rootstocks for various growth, yield and quality attributes, polyembryonic rootstock Muvandan recorded maximum plant height and canopy spread, whereas Vellaikolumban least growth, indicating pronounced dwarfing effect for Alphonso mango. Productivity per unit canopy volume and unit land area was maximum with Vellaikolumban rootstock suggesting that this rootstock can be beneficial for induction of dwarfing in this cultivar to accommodate more trees per unit area. Fruit yield of Alphonso mango increased remarkably with increasing planting density from 100 to 1,111 trees/ha during first year of bearing.

Three foliar sprays of 0.1% borax and 0.2% $ZnSO_4$ at pH 5.5 with wetting agent sprayed in June, November and December increased fruit setting and yield. Ragi and Dolichos as intercrops in mango gave additional income of Rs 12,000/ha.Circular basin with 5% slope + ragi straw mulch increased mango yield by 15-20%.Use of biofertilizers + compost enhanced fruit yield in mango by 20% and reduced cost on fertilizers. Poor fruit retention rather than flowering or fruit setting was found to limit the productivity of grown-up Arka Puneet mango trees. Pruning at a height of 5m from the ground level induced maximum number of flushes, giving fruit yield of 145.92 kg/plant.

Paclobutrazol effectively controlled irregular bearing in mango. At CISH, Lucknow, after 28 years of age, Rumani rootstock showed dwarfing effect for Dashehari, while maximum yield was recorded on random seedling rootstock. Five sprays of Micnelf along with 300 g Borocal (a micronutrient preparation) and 60% of recommended fertilizer could result in maximum fruit yield. Maximum cumulative fruit yield was recorded from trees propagated by air-layering followed by veneer grafting at Pantnagar, while veneer grafted trees produced highest yield (118.42kg/tree) at Rewa.

At Rewa, random seedling rootstock, Kalepad and Olour, produced lesser tree volume in Langra, whereas it was maximum in Bappakai rootstock closely followed by Chandrakaran and Vellaikolumban. At Sabour, Latra rootstock imparted maximum dwarfness to Bombai scion against maximum vigour on random seedling. Double hedge- row system of planting gave significantly higher yield than control (square system).

On-farm trial on management of fruit fly (*Bactrocera zonata*) in north-eastern Ghats agro-ecosystem of Orissa was taken up by CHES, Bhubaneshwar. Fruit flies cause heavy loss in mango fruits especially in late-manuring varieties, which is further aggravated by early rains. The infestation level of fruit fly in mango was as high as 40%. The farmers had no idea about infestation. The area is

otherwise an emerging potential locality for mango production tribal region. Being located at higher altitude, mango ripening starts almost one month later than the coastal belt of the state, providing better opportunity for growers to escape from glut in the market and fetching high price. Traps of methyl eugenol comprising ethyl alcohol, methyl eugenol and malathion in a 6:4:1 ratio soaked in plywood of 5 cm × 5 cm × 5 cm could manage the pest.This successful technology was highlighted.

Biopesticides, Praghat (0.05%), Cartap hydrocholoride (0.05%), Ethophenprox (0.005%), Azadirachtin (1500 ppm) proved effective in checking midge and hopper populations. Neem excel (1500 ppm) on mango followed by Endosulfan (0.07%) proved effective against mango hoppers at pre-and post-bloom stages. Mango mealybug was controlled by soil application of *B. bassiana* combined with alkathene banding. Post-harvest treatment with Prochloraz (0.1%) and hot-water treatment (52ºC) for 10 minutes were most effective for post-harvest management of disease in mango. Prochloraz is a safer fungicide for post-harvest treatment of anthracnose on mango. At Paria, higher activity of hopper was observed during flowering stage, while thrips had two peaks (October-November and March - May), coinciding with new flesh period of the crop.

At Sabour, proper orchard hygiene with neem and fungal bioagents controlled mango hopper and produced higher yield. Monocrotophos (0.72%) as well as quinalphos (0.05%) were effective to control shoot gall psylla. Mango hopper is found throughout the year in trunk and leaves/panicles. Maximum hopper population was recorded on trunk (48.0) during first fortnight of May followed by on panicles (85.00) during flowering stage (second fortnight of March) and on leaves (90.17%) in first fortnight of April. Spraying of monocrotophos (0.05%) thrice was most effective treatment in reducing the hopper population producing maximum yield at Vengurle and Sabour.

Banana

A total of 273 banana accessions were collected and conserved at NRC for Banana, Trichy. Database have been updated for 48 accessions in MGIS. Molecular and Morphotaxonomic characterization was completed for 34 accessions collected from Andaman and Nicobar islands using RAPD markers. Protocol has been standardized for surface sterilzation and *in vitro* germination of mature zygotic embryos. The genetic variation and phylogenetic relationships of 25 Silk accessions representatives of both indigenous and exotic origins were analyzed using RAPD markers. Two clusters one each major and minor were recorded. Of the 23 accessions, 11 were synonymous. Mutheli was found to be a mutant of Malbhog. *Musa balbisiana* is a rich gene pool consisting of genes resistance to various biotic and abiotic stresses. These were analysed using OPA11primer adapting RAPD method. The wild B genome from mainland formed Cluster-I, showed 2 major subclusters. The first one represented Borkal Baista, an unique collection from Assam and Bhimkol-1 and Manguthamng as synonym. Cluster II included 13 clones collected from Andaman and Nicobar Island of which, New Wandoor was found to be a unique collection.

- A novel technique to feed banana bunches through distal end has been developed.
- A total of 273 banana accessions were collected and conserved at NRC for Banana, Trichy.
- Banana fingers packed with foam in 2-ply card board boxes weighing 13.5 kg each with ethylene absorbents are suitable for export purpose.
- Production technology of organic banana showed promising results.

SUCCESS STORY

Biodynamic Farming

"Biodynamic Farming" involves certain principles and practices for healthy soil, production and quality. All the cultural activities are performed as per zodiac principles. This includes nutrient, pest, disease management and sowing/ transplanting at appropriate time (agriculture calendar), crop modeling, through training/pruning and crop allelopathy. There has been a continuous improvement in physical, chemical and biological properties of soil, besides an improvement in production and quality of fruits. Following package of practices have been recommended.

- Application of organic manures through NADEP/vermi/ biodynamic compost (BD) /microbe mediated compost (MM compost).
- Use of cakes (neem, karanj, castor, groundnut etc.) as per availability.
- Green manuring and legumes as inter and cover crops as per the requirement.
- Mulching after the application of 5 - 20 kg vermi/BD compost, 100g CPP and release of earthworms in basin.
- Regular use of cow pat pit (CPP) and cow horn manure (BD-500) to refurbish biological properties of soil.
- Need based use of liquid manures prepared from cowdung; cow urine, leguminous leaves or vermiwash to promote growth and fruiting.
- Spraying of biodynamic pesticides prepared through fermentation of cowdung, cow urine, neem, karanj, caliotropis, castor or neem leaves.
- Two sprays of cow horn silica (BD-501) at flowering and fruit development stages.
- Biodynamic tree paste/cowdung paste to control gummosis and dieback.

Modified high-density planting with 3 suckers/hill at a spacing of 1.8 m × 3.6m (4,500 plants/ha) with 150 : 30 : 225g NPK/plant/year gave 70 tonnes/ha yield with a cost : benefit ratio of 1.74 in Robusta banana grown in wetland. Paired row system with 5,200 plants/ha (2m × 1.2m × 2 m spacing) with 200g N, 30 g P and 300g K recorded 90 tonnes/ha with a cost : benefit ratio of 2.02. Banana bunches covered with polysleeves with 4-6% ventilation produced fruits with uniform attractive pale- green colour without blemishes which had a premium market and are also suitable for export. Application of cement kiln flue dust (0.5 kg/plant) and 30,000 litres of distillery effluent/acre with 60% K recorded 25% increase in bunch weight in both plant and ratoon crops of Ney Poovan banana. An additional profit of Rs 35,000/ha was obtained by adopting this technology. Standardization of technology for organic banana production revealed maximum vegetative parameters in Rasthali and Karpuravalli bananas with a treatment combination of 2.5 kg distillery sledge, 1 kg vermicompost, 1 kg neem cake and 2.5 kg poultry manure. Application of 150 g each of N and K_2 O/ plant / year for Basrai and Grand Naine resulted in a saving of 25% of N and K_2 O.

The IIHR, Bangalore, has developed a novel technique to feed banana bunches through distal end for increased bunch weight. Nutrient feeding through distal end was confirmed using radio tracers. Blending 5g of ammonium sulphate with 2.5g of sulphate of potash was significantly superior to10g of ammonium sulphate alone in increasing bunch weight up to 78% compared to the control.

Banana pseudostem (longitudinal) @100/ha effectively traps all banana weevils. Cosmolure @5/ha can be used for monitoring banana corm weevil. Entomopathogenic fungi, *M. anisopliae*, was isolated from banana stem weevil (*Odoiporus longicollis*). Application of *Trichoderma viride* @ 20 g/plant, once at planting and after 3 months was found effective in controlling nematodes (*P. coffeae* and *M. incognita*), reducing the incidence of Panama wilt in Rasthali and Virupakshi. Econeem and Nimbicidine showed maximum efficacy in reducing nematode population with increased plant growth and yield. *Verticillium chlamydosporium* culture filtrates successfully controlled second stage juveniles and eggs of *M. incognita* under *in-vitro* conditions. *Tagetes* spp. grown as an intercrop in Nendran banana field resulted in significant reduction in root-lesion nematodes with increased yield. Spraying of native stain of *Pseudomonas* sp. 2 @ 10^6/ml in Robusta prevented the occurrence of crown rot disease. Plant extract of *Solanum torvum* (50%) is recommended to control post-harvest diseases, and increasing shelf-life by 26 days.Spraying of paraffinic oil (5%) + Propiconazole (0.05%) or Carbendazim (0.05%) is recommended to control Sigatoka leaf spot disease on banana.

Citrus

Two hybrids of rough lemon ´Troyer citrange were promising rootstocks for resistance to *Phytophthora*. For determining quantum of water stress in Nagpur mandarin, leaf water potential of –3.5 MPa was found effective for inducing flowering. Paclobutrazol @ 18g/plant was found effective in inducing flowering in problematic high clay soils. Chlormequat chloroide (CCC) (2000 ppm) or stem girdling (0.3 - 0.5 cm) applied in September induced *hasta* flowering in October.

Nagpur mandarin bearing quality fruits

Extracts of *Nerium odorus* and *Vitex negundo* (1%) were found effective against citrus psylla, while these *of Alpinia galanga* and *Acorus calamus* (1%) were safer to *Tamarixia radiata* parasitised psylla nymphs. Similarly, extracts of *A. galanga* and *A. calamus* (1%) were found safer to predators *Mallada boninensis* and *Serangium parcesetosum*. *Trichoderma hamatum* strain 4, *T. harzianum* strain 20,25,37 and *T. reesei* strain 7 were found good root growth promoters of citrus.

Three fungal isolates, one bacterial isolate and botanicals like neem, tulsi and Eucalyptus leaf extracts, were found inhibitory towards *Xanthomonas* when tested by dual culture assay. The highest reduction in citrus greening disease was obtained through soil application of Ledermycin (600 ppm) along with $ZnSO_4$ and $FeSO_4$@200 g each per plant. For molecular diagnosis of citrus Trestiza virus, PCR based method was standardized for its detection. The results demonstrated that RT-PCR

- Paclobutrazol @ 18 g/plant was quite effective in inducing flowering in problematic high clay soils in citrus.
- Maturity indices for *mrig* (monsoon blossom) *behar* in Nagpur mandarin have been standardized.

method is accurate and efficient for CTV detection.

Maturity indices for *mrig* (monsoon blossom) crops of Nagpur mandarin fruits have been standardized. Fruits attained proper maturity 240 days after fruit setting. The extraction methods of essential oil of orange and lemon peel were standardized following hydrodistillation method at 65°C.

Guava

Fifteen guava accessions were added to field gene bank. Characterization and documentation of 30 accessions was performed. Hybrids raised from *Psidium molle* and *P. guajava* crossing were found to be tolerant against guava wilt in artificial testing. The evaluation of germplasm revealed that maximum fruit yield was recorded in Allahabad Safeda and Sardar guavas.

- Fifteen guava accessions were added to field gene bank.
- Cultivation of marigold and garlic in guava basin resulted in reduction of population build-up of spiral nematodes.
- Methy eugenol was ideal for management of fruit fly in guava.

In various guava accessions treating seeds with HCl (35%) for 3 minutes resulted in higher and early seed germination. It was found possible to grow up to 5,000 plants/ ha at a spacing of 1.0 m × 2.0 m coupled with regular topping and heading at Central Institute for Subtropical Horticulture, Lucknow. The maximum yield/ plot was recorded in double hedge row system of planting at Rewa, Sabour and Udaipur.

Cultivation of antagonistic crops like marigold and garlic in the basin of guava plants was found to result in population reduction of spiral nematode identified as a co-factor in guava wilt. Biological control of guava wilt indicated the possibility of its control with *Aspergillus niger*. Methyl eugenol trap was found best for management of fruit fly population.

Grape

Seven wine varieties and 4 natural mutants were added to germplasm collection bringing the total number of accessions to 374 at NRC for Grapes, Pune. Grape accessions were characterized using morphological traits and evaluated for powdery mildew resistance, early ripening, self-bud breaking, raisin and juice quality. Grape Centennial Seedless was found promising for raisin, while Concord and Country Bangalore for juice-making. Several accessions were identified for self-bud breaking. Positive correlation was observed between yield/vine and bunch number, yield and mean bunch weight and juice percentage and berry diameter. Graphical user interface for grape germplasm information system containing menus for application, and input and output forms were designed. At IIHR, Bangalore, embryo rescue technique has been standardized to incorporate downy mildew resistance in Thompson Seedless grape.

- Seven wine varieties and 4 natural mutants were added to grape germplasm.
- Embroy rescue technique has been standardized in grape.
- Metwing 2 software saves as much as 11 sprays in a year in grape cultivation.
- Pre-harvest treatment of grapes with chitosan alone or in combination with *Trichoderma* improved shelf-life of grapes.

Thompson Seedless and Flame Seedless scions showed maximum compatibility with drought tolerant Dogridge-B and 99 R rootstocks respectively. DRIS norms for vineyards, based on petiole nutrient contents were developed. Among different diagnostic parameters, P/N, K/N, P/Zn had greater physiological rationale during flowering stage, whereas N/P and N/K were critical during bud-differentiation stage. Sodium was most common limiting nutrient. The irrigation schedule using saline irrigation water of EC 1.87 mmhos/cm resulted in 52.5% saving in irrigation water. This irrigation schedule comprises replenishment of water @ 60% of pan evaporation 40 days after back pruning, 40 days after forward pruning and from 56 days through harvesting and @ 20% of pan evaporation during rest of the period from back pruning to harvesting.

SUCCESS STORY

Dogridge: an Ideal Rootstock

Raising a grape garden on Dogridge rootstock is a new concept. It has become very popular in Maharashtra, Andhra Pradesh and northern Karnataka. Use of Dogridge helps mitigate twin problems of salinity and drought. Beside, Dogridge can also take care of nematodes in soil, providing excellent nutritional support to the grafted scion.

Compared to gardens grown on their own roots which can start yielding in one-and-a-half year, the rootstock gardens take 6-8 months more since they have to be first planted in the field and then grafted with suitable scion variety after 6 months. This delay in getting first crop is unavoidable, but is more than made up when grafted vine starts yielding. Digging of trenches, cost of manures/fertilizers, training structures, drip systems and plant-protection chemicals cause an additional cost of Rs 6,000/acre on cost of nursery plants and grafting charges for raising a successful rootstock garden. Thus, there is a 20-25% increase in yield with improvement in quality of the produce. About 60-70% of the total grapes produced in such gardens are exported to European markets compared to 40% produced by traditional gardens. In gardens planned for making raisins, the recovery is 20% more compared to those grown on own rooted gardens.Dogridge has played a key role in many grape-growing regions of Maharashtra and Karnataka this year where drought situation worsened due to failure of monsoon.

Use of mulch and antistress at 75% of the recommended irrigation level saved 25% of irrigation water. Similarly, use of subsurface irrigation resulted in a saving of 25% of water. Application of CPPU on bunch having more than 10 leaves resulted in thick pedicel and higher berry diameter. Quality of Sharad Seedless grape could be improved with the use of GA_3 @ 50 and 30 ppm at 3-4 and 6-7 mm berry size stage respectively along with 6 BA @ 10 ppm. Use of complex stimulants, bioforce and biopower increased bunch weight, brix yield/vine, berry size and shelf-life of Thompson Seedless grapes.

Forecasting-based disease management using Metwin 2 software resulted in a saving of as much as 11 sprays during one year of production cycle. This, in turn, has reduced consumption of pesticide and cost of cultivation.Use of acrylic polymer anti-stress and chitosan improved efficiency of sulphur and hexaconazole has increased the shelf-life of grapes. Potassium bicarbonate (0.5%) and surfactant also improved efficiency of hexaconazole.Use of fungicides, viz. thiophenate methyl, mancozeb and sulphur in combination with hydrogen cyanamide (bud breaker), did not affect sprouting in vines. This approach would reduce the cost of labour in application of various chemicals.

Papaya

Two papaya accessions were added to field gene bank. A total of 49 gynodioecious and 35 dioecious lines of papaya were maintained at Coimbatore. In the

- Two papaya accessions were added.
- The planting density of 555 trees/ha of papaya gave 48% more yield.

improvement of 9-1 (D) papaya (high-yielding, red-fleshed and dioecious line), 4 superior single plant selections have been made in BC5F1 generation for fruit yield and pulp colour. The maximum fruit yield was recorded in papaya Ranchi 1, while maximum TSS (11° Brix) was recorded in Washington. The population density of 555 trees/ha with a spacing of 3.0 m × 6.0m gave 48% more yield compared to planting at 1.5 m × 3.0 m spacing.

Litchi

A total of 57 germplasm accessions and 13 superior seedlings were maintained at different centres. Litchi Rose Scented produced high yield with good fruit quality at Pantnagar. Highest yield was obtained in double hedge-row system of planting at Pusa (Bihar) and Pantnagar. Irrigation and sprinkling of water through overhead

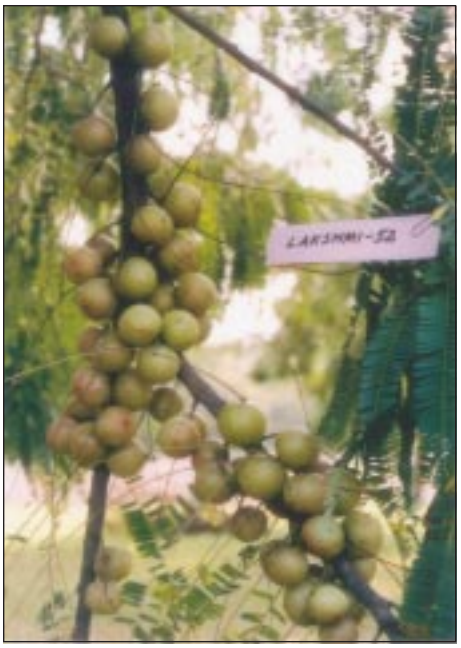
- Litchi Rose Scented produced high yield with quality fruits.

sprinkler had marked influence on minimizing pericrap cracking in litchi Shahi at Pusa. Carbaryl (0.1%) or Endosulfan (0.07%) sprayed twice at 10 days interval was effective in controlling litchi fruit-borer at Pusa (Bihar) and Mohanpur (West Bengal).

ARID ZONE FRUITS

Twelve new frost resistant aonla genotypes were collected from midhill region of Himachal Pradesh. About 322 genotypes of *ber*, 22 of *boradi*, 152 of pomegranate, 43 of *aonla*, 105 of cactus pear, 50 of date palm, 32 of *ker*, 32 of g*onda* and 4 of phalsa and kinnow mandrin were maintained in field gene bank at Central Institute for Arid Horticulture, Bikaner. Six varieties of pomegranate, and 3 of fig and *A. cherimoya* were introduced by Bangalore centre.

- Twelve new frost resistant aonla genotypes were collected from midhills region of Himachal Pradesh.
- Kaithali and Gola ber varieties have been recommended.
- APK 1 custard-apple is suitable for commercial cultivation.
- Pomegranate DKS/H/97/003 is a promising hybrid.
- Indian aloe was integrated with ber for cultivation.
- Apricot selection, Suka, having red cheeks has been collected.



Lakshmi 52 aonla yields 2–2.5 q/tree

A seedling selection of aonla, Lakshmi 52, has been identified in the village Bhadausi, Garwara, district Pratapgrah, Uttar Pradesh. Its tree growth is semi-erect and branches are semi-spreading which do not droop. The fruit matures during November-December and is free from necrosis having a yield potential of 2-2.5 q/tree (10 years

onwards). The fruit weighs 40-60 g containing 90.4% pulp, 82.5% moisture, 11° Brix TSS, 1.7 % acids, 512 mg/100g vitamin C and 3.3 % tannins. The fruits have great processing potential due to bigger size and high nutritive quality. Aonla NA 10 recorded best growth and highest fruit yield/plant,while NA 7 was superior under rainfed cultivation.

Ber Kaithali and Gola and custard-apple APK 1 are recommended for commercial cultivation in rainfed vertisol in Arupukkotai region. Twenty collections of bael and 41 of ker and 6 of lasora were collected at Bawal.

Selection of better type in aonla for earliness and yield was made at Godhra, Gujarat. Selection 6 had high yield (98.66 kg) /tree. Internal necrosis in aonla fruits due to boron deficiency was noticed up to 23% in Jobner.

Pomegranate hybrid (DKS/H/97/003) showed potential of high fruit quality traits like sweet, soft, bold and dark red aril. Vermicompost either alone or in combination with sheep manure helped check the depletion of soil moisture in active root zone of pomegranate. Best plant growth was achieved with same yield level with 0.75CPE irrigation along with 75% recommended dose of N fertilizer through drip. Thus in aridisol soils, 25% irrigation water and 25% nitrogen fertilizer could be saved through drip fertigation in pomegranate.

Indian aloe (*Aloe barbadensis*) was integrated with ber Gola planted at 3 spacings, i.e. 16 m × 4 m, 8 m × 8 m and 6 m × 6 m. Vegetative growth of ber plants was better with Indian aloe as compared to sole plantation of ber under the same spacing. It was observed that growing of groundstorey crops had positive influence on survival and vigour of ber plants. The clusterbean-mustard had given second best response but its adoption is practically feasible at farmers' fields, as it requires less input than other combinations. Indian aloe and clusterbean-mustard are good intercrops for ber under irrigated hot arid ecosystem. Ber Umran was high-yielding compared to other cultivars.

In fig, spraying of 500 ppm ethryl immediately after pruning resulted in higher yield. Date palm Medjool recorded maximum yield of fruits at *doak* (37.65 kg / palm) under 1:6 bunch:leaf ratio at Bikaner. Date palm Halawy is recommended for fresh fruits and Medjool for dry dates. Date palm fruits of *khala* stage of Halawy can give quality *chhuhara* if they are dipped for 10-15 minutes in boiling water followed by drying in air circulating drier at 45°C for 60-65 hours. Barhee was observed best for making *pindkhajoor*. It was also recommended that low to medium quality date varieties are useful for preparing good quality beverages.

Maximum temperature of 23.1°C and minimum of 6.0°C were congenial for the development of Graphiola leaf spot of date palm. The predator *Chilocoru nigritus* reduced the population of scale insect. Biochemcial basis on aonla rust resistance revealed that Mn and Zn were high and Fe was less in resistant cultivars. Dusting or spraying of 0.2% sulphur is recommended to control powdery mildew on ber.

TEMPERATE FRUITS

Apricot selection, Suka, has been made from Ladakh region, which has very attractive appearance due to red cheeks. This selection has 22 g fruit weight, 3.61 cm length, 3.64 cm diameter and 31.26° Brix. The average pulp weight is 20 g and pulp stone : ratio being 10. Its kernels are also sweet.

The fruits of Apricot Suka have red cheeks

VEGETABLE CROPS

Muskmelon NDM 15 for north-western alluvial plains and garlic DARL 52 and G323 have been released for humid western Himalayan region and arid western plains respectively. Besides, 5 open-pollinated (LCA 334 chilli, NDCP 13 cowpea, VRO 6 and VRO 5 okra, and DPP 9411 pea) and 7 hybrids (KTH 2 tomato, BH 2 and VRBHR brinjal, ARCH 228 chilli, DARL 202 capsicum, Pusa Hybrid 2 bittergourd and DCH 541 cauliflower) have been identified for release. Tomato Arka Meghali suitable for rainfed cultivation and bacterial wilt resistant tomato hybrids, Arka Shreshta and Arka Abhijit, were released. Frenchbean Arka Anoop with a pod yield of 18-21 tonnes/ha and resistance to rust has been identified for release. A chilli hybrid (developed by using male sterile line MSH 96), yielding 18 tonnes/ha green pods and 7-8 tonnes/ha dry pods with resistance to powdery mildew and viruses is in the advanced stages of testing. Three advanced breeding lines, TLBR 1, TLBR 3 and TLBR 6, of tomato were evolved for combined resistance to tomato leaf curl virus and bacterial wilt.

Eight new varieties of vegetable crops were released by Delhi State Variety Release Committee for commercial

cultivation in north Indian plains. These are: cauliflower Pusa Sharad (November maturity) and Pusa Meghna (September maturity) with compact curd and average yield of 240 and 125q/ha respectively. Vegetable mustard Pusa Sag 1 with an average yield of 700q/ha; ash gourd Pusa Ujwal with 485 q/ha in *kharif* season; Pusa Shandar, the first variety of snapmelon with 400 and 370 q/ha in summer and rainy season respectively; cucumber Pusa Uday with light green, smooth-skinned fruits and average yield of 157 q/ha in sprig-summer and 96 q/ha in *kharif* season; sponge gourd, Pusa Sneh with dark green fruits and average yield of 125 q/ha; and Pusa Rohini, a determinate tomato, with attractive red colourd fruits of 412 q/ha yield, have also been released.

Two advanced progenies of bottle gourd (AHLS Round

- In vegetables, 5 open-pollinated and 7 hybrids have been identified for release.
- Eight new vegetable varieties were released by Delhi State Variety Release Committee for cultivation.
- Technology for producing quality tomato and capsicum has been standardized.
- Packaging of onion in netted nylon sheet bags was better than open weaved hessian bags.
- A new species of begomovirus causing leaf curl on tomato was discovered.
- Sex pheromone-based IPM technique has been developed for brinjal shoot-and fruit-borer.

Arka Anoop provides 18–21 tonnes/ha quality pods

Varieties/Hybrids identified for release

Crop	Entry	Source	Zone(s) for which recommended
		Varieties	
Chilli	LCA 334	ANGRAU Reg. Res. Station, Lam (Andhra Pradesh)	III, IV, V, VII
Muskmelon	NDM-15	NDUA&T, Faizabad	IV
Cowpea	NDCP-13	NDUA&T, Faizabad	II, III, IV, VII
Garlic	DARL-52 G-323	DARL, Pithoragarh NHRDF, Nasik	I VI
Okra (YVMV)	VRO-6	IIVR, Varanasi	IV, V
Okra (YVMV)	VRO-5	IIVR, Varanasi	VI
Pea (mid-season) (powdery mildew)	DPP-9411	HPKV, Palampur	I
		Hybrids	
Tomato (indeterminate)	KTH-2	CSAUA&T, Kanpur	IV, V
Brinjal (round)	BH-2 VRBHR-1	PAU, Ludhiana IIVR, Varanasi	IV, V IV, VI
Chilli	ARCH-228	Ankur Seeds	IV, V, VI
Capsicum	DARL-202	DARL, Pithoragarh	I, IV
Bitter gourd	Pusa Hybrid-2	IARI, New Delhi	IV, V, VI
Cauliflower	DCH-541	IARI, New Delhi	II, IV

1 and AHLS Long 1) developed at CIAH, Bikaner, showed high potential under hot arid environment. For improvement in drought hardy *mateera* (watermelon), evaluation of advanced family block revealed the superiority of F6/a/10 (*mateera* AHW 19 × Sugar Baby). Seed production of *mateera*, *kachari*, snapmelon and *salad kakdi* were undertaken. About 300 kg of foundation seed was produced.

A total of 1,835 onion and garlic germplasm collected from indigenous and exotic sources are being evaluated against biotic and abiotic factors. Five hybrids with heterosis (75-100%) was developed and currently under trial in different cropping seasons to know G × E interaction.

Technology for producing quality tomato and Capsicum has been standardized. Pre-harvest application of benzyl adenine @ 25 ppm on broccoli Pusa Broccoli 1 was found effective in retaining green colour of heads up to 6 weeks in cold stores (4°C). Packaging of onion in netted nylon sheet bags was found comparatively better than open weaved-hessian bags for onion bulbs storage. In low-cost polyhouse cultivation of vegetable, cucumber hybrid Pusa Sanyog, capsicum hybrid Pusa Deepti, tomato hybrid DTH 7, and summer squash hybrid Pusa Alankar, were observed to be most promising with yield of 1764, 312, 744 and 1670 q/ha, respectively during off-season. Tomato genotypes, H 86, H 24, Bilali 1 and 6-11 B, showed tolerance to leaf curl. Hybrids, DTEH 2, DTEH 8, DTEH 9, DTEH 18 and DTEH 19, showed resistance to early blight. Three lines/variety, NF 31, VFN 8 and Pusa 120, showed resistance to root-knot nematode.

A regeneration protocol was developed using epicotyl and hypocoytl explants, which effectively regenerated five commercially grown eggplant cultivars. This regeneration procedure was used to facilitate gene transfer through *Agrobacterium tumefaciens* in eggplant var. Pusa Purple Long using gene from T-DNA of the binary vector plasmid *pBin AR*, which also contains gene that encodes neomycin phospho transferase II (*npt II*). The explant were co-cultivated with *Bin AR - Cry 1AB* and the shoots were regenerated on MS medium containing 4.44 uM/I BAP and1.14 uM/l IAA. The selection was done on a medium containing 50 mg/l cefotoxime. The Ro brinjal plants were normal and tested positive for NPT II enzyme activity through PCR with *npt II* specific primer. The NPT II positive transformants were further subjected to ELISA, which indicated that *Cry 1AB* protein is present in protein extracts of progeny plants. The southern blot analysis revealed that five of the putative transformed plants have single copy insertions of the transgene. The southern blot with *Cry* gene specific probe showed the presence of 2.4 kb fragment specific *Cry* gene suggesting its integration with plant genome.

A new species of begomovirus *(Tomato leaf curl Gujarat virus)* causing leaf curl disease of tomato in Varanasi was discovered which appears to be a recombinant one. It shares many fragments of its genome with several Asian begomoviruses, confirming that recombination is an essential molecular component for geminivirus evolution. Tomato leaf curl disease (TLCD) is a very significant problem for tomato growing regions in India. During November 2001, a severe tomato leaf curl disease (TLCD) manifesting yellowing of leaf lamina with upward leaf curling, leaf distortion, shrinking of the leaf surface and stunted plant growth was observed in the research farm of the Indian Institute of Vegetable Research and surrounding tomato growing areas in the Varanasi and Mirzapur districts of eastern Uttar Pradesh, causing yield losses up to 100%. The full-length genome of DNA-A and DNA-B of the virus was cloned in pUC18. Sequence analysis revealed that DNA-A (GenBank accession number AY190290) is 2757 bp and DNA-B (GenBank accession number AY190291) is 2688 bp in length. The virus could infect and cause symptoms in tomato, pepper, *Nicotiana benthamiana*, and *N. tabacum* when the partial tandem dimeric constructs of DNA-A and DNA-B were artificially inoculated through particle bombardment. This sap transmissible begomovirus is mono-bipartite in nature, indicating that DNA-A alone is infectious, but association with DNA-B increases symptom severity and shortens incubation period. ORFs in both DNA-A and DNA-B are organized similarly to other begomoviruses. DNA-A and DNA-B share a common region of 155 bp with only 60% sequence identity. DNA-B of the present isolate shares overall 80% identity with DNA-B of *Tomato leaf curl New Delhi virus*-Severe (ToLCNdV-Svr) and 75% with *Tomato leaf curl New Delhi virus*-[Lucknow] (ToLCNdV-[Luc]). Comparison of DNA-A sequence with different begomoviruses indicates that the present isolate shares a maximum of 98% homology with another isolate from the same region (ToLCGV-[Mir]; AF449999) and 97% with one isolate from Gujarat (ToLCGV-[Vad]; AF413671). All three viruses belong to the same species that is distinct from all the other geminivirus species described so far in the genus Begomovirus of the family Geminiviridae and the name *Tomato leaf curl Gujarat virus* (ToLCGV) is proposed, as the first sequence was taken from an isolate of Gujarat, India. The isolate here described has therefore been named *Tomato leaf curl Gujarat virus*-[Varanasi] (ToLCGV-[Var]), as it was isolated near Varanasi.

Attempts were also made to evaluate the putative recombination events that occurred between ToLCGV-[Var] isolate and the 21 Asian begomoviruses considered in this study. For example, when the full-lengths of ToLCGV-[Var] and ToLCKV were compared, there was high nucleotide sequence identity for their IR (approx. the first 100 nts), 5'-end of AV1 (200 nts), and a long stretch of 1350 nts from the 5'-end of AC3 to the 5'-end of the IR, indicating that at these sites, recombination events possibly took place between these two tomato infecting viruses or with a third unknown virus. Within the subset of viruses studied

here, one can recognize two clusters of viruses relative to putative recombinations with ToLCGV-[Var] : the first cluster would comprise the top 14 viruses would include ToLCGV- [Var], for which there is a substantial amount of recombination culminating to about 60% of the genome length with ToLCKV; the second cluster includes the bottom 8 viruses of the tree and would include ToLCKV; for which there is little or no apparent recombination with ToLCGV-[Var]. The pattern of these recombinations is very similar within the first cluster with two major blocks: the first one in the CP and the second one, with variable lengths, over the AC2-AC1 region of the genome. It is also remarkable that in the case of 4e CP, the segments look almost identical and at the same place in the ORF, possible indicating biological and structural constraints for recombinations to occur. Finally, ToLCGV-[Var] shares many fragments of its genome with several Asian begomoviruses, confirming that recombination is an essential molecular component for genminiviurs evolution.

Sex pheromone based IPM technique has been developed for management of brinjal shoot-and fruit-borer. Four tomato genotypes, H 86, H 24, Bilali 1 and 6 11B, showed tolerance to leaf curl. Hybrids, DTEH 2, DTEH 8, DTEH 9, DTEH 18 and DTEH 19, showed resistance to early blight. NF 31, VFN 8 and Pusa 120 showed resistance to root -knot nematode. Brinjal hybrids, DBHL 135 and DBHL 137, were found tolerant to shoot- and furit-borer and phomopsis blight respectively. Caluliflower, selection, Kn 81, BR 2 and 3-5-1 showed resistance for downy mildew, black rot and *Sclerotinia* rot.

TUBER CROPS

Potato

Germplasm collection was augmented by adding 20 accessions, raising its strength to 2,600 of cultivated and wild species from 30 countries. Potato hybrids, JW 160, MS/92-2105, SM/87-185 and HT/92-621, have been recommended for release. HT/92-621 is heat tolerant, resistant to leaf hopper and mites. Since it has high dry-matter content, it is most suitable for French fries. It is suitable for cultivation under early planting conditions in northern plains and warmer areas. JW 160, a high medium-maturing white hybrid having field resistance to late blight, possess wide adaptability and excellent keeping quality. It can be cultivated in plains and plateau region of the country. MS/92-2105 is a red skinned, high-yielding hybrid with oval attractive tubers having field resistance to late blight. It is suitable for cultivation in Indo-Gangetic plains, replacing late blight susceptible varieties Kufri Sinduri and Kufri Lalima. SM/87-185 is a late blight resistant white tuber hybrid having higher dry-matter content and better keeping quality.

Integrated use of vermicompost and inorganic fertilizers improved dry-matter content, specific gravity and chip colour in Kufri Chipsona 1 and Kufri Anand. A vermicompost production unit using *Eisenia foetida* species of earthworm was established at Modipuram, which produced about 15 tonnes of vermicompost and vermiculture worth Rs 50,000.

Totally virus-free mericlones (plantlets) and fully-grown plants of Kufri Jawahar, Kufri Lauvkar and Kufri Bahar were also confirmed using immune electron microscopy. A potyvirus isolated from *Physalis floridana* was characterized and identified as PVY. Another potyvirus from *Solanum nigram* was partially characterized which showed seroaffinity with Peru tomato virus. Both the isolates caused veinal necrosis in tobacco under short days.

Tropical Tuber Crops

The germplasm wealth of tuber crops has been enriched to 3,987 by adding 50 new accessions at CTCRI, Thiruvananthapuram and 685 by adding 15 new collections at Regional Centre, Bhubaneswar. Under *in vitro* active gene bank, 474 accessions have been brought. Twenty-five elite breeding lines were selected for registering with NBPGR, New Delhi. DNA fingerprinting of germplasm accessions and their molecular characterization using RAPD are in progress.

- Twenty accessions of potato were added to germplasm.
- The technical programme of IVLP was implemented in Rampuri and Baghi *panchayats* of Shimla, and Alampura, and Goanpur *panchayats* of Patna district in Bihar covering 300 and 700 farm families respectively.
- *Kisan melas* were organized at Modipuram, Patna and Gwalior centres of Potato
- Special trainings for State Government officers were organized at Shimla, Jalandhar and Gwalior centres
- A training course on research methodology on potato for scientists of AICPIP was arranged at Shimla
- Eight training programmes — one for officers of NEH states at Shimla and 7 farmers' training camps — were organized at Gangtok, Shillong, Agartala, Jharnapani, Aizwal and Imphal

About 113 species of various tubers have been collected from the 8 germplasm trips undertaken during the year

H-13 is a promising taro hybrid

including a trip to Andaman and Nicobar Islands under NATP project. Currently, 1,094 accessions have been conserved, 620 under shade net house and 474 *in vitro*.

Two triploid cassava clones 4-2 (3x) and 5-3 (3x) having higher extractable starch (>27%) were identified for industrial use. In sweet potato, 3 high carotene

Pre-released accession of greater yam

(5,700 IU) lines, S 1156, S 594 and S 1289, are under advanced stage. Of the 124 taro accessions, 13 have been identified which are tolerant to *Phytophthora* leaf blight.

Sweet potato entries, 90/101, 90/704, 90/566 and local, were tested at 5 locations in West Bengal. Of them, 90/101 recorded an average yield of 23.04 tonnes/ha followed by 90/704 (19.38 tonnes/ha). IB-90-15-9 (Indira Orange) recorded highest tuber yield in all the 5 locations in Chhattisgarh with an average yield of 22.43 tonnes/ha. This entry has been identified for release as Indira Sakarakand 1 for Chhattisgarh. In a multilocational trial of colocasia at Jagadalpur, IGCOL 3 was superior to others with an average yield of 19.00 tonnes/ha. Kadma Local was superior with an average yield of 11.16 tonnes/ha over all the locations.

The application of two-thirds of recommended dose of N along with 10 kg/ha *Azospirillum* as soil application alone or in combination with 2 kg/ha *Azospirillum* as vine dipping gave highest marketable tuber yield and dry

A promising hybrid of elephant-foot yam

weight of tubers. In an on- farm trial of sweet potato-based cropping system at Jagadalpur, cowpea – sweet potato combination was found ideal which produced 24.00 tonnes/ha tubers and 57.33 tonnes/ha green pod yield. The plots treated with half of the recommended dose of P (30.0 kg/ha) and full of N and K (120:120 kg/ha) + FYM (15 tonnes/ha) + mycorrhizal fungi recorded maximum tuber yield of 12.81 tonnes/ha followed by the plots treated with half dose of P (30) and full of N and K (120 : 120) + FYM (15 tonnes/ha) + mycorrhizal fungi + phosphate- solubilizing bacteria) (11.57 tonnes/ha). These treatments were at par with each other. On-farm trial of intercropping vegetable cowpea in *Amorphophallus* indicated that the mean tuber yield of *Amorphophallus* was 47.85 tonnes/ha under intercropping system against 45.25 tonnes/ha in pure crop. The cost analysis of intercropping system showed that an additional net return of Rs 11,225 can be obtained by intercropping vegetable cowpea over pure crop system of *Amorphophallus*.

The IPM package developed against sweet potato weevil

- Sweet potato Sree Arun, Sree Varun and Co-CIP 1 have been recommended for Kerala.
- X 109-2 sweet potato has been recommended for Tamil Nadu.
- Sequential cropping of vegetable cowpea with cassava under varying levels of FYM indicated the superiority of the treatment.
- Neem- coated urea is recommended to cassava growing farmers of Tamil Nadu.

incorporating indigenously developed (by BARC) pheromone septa (@ 1 mg/cm of 4 mm ID rubber tube) gave higher marketable tuber yield over the control. The population of biocontrol agents in IPM field that include entomopathogenic nematode, *Heterorhabditis indica* and *Rhaconotus menippus*, was comparable to that of untreated sweet potato fields. During storage, taro was found more severely damaged by *Araecerus fasciculatus* compared to other tuber crops. Parasitoids *Bracon*, *Pteromalus* sp., *Anisopteramalus calendrae* and *Anastatus* sp. were observed to parasitise *A. fasciculatus*. Two species of *Encyrtid parasitoids* were collected from mealybugs infesting elephant-foot yam during storage.

Application of neem cake or cassava leaf powder at the time of planting reduced root-knot nematode infection in elephant-foot yam. Aqueous extracts of *Gliricidia sepium* and *Eupatorium odoratum* caused 100% mortality of root-knot nematode even at 25 times dilution under *in-vitro* conditions. Yam-bean seed extract and cassava seed extract stored for a long time retained their toxicity even after 75 days. While 3 and 5% concentration of yam bean extract was highly effective against first and second instar larvae of *Spodoptera litura*, concentration of cassava seed

extract was effective against first instar larvae.

Whitefly transmission of yellow netting symptom from sweet potato to sweet potato was achieved. The symptom expression of sweet potato feathery mottle virus was found high during August-September. The plants subjected to hot-water treatment (40°C) were free from sweet potato feathery mottle virus. Application of neem cake @ 1 kg/ pit at the time of planting was effective in controlling tuber rot in elephant-foot yam. The seed tuber treatment and foliar application of rhizo-bacterial cultures controlled *Phytophthora* leaf blight and rotting of tubers by other fungi during storage of taro. New records of leaf spot pathogens, viz. *Pestalotiopsis* sp. and *Curvularia lunata* var. *aeria*, were reported from greater yam. The rust pathogen, *Canna edulis*, was identified as *Puccinia thaliae* which is a new record in India. *Rhizoctonia solani* causing severe leaf blight in yam bean was isolated and its pathogenicity was proved.

On-farm trials on IPM package against sweet potato weevil was conducted at Hyderabad, Coimbatore, Dapoli, Dholi, Ranchi, Bhubaneswar and Kalyani. The IPM package recorded higher yield of uninfected tubers and low tuber damage than chemical treatments and control. Percentage of crown damage was least under IPM package. The IPM package has been found cost effective at all the locations. Planting material of recommended varieties were multiplied at farmers' fields. Presently, *Amorphophallus* (Gagendra), cassava (Co 2, Co 3, Co 4 and (TP) -4), and sweet potato (C0 3, Co CIP 1) are included in seed production programme at TNAU, Coimbatore. The planting material was distributed to 100 farmers.

SUCCESS STORY

Nutritional Security

The sweet potato has been widely recognized as a 'saviour crop' due to profitable yield for sustaining food and nutritional security in Sujeli village of Kandhamala district in Orissa.It has brought a revolution by minimizing malnutrition and improving nutritional security. With the launching of NATP project *Horticulture and Vegetable Gardening for Food and Nutritional Security* during 2002-03, the Regional Centre, Bhubaneswar, has popularized high-yielding Gauri, Sankar and Sree Bhadra sweet potatoes. Within a span of one year, these varieties have spread faster and replaced the local ones. The tribal farmers who were hitherto getting around 7-8 tonnes/ha of sweet potatoes, are now getting 11-15 tonnes/ha. The income level too has enhanced from Rs 30,000 – 32,000/ha, to Rs 48,000 – 56,000/ha. The vegetable consumption of 150-200 g/day/ family of 4-5 members has doubled (300-450 g).

MUSHROOM

Twenty-one new wild mushroom species were collected. Two high-yielding single spore selections of *Agaricus bisporus*, SSI-689 and SSI-17, produced 18.5 and 15.6 kg mushrooms from 100kg compost respectively in 6 weeks, while hybrid 1 yielded 22.7kg mushrooms. Successful hybridization was obtained between strains NCB-6 × NCB-13 and NCB-14 × NCB 15. Of the 90 crosses, 46 interspecific hybrids were identified. These are being evaluated for mushroom yield and fruit body quality.

The DNA fingerprinting of 22 strains of *Agaricus bisporus* was accomplished with reproducible polymorphic bands at several loci using 20 decamer primers of OPO series. All the strains could be distinguished with aggregate primer data analysed by UPGMA and Jaccard's coefficient analysis. White pileal strains formed a separate cluster, whereas brown strains showed high degree of genetic diversity. All the 8 putative species of family Morchellaceae namely, *M.esculenta*, *M.crassipes*, *M.spongiola* var. *dunensis*, *M.vulgaris*, *M.conica*, *M.angusticeps*, *Mitrophora semilibira* and *Verpa conica* showed significant polymorphism and could be distinguished from each other by primer OPP-6 (5'-GTG GGT TGA C-3') and Custom primer (f'-CGC ACC GCA G-3'). These primers can be used as molecular markers for species identification in morels.

High-yielding mushroom selection

Yield data before preservation of mushroom stock culture and after 30 months of preservation showed static biological efficiency, vigour and fruit body weight. The comparison of Random Amplified Polymorphic DNA (RAPD) and Internal Transcribed Spacers (ITS) PCR amplified products did not show scorable variations at intraspecific levels in banding patterns during preservation

- Twenty-one new wild mushroom species were collected.
- The DNA fingerprinting of 22 strains of *Agaricus bisporus* was accomplished.
- Sugarcane bagasse with straw in a 1:1 ratio gave higher mushroom yield of white button mushroom.
- The cryopreservation for long-term preservation of mushroom stock has been developed.
- The low temperature sensitive edible mushroom, *Volvariella* and *Morchella*,can be preserved satisfactorily.

of stock cultures by either of the methods. The germplasm can be preserved safely under liquid nitrogen conditions for many years.

Sugarcane bagasse in combination with straw in a 1:1 ratio gave higher yield (17.53kg mushroom/100 kg compost) of white button mushroom compared to wheat straw alone (15.4 kg). Eight different isolates of thermophilic fungi isolated from compost samples were categorized based upon their RAPD profiles. Well-decomposed farmyard manure, spent mushroom substrate, combination of two (3:1, w/w) and coirpith gave significantly higher mushroom yield over the municipal garbage, vermicompost and wastes from coir industry. The casing materials fermented with thermophilic microbes at thermophilic temperature range gave significantly higher mushroom yield over unfermented casing materials.

Oyster mushroom has been successfully grown on wheat straw, paddy straw and maize stalk and leaves. Supplementation with deoiled soybean cake has given 85% biological efficiency. Higher yield of *P.eryngii* was obtained on wheat straw supplemented with deoiled soybean @ 5% wet weight basis. The paddy straw-based compost substrate gave higher mushroom yield than wheat straw, sugarcane bagasse and wheat straw+sugarcane bagasse-based composts. The strain, Ovv-01, obtained from OUAT, Bhubaneshwar, gave higher mushroom yield than other strains of different origins. Highest colonization of substrate by medicinal mushroom (*Ganoderma lucidum*) was recorded at 70% moisture level. Sawdust substrate supplemented with wheat bran @ 20% was best substrate for *Ganoderma lucidum*. Lyophilized cultures of edible fungi showed anti-dementia activity under *in-vitro* conditions.

Of the 10 plant extracts evaluated under *in-vitro* conditions against edible fungi, extract of *Gardenia* sp. caused maximum inhibition of *L.edodes* mycelial growth, followed by *M.procera* and *A.bisporus* (U-3). However, extracts of *Eucalyptus* sp., *C.lanceolatus* and *C.sativa* stimulated mycelial growth. In case of *P.sajor-caju*, no inhibition in mycelial growth was recorded from the extracts of *Cathranthus* sp., *C.lanceolatus*, and berries of *C.lanceolatus*. Of the 3 neem products, viz. Neemactin, Neemjeevan and Rakshak tested under *in-vitro* conditions against moulds and diseases of button mushroom, Neemactin caused maximum inhibition (37.55%) in *V.fungicola*, followed by *Chaetomium* sp. (36.92%). Neemjeevan caused maximum inhibition (44.88%) in *M.perniciosa*, followed by *C.dendroides* (42.22%). Rakshak caused 47.11% inhibition of mycelial growth of *T.viride* followed by *Chaetomium* sp.

SUCCESS STORY

Cryopreservation of Mushroom Cultures

A cryopreservation technique for long-term preservation of mushroom stock cultures has been developed at NRC for Mushroom, Solan. The mushroom stock cultures are invariably preserved as mycelial cultures. These mycelial cultures are required for preservation of spawn (seed) for mushroom cultivation. Repeated subculturing at 3-6 months interval often leads to loss of desirable traits, degeneration (slow growth) and genetic erosion. The technique involves multiplication of mushroom mycelium on water-soaked autoclaved cereal grains (preferably wheat grains) pre-treated with clacium salts for 3 weeks at 25°C. These cereal grains containing concealed mushroom mycelium are then submerged in sterilized cryovials containing cryoprotectants (Glycerol, Ethylene glycol, Dimenthyl - sulfoxide). These cryovials are then slowly cooled for several hours at 4, -20 and –70°C and finally plunged into big vessel containing liquid nitrogen at (-196°C). As and when stock cultures are required, these can be retrieved on malt extract culture medium, following rapid thawing by pluging into water blanks maintained at 37°C.

The low temperature sensitive edible mushroom stock cultures of *Volvariella* and *Morchella* which are otherwise maintained at room temperature, were also preserved satisfactorily by this technique. After comparing DNA fingerprinting profiles by Random Amplified Polymorphic DNA (RAPD) technique confirmed no genetic changes during cryopreservation in 11 edible mushrooms strains. Since this technique had no adverse effect on yield potentials of commercially important mushroom strains, it can be effectively utilized for conservation of mushroom germplasm of the country. Timely phylogenetic cataloguing and cryopreservation efforts may provide legal protection to indigenous mushroom germplasm both at national and international levels.

FLORICULTURE

Rose

Six new rose varieties, Pusa Mohit, Pusa Abhishek, Pusa Manhar, Pusa Muskan, Pusa Urmil and Pusa Ranjana, were released by IARI, New Delhi. Of them, Pusa Mohit is a Hybrid Tea which produce red coloured flowers on long stems suitable for cut flowers while others 5 are floribundas. The plants of Pusa Abhishek are hardy and tolerant to powdery mildew and black spot. Pusa Manhar is medium- growing floribunda which produces creamy white flowers with magenta shade. It is also tolerant to powdery mildew and black spot. Pusa Muskan produces creamy white flowers in clusters having pink shade and red coloured edges. Pusa Urmil is a bud sport 'Jantar Mantar' which produces a large clusters of 40-45 brown pink coloured flowers. Pusa Ranjana, a dwarf floribunda, produces dark pink flowers in a big clusters. It is suitable for pots and bedding pruspses. Pusa Gaurav for cut flower, Neelambari and Arunima for loose flowers and Arunima and Banjaran for garden display were found promising under Bhubaneswar conditions.

Gladiolus

Five new gladiolus varieties — Urmi, Jyotsana, Gulal, Shabnam and Urvashi — were released by Delhi centre. Application of Captaf (0.3%) controlled corm rot disease

significanly at Ludhiana and Pune. The bioagent, *Trichoderma herzianum*, controlled corm rot effectively at Pune and Kahikuchi. Benomyl (0.2%) Carbarandum and Bagalot (0.02%), were found most effective fungicides against *Fusarium* wilt.

Carnation

Pinching of carnation Impala growing under protected condition with pinch and foliar feeding of N (150 ppm) at fortnightly interval were found best. For controlling Fusarium wilt, Bordeaux mixture followed by mixture of Benomyl + Captaf and Bavistin + Captaf was found effective. Vase-life of carnation Impala and Tasman increased with pulsing treatment with glucose 10% + STS (2mM) for 8 hours and storage of cut spikes at 1°C in vase solution + STS (50 ppm) + HQC (50 ppm) for 24 hours.

Anthurium

Spadix explant cultured on MS medium supplemented with 2,4-D (3 mg/litre) and kinetin (0.3mg/litre) and kept under dark produced friable and nodular calli while petiole explant of Nitta Orange produced same on MS medium + Adenine (5 mg/litre). Pulsing solution with sucrose @ 2% (Meningue) to 8% (Lima) holding solution having BA (25 ppm) packing in polythene cover were found to be promising for increasing the vase-life at Vellanikkara.

Tuberose

For control of *Sclerotium* wilt disease of tuberose, treatment of *Trichoderma viride* @ 20g/m^2 followed by Carbendazim (0.1%) + Captan (0.2%) were found to be effective. Chemical treatment of tuberose spikes with sucrose (2%) + Al_2SO_4 ($_3$) (300 ppm) and wrapping them in newspaper increased post-harvest life at Pune, Kalyani and Vellanikkara.

Gerbera

Gerbera cultivars grown under low-cost polythene performed better than those grown under shade net and open field conditions. Leaf spot disease of gerbera could be controlled by treating the plants with Benomyl (0.1%) followed by Kavach (0.2%). Spraying of copper oxychloride (0.3%), followed by Mancozeb (0.2%) was found superior in reducing leaf spot/ blight disease in gerbera.

- Five gladiolus varieties have been released by Delhi centre.
- Vase-life of carnation could be increased by pulsing treatment with glucose for 8 hours.
- Gerbera grown under low-cost polythene performed better than those grown under shade nets and open field.
- About 450 species of 93 genera of orchids were collected.
- Eighty hybrids of cymbidium were characterized for mass multiplication.
- A mixture of brick chips, leaf manure, charcoal and coconut husk (1:1:1:1), and rotten log with moss (1:1) performed better growth and flowering in Cymbidiums.
- About 11 diseases of orchids have been identified.

Orchids

About 450 species of 93 genera of orchid were collected. Of them, 393 species of 90 genera are evaluated and characterized. These plants are maintained for further studies in *ex-situ* conservatories. Other than orchid species, 80 hybrids of Cymbidium are also collected and characterized for mass multiplication. The selected hybrids are Soul Hunt, Golden Girl, Show Girl and Lunavian Atlas. About 1,000 plantlets of Cymbidium hybrid Soul Hunt are ready for further experiment.

Low-cost Bamboo Polyhouse

A low-cost bamboo- based polyhouse has been evaluated for commercial cultivation of Cymbidiums. The bamboo-based orchid structure with 200 μ polysheet on top is able to accommodate 500 grown plants or 1,000 one-year-old seedlings. The poly structure of size 50′ × 20′ costs about Rs 25,000 for its construction with local materials.

Planting of Cymbidium in raised bed comprised brick chips, leaf manure, charcoal, coconut husk (1:1:1:1) and rotten log with moss (1:1) also equally performed better of overall growth and flowering of Cymbidium hybrids and significantly influenced height of plant, length of leaves and length of spike. Maximum height of plant, length of leaves, number of pseudobulbs, spikes and number of flowers/spike were recorded in raised beds. It is also observed that coco pith with perlite (1:1) gives better growth performance for Cymbidium hybrids.

About 11 diseases of orchids are identified from Sikkim and Darjeeling districts of West Bengal. Orchid wilt caused by *Sclerotium rolfsii* is a serious disease to commercial hybrids of Cymbidium. Other serious disease recorded is black rot caused by *Phytophthora* species. This disease is a serious problem for orchid growers in Darjeeling district.

PLANTATION CROPS

Coconut

Somatic embryogenesis and plantlet development were achieved from inflorescence and adult leaf tissues of arecanut Mangala, Sumangala, Mohitnagar and South Kanara Local. Coconut using DAF (DNA amplification fingerprinting) analysis, a putative marker for resistance to root (wilt) disease in coconut, has been identified.

Technology of sweet, ginger and vanilla flavoured chips was transferred to coconut entrepreneurs. Twenty entrepreneurs have already purchased this technology. Of them, 6 have already started production and marketing of chips. A solar-cum-electric-dryer has been fabricated. This dryer works with solar energy as the main source of energy and electrical or agricultural waste as another

source whenever sufficient solar energy is not available.

Participatory technology transfer of integrated root (wilt) management practices were demonstrated in 25 ha area owned by more than 200 farmers. The average yield increased from 25 nuts to 46 nuts/palm/year (91% improvement). The participant farmers expressed their confidence in the adoption of technology in improving the health and vigour of root (wilt) affected palms.

Oil palm

Genetic diversity was studied with 25 palms from 5 different accessions, 98C-254D (ASD Costa Rica), GD-3 (Palode), 98C-208D (ASD Costa Rica), 240D × 281D (Palode), 80D × 281D (Palode) using Randomly Amplified Polymorphic DNA (RAPD). RAPD analysis using 10 deca nucleotide random primers revealed that no two palms from the same accession or from different accessions were genetically similar. Maximum similarity of 0.917 was observed between 2 palms in accession No. 80D × 281D from Palode. Maximum genetic diversity (0.583) was observed between P8 and P12, which were 2 different palms from GD3 from Palode and 98C - 208D from ASD Costa Rica. However, P12 cand P13 from 98C - 208D accessions from ASD Costa Rica also showed maximum genetic divergence (0.583). Dendogram from cluster analysis showed 6 major clusters (groups).

Carotenoids from crude palm oil could be recovered without affecting the edibility of the oil by using specific adsorbents. Adsorbed carotenoids were recovered using specific solvents. Of the 11 adsorbents, fullers earth showed maximum adsorption and recovery. Among different solvents used to recover the adsorbed carotenoids, acetone was found to be the best. Recovered carotenoids were further concentrated up to 160 times under nitrogen using rotaty vacuum flash evaporotor. Concentrated carotenoids were obtained in powder, gel and liquid forms.

Preliminary results showed a wide variation in the degree of unsaturation as well as fatty acid composition among the oleifera palms. Few oleifera palms were found superior as they had more unsaturated fatty acid content (specially oleic and linoleic acid) in oil. Oleifera oil (American palm oil) contains more unsaturated fatty acids compared to Guineensis oil. Iodine values were determined for the oil samples from different oleifera palms and also analyzed by GLC. The Iodine value showed the degree of unsaturation, whereas GLC analysis revealed the individual fatty acid composition.

Cashew

Cashew accessions, Anagha, Akshaya, Sulabha and Dharashri, were planted in National Cashew Gene Bank (NCGB) for conservation, which raised the total number of accessions to 478. A total of 12 trees with higher yield and bold nut characters were identified for collection and conservation during survey of north- eastern region. Promising hybrids and Tea Mosquito Bug (TMB) tolerant material were planted in a new multilocational trial in 6 AICRP centres. Multiple shoots have been induced from cotyledonary and shoot tips. Shoot cultures from nodal explants of grafts were established.

In organic farming trial, highest biomass (6.8 tonnes/ha) was obtained from *Sesbania* followed by *Glyricidia* (3.25 tonnes/ha). In cashew orchard, turmeric was found to be a promising intercrop with a yield potential of 8 tonnes/ha.

Cashew growing luxuriantly after pruning

At Jhargram, yield/tree was maximum in widest planting (10m × 10m rectangular system), whereas yield/unit area was maximum in 6m × 6m × 6m triangular planting. At Vengurle, highest yield/unit area was obtained from 5m × 5m square planting and highest nut yield/tree was in 8m × 8m square planting. At Bapatla, clusterbean was found most economical intercrop

- Twenty entrepreneurs purchased technology of making ginger and vanilla flavoured chips of coconut.
- A solar-cum-electric-dryer has been fabricated.
- Oil palm empty bunch decorticator with a decorticating capacity of 45 kg empty fruit bunches/hour has been developed.
- Carotenoids from crude palm oil could be recovered without affecting edibility of oil by using absorbents.
- A total of 478 accessions of cashew have been conserved in the National Cashew Gene Bank.
- In cashew orchard, turmeric was found to be a promising intercrop.

Oil Palm Decorticator

An oil palm empty fruit bunch decorticator was developed and fabricated for separation of fibres from oil palm empty fruit bunches. The decorticator has a capacity of decorticating 450 kg of empty fruit bunches/hour and can produce about 180 kg of dry fibres. Its cost is Rs 1.40 lakhs. The fibre obtained from decorticator can be used for various value-added products like blended yarn, fiberboard and rubberized mattresses. The rubberized mattresses were of extra firm grade as per the Indian standards with indentation hardness of 15.88.

in *kharif* season and blackgram was remunerative in *rabi*. Groundnut was found economical intercrop at Jhargram and Vridhachalam, whereas bitter gourd was highly profitable at Vengurle.

Crude fibre from cashew apple pomace was extracted and studied in order to develop fibre rich value-added products from cashew apple. The crude fibre shaved higher water absorption capacity. Extent of *in vitro* digestibility of carbohydrate in crude fibre was found to be less compared to protein, which was digested completely. A total of 28 released varieties were analyzed for P, Ca, Mg, Na, K, Cu, Fe, Se and Mn.

SPICES

Two high-yielding and high quality ginger varieties, IISR Mahima and IISR Rejatha and a high-yielding and high-quality nutmeg clonal selection, IISR Viswashree, were released for cultivation in Kerala.

Sixty-eight accessions of *Piper* species and cultivated black pepper types were collected from Kerala and Andaman Islands. One hundred accessions were characterized and catalogued based on IPGRI descriptors. Twenty-five accessions of cardamom,11 of related genera, 5 *Zingiber* species and one cultivated turmeric type,7 *Garcinia* species, one collection of *Cinnamomum sulphuratum* and 6 wild species of *Myristica* were added to the germplasm. Twenty accessions of black pepper, 18 of turmeric, 15 of ginger and 100 of vanilla were added to *in-vitro* gene bank.

New germplasm collections of ginger, turmeric, coriander and fenugreek were collected at Pundibari.

- Two high-yielding ginger varieties and one nutmeg clonal selection were released for cultivation.
- A number of accessions of various spices — ginger, cardamom, turmeric, Garcinia, cinnamon etc. — were added to germplasm.
- About 991 accessions of 9 seed spices were collected, evaluated and maintained at NRC for Seed Spices.

Cardamom clones, CL-629, CL-681 and CL-730 and OP progenies, D-237, CL-730, 8-4-D-11 and 7-24-D11, were identified as promising at Mudigere. The promising clones, P-6, D-237 and CL-746, were drought tolerant. Germplasm accessions tolerant to various diseases were identified in ginger, turmeric, coriander and cumin. Turmeric accession, SG 685, gave high dry recovery and coriander, Jco 331, high oil (0.45%) content.

In cardamom, 15 hybrid combinations were identified as promising for yield and tolerance to leaf blight. *Garcinia gummigutta* grafted on *G. hombroniana* and *G. cowa* by softwood grafting gave 90% success and *G. indica* grafted on *G. gummigutta* gave 54.5% success.

In *Piper*, Acc. 5411 yielded 31.0% oleoresin and 6.2% piperine followed by Acc. 5442 with 21.0% oleoresin and 6.0% piperine. Acc. 60, 63, 75 and 273 had more than 8.0% volatile oil and Acc. 257, 258, 259, 277 and 325 had about 30% á-terpinyl acetate and about 25% 1,8-cineole. In ginger, Gurubathani, Kozhikkalan and Accs. 121, 260, 340 and 342 had above 5.5% oleoresin and Kozhikkalan and Gurubathani had 4% crude fibre.

In nutmeg, essential oil content ranged from 7.67 to 13.89% and that in mace from 7.48 to 20.99%. The colour value of paprika accessions ranged from 42 to 171 ASTA units and 33 to 176 ASTA units for indigenous and exotic germplasm collections, respectively.

Application of vermicompost @ 1.25 kg/pot significantly increased build-up of soil P from 2.1 to 55.0 mg/kg, K from 103 to 262 mg/kg and yield by 51% over chemical fertilizer sources in bush pepper. Black pepper hybrid, HP-29, maintained higher water status, lower membrane damage and higher SOD activity during water stress. Cardamom genotype, APG-18, was superior in withstanding drought stress. Pineapple as live barriers in between cardamom showed promise for soil and water conservation in cardamom-based cropping systems.

Metalaxyl Gold MZ and *Trichoderma* sp. were effective for the management of *Phytophthora* foot rot of black pepper. Two sprayings of either monocrotophos (0.05%) or dimethoate (0.05%) at fortnightly intervals after harvesting of berries were effective for the management of mussel scale (*Lepidosaphes piperis*) on black pepper at high ranges of Idukki district in Kerala.

Five accessions (Accessions 6, 17, 130, 155 and 208) were found promising against rhizome rot of ginger. ITS-PCR and RAPD analysis confirmed the narrow genetic base of bacterial wilt pathogen in ginger. A protocol was refined for isolation of DNA *R. solanacearum* from soil. The Thermal Death Point of *R.solanacearum* was determined as 45.8°C at 30 minutes of exposure. The time and duration of rhizome solarization was optimized.

Field evaluation of promising fungal (*T. harzianum* and *Verticillium chlamydosporium*) and bacterial (*Pasteuria penetrans*) isolates indicated that black pepper vines treated with *V. chlamydosporium* yielded highest compared to other treatments. Four promising fungal isolates (*V. chlamydosporium*, *T. harzianum*, *Paecilomyces lilacinus* and *Scopulariopsis* sp.) and rhizobacteria (IISR 853 and IISR 859) also reduced foliar yellowing in black pepper vines.

Evaporation cool chamber (a double-walled brick structure filled with sand between the walls, frequently moistened with water) was found ideal for storing fresh ginger.

About 991 germplasm accessions of 9 seed spices were collected, evaluated, maintained and conserved at NRC for Seed Species. Coriander ACr 256 has been identified promising for high yield and resistance. Fennel Sel-01-87 was identified for better yield and Sel-01-119 was found suitable for cultivation during *kharif* season. New selections of fenugreek, AM 10 and AM 35, were identified having early maturity, large pod size and high yield potential, and field tolerance to powdery mildew. New

ajowain selections, AA-19 and AA-61, have been identified for earliness, high yield and resistance to powdery mildew.

New superior selections have been isolated in Indian dill and European dill. The European type of dill AD-43 identified for quality was found suitable for export. New selection of cumin AC 167 isolated for high yield possessed wilt resistance. The agro-techniques for minor seed spices, viz. *ajowain*, dill and kalongi were standardized.

BETELVINE

Betelvine germplasm was maintained and catalogued raising to total accessions to 269. Betelvine Swarna Kapoori was found superior in vine growth (40.5 cm/ month), leaf yield (93.63 lakh/ha), and low incidence of *Phytophthora* foot rot disease.

The plant population density of 1.5 lakh plants/ha produced maximum number of leaves/plant (14.85) at JNKVV centre. However, maximum number of leaves /ha (23.65 lakh) was obtained with 2.0 lakh plants/ha. The cost : benefit ratio was maximum (1:4.43) with 1.5 lakh plants/ha. At AAU centre, 2 lakh plants/ha produced maximum number of leaves (48.64). At OUAT, 2.00 lakh plants/ha showed significantly higher leaf yield (55.6 lakh) /ha. Shelf-life of leaves was more (13 days) in 1.75 lakh plants /ha. Leaf yield was maximum (35.29 lakh/ha) at the plant population of 1.75lakh/ha at RAU centre. Maximum disease incidence (27.6) was, however, recorded at 2 lakh plants /ha. The plant population of 1 lakh/ha was found to be optimum for higher leaf production and better cost : benefit ratio at ANGRAU and

- Betelvine germplasm was catalogued, raising its total number to 269.
- Swarna Kaprori betelvine was found superior in vine growth, leaf yield and low disease incidence.

75,000 plants/ha (45 lakh leaves/ha) at TNAU centres. However, the PDI was maximum (11.52) under this population density.

The keeping quality was maximum with application of Azotobacter 5kg+100 kg N through oil cakes, phosphobacter 5 kg + 50kg P_2O_5+ 100 kg K_2O/ ha and vermicompost (200kg N), 100 kg P_2O_5+ 100 kg K_2O/ ha.

The recommended dose (200 kg N + 100 kg P_2O_5 +100 kg K_2O/ha) yielded significantly more number of branches (32.75), maximum leaf yield (105.82 lakh/ha) and weight of 100 leaves (258.79 g) and increased keeping quality of leaves (17.2 days), followed by application of biofertilizer Azotobacter 5 kg + phosphobacter 5 kg + 100 kg K_2O/ha. Maximum cost: benefit ratio (1: 2.51) was received with Azotobactor + phosphobacter + K_2O.

Leaf yield was maximum (48.30lakh/ha/year) in phosphobacter (5kg/ha). Application of vermicompost @ 2.0 tonnes/ha helped in increasing the leaf size (16 cm×13.30cm). Shelf-life of leaves was found to be longer (13.4 days) with the application of phosphobacter (5kg/ ha) remaining at par with Azotobacter (5kg /ha) + phosphobacter (5kg/ha) and vermicompost application. The disease incidence was lowest (7.4%) with the application of phosphobacter (5kg/ha) which remained at par with Azotobacter (5kg/ha) and Azotobacter (5kg/ ha) + phosphobacter (5kg/ha). The cost: benefit ratio revealed that an increased return of 1:3.86 could be achieved with incorporation of phosphobacter (5kg/ha) followed by vermicompost application.

The leaf yield was significantly highest (48.00lakh/ha/ year) remaining at par with application of NPK (kg/ha) : 150 (oil cake +urea) : 100:125. The percentage of disease incidence was significantly lowest with NPK (kg/ ha) : 150 (oil cake) : 100:125 and highest with NPK (kg/ ha) : 150 (oil cake + urea) : 100:125. The cost : benefit ratio indicated that an increase return of 1:0.77 could be obtained with application of NPK (kg/ha) : 150 (oil cake + urea) : 100:125. Application of 200 kg N/ha (oil cake) + 100: 100 P and K kg/ha gave maximum leaf yield/ha at MPKV. At TNAU centre with NPK (kg/ha) : 150 (FYM) : 50: 50, better leaf yield (30.23 lakh/ha) was recorded.

Phytophthora foot rot disease in betelvine could be best managed with sanitation + 1 application of BM% at the monsoon + application of biological agent (*T.harzianum*) one month later + 1 additional BM after 2 months of 1st BM. Aplication of oilcakes + carbofuran + 3 inoculations of *P.lilanus* inoculated oil cakes showed best control of root-knot nematode and increased leaf yield compared to other treatments at JNKVV, AAU, OUAT and RAU.

MEDICINAL AND AROMATIC PLANTS

A total of 380 accessions of medicinal and aromatic plants were maintained in the genebank. In safed musli, a number of promising lines; MCB 405,412,414 (Mandsaur), CBI 5,7, 12, 24 and 15 (Indore) RC 62, 74, 77 and 86 (Udaipur) and NRCCB 1 (NRCMAP) were identified. Yield of fresh fleshy root varied from 2.44 to114.85g/plant. Maximum yield of fresh fleshy root was found in Vireswar lines (2,506 kg/ ha). Total steroidal sapogenine content ranged from 0.562 to 1.21%.

Fresh fleshy root yield was found significantly superior (2,130 kg/ ha) in MCB 412 at Mandsaur. However, maximum (1.025 %) sapogenine content was in MCB 405. Highest yield (2,979 kg/ha) of fleshy root was recorded in RC 62 at Udaipur.

- A total number of 380 accessions of medicinal and aromatic plants were conserved.
- Safe musli, isabgol, guggal, aloe, kalmegh, aswagandha, opium poppy, valeriana etc. plants were evaluated for their high yield potential.

Two species were studied morphologically, physiologically, cytologically and chemically. Saponin profile was studied by HPTLC method. Eight saponin components were present in *C. arundinaceum* and *C.borivilianum*.

Planting on ridges was superior over others at Udaipur and yielded highest (1,735 kg/ ha) fleshy roots. At NRCMAP, double-row raised bed planting gave highest (1,911 kg/ ha) fleshy root yield. It was also found that planting on 1 July yielded significantly highest yield of fresh fleshy roots (1,537 kg/ ha). Neem leaf mulch produced maximum (1,677 kg/ ha) fresh fleshy roots. At Anand, removal of floral parts increased vegetative growth and length of fleshy roots. Detopping enhanced fleshy root yield by nearly 30%.

In kalmegh (*Andrographis paniculata*), fresh and dry herbage yields were maximum (923.28 and 307.76 g/ plant respectively) in Attarsumba accession.

Aloe (*Aloe barbadensis*) has maximum (1,565.87 mg) total aloin (aloin A) /plant. *Aloe* species, used as vegetable in Rajasthan, had aloin only in negligible quantity (4.07 mg/plant). Other species had 713.13 mg of aloin/plant. An artificial inoculation method (detached leaf inoculation method) was also developed for easier and quicker screening of germplasm for disease resistance.

In guggal (*Commiphora wightii*), highest rooting success was observed in cuttings raised in soil medium (53.33%). Quick dip method in 1500- 2000 ppm IBA gave highest (60-65.33%) cutting success in soft wood cuttings. It was also found that semi hard wood cuttings (up to 10 days old) could effectively cause good rooting success (66.7-72.00 %).

Isabgol (*Plantago ovata*) at Mandsaur, swelling factor was found to range from 6.2 (SPS 20) to 10.1 in SLS 59. Three lines at Mandsaur and 2 at Udaipur were found resistant to disease.

In aswagandha (*Withania somnifera*), dry root yield was highest in MWS 216 (833 kg/ ha). Alkaloid content (%) of dry root was found to range from 0.310 (MWS 312) to 0.604 (MWS 226). Highest root yield was in RAs 11 (5.63 g/ plant) at Udaipur. Total alkaloid content was highest in RAs 10 (0.68) followed by RAs 11 (0.60).

In opium poppy (*Papaver somnifera*), seed yield ranged from 379 (IC11) to 1,041 kg/ ha and morphine content varied from 9.6 (NGRI 10 and ND 1001) to 14.1% (MOP 587). Latex yield varied from 16.33 (ND 25) to 78.79 kg/ha (UO 1585), seed yield 145 (UO 1,285) to 1,333 kg/ ha (ND 17) and husk yield 124 (UO 1285) to 958 kg/ ha (ND 35, ND 43, ND 17 and MOP 539) at Faizabad.

Maximum disease index was recorded in 15 November-sown crop (68.02%), whereas in 25 October sowing, it was lowest (49.62) and crop sown on 25 October to 1 November produced highest latex (6,573-6,398 kg/ ha) at Udaipur. At Mandsaur, minimum disease (14.30%) and maximum latex (53.54 kg/ ha, seed (1,443 kg/ ha) and husk (690 kg/ha) yields were observed in 2 November sowing.

In Valeriana (*Valeriana jatam ansi*), maximum rhizome width was in VJ-99-UHF-8 and VJ-2K2-UHF-20 (0.60cm). Rhizome length varied from 6.30 cm in VJ 2K1-UHF-3 to 9.80 cm in VJ 99-UHF-10 (9.80 cm) and maximum rootstock yield per plant was maximum in VJ 2K2-UHF-19 (17.80 g) and minimum in VJ 2K2-UHF-28 (2.60g).

POST-HARVEST MANAGEMENT

The fruits of Baneshan at mature green stage could be kept in unripe condition for 45 days at 8°C under controlled atmosphere storage of 5% O_2 +2.5–3.0%CO_2 as against a week at ambient conditions.Chlorinated water was found best disinfectant for reducing surface microflora of mango fruits followed by actinomycetes. Mango, EC 95.862, Ambika, H 1591, H 1612 and H-533, were found suitable for processing. Good quality mango-bael blended bar could be prepared by blending 20% bael pulp with mango pulp.

Mango stones left after processing, still have 6-7% pulp adhering to them, which attract moulds that make stones unhygienic to handle. One cheap device has been developed by CISH, Lucknow, to utilize this waste pulp for baker's yeast production by using solid-state fermentation technology. The baker's yeast thus obtained may be used by the baking industry or added to low quality rice flour for making protein enriched animal/poultry/fish feed supplement. The stones, thus obtained are clean and can be utilized for raising seedlings. Yeast treatment of stones has no adverse effect on seed germination.

Ney Poovan, bananas treated with GA (100ppm) and stored at ZECC had highest green life (6 days) and yellow life (5 days). The untreated fruits stored at RT had highest PLW. The organoleptic score was highest in fruits packed in polybags with ventilation and stored at ZECC. Virupakshi bananas treated with Ethrel (500 ppm), sealed in polybags and stored at RT failed to ripen normally even after 7 days while those without polybags ripen within 3 days after treating with Ethrel. Banana fingers packed with foam in 2-ply cardboard boxes weighing 13.5 kg with ethylene absorbent is suitable for export.

Drenching of *Botryodiplodia* affected vines with Bavistin significantly increased brix yield in affected vines. Pre-harvest treatment of grapes with chitosan alone or in combination with *Trichoderma* improved shelf-life of grapes.

The individually shrink-wrapped pomegranate fruits retain their freshness up to 3 weeks at ambient condition and up to 12 weeks at 7-8°C storage. The weight loss during storage is highly reduced, which makes up for the cost of wrapping individual fruits. Individual shrink wrapping also prevents the spread of rots and spoiling of fruits.

❑

Natural Resource Management

SOIL RESOURCE INVENTORY

Model District Planning

Soil resource atlases of the following districts were brought out for sustainable land use planning: Bilaspur in Chhattisgarh, Chindwara in Madhya Pradesh and Adilabad, Anantpur, Chittoor, Cudappah, East Godavari, Guntur, Karimnagar, Khammam, Krishna, Kurnool, Medak, Mehboobnagar, Nalgonda, Nellore, Nizamabad, Prakasam, Rangareddy, Srikakulam, Vishakhapatnam, Vizayanagaram, Warangal, West Godavari in Andhra Pradesh.

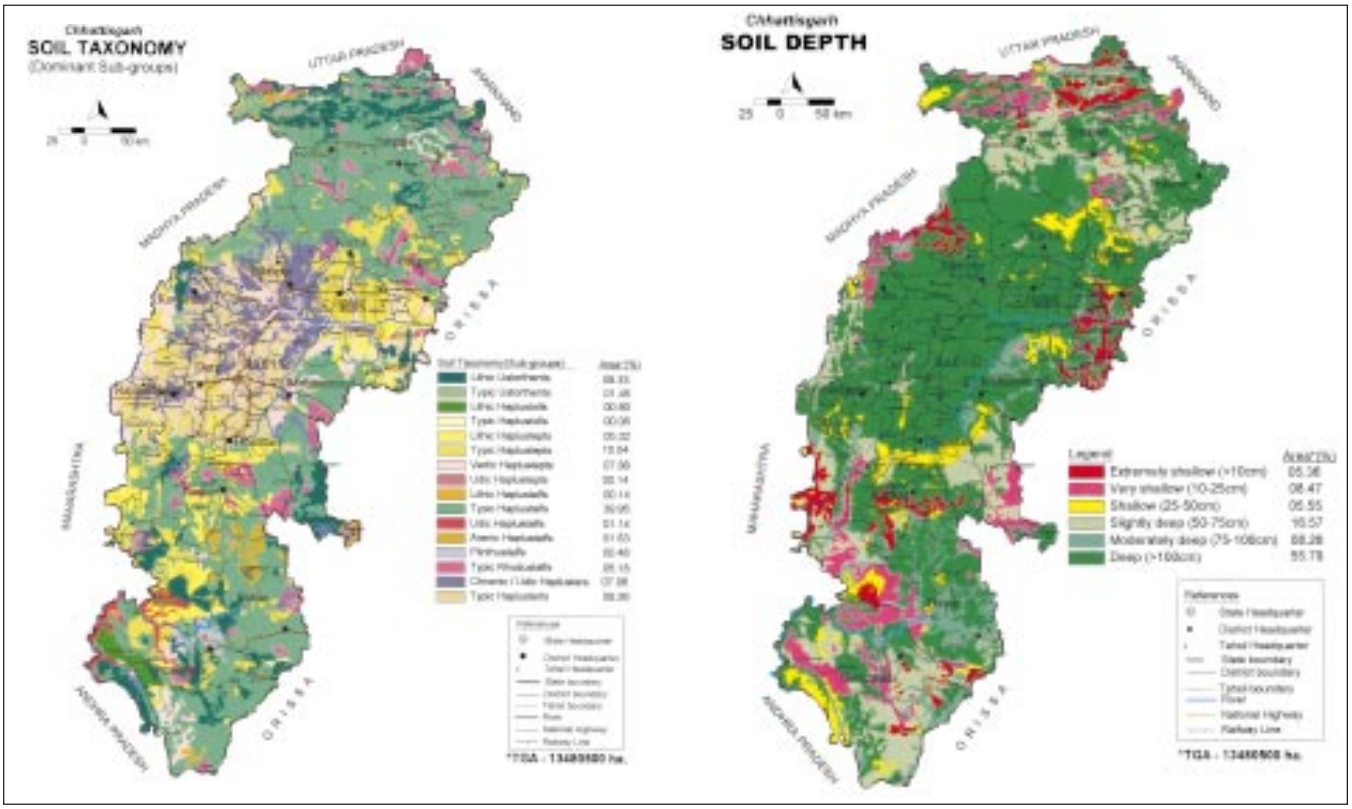
There are 40 to 45 themes pertaining to soil-site characteristics like texture, slope, depth, organic carbon, available water capacity etc. These atlases are useful for sustainable land use in the districts.

- Soil resource atlases of several districts were brought out. These atlases are useful for planning sustainable land use.
- Soil erosion maps of 3 states, viz Rajasthan, Madhya Pradesh and Chattisgarh were generated.
- Important benchmark soil series were identified in districts of Jorhat, Sibsagar, Morigaon and Kamprup of Assam. Suitability of these benchmark soils was evaluated for growing crops.

Soil Degradation

Based on the soil resource data (1:250,000 scale), the soils were assessed at each grid observation (10 km × 10 km) for their degradation status. The soil erosion maps of 3 states namely Rajasthan, Madhya Pradesh and Chhattisgarh were generated and reports were brought out.

In eastern Rajasthan, the area is affected by slight to moderate (64 per cent), severe (21 per cent), and very severe erosion (15 per cent) and is mainly due to wind erosion. Severity of water erosion in south and south east



Thematic maps showing soil taxonomy (*left*) and soil depth (*right*) of Chhattisgarh

Rajasthan is mainly due to higher slopes having more than 15 per cent area.

In Madhya Pradesh, about 2.39 m ha (17.7%) is under severe erosion which is restricted to western and hilly areas of the state.

Benchmark Soils of Assam

The important benchmark soil series were identified in districts of Jorhat, Sibsagar, Morigaon and Kamrup. The suitability of these benchmark soils was evaluated for growing crops. The major limitations of the soils were low pH, low organic matter and fertility and coarse texture.

RESOURCE CONSERVATION AND MANAGEMENT

Sustainable Cropping System for Rice Fallows of Brahmaputra Valley of Jorhat District, Assam

A study was conducted at Nagaon and Jamuguri in Jorhat district, Assam regarding performance of early maturing rice varieties under different phosphorus sources and performance of winter crops such as rapeseed, Frenchbean, pea and potato in rice fallows under recommended doses of fertilizers. The study shows that the plant population of the winter crops, particularly pea and Frenchbean, was affected due to low germination of seed in acidic soils. However, the growth yield attributes and yield of other two crops, i.e. rapeseed and potato show considerable productivity indicating thereby that successful cultivation of short duration crops can be done in rice fallows with substantial yield advantage.

- Rapeseed and potato showed considerable productivity in rice fallows of Brahmaputra valley.
- The soils of Chiratijan microwatershed in Gelabil Kakdanga watershed were evaluated for suitability of rice, potato, cabbage, tomato, Frenchbean, pea and cowpea cultivation.

SUCCESS STORY

Watershed Management

A microwatershed having an area of 532 ha in villages Bajni and Prakash Nagar in Datia district was selected. Several treatments were imposed through participatory approach on arable and non-arable lands. In most of the activities, labourers of watershed village were engaged. Tractor was used in desilting of village pond and land shaping. The contribution made by the farmers towards creation of Watershed Development Fund (WDF) ranged from 1-40% in cash.

A model of protected rocky wastelands patch of about 37 ha with conservation measures recorded forage yield of 1.97 tonnes/ha as compared to that of 0.08 tonne/ha from catchment without conservation measures. The open-grazing was controlled through the introduction of stall-feeding which increased milk production by 2-3 times in the watershed. Cropping intensity and crop yields increased from 67% to 105%. To utilize low lying waterlogged fields, paddy crop was introduced in the watershed which gave an average yield of 2 tonnes/ha. Thus, the waterlogged fields were put to profitable cultivation of paddy during *kharif* season which were otherwise kept fallow prior to the project. In addition to this, a revolving fund scheme was also launched to create employment opportunities among the rural unemployed poor by creating 10 Self Help Groups.

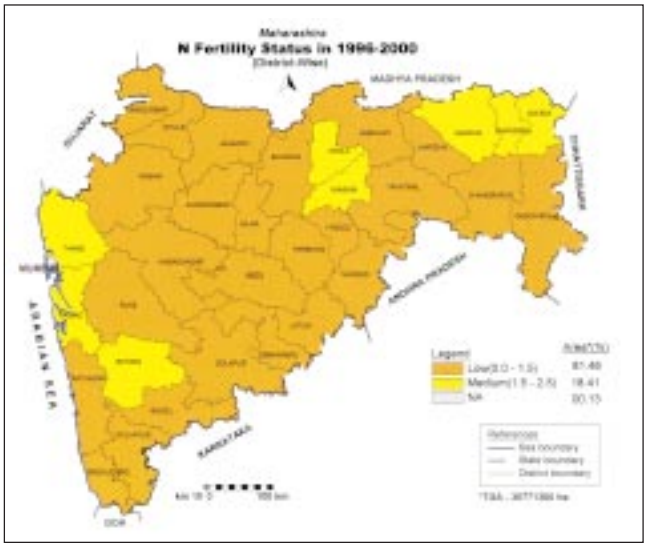
Identification of Critical Areas for Prioritised Land Treatments in Watersheds

Soil map of Gelabil Kakadanga watershed (138,655 ha) was prepared by carrying out reconnaissance survey of the area. A total of 14 microwatersheds were delineated in the watershed. The Chiratijan micro watershed was selected for detailed survey using landform map prepared from IRS-ID, LISS III and PAN merged satellite imagery at the scale of 1:12,500. Four soil series were identified in the watershed and mapped into 11 units at phase level. The soils of microwatershed were interpreted and evaluated for suitability of rice, potato, cabbage, tomato, Frenchbean, pea and cowpea. The main limitations are low pH, low organic carbon status, coarse texture and flooding. Different thematic maps such as landform, land use, soil reaction, organic carbon, surface texture, available P and available K were prepared.

SOIL FERTILITY AND NUTRIENT MANAGEMENT

Digital Soil Fertility Maps

Digitized soil fertility maps (N, P and K) at district level for Andhra Pradesh, Maharashtra, Orissa, Punjab, Chhattisgarh, Haryana and Himachal Pradesh have been prepared.



The Nitrogen fertility map of Maharashtra

Long-term Evaluation of Soil Test Based Nutrient Prescriptions

Long-term demonstrations on soil test based fertilizer and manure prescriptions for the *kharif* and *rabi* rice to

- Long-term demonstrations on soil test based fertilizer and manure prescriptions for rice to establish the possibility of achieving the targeted yield and maintaining soil fertility are in progress. Higher grain yields were recorded in the treatments where fertilizer was applied on targeted yield basis compared to the general recommendation.
- Integrated nutrient management technologies for pulse and oilseed-based cropping systems have been developed by conducting field experiments on farmers fields.
- Mixed biofertilizer formulations consisting of nitrogen-fixing organisms and phosphate-solubilizing bacteria proved superior to individual inoculants.
- In Marathwada region, groundnut pod yield was increased by 25% owing to *Rhizobium* inoculation.

find out the possibility of achieving the targeted yield and maintaining the soil fertility are in progress since 1998 in the same field (Noyyal series, Typic Haplustalf) at Coimbatore. The results of ninth and tenth crops of rice (var. CO 47) raised during 2002-2003 highlighted that higher grain yields were recorded in the treatments where fertilizer was applied on targeted yield basis compared to general recommendation by State Agriculture Department. Fertilizer prescription for targeted yield with integrated plant nutrient supply system (IPNS) recorded relatively higher yield and response ratio over the fertilizer prescription alone.

Results of the post harvest soil test values (*rabi* 2002) indicated that available nitrogen ($KMnO_4$-N) in soil after the harvest of the tenth crop of rice declined. With IPNS prescription, the $KMnO_4$-N level was maintained (280 to 272 kg/ha). Available P status was maintained in the general recommendation and increased in fertilizer alone and IPNS prescription treatments. In case of available K, a decline from the initial status was noticed and the status was maintained for the past four seasons in all the nutrient prescription treatments. In general, wherever the nutrients are added based on soil tests for specific yield targets, yield has sustained and soil fertility was maintained.

Integrated Nutrient Management Technology

Integrated nutrient management (INM) technology for pulse-based cropping systems has been developed by conducting about 150 field experiments on 60 farmers' fields in five target districts over a period of three years. The benefit of optimum nutrient managements, especially integrated nutrient management, in conjuction with soil moisture conservation measure for rainfed pulses was demonstrated to the farmers. In a year of drought farmers were able to harvest about 12-25% more chickpea and 15-28% more lentil through proper nutrient management compared to their own practices in Bhopal and Raisen districts of Madhya Pradesh. The best INM treatment was: 75% recommended NPK plus 2.5 tonnes/ha FYM (on dry weight basis) plus soil moisture conservation measure for the *kharif* crop, and 50-75% of recommended NPK depending on soil moisture stock for the *rabi* crops. In both seasons, seed inoculation with *Rhizobium* is a must.

Integrated nutrient management (INM) technology has been developed for seven rainfed oilseed based cropping systems by conducting more than 300 field experiments on about 100 farmers' fields in 9 target districts of 7 states over a period of three years. Results showed that conjunctive use of different locally available organic manures along with fertilizers increased the seed yield of safflower, mustard, castor, soybean, sunflower, raya and groundnut by 24.5, 25.7, 33.2, 35.7, 40.7, 51.7 and 67.2%, respectively over the existing nutrient management practice of farmers (which is generally 50% RDF).

Nitrogen Economy due to Rhizobial Inoculation in Soybean-wheat

Despite continuous cultivation of inoculated soybean and wheat for 3 years in Vertisols of Jabalpur, there was significant response to *Bradyrhizobium* inoculation on soybean seed yields which increased by 10.6%. Additional mineral N of 16 ppm in 0-30 cm layer was recorded after soybean growth. In case of wheat, additional yield due to *Azotobacter* inoculation was 11.6 and 10.6% under soybean-wheat and sorghum-wheat rotation, respectively, over uninoculated control. After harvest of wheat in soybean-wheat plots, there was 18.3 ppm additional mineral-N in comparison to soils under sorghum (non-fixing cereal control) -wheat rotation. The wheat yields obtained due to 120 kg N ha^{-1} without biofertilizers was close to the yield with 90 kg N ha^{-1} with biofertilizers. Thus there was saving of 30 kg N/ha due to use of biofertilizers.

Mixed Biofertilizers

Mixed Biofertilizer formulations consisting of nitrogen fixing organisms and phosphate solubilizing bacteria (PSB) proved superior to individual inoculants. In wetland rice inoculation of 'Azophos' (*Azospirillum* and PSB) and PGPR (*Pseudomonas*) along with 75% NPK gave maximum rice grain yield (6250 kg/ha), an increase of 5.8% over 100% NPK alone (5905 kg/ha) at Coimbatore. In on-farm trials on large field plots on rice at Amaravathi, Andhra Pradesh, dual inoculation of *Azospirillum* and PSB at 100% N, gave 5.35 tonnes/ha yield, whereas 100% N alone yielded 4.77 tonnes/ha. The 75% N + dual inoculation gave 5.03 tonnes/ha and, thus, saved 25% nitrogen.

In case of cotton, use of *Azotobacter* + PSB resulted in a significant increase in seed cotton yield (287 kg/ha) in the presence of chemical fertilizers (100 and 75% RDF) in a Vertisol at Parbhani. In black gram, there was highly significant improvement in nodulation, nodule mass and grain yield (122 kg/ha) over control. In sunflower, seed yield increase due to bacterization was 367 kg/ha.

For growth of diazotrophs and PSB in mixed biofertilizer formulations, a new medium-yeast extract

glucose molybdate agar (YEGMA) was developed which had glucose as carbon source instead of mannitol and 50 ppm sodium molybdate. In field trials on inoculation of mixed biofertiliser on pearlmillet, inoculation was found to save 25% of the N dose.

Shelf-life of Biofertilizers

Incorporation of 5 % glycerol and 2% PVP (polyvinyl-pyrillodone) in media maintained higher cell load than control. Even incorporation of 1% arabinose recorded higher population. In attempts to concentrate the inoculants to reduce volumes, incorporation of 10% cellulose and 2% CMC (carboxymethyl cellulose) maintained satisfactory titre even after 8 months, the population of *Rhizobium* TNAU 14 was 28×10^7 and 6×10^7 per ml with the two additives respectively.

Frontline Demonstrations on *Rhizobium* Inoculation in Groundnut

Front line demonstrations on six farmers fields on groundnut gave pod yield increases ranging form 3.5-17.6% over control. Absolute pod yield increases were from 60-265 kg/ha. In Marathwada region, groundnut (var Tag 24) pod yield was increased by an average of 25% in the presence of recommended doses of fertilizers due to inoculation of *Rhizobium* in 5 of the 6 demonstrations.

In a demonstration in Parbhani district *Rhizobium* inoculation increased groundnut pod yield to 9.13 tonnes/ha as compared to uninoculated control (7.03 tonnes/ha). The impressive effects of inoculation are apparent from the spectacular influence on root nodulation demonstrated to several farmers in farmers' fair held here.

The actual pod yields were 2.70 tonnes/ha in control and 3.38 tonnes/ha in inoculated. In the sixth demonstration conducted at village Kehal in District Parbhani by a progressive farmer (state awardee) by adopting the best package of practices along with good seeds and all precision farming techniques, very high yield of groundnut was obtained even in uninoculated control (7.03 tonnes/ha). Inoculation increased the pod yield further to 9.13 tonnes/ha. This represented the highest groundnut pod yields increase of 2.10 tonnes/ha ever recorded due to inoculation of *Rhizobium*.

WATER MANAGEMENT

Water Resource Development for Cyclone-affected Farmers of Coastal Orissa

A study was undertaken in the super cyclone affected coastal districts of Orissa (Erasama in Jagatsinghpur and Astarang in Puri district) to develop a comprehensive land and water management system that can enhance productivity and bring the farming community of the area out of perpetual poverty. At Erasama, small sub-surface water harvesting structures and at Astarang small shallow tube wells (up to 40 feet depth) were constructed to downsize the regular water resource structures like big tanks and shallow tube wells. These were constructed in participatory mode keeping in view the topography, water resources availability, saline water intrusion into coastal aquifers, poverty level of rural people, and low level of employment. The depth of subsurface water harvesting structure is limited to 3 m as the groundwater below 3 m is saline.

- A study was conducted in the super cyclone affected coastal districts of Orissa to develop a comprehensive land and water management system that can contribute enhancement in productivity.
- A study of developed watershed of the eastern region reflect that the adoption of improved technologies varied from 23% to 38% of the total interventions.
- At Madurai, 32.7 to 75.7% increase in groundnut pod yield was obtained under micro-sprinkler irrigation over surface irrigation.
- Adoption of drip irrigation in banana increased fruit yield significantly (60 tonnes/ha).
- A gross benefit of Rs 5,070/ha was found under zero tillage over conventional method of sowing.
- The feasibility of multiple uses of irrigation water for fish culture and irrigation has been experimented at ICAR-RCER, Patna.

In super cyclone affected coastal districts of Orissa land and water management system were developed. Small sub-surface water harvesting structures were constructed which can enhance productivity and bring farmers out of perpetual poverty.

The B:C ratio varied from 0.67 to 2.3 in the first year itself. The cropping intensity varied from 130% to 192%. Initially, only seven farmers constructed the structures paying 40% of the cost of construction. However, noticing the benefit, in the second year, twenty-three farmers came forward to construct the structures paying 67% of the cost. Cost of structures varied from Rs 9.51/m^3 to Rs 16.80/m^3. Adoption of integrated farming system approach, total income varied from Rs 12.93/m^3 to 47.20/m^3 capacity of pond. Water productivity varied from Rs 8.87 to Rs 31.69/m^3. Pumping test determined the replenishment rate of the subsurface water harvesting structures as 1.58 m^3/hr to 4.7 m^3/hr in sandy and 1.01 m^3/hr to 3.4 m^3/hr in clayey zone.

At Astarang, small shallow tube wells were constructed for four water user groups to a depth of 13 m with diameter of 7.5 cm as ground water below 15 meter is saline. The benefit cost ratio of these structures also worked out as 2.1. The participatory approach of implementing the above technology has improved the financial status of the rural people and increased the employment opportunity.

Scientific Resource Management in the Eastern Region

A study of developed watersheds at different locations of the eastern region reflect that on an average, percentage of irrigation to total operational area in developed watersheds during *kharif* was 33.96%, 28.02%, 17.9% and 8.76% for Keonjhar, Mahasamund, Dhenkanal, and Ranchi districts, respectively from almost zero level of irrigation in pre-intervention period. The cropping intensity in the

Intercropping of groundnut and pigeonpea for increasing cropping intensity and on farm income in developed watershed area under NATP project. These are measures of crop diversification in rainfed uplands.

developed watershed villages was 119%, 100 %, 154% and 121% for Keonjhar in Orissa, Mahasamund in Chhattisgarh, Dhenkanal in Orissa, and Ranchi in Jharkhand respectively. Cropping intensity of control villages was comparatively lower at 92%, 100 %, 139% and 106% for above districts respectively.

In developed watershed villages for Keonjhar, Mahasamund, Dhenkanal and Ranchi, the combined employment generation after development was 82, 97, 104, 294 mandays per year per farm family respectively whereas it was 73, 51, 64 and 283 man days per year in the control villages in these districts.

The study reflected that the adoption of improved technologies in developed watershed varied from 23% to 38% of the total interventions in developed watersheds. Under intervention programme in developed watersheds for scientific resource management, paddy-blackgram performed better as intercrops in unbunded uplands of Keonjhar and Dhenkanal. Intercropping of paddy with black gram gave per hectare-combined yield of 3.84 tonnes for paddy and 0.85 tonne for black gram. The per hectare combined yield was 0.9 tonnes in case of pigeonpea and 1.2 tonnes in case of groundnut in intercropping of groundnut and pigeonpea as measures of crops diversification in rainfed uplands.

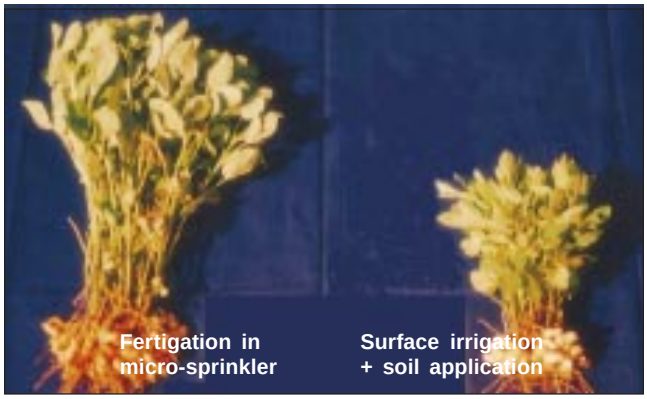
Drip Fertigation for Enhanced Productivity of *Typhonium*

Karunai kizhangu (*Typhonium trilobatum*) possessing high medicinal value is one of the long duration tuber crops grown in Tamilnadu. At Madurai, farmers' method of frequent surface irrigation (at 1.00 and 1.20 IW/CPE ratio) with soil application of 100:75:200 NPK kg/ha was compared with drip irrigation at 100, 75 and 50% pan evaporation (PE) and soil application of recommended NPK or fertigation of N and K. With drip fertigation at 100% PE, tuber yield was highest (39,450 kg/ha), which was comparable to drip fertigation at 75% PE (37,650 kg/ha) as against a yield of 23,140 to 26,600 kg/ha under surface irrigation, The water requirement with drip irrigation at 75% PE was 26% lower at 840 mm as against 1133 mm for the farmers' method of surface irrigation once in 4 days. The water productivity of 44.82 kg/ha mm through drip fertigation at 75% PE was a distinct improvement by 120 per cent over farmers' method of surface irrigation.

Drip fertigation at 100% PE gave high tuber yield (39,450 kg/ha) of *Typhonium* which was comparable with drip fertigation at 75% PE (37,650kg/ha) as against a yield of 23,140–26,600 kg/ha under surface irrigation.

Micro-sprinkler Irrigation and Fertigation to Summer Groundnut

Micro-sprinkler irrigation system enables precise control over quantity of irrigation water applied which is not possible through surface irrigation system. It also offers scope for fertigation. In an experiment on micro-sprinkler irrigation and fertigation in groundnut at Madurai in Tamilnadu over three seasons, increase in groundnut pod yield under micro-sprinkler irrigation over surface irrigation at 0.8 IW/CPE ranged from 32.7 to 75.7 per cent, higher moisture availability, higher leaf water content and greater nutrient uptake. The enhanced productivity under micro-sprinkler irrigation was more pronounced with partial or full fertigation (54.6-75.7%) than with soil application of fertilizers (32.7-54.9%) The yield improvement with micro-sprinkler irrigation was higher with irrigation regime of 100 % PE over 75% PE. Irrigation through micro-sprinklers scheduled at 75% PE saved about 34% water over surface irrigation.



At Madurai, increase in groundnut pod yield under micro-sprinkler irrigation over surface irrigation ranged from 52.7 to 75.7%.

Performance of Banana under Drip Irrigation System

The water requirement of banana under gravity flow of irrigation system is high with low water-use efficiency owing to its inherently low irrigation efficiency. Long-term experiment on the Vertisols of western Maharashtra showed that adoption of drip irrigation in banana increased fruit yield significantly (60 tonnes/ha) and saved about 38% irrigation water over gravity flow surface irrigation. Paired row planting effected 50% saving in the cost of laterals and drippers. The payback period of expenditure incurred on installation of drip system was only 1-2 years with additional annual net profit of Rs 23,400. Besides economic benefits, drip system improved the quality of banana bunches.


Water is a high energy and costly, but scarce and precious input in crop production system. Its efficient use is of utmost importance. In western Maharashtra adoption of drip irrigation in banana increased fruit yield, significantly (60 tonnes/ha) and saved about 38% irrigation water over surface irrigation.

Drip Irrigation for Vegetable Crops

Drip irrigation scheduling for brinjal, okra, tomato and cabbage and fertigation for bitter gourd with irrigation scheduled at 100, 80 and 60% ET in main plots and irrigation intervals (daily, 1 and 2 days) in sub-plots show that yield of brinjal/ okra was maximum at 80% ET and significantly higher at 100% ET. Maximum water-use efficiency was obtained at 60% ET with daily irrigation.

Irrigation and Nutrient Management in Heavy Soils of Bihar

Three recommended irrigation schedules against farmers' irrigation practice and five integrated NPK management levels were evaluated for wheat in heavy soils of south Bihar, Patna. The data reveals that there were no significant differences among the irrigation schedules for physiological parameters and growth characters like plant height, tillers/m^2. Thousand grain weight and grain yield were significantly higher under 0.9 IW/CPE irrigation schedule over farmers' practice. Fertilizer cut by 25% and use of 15 tonnes/ha FYM gave equivalent yields indicating an economy in fertilizer use by integrated nutrient management.

Tillage and Water Management in Wheat

Three methods of wheat establishment (conventional, zero tillage and raised bed planting) in combination with four depths of irrigation water (3, 5, 7 and 9 cm) were evaluated in split plot design. Adoption of zero tillage could save a total of Rs 1,650/ha under land preparation, Rs 1,200 in sowing and Rs 450 from irrigation. Under raised bed sowing, excess amount of Rs 800/ha was incurred for preparation and sowing but there was a saving of Rs 2,605/ha from irrigation water application. A gross benefit of Rs 5,070 /ha was found under zero tillage over conventional method of sowing.

Potential of *Boro* Rice in Waterlogged Area of Sone Command

The objective of this project is to find out possibility of boro rice cultivation in waterlogged lands in Sone Canal Command and to suggest a suitable method of nursery raising and optimum water regime for *boro* rice in south Bihar. To offset the adverse effect of cold, use of FYM @ 15 tonnes/ha for *boro* rice sown in November in open

field could produce 15 per cent additional seedlings for transplanting. However, by the use of polyhouse, raising of boro rice seedling was further possible in January when seed did not germinate in open field. A total of 14 irrigations with 72.0 cm depth were required for a successful crop. The crop responded upto application of 150 per cent NPK (150:75: 60).

Multiple Uses of Irrigation Water

Integrated fish farming increased water productivity with corresponding improvement of fish productivity (10 tonnes/ha against existing 2 tonnes/ha) due to increased aeration and irrigation efficiency. The feasibility of multiple uses of irrigation water has been experimented at ICAR-RCER, Patna. The study was started in July 1999 with a secondary reservoir (16.5x14.5m surface area) linked to the existing tubewell based network of irrigation channels. Out of 2.0 m of total depth, 1.5 m is kept as dead storage exclusively for fish production, while top 0.5 m was kept as line storage for providing irrigation water. The tubewell water is first fed to the reservoir, from where it is released for irrigation to the fields. This exchange of reservoir water is helpful in maintaining the water quality (dissolved oxygen, temperature, pH, turbidity etc.) for intensive fish production. Results indicated that such routing of irrigation water through the fishpond-cum-secondary reservoir effects thorough mixing of water and ill effects of quality stratification are minimized.

Improvement of Plant Genetic Resources and Improvement of Horticultural Crops

The 97 genotypes of different fruit crops were identified/collected from different region. Jackfruit selection HPJS-5/8 has been found suitable for table purpose and proposed for release.

Among the vegetable crops, brinjal variety Swarna Pratibha and tomato hybrid Swarna Baibhav and cucumber variety Swarna Poorna have been identified for release at National level. Two stable high-yielding lines of vegetable soybean, viz. GC-89009-1-1-2 and AGS-337 were identified as promising.

Production and Utilization of Horticultural Crops

Under the spacing cum planting system trials in mango cv. Amrapali, intermingling of canopy in closer spacing after 9 years was observed. Among the intercrops, *Stylosanthes* and Frenchbean have been found to improve the soil organic matter content. Phophobactrin was found to be the most effective in improving physio-chemical properties of guava fruits cv. Lucknow-49. In Studies on flushing and panicle emergence in litchi, complete cessation of shoot elongation of 2nd flush, 30 days before initiation of third flush, whereas no clear-cut cessation of growth was noticed in cv China.

Multiple cropping system with litchi cv. Swarna Roopa as base crop and guava cv. Allahabad Safeda as filler crop, cowpea intercropping proved remunerative under rainfed conditions of Chotanagpur region.

Integrated Pest Management in Horticultural Crops

A nitrogen dose of 140.5 kg and 169.5 kg /ha for rainy and winter season, respectively was most effective for minimizing infection of early blight of tomato. *Ralstonia* wilt of tomato and brinjal could be significantly managed by manipulation of hosts resistance through organic amendment of soil. Systematic fungicide were found superior over other groups when the percent disease and yield were taken into consideration for control of powdery mildew in cucumber.

Effect of Sources and Levels of Sulphur on Tobacco

Among the sources of sulphur, iron pyrite was on a par with gypsum, produced highest total cured leaf yield per hectare but they had no effect on the yield of first grade leaf. Levels of sulphur application did not influence total cured leaf but application of 40 kg S/ha had increased yield of first grade leaf. Net return was highest, i.e. Rs. 26,725/ha when iron pyrite was applied to the tobacco crop.

SOIL SALINITY AND COASTAL ECOSYSTEM

Long-term Effect of Integrated Nutrient Management in a Gypsum Amended Alkali Soil

Results of the long-term field experiment showed that rice and wheat yields could be maintained even at 50% NPK when used in conjunction with FYM or green manuring (GM). Rice and wheat yields and build up of organic carbon and available P at 100% NPK along with

Wheat yields can be maintained even at 50% NPK when used in conjunction with FYM or green manuring

- Long-term field experiment showed that rice and wheat yield could be maintained even at 50% NPK used in conjunction with FYM or green manure.
- The potential of using sewage waters for irrigation was assessed on crop production. Higher yields of paddy, wheat (4%) and cauliflower were obtained under sewage water irrigation compared to tube-well water irrigation.
- For selective extraction of fresh water overlying saline groundwater, skimming structures and their operational schedules are being designed.
- Studies on bioremediation of pulp and paper mill effluents revealed that fungal treatment for 7 days and phytoremediation for 20 days reduced the COD, BOD and solid content.
- Use of composite industrial effluent for irrigation for the past 20 years has led to contamination of groundwater.

FYM or GM equals the yields obtained with 150% NPK. In another study on gypsum amended alkali soils, one year alternate application of organic manures produced equal rice and wheat yields as with its continuous application each year.

Development of Regional Salt and Water Balance Models

In a study on the modelling of field and regional scale salt and water balance, application of Standard Groundwater Model Package (SGMP) for inverse application used to assess the seasonal groundwater recharge with seasonal groundwater table data as an input is established. The calibration and verification of the model for more sites should help in confidence building and wider application of the model.

Irrigation Potential of Sewage Water Use

The potential of using sewage waters for irrigation was assessed on crop production, in three cropping systems, viz food grain production (rice-wheat) alone or with agro-

The possibility of using sewage waters for irrigation was assessed on crop production. Here rice is seen with poplar. Higher yield of rice (14%) was obtained under sewage water irrigation than tubewell water irrigation.

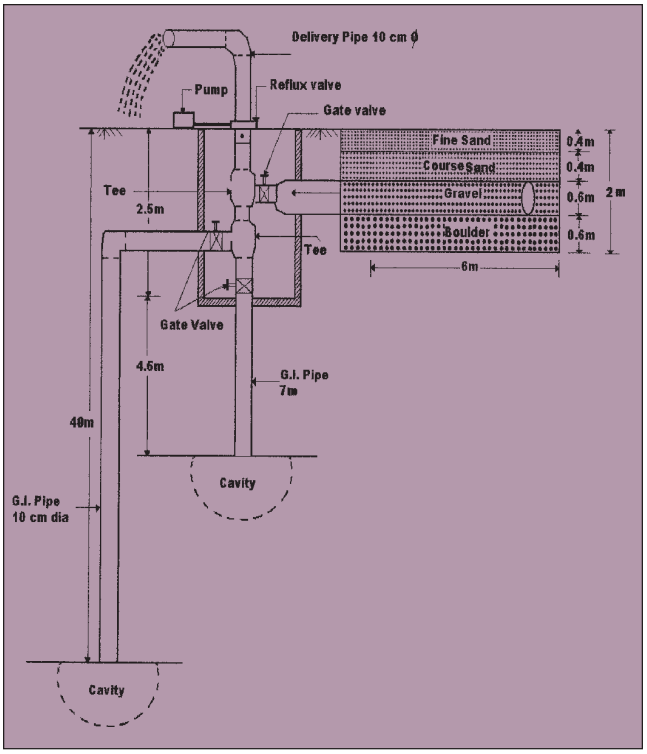
forestry (rice-wheat with poplar), vegetable production (cauliflower-okra-spinach) and fodder production (berseem-sorghum) systems. The study shows higher yields of paddy (14%), wheat (4%) and cauliflower (23%) under sewage water irrigation compared to tubewell water irrigation.

Long-term Effect of RSC Waters and Amendment Application on Soil Properties and Crop Growth

Monitoring of long term effect of irrigation with RSC waters varying in salinity (EC 2 and 4 dSm^{-1}), residual alkalinity (RSC 5 and 10 meL^{-1}) and sodicity (SARw 10, 20 and 30, adj SAR 33 and 36) on soil changes and yield of pearlmillet fodder and wheat showed that the relative yields of wheat varied from 0.88-1.03 and of pealmillet fodder from 0.55-1.0. Twelve years of continuous irrigation with these waters didn't result in increase in pH in the surface 30 cm soil layer.

Technologies for Skimming and Recharging Fresh Water in Saline Groundwater Regions

For selective extraction of fresh water overlying saline groundwater in inland areas of Haryana, skimming structures and their associated operational schedules are being designed. A skimming cum recharge structure has been designed at a downstream location at Jagsi in Safidon block of Jind District, having potential of groundwater recharge with excess rainfall during heavy rains. Two cavity tubewells installed at 7 and 40 m depth can be operated separately or together to obtain water of



A skimming-cum-recharge structure for extraction of fresh water overlaying saline ground water has been designed at down stream location at Jagsi in Jind district.

desired quality. A recharge chamber, close to these cavities facilitate recharging one or both the cavities with filtered surface runoff during rainy season which is expected to increase the availability of good quality water in upper cavity or improve the quality of water in lower cavity through dilution for possible use either directly or after treatment with gypsum.

Rapid Screening of Indian Mustard Genotypes for Salt Tolerance

Seedling emergence is a critical stage in Indian mustard when raised on salt-affected soils. Screening of different mustard genotypes in laboratory for salt tolerance during germination and seedling emergence growth had positive correlation (r=0.92) between seedling emergence at 26 dS/m in solution culture and 12.8 dS/m in soil culture.

Use of Urban and Industrial Effluents in Agriculture

- Characterisation of effluent from towns located near different centres of the project show that excessive contents (> 1ppm) of toxic ions like Cd, Ni, Cr etc and those of pathogenic bacteria (*E. coli* $2x10^6$-$4x10^9$ /100 ml) pose serious health risks.
- Use of composite industrial effluent for irrigation for the past 20 years has led to contamination of groundwaters. Pollutants like Cr could be detected to a distance of 1 km in Cauvery water from disposal point of tanneries effluent in Erode.
- Enhanced organic matter in sewage-irrigated soils reduces bio-availability and mobility of toxic ions (Xm 320-385 for Cr and 322-1489 mg/kg for sewage irrigated alluvial soils of Haryana). Due to high cation exchange capacity, organic matter and CaCO3 content in soils, toxic metal ions are retained in the surface soils only.
- Some of the case studies show that wastewater from domestic origin can also be used as source of irrigation as well as plant nutrients.

Causes and Remedial Measures for Resodification of Reclaimed Soils in Uttar Pradesh

Reports of resodification of reclaimed alkali lands in Uttar Pradesh is due to the increase in soil pH in reclaimed lands and was related to the water table condition in that particular area. It was observed that the resodification problem was found to be more severe under shallow water condition (<2m below ground level), followed by medium water table condition visible in deep water table condition (>3m bgl). The crop growth was also severely affected by resodification in 74.7% area under shallow water table condition and 15.9% under deep water table condition.

Agronomic Practices for Rice Based Cropping Systems in Saline Coastal Soils

Combined use of organic and inorganic sources of N alone are important for improving crop yield and soil health in coastal saline soils. Application of as low as 5 tonnes/ha (fresh weight basis) of locally available organic sources (*Sesbania*, *Gliricidia*, compost, locally trees) etc., contributing 10-15 kg N/ha, once in a year, was quite effective in increasing N use efficiency, soil microbial activity and fertility status of soil.

Effect of Aquaculture on Cultivated Fields in Coastal Andhra Pradesh

A survey conducted in Guntur, Prakasham and Nellore districts revealed that due to prawn culture (Aquaculture), the quality of groundwater is being rendered saline as indicated from the analysis of water samples. Paddy crop is affected severely up to a distance of 20 m unless trenches are dug around the ponds to control the seepage of saline water which affected the tree planted at the ridges.

Potentialities of Using Drip System for Saline Irrigation

Drip irrigation experiments (at 1 and 2 days interval) with saline water on vegetable crops had adverse effects as the most of the applied water was evaporated, but application of water equal to open pan evaporation resulted in optimal yield of tomato and application of 80 percent of cumulative pan evaporation in sugarcane with alkali water produced highest cane yield and saved 30% water as compared to farmers' practice. The highest water use efficiency (WUE) of 61 kg/ha-mm was achieved in case of drip irrigation in brinjal at Ganganagar at 1.2 ET while, the lowest WUE of 28.7 kg/ha-mm recorded in case of surface irrigation at 1.4 ET.

Reclamation of Alkali Vertisols Under Rainfed Conditions

Leaching of the reaction products of amendments is one of the pre-requisites for reclamation of alkali soils with assured water supplies but such water supplies are not available under this condition for which various configurations of raised and sunken bed system were tested at Barwaha farm, Indore centre for the past 8 years. Results show that cotton and paddy yields could be sustained during normal rainfall years but in case of deficit rains or long dry spells, provision for rain water harvesting ponds with water for 1-2 life saving irrigations becomes necessary. Performance of paddy crop improved with increasing ratio of sunken:raised bed ratio of 3:2 with the minimum for the ratio being 1:2.

Evaluation of Agro-potentiality of Pulp and Paper Mill Effluent for Irrigation

Studies on bioremediation of pulp and paper mill effluents revealed that fungal treatment for 7 days and phytoremediation for 20 days reduced the COD, BOD and solid content by 90, 93 and 89 percent and 91, 94 and 93 percent respectively. Thus the degradation of paper mill effluent by *P. chrysosporium* and removal of pollution by growing water hyacinth (*Eichhornia crassipes*) in effluent appear better option for safe disposal of pulp and paper mill effluent.

RAINFED RESEARCH

Resource Characterization

Information on 320 ITKs on various aspects of dryland agriculture from Zone × (AP) was collected and

- Information on 320 ITKs on various aspects of dryland agriculture were collected and documented.
- Conservation furrows plots stored 4 to 37% additional soil moisture compared to control.
- The CRIDA has signed MoUs with four entrepreneurs for mass production of 12 implements developed by it.

documented. Validation of many of these is in progress. These ITKs have been included in a publication comprising of two volumes.

- Validation of an Indigenous Rain Gauge developed by farmers in rainfed Alfisols of Rangareddy district to perform important operations like sowing, tillage and fertilizer application in sorghum+pigeonpea and castor crops is underway.

Pingali danti—an animal drawn interculture implement, has an edge over traditional blade harrow in terms of coverage, weed control, handling, cost effectiveness, durability and replicability →

Guddeli—an indigenous hand tool for uprooting ginger crop. It requires 15–20 mandays per acre for harvesting of ginger crop ←

- Validation of Pingali Danti, an indigenous animal drawn interculture implement used in tomato cultivation in Kandukur Mandal of Ranga Reddy district is also underway.
- Guddeli, an indigenous hand tool used for planting and up rooting of ginger roots (*Zinziber officinalis*) was found effective. The tool is efficient, easy to operate and reduce drudgery of farm labour. It requires 15-20 man-days per acre for harvesting of the crop, costs about Rs 30 per tool and has a life span of 2 years.

Impact of Peddagadda Watershed, Srikakulam District under NWDPRA

Implementation of watershed programme in Peddagadda watershed in Srikakulam district of Andhra Pradesh resulted in:

- Increased availability of soil moisture and rise in groundwater level by 1.5 meters.
- A substantial increase in net irrigated area (34%) and number of wells/bore wells (67%).
- Reduction in tank siltation.
- Change in cropping pattern and introduction of new crops like sugarcane, onion and maize.
- Increase in area under organic recycling by growing green manure crops like *pillipesara* and *dhaincha,*
- Overall increase in greenery, attributed mainly to plantation of casuarina and cashew,
- Ten-fold increase in the area under plantation at the cost of decline in area under coarse cereals like jowar and bajra.
- Marked improvement in participation of women in decision making process.
- BC ratio of 1.54, 1.24, 1.06 for years with good, moderate and poor rainfall, respectively after watershed treatment as against 1.08 before the implementation.

Integrated Nutrient Management

One of the major problems for low adoption of integrated nutrient management in dryland conditions is poor availability of organic residues. Long-term experiments conducted at the CRIDA, Hyderabad have revealed that it is possible to generate about 4 tonnes/ha of nitrogen rich horse gram biomass through cover cropping by utilizing the post-seasonal rains and stored soil moisture. The incorporation of this biomass has shown a positive impact on the yield of the succeeding *kharif* crops like sorghum and sunflower and also resulted in improvement of soil health.

Conservation Furrows

Conservation furrows across the slope at 3 m interval, as a measure of moisture conservation and runoff management were evaluated in ten farmers fields in five villages of Nalgonda district, Andhra Pradesh. Castor with pigeonpea (5:1) was the test intercrop. During the growing season, the study area received 290 mm rainfall in 28 rainy days (rainfall >2.5 mm/day^{-}). The results showed that conservation furrows plots stored 4 to 37% additional soil moisture compared to control throughout the growing season. This additional moisture resulted in better plant growth and 12% higher bean and grain yields of castor and pigeonpea than the control.

Crops and Cropping Systems

Tolerance of sorghum to biotic stress was enhanced through genetic manipulation

- Experiments to develop efficient regeneration protocol from sorghum shoot apices revealed that the shoot tips of cvs SPV 462, SPV 839 and M35-1 produced better regenerable calli on media containing 2,4-D and kinetin.
- Efforts were also made to produce embryogenic calli with better regeneration frequency by incorporating various amino acids, growth hormones, anti-oxidants and antibiotics in the growth and regeneration media.
- Regeneration was achieved from calli induced from shoot tip and meristem using basal MS media. About 5-8 shoots per calli were obtained. By altering the hormones and media conditions finally success was achieved in standardization of the protocol for efficient regeneration from shoot apex. The frequency of regeneration in the present protocol is about 15-20 shoots per calli.
- Histological studies of the calli were carried out and callus in regeneration media showed multiple shoot apex.
- A protocol for transformation of sorghum using biolistic approach was standardized. It was observed that GUS expression was good in shoot tip calli with the construct Pcambia1305.1.

In-situ Grafting of Fruit Plants

Establishment and survival of trees in the harsh climate prevalent in the semi-arid regions is very poor. At the CRIDA, Hyderabad, mango cv Kesar was *in situ* grafted in the field on one year old seedlings of cv Totapari. About 90% success was achieved.

Documentation of ITKs on Soil and Water Conservation Methods

Indigenous methods of *in-situ* moisture conservation and runoff management prevalent in the rainfed areas of India were collected. The findings were published in a book entitled "Indigenous Technical Knowledge on Soil and Water Conservation in Semi-Arid India". The publication describes each ITK by indicating name, purpose, location, agro-ecology, description, advantage, constraints, replicability/feasibility and researchable issues.

Alternate Land Use Systems

Field evaluation of tissue-cultured explants through participatory on-farm trials has generated much interest in the farming community. So far 50,000 neem and teak saplings have been supplied on cost basis to farmers of Andhra Pradesh, Tamil Nadu, Maharashtra and Karnataka. A production centre at Gaddipalli (SAIRD) was also established, and is producing 25,000 neem and teak explant annually.

Fruit and Vegetable Preservater

Fruit and vegetable preservation at farmers' level is a major problem in India. Though many cold storage units are available, they are restricted only to bulk produce and high value products. In order to overcome this deficiency the CRIDA has successfully fabricated a low cost and energy saving fruit and vegetable preservator.

This portable structure is made of fibre reinforced plastic and consists of two compartments with circular holes all around the periphery. They are kept offset by 1- inch thick pine grass mat. Water is dripped on to the mats continuously as per the requirement through a circular flexible pipe placed above the mats. This system keeps the basket 8-10°C cooler with 30 to 40% more humidity than the conventional method. The water requirement varies between 2-4 litres/day as per the need. The approximate cost is around Rs 2,400 for a 50 kg capacity preservator.

It has the following advantages:

- Increase shelf life by 7-12 days.
- It is portable.
- Reduces handling damages.

Castor Planter

A tractor-drawn castor planter was improvised by adding a marker to it for better maneurability of the machine. This modified version seeds around 40 acres of castor in an hour and helps farmers to sow a large area within the limited time of moisture availability, thereby reducing the cost of cultivation and helping better seed establishment.

Mechanized Weeding in Castor

A tractor-drawn 3-row weeder was developed and found very effective. Under on-farm conditions, this weeder can cover an area of 1.1 ha in an hour as compared to the traditional method which covers an area of only 0.15 ha.

A tractor drawn 4-row weeder was developed. It can cover an area of 1.1 ha/hr.

Castor Sheller

Castor shelling is a time consuming and tedious process. To make the operation easy, CRIDA Castor Sheller was modified and used during this crop season. The performance was very satisfactory and appreciated by the farmers.

CRIDA castor sheller. Its performance was very satisfactory.

Mini Dal Mill

A flour mill owner Mr Jayaprakash, Settur village, Anantapur district purchased a mini dal mill at a cost of Rs 60,000 in Kisan Expo 2000 held at Nagpur. Due to operational and mechanical problems, he could not install the machine. He attended a mini dal mill field demonstration organized at HRF (CRIDA) in March 2002. After thorough discussion and knowing the details of his mill, he was advised to replace the existing emery of the roller with rough grit, add a sieve set and a screw auger type dal polisher as extra components. The farmer spent Rs 15,000 on these works and installed the mill. Now the mini dal mill is working satisfactorily. The capacity of the mill is 100 kg redgram hr^{-1} with a recovery of 68 kg dal. The farmer is running the mill on custom hiring basis to make dal from whole redgram. He is charging Rs 60 per 100 kg grain. Mr Jayaprakash now in a normal year, gets work for about 4 months, processes 30 tonnes of redgram and earns a huge profit.

Mini Dal Mill

The conventional mini dal mill for blackgram was modified by fitting a C-type roller. A best protocol for this modified mini dal mill comprising of pitting followed by 0.3% oil application, heaping for 48 hr and 16 hr sun drying of grains was standardized. This resulted in 99% dehusking efficiency and 55% dal recovery.

AGROMETEOROLOGY

Agroclimatology

- Analysis of rainfall data of Kerala State for the period 1871 to 2001 (131 years) revealed that mean annual rainfall of the State is 2828 ± 409 mm. The rainfall in this State is highly stable and dependable with coefficient of variation of only 14.4 percent. The season-wise rainfall distribution over Kerala indicated that 68 percent of the annual rainfall is received during the southwest monsoon followed by post-monsoon (16%), summer (14%) and winter (2%) in order.
- The rainfall analysis indicated that wetland paddy could be grown under rainfed conditions during *virippu* (*kharif* season) and it could be grown during *mundakan* (winter) under assured irrigated conditions only. Many of the plantation crops mainly in north Kerala require irrigation during December to April, as the dependable rainfall (rainfall at 75% probability) is less than 100 mm.
- Agroclimatic characterization of Marathwada region of Maharashtra brought out that the chances of getting sowing rains for sowing of *kharif* crops is around 24th standard meteorological week (11-17 June) in Osmanabad and Latur districts, 25th week (18-24 June) in Parbhani, Nanded, Jalna and Aurangabad and 28th week (9-15 July) in Beed district of Marathwada. Break monsoon conditions were observed to be occurring in the month of August throughout Marathwada region. Based on the agroclimatic analysis, a short duration intercrop with a long duration sole crop or a single crop of 180-200 days duration suits best for deep black soil, while a sole crop of 110-115 days suits well in shallow soils.
- Agroclimatic analysis of Midnapur (West) district of West Bengal based on daily rainfall data of 90 years (1901-1990) showed that rainfall is most assured with probability of getting 20 mm of rainfall per week exceeding 70 percent during the southwest monsoon, i.e. 23rd to 39th standard meteorological weeks. Water balance studies of this district showed that the length of growing period (LGP) in this district varied from 203 days in sandy loam soil to 261 days in clay soil. This information can be utilized for crop planning under rainfed conditions. In sandy loam soils having LGP of 203 to 230 days, upland variety of 100 days duration followed by a second crop of mustard maturing in 100 days can be recommended and in clay loam and clay soils transplanted rice followed by mustard / lentil / gram / linseed can be grown under rainfed conditions.
- Analysis of drought years in *kharif* and *rabi* seasons in different districts of Himachal Pradesh brought out that except Kangra, Palampur and Mandi districts, all the other districts experience either moderate or severe drought during the *kharif* season in more than 20 percent of years. Similarly, except Bajaura and Chamba, all the districts experience droughts in more than 20 percent of years in *rabi* season. Drought occurs in more than 30 percent years during *kharif* season in Hamirpur, Una, Kinnaur and Sirmaur districts and during *rabi* season in Kangra, Palampur, Hamirpur, Una, Solan and Sirmaur.

- Analysis of rainfall data of Kerala during 1871-2001 revealed that mean annual rainfall of the state is 2, 828±409 mm.
- Crop-weather relationship in *rabi* crops like sorghum, sunflower and safflower at Solapur showed significant positive relationship of the yield with cumulative moisture use.
- As winter period is shorter in Raipur region, there is demand for thermal stress tolerant wheat varieties. Varieties Kanchan, Sujata and Arpan were found suitable for normal sowing, while Lok 1 for late sowing.
- Using 43 years yield data of mustard in Nadia district, scientists developed a yield prediction model for mustard crop.
- In safflower, minimum temperature and relative humidity positively influence the aphids population.
- A model for predicting groundnut leafminer based on rainfall and minimum temperature was developed at Anantapur.

Crop-weather Relationships

- Crop-weather Relationship Studies in *rabi* crops like sorghum, sunflower and safflower at Solapur centre showed significant positive relationship of the yield of respective crops with cumulative moisture use.
- In Crop-weather relationship studies in rice at Jabalpur, the moisture stress during grain filling period of rice was found to have adverse effect on yield. The results further showed that in a severe drought year like 2003, early maturing variety IR-36 could produce highest yield under all the dates of sowing when compared to late maturing varieties like Mahsuri and Madhuri, which failed to reach reproductive period under delayed sowing conditions.
- Crop-weather relationship studies in soybean at Akola centre brought out that variety JS-335 recorded higher grain yield over other varieties because of its higher thermal use efficiency and higher radiation interception ability.
- At Anand centre, weather during flowering and pod development stages of mustard have significant influence on yield. Maximum temperature (MXT) and diurnal temperature (DTR) showed positive relationship with yield while minimum temperature (MNT) showed negative relationship.
- The equations further revealed that higher maximum temperature (> 30°C), lower minimum temperature (< 14°C) and higher temperature range during flowering and grain development stage are highly beneficial for obtaining higher seed yield in mustard.
- As winter period is shorter in Raipur region of Chhattisgarh State, there is demand for thermal stress tolerant wheat varieties for *rabi* season. For this purpose, eight varieties of wheat were evaluated for their thermal tolerance using a thermal sensitivity index (TSI) at Raipur. Varieties Kanchan, Sujata and Arpan were found suitable for normal sowing while Lok-I was found suitable for late sowing, as it gives better yield under moderate thermal stress conditions.
- Crop-weather relationship studies in mango at Bangalore brought out that initiation of flowering is related to the soil moisture content during the month of November. Higher soil moisture in November due to rains in October postpones the flowering initiation to the month of January and lower soil moisture prepones the flowering initiation to December.

Crop Growth Modelling

- Yield forecasting model for coconut based on monthly index of moisture adequacy (ratio of actual and potential evapotranspiration) and humidity index (the ratio of water surplus and potential evapotranspiration) was developed by working out the water balance of Kerala for the years 1945 to 2001. The monthly moisture adequacy index (Ima) and humidity index (Ih) value for the past 42 months (time from *primordium initiation to* harvest) were used for predicting coconut yield 7 months ahead of its harvest.
- Using 43 years' yield data of mustard in Nadia district of West Bengal, scientists at Mohanpur centre developed a yield prediction model for mustard crop. The model, predicts yield based on the accumulated rainfall during different periods of crop growing season, viz 36 to 39 meteorological standard weeks 4-43 weeks 44 to 52 weeks 1 to 5 weeks and technological trend (T).
- A predictive model for predicting rice yield-using agroclimatic ARFL (Accumulated Rainfall) was developed at Jorhat. The percent variation of predicted yields from actual yields were found to be lower (< 10%) showing the efficiency of predictive models in estimating yields ahead of crop harvest under agroclimatic conditions at Jorhat.

Web Site of AICRPAM

A website named "Crop Weather Outlook" was developed by the AICRPAM.

The Website is operating from the Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad where the AICRPAM is located and is linked to ICAR Website for a wider use by the planners, researchers, farming community and other public users. This Website contains links to various AICRPAM centres to view:

- Weekly report on crop-weather conditions at the respective centres of AICRPAM.
- Current weather data of the centres
- Agro advisory services based on knowledge generated at the centres and weather forecasts issued by NCMRWF, New Delhi.

Weather Effects on Pests and Diseases

- Pest and weather relationship studies in safflower indicated that minimum temperature and relative humidity positively influence the aphids population in safflower.
- The study on fortnightly mango hopper population with weather parameters at Anand centre brought out that high humidity results in lower population of mango hopper and *vice versa*. Humidity less than 50 percent was favourable conditions for outbreak of hopper population in mango.
- A model for predicting groundnut leafminer based on rainfall and minimum temperature was developed at Anantapur. The model showed that occurrence of leaf miner is negatively associated with increase in rainfall.
- At Bhubaneswar, a multiple regression model was developed with cumulative rainfall (15 days prior to prediction date), afternoon humidity (14 days prior), maximum temperature (7 days prior) and stage of the crop as independent variables to predict bacterial leaf blight incidence in rice. Similarly, leaf folder in rice was predicted based on bright sunshine hours and

average temperature accumulated over past 15 days prior to the incidence of the pest.

Pests and Diseases Forewarning

Predictive equations or thumb rules were developed for forewarning of pests/disease incidence in crops, viz. rice and groundnut using historical pest / disease collected from different Cooperating Centres of NATP Project on Development of Weather Based Forewarning Systems for Crop Pests and Diseases.

The neural network technique was applied to analyze 25 years long-term data provided by the DRR, Hyderabad on trap catches of yellow stem borer, a key pest of rice. It was observed that if rainfall is less than 8 mm and sunshine hours greater than 8 hr, the possibility of moth catch greater than 100 is 40 per cent. The neural network was tried with data of yellow stem borer from 1975-96 and subsequent years data (1997-2000) was used for validation as independent data sets. The peaks of yellow stem borer incidence were predicted one week in advance.

A prediction model was developed using five years data (1996-2000) for estimating late leaf spot incidence with weather parameters, viz. Evening RH, Morning RH, Max Temp, Rainy days and inoculum potential (current week) using data from Tirupati collected during 1996-2000. The equation could explain 65 percent variation in late leaf spot incidence due to weather parameters. Actual and predicted values of late leaf spot at Tirupati were depicted.

CROP PRODUCTION

A New Technique of Growing Mat Type Nursery for Rice Transplanters Developed

Self-propelled and manual rice transplanters have been developed and popularized to cater to the needs and requirements of farmers. These transplanters require mat type nursery that is generally grown with the help of frames. However, this process is very cumbersome. To overcome this problem, a new technique has been developed to grow the mat type nursery without the frames in open field. In this technique, the nursery beds of 5 × 1.2 m^2 area (75 m^2 per ha of transplanting) with side channels are prepared in the tilled field, polythene sheet (50/ 60 gauge being 10% perforated) is placed on the nursery bed, soil (sieved by 2 mm diameter sieve) - farmyard manure (FYM) mixture is spread over the sheet (15 mm thick) in the ratio of 3:1, sprouted seed (30-40 kg/ha depending on coarse or fine grained variety) is uniformly spread over the soil, and covered by soil- FYM mixture (5 mm thick) and by gunny bags or dry hay also (if needed). Water is sprinkled over the seedlings by rose cane for 3-4 days and then gunny bags/hay is removed and water is applied by flooding through side channels. If needed, weeding and spraying of urea and zinc sulphate is done. The seedlings become ready for transplanting in 20-22 days when height reaches 125-150 mm.

A new technique has been developepd to grow the mat type nursery without frames in field. In this technique, the nursery beds with side channels are prepared, polythene sheet is placed on the nursery bed, soil-farmyard manure mixture is spread over the sheet, sprouted seeds are uniformly spread over the soil, and covered by soil-FYM mixture. The seedling mats are rolled back over the polythene and cut according to the requirement of transplanter (about 1400 mats/ha of transplanting). This technique has been standardized which completely eliminates the requirement of farmers. The adaptive trails of this technique along with transplanting by transplanter have been carried out at farmers' fields.

- A new technique to grow the mat type nursery for rice transplanters was developed.
- In zero tillage based wheat cultivation net monetary benefit was Rs 5700/ha. It may be attributed to saving in land preparation, seed and additional grain yield.
- Cumulative effect of long-term integrated nutrient supply system on crop productivity and soil fertility under rice-rice system was studied.

Nitrogen and Phosphorus use Efficiencies Improved Through Inclusion of Forage Cowpea in Rice-Wheat System

Field experiments were conducted at the PDCSR, Modipuram, for 3 consecutive rice-wheat cycles to study the effect of forage cowpea grown in pre-rice summer season on soil organic carbon, NO_3-N leaching, N and P use efficiencies, and yields of rice-wheat system. Cowpea (forage) harvested at 50-days removed greater amounts of N and P through above ground biomass than that recycled through belowground roots and nodule. The NO_3-N in soil profile below 45-cm depth after wheat harvest was greater under fallow during summer than under cowpea, suggesting that cowpea minimized NO_3-N leaching beyond 45-cm depth. Similarly, in the treatments receiving both 120 kg N and 26 kg P ha^{-1}, NO_3-N in soil below 45-cm depth was lower as compared to those receiving N or P alone. After 3 crop cycles, incorporation of cowpea roots and their subsequent decomposition increased the soil OC content by 11.6% in 0-15 cm layer, 10.5% in 15-30 cm layer and by 6.3% in 30-45 cm soil layer. P applied at 26

kg ha^{-1} increased the available P content, which was however, invariably low under summer cowpea plots as compared to that under no cowpea ones.

This study revealed that in Upper Gangetic Plain (UGP) the 60-70 day period between wheat harvesting and rice transplanting could be successfully utilized for raising cowpea as a forage legume in rice-wheat system. Cowpea, besides providing green forage during otherwise forage-scarce summer season, may also help improving the annual productivity and nutrient use efficiency, provided both rice and wheat crops receive recommended fertilizer input.

Zero-tillage Technique in Wheat

A study on zero tillage based wheat cultivation under rice-wheat system was undertaken on farmer's field involving 71 farmers belonging to 23 villages of Meerut, Baghpat and Saharanpur districts of western Uttar Pradesh.

An overall increase in net monetary benefits due to adoption of zero tillage over conventional tillage was to the tune of Rs 5700/ha. This is attributed to saving in land preparation (45%), seed (5%) and additional grain yields (50%). In addition, saving in irrigation water at first irrigation, less weed population particularly of small canary grass (*Phalaris minor*), advancing of time of sowing by few days and early emergence of seeds by two to three days also observed.

Spatial Variability of Soil Organic Carbon Content under Different Cropping Systems

Soil organic carbon (SOC) content of fifty-three locations spread across various agro-climatic zones of India was analyzed for its relationship with climatic parameters. The combined effects of rainfall and temperature that controls the carbon turn over and its accumulation were studied. In low rainfall zones, SOC content decreased with increasing temperatures, however, in high rainfall zones, SOC content increased with increasing temperature. A significant negative relationship of SOC content with soil pH was evident. Other meteorological parameters such as relative humidity and sunshine hours further highlighted the role of rainfall and temperature in maintaining SOC content. Similar trends were observed when data were grouped according to predominant cropping systems such as rice-rice, rice-fallow, maize-wheat, pearl millet- and soybean-based systems. The locations under the rice-pulse system exhibited reverse trends in the effect of climate on SOC content.

Cumulative Effect of Long-term Integrated Nutrient Management on Crop Productivity and Soil Fertility under Rice-Rice System

Cumulative effect of long term integrated nutrient supply system on crop productivity and soil fertility under rice-rice system was studied at five locations situated at various agro-climatic zones in India. The cumulative effects of 50% recommended NPK+ 50% N as green manuring during *kharif* followed by 100% recommended NPK during *rabi* was highest at Siruguppa, Rajendranagar, Maruteru, and Bhubaneswar locations. At Chiplima and Jhorhat, 50% or 25% N substitution through FYM gave highest performance. In contrast, cumulative effects of treatments over locations were compared wherein 50% N substitution as green manuring gave best performance. Organic carbon build up was noticed irrespective of integrated plant nutrient supply system at all locations. Build up in available P was noticed at all centers. Available K status improved only at Rajendernagar, and Maruteru with integrated plant nutrient supply system where the impact of N substitution as FYM was superior at Rajendernagar and that of green manuring at Maruteru.

Enhanced Decomposition of Machine Harvested Rice Straw and its Impact on Soil Fertility and Crop Yield in Rice-Wheat System

Application of mineral salts and urea alone or in combination to the soil helped in the enhancement of decomposition of crop residues in rice-wheat system. Application of cellulolytic micro-organisms further helped in accentuating the rate of decomposition of crop residues. Substantial increase in soil organic carbon was recorded after completion of 3 crop cycles in rice-wheat system. The status of soil organic carbon after harvest of wheat was generally higher than that of rice. Soil application of ferrous sulphate, zinc sulphate and urea @ 10, 20, 20 kg/ha along with *Aspergillus awamorae* and *Trichoderma viride* was best in attaining highest crop yield, soil organic carbon and available P and K in contrast to other treatments.

ARID ECOSYSTEM

Pearl Millet Variety CZP 9802 Released for Drought-prone Arid Areas

A dual purpose pearl millet variety CZP 9802, bred and developed at the Central Arid Zone Research Institute, Jodhpur, has been released for cultivation in the scanty rainfall and drought-prone areas of Rajasthan, Haryana and Gujarat. During three years of testing at the All India Coordinated Pearl Millet Improvement Project locations, it provided a grain yield of more than 1.3 tonnes/ha under very severe drought stress conditions, the yield being 15% higher than the national check Pusa 266 (1.14 tonnes/ha) and 52% higher than the check ICTP 8203 (0.98 tonne/

- CZP 9802 pearl millet variety, developed at the CAZRI, has been released for cultivation in the scanty rainfall and drought-prone areas of Rajasthan, Haryana and Gujarat.
- A passive-cool chamber for preservation of vegetables and fruits has been developed.

ha). Under favourable growing conditions, the variety CZP 9802 has a grain yield potential of 2.0-2.2 tonnes/ha. The special feature of this variety is its ability to produce high quantity of dry stover (average 3.3 tonnes/ha, in comparison to 2.1-2.7 tonnes/ha from checks Pusa 266 and ICTP 8203), even under harsh growing conditions. The CZP 9802 adapts well to the soils of poor fertility in arid region, and responds very well to additional doses of nitrogen.

A dual-purpose pearl millet variety CZP9802 has been released for cultivation in drought prone areas of Rajasthan, Haryana and Gujarat. During three years of testing it gave yield of more than 1/3 tonnes/ha under severe drought conditions which is higher than the national check Pusa 266.

Plants of CZP 9802 are good in tillering (2-4 panicles per plant), grow 180-200 cm tall and produce compact heads (23-26 cm long) of cylindrical shape. The variety flowers within 45 days and has a maturity period of 72-75 days. Thus, it escapes terminal droughts that are very frequent in arid region. The grains are light grey in color with yellow base, and are medium-bold with 1000-grain weight of 8-9 g. This dual-purpose variety is highly resistant to downy mildew, smut and ergot diseases.

A low-cost Passive-Cool Chamber for Preservation of Vegetables and Fruits

High temperatures in the desert region, especially during the summer months, affect the keeping quality and shelf life of fresh fruits and vegetables. Conventional methods of air conditioning and refrigeration are costly and not feasible due to non-availability and erraticity of electric power in many villages. A low cost passive system based on the evaporative cooling principle has been developed by CAZRI, Jodhpur, to preserve vegetables for short duration.

The device is a double walled system (170 × 95 cm) made up of bakes, bricks and cement, filled up with coarse sand. The water, filled up between double chambers, creates sufficient humidity within the inner chamber from the sidewalls and reduces the temperature inside. Provisions are also made for water evaporation from the bottom side of the cool chamber by providing suitable drainage system, which hastens the process of

A low-cost passive cool chamber has been developed by the CAZRI, Jodhpur to preserve vegetables for short duration. Conventional methods of refrigeration are costly and not possible due to non-availability of electric power in villages. The chamber can preserve 30–50 kg vegetables.

temperature reduction and maintains high humidity in the cooling area. As compared to the ambient conditions, temperature within the inner chamber is reduced by 15°C, while humidity is maintained at >85% level. A suitable shed is also erected to protect the cool chamber from direct solar insolation.

Under normal capacity, chamber can load and preserve 30-50 kg vegetables (tomato, brinjal, cluster bean, lady fingers, chilly, lemon, bottle guard, cabbage, carrot, etc.) can be preserved for a period of 4-5 days during summer and 4-7 days in winter. The chamber requires 30-35 litres water daily in summer and 20-25 litres in winter. Approximate cost is Rs 4,000.

Chemical Differences between Khara and Meetha variety of *Aloe vera*

Indian aloe (*Aloe vera* syn *Aloe barbadensis*) has been traditionally used as an ailment and domestic medicine for gastrointestinal disturbances, burn, insect bite, minor cut, etc. It is extensively used in drug and cosmetic industries. Three commercial products: aloe, gel and the oil can be obtained from the leaves of the plant. Aloe, the bitter yellow coloured dried sap, is known for its cathartic effect and its main active principle is aloin. Aloe is also used as a bittering agent in alcoholic beverages. The gel is used as a hydrating ingredient in creams and other cosmetic products, and as a dietary supplement in several beverages. The oil is used in cosmetic industry as a carrier of pigments and soothing agent.

Two varieties of Indian aloe -Khara and Meetha, look apparently similar, and have similar colour of the sap, which oozes out after incision of leaves, making people believe that both the varieties have bitter aloin.

Thin layer chromatography (TLC), column chromatography and reversed phase HPLC of yellow sap samples of both the varieties revealed that Meetha variety were three times more concentrated than that of Khara variety. But some of the peaks present in the Khara variety were missing in the chromatogram of Meetha samples,

indicating variation in their composition.

Negligible amount of aloin (0.03 to 0.06% w/v) was detected in Meetha while in Khara it was 10.00 to 15.40 % (w/v). Aloesin, the pungent odored compound, was found in Khara variety only. Khara variety can be utilized as a rich source of aloin.

Hand Weeder

A light weight (~ 500 g), agronomically efficient, hand weeder, with a blade size of 150 mm, has been developed at CAZRI, Jodhpur. During operation, the push-pull action of the weeder helps in better utilization of kinetic energy. It collects grasses while weeding, and does not give jerk when encountering stones in the field. The hand weeder can be easily fabricated by any village blacksmith. The fabricatioin cost is about Rs 40.

A light weight hand weeder has been developed at the CAZRI, Jodhpur.

WEED MANAGEMENT

Weed Competitive Crop Cultivars

Weeds are a major problem in direct seeded rice. No single method of weed management will serve fully the purpose. Many a times no weeding is attempted as the risk of losing the crop due to adverse climatic conditions is high. Adoption of cultivars with better weed competitive traits like fast canopy closure is a potential tool in minimizing weed competitive effects and is expected to reduce costs on direct weed control methods considerably. Investigations are underway to identify crop cultivars with better weed competitive abilities and higher yield potential under sub-optimal weed management practices. The results revealed that in highly weed-infested rainfed direct seeded uplands, the short duration rice varieties of intermediate stature such as Vandana, Kalinga-III and RR 151-3 were found promising.

The other crop varieties with better weed competitive abilities and higher yield potential identified were : JG-11, JG-16 and JG-315 in case of chickpea and WH-147 and DL-803-3 in wheat.

- A light weight (500g), agronomically efficient, hand weeder has been developed at the CAZRI.
- Weed competitive crop cultivars are potential tool in minimizing weed competitive effects in rice. Vandana, Kalinga 11 and RR 151-3 varieties were found promising.
- An integrated management package has been developed by AICRPWC for successful management of lantana.

Integrated Weed Management in Wet Seeded Rice

Experiments carried out under the All India Coordinated Research Programme on Weed Control have revealed that in wet seeded rice, integrating pre-emergence application of pretilachlor with safener (Sofit) 0.45 kg/ha at 7 DAS + growing *dhaincha* as weed smoother intercrop and mechanical incorporation by cono weeder along with manual weeding on 35 DAS reduced the labour requirement and increased the yield and economics of wet-seeded rice.

SUCCESS STORY

Control of Barnyard Grass Weed in Rice

Weeds are a big constraint in direct seeded rice. Barnyard grass (*Echinochloa* sp.) is a major weed in rice system. Although, many herbicides such as butachlor, anilophos, oxadiazon etc. available for successful control of this weed under transplanted condition, the performance of these herbicides in direct seeded rice is eratic basically due to the fluctuating soil moisture status. Rice production under direct seeded rice is a virtually gamble with weeds. It requires repeated mechanical or manual removal for successful crop production, which many a times is not cost-effective particularly in areas where labour is scarce and expensive.

However, with the introduction of few post-emergence herbicides, which are specific to barnyard grass, it appears that the solution for this weed is round the corner. The demonstrations carried out by the NRCWS in farmer's fields have clearly shown the excellent control of barnyard grass (locally known as *sanwa*) with single post-emergence application of fenoxaprop (Whip Super) at 60 g/ha at 3-4 weeks after sowing. The farmers are so impressed with the performance of the herbicide that there has been a mad rush for the herbicide, which was otherwise not readily available in the local market. Farmers are pleading with the NRCWS for making this herbicide available in sufficient quantity for next year. They are prepared to deposit the money in advance with the pesticide dealers. The herbicide application involves an expenditure of Rs 1500/ha against an amount of Rs 2000-3000/ha for manual removal. According to the farmer's own submission, an estimated 60-80 man-days are required for a single manual weeding in one acre area. Due to peculiar soil type (heavy and sticky) no mechanical weeding is possible. From the response of the farmers, it is expected that there will be a huge demand for herbicide in the coming season.

Swamp morning glory (*Ipomoea carnea*) is one of the most problematic weeds spread across the length and breadth of the country. Though this weed is primarily a weed of non-cropped areas, is occasionally found to migrate rapidly to cultivated areas particularly paddy fields. This weed also causes drainage congestion in streams, rivers, and irrigation channels etc. ultimately leading to flash floods in many areas. Experiments carried out under All India Coordinated Research Programme on Weed Control have revealed that spraying of 2,4-D (2,4-D amine) 1.5 to 2.0 kg /ha, glyphosate (Round Up) at 1.5 kg /ha on actively growing plants/new shoots was very

effective in complete drying of this weed and no re-growth was recorded up to 90 days after application.

Turning waste into wealth

Huge quantity of weed biomass is available in many parts of the country which could be effectively utilized as mulching material as compost. Weeds are an excellent source of nutrients and hence serve as a very good raw material for compost making. The investigations carried out under All India Coordinated Research Programme on Weed Control has shown that the invasive weeds such as *Parthenium hysterophorus, Chromalaena odorata*), *swamp morning glory (Ipomea carnea*), lantana (*Lantana camara*), negro coffee (*Cassia occidentalis* and water hyacinth (*Eichhornia crassipes*) could be effectively used for this purpose. The compost prepared using the weed biomass has been found to be as good as FYM with regard to its nutrient composition. The response of crops has also been found to be as good as that from FYM.

Lantana camara Management in Pasture Land

Lantana (*Lantana camara*) is a noxious exotic weed and threatens the native vegetation and is a great menace in pasture and grassland. An integrated management package has been developed by AICRP-WC center at CSKHPKV, Palampur for its successful management This involves cutting of lantana bushes 5-7 cm above ground in September, spray of glyphosate 0.41 per cent on regenerated bushes in October followed by planting of bamboo, mulberry and improved grasses. The original ecosystem was restored and could be used for grazing by cattle and other livestock. Consequently the milk production increased in the adopted area and also reduced the animals toxicity cases. The productivity of grasses and other useful vegetation increased by 90 per cent. The danger of wild animals in the vicinity of the village was also reduced considerably.

Herbicide Residue Monitoring

Herbicides have come as a useful alternative in weed management. They save labour and enhance productivity. Investigations carried out under All India Coordinated Research Programme on Weed Control for the last several years have revealed that the herbicides applied at recommended doses have not been found in edible parts of many crop plants. Neither it has remained in soil to influence the soil microflora nor the crops grown in rotation. This is because of the fact that herbicides are by and large (compared to insecticides) less toxic in nature (with higher LD_{50} values) and are applied during the very early stages of the crop growth. Due to the longer interval between application and harvesting of the crop, the herbicides get degraded in the plant system with little chance of being accumulated in food, feed, fodder, soil or water.

AGROFORESTRY

Agrisilviculture

Tree crop interaction of *safed siris* (*Albizia procera*) studies indicated that moisture stress causes 30 % reduction in crop yield while canopy caused 4-5% and root competition caused 1.8% reduction in crop yield during *rabi* (mustard) crop. While in *kharif* (blackgram) crop, moisture stress caused 10% effect, share 4% and root invasion 2%.

White silk cotton tree (*Ceiba pentandra*) based agri-silviculture system at Raipur showed that tree height was highest in narrow tree spacing (4x4 m) at the age of seven years. Whereas it gradually decreased with an increase in tree spacing. The maximum height of 8.67 m was recorded in unpruned tree in 4x4 m spacing. While a lowest of 7.24 m height was observed in pruned trees in 4x8 m spacing. DBH was highest in unpruned stands (19.51 cm) and lowest in pruned stands (14.61 cm) at 4x8m spacing. Four varieties of wheat, viz Sujata, Lok-1, Kanchan and GW-173 were intercropped with white silk cotton tree. The grain yield performance due to variety was found in the order to GW-173 (26.97 tonnes/ha) >Sujata (22.42 tonnes/ha) >Kanchan (18.57 tonnes/ha) >Lok-1 (16.42 tonnes/ha).

Effect of pruning of neem trees raised on bunds on biomass yield of sorghum fodder in agrisilviculture system

- Tree-crop interaction of *Alibizia procera* and mustard crop indicated that moisture stress caused 30% reduction in crop yield while canopy 4-5% and root competition 1.8%.
- In chronjee veneer grafting and chip budding were done on plants with more than 2 or 3 year age. Veneer grafting recorded 80.0% success in August and September. While chip budding showed maximum (25%) success in August.
- Growth and biomass production of three species (*Acacia nilotica* var *Cupressiformis, Dalbergia sissoo* and *Hardwickia binata*) revealed that in 11th year *D. sissoo* showed significantly higher survival (95.1%), height (9.2%), dbh (14.9 cm). canopy diameter (5.3m) and pruned biomass (0.79 tonnes/ha).
- Genetic improvement work in progress in neem, sisham and *Anogeissus* spp.
- In plus tree progenies trial of sisham, progenies PT-2 and PT-6 proved their superiority to check for growth characters as well as straightness.
- The investigation are being carried out to develop a comprehensive online database on agroforestry entitled Agroforestry Base containing information on various aspects of agroforestry under four independent modules, namely MPTS, research projects, economic analysis and agroforestry intervention/innovations.
- At Raipur, height of white silk cotton tree was highest under narrow tree spacing.
- In sisham and Indian gooseberry agri-silvi-horti system developed at Faizabad, grain yield of mustard increased with 120, 60 and 40 kg/ha of NPK application.

at Kattupakkam revealed that the protein content was reduced marginally to the extent of 2.8% in the sorghum fodder raised 2 m away from the bole of the neem trees, however, 4 m onwards there was no reduction in the crude protein content. The total ash, which represents the mineral status in the fodder, was highest when the sorghum fodder was raised under the canopy. The fibre quality of the fodder was also not significantly affected under canopy. In the salt-affected soil, the survival percentage of different jojoba clones varies from 45.8 (C-64) to 72.6 (Local) at Hissar. After six months of plantation, maximum height (39.4 cm) was recorded in local clone and diameter was highest in clone 102 (5.47 mm). The yield of barley varied from 0.21 to 0.23 tonne/ha).

Agrihorticulture

- In chironjee in situ veneer grafting and chip budding were done on plants with more than 2 or 3 years age. During the year, 80.0% success was recorded with veneer grafting in the month of August and September. Chip budding showed maximum 25% success in August.
- Studies with four live-fence species/species combinations, viz. (i) two rows of *karaunda* (*Carissa carandas*) (ii) two rows of lantana (*Lantana camara*) (iii) one row of rambas/sisal (*Agave sisilana*) + century plant (*A. americana*) and one row of mehandi (*Lawsonia inermis)* under two method of planting (flat and ridge) were continued during third year. Results showed that the ridge method of planting was found better than flat for survival and growth. The maximum survival of 95.7% was recorded in mehandi followed by agave (92.9%) and *karaunda* (92.8%).

Silvipasture

- Growth and biomass production of three species (*Acacia nilotica* var. *cuppressiformis*, *Dalbergia sissoo* and *Hardwickia binata*) with and without pasture and with and without pruning revealed that in 11th year *D. sissoo* gave significantly higher survival (95.1%), height (9.2 m), dbh (14.9cm), canopy diameter (5.3 m) and pruned biomass (0.79 tonne/ha) but lower understorey forage yield than others. Fifty per cent trees harvested at 10 years age revealed that *Dalbergia sissoo* gave significantly higher dry biomass

Online Computerized Database for Agroforestry System

The present investigations are being carried out with the idea of developing a comprehensive on line database on agroforestry entitled Agroforestry Base containing information on various aspects of agroforestry under four independent modules namely MPTS, research projects, economic analysis and agroforestry intervention/innovations. The database are designed in MS-Acess-2000 and SQL (Standard Query Language), ADP (Active Server Pages), HTML, DHTML have been used for creating the dynamic pages of the database. The software runs on a HTTP Server and serves the request of a client on any computer connected with Internet and having a graphic web browser. The databases has been equipped with interactive web pages to browse information on on-going/complete agroforestry research projects in India, detailed information on multipurpose tree species being used for agroforestry, economic analysis of agroforestry case studies and agroforestry interventions/innovations for specific regions of India. Agroforestry Base has been designed with objective of dissemination of scientific information on agroforestry in India and the major constraint faced during its development was the current lack of information on AF technologies suitable for specific soil and climatic conditions.

Data base of the Indigenous/traditional Agroforestry systems of Kangra and Mandi districts of HP, revealed that in the in foot hills the farmers preference was mainly to grow sisham (*Dalbergia sissoo*), followed by nettle weed (*Celtis australis*), biul (*Grewia optiva*) and *Salix sp*. In midhill, the complete dominance of *Grewia optiva* was clealry seen and other additional tree species were *Ficus sp.*, white mulberry (*Morus alba*) and kachnar (*Bauhinia variegata*). In low mid hills, farmers preference was biul, *Salix* sp and *Albizia chinensis* in descending order of the adoption.

Growth performance of mehandi in the live fence of one row of sisal and one row of mehandi

Sheeps and goats grazing on silvipasture system

of 59.3 tonnes/ha than other two tree species. On the basis of ten years rotation revealed that *Dalbergia* based silvipastoral system produced more than 11 tonnes/ha/year total dry biomass (forage+leaf fodder+fuel wood+timber).

- Studies on growth and biomass production in 3 *Albizia* species (*Albizia amara, A. lebbek and A. procera*) with four pruning intensities (0,25,50 and 75% height from the ground level) during 7th year in natural grassland revealed that *A. procera* gave significantly higher survival (89.1%), tree height (6.2m), dbh (11.1 cm), canopy diameter (3.8 m), dry leaf fodder (1.12 t ha^{-1}) and fuel wood (0.87 t ha^{-1}) than other two tree species. Pruning of trees up to 75% height gave higher forage than other pruning intensities.

Tree Improvement and Silviculture

- Genetic improvement work is being carried out in neem (*Azadirachta indica*), sisham (*Dalbergia sissoo*) and *Anogeissus* spp. In neem Centre has collected 276 accessions from eight states (Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Orissa, Rajasthan, Haryana, West Bengal and Gujarat). In these collections, a wide range of variability was observed for 10-seed weight (11.00-33.04g), seed length (0.80-1.90cm), seed width (0.58-0.83 cm), 100-kernel weight (4.43-18.73g), oil content (36.39-52.40%) on kernel basis, seed-kernel ratio, seed colours, seed shape, tree height, tree diameter, fruit ripening period and crown shape. Ten selections were identified in provenances and plus tree progeny trial based on fast growth and high fruit yield. Out of these, Sel-2 and Sel-3 had more azadirachtin A.

Ten selections were identified in provenances and plus tree progeny trial based on fast growth and high fruit yield. Out of these Sel-2 and Sel-3 had more azadirachtin A.

- In plus tree progenies trial of sisham (*Dalbergia sissoo*), progenies PT-2 and PT-6 proved their superiority over check both in cultivated and degraded lands for growth characters as well as for straightness. *Anogeissus latifolia* was considered as a fast growing species as compared to dhawa *A. pendula*. It was also more straight than *A.pendula*. In *A. pendula*, five trees have been identified which have mean annual increment more than 90 cm for tree height and more than 1.50 cm for collar diameter at the age of 7.5 years.
- Study on reproductive biology of *Acacia nilotica* ssp. *indica* revealed that flowering remains from first week of June to the December with peak in July and October. Inflorescence is globose head and each head contain 22 to 40 flowers with mean of 32.2. Majority of flowers are hermaphrodite. Carpel is found absent in 2-3 flowers. Anthesis occurs during night between 00.30-1.30 hrs and all the buds open synchronously. Anther dehiscence occurs in the morning of same day (between 5.00-9.00 hrs). Pollen grains are in the form of compound grain, each containing 12 or 16 pollen grains in multiple of four. Pollen viability is more than 90 per cent.

Variability in pods of *Acacia nilotica* ssp *indica*

- Ten districts of Maharashtra were surveyed to identify genetically improved material of Pongamia. Among 216 collection, 13 tree have been identified as plus trees at Rahuri. The oil content in the selections varied from 27 to 49.8 percent.

Agri-silvi-horti System

In sisham (*Dalbergia sissoo*) and Indian gooseberry (*Emblica officinalis*) agri-silvi-horti system developed at Faizabad, grain yield of three mustard varieties (Kranti-53, NDYR-10, NDYR-4) in rabi increased up to T_3 level of fertilizer application [120 (N) : 60 (P) : 40 (K) kg h^{-1}]. Mustard variety Kranti-53 had maximum seed yield across treatments in open field condition (0.67 tonne/ha) followed by agri-silvi-horti system (0.62 tonne/ha). Mean tree height for sisham and Indian gooseberry in agri-silvi-horti system across treatments for mustard varieties was 8.6 –10.4 m and 4.1-4.3 m, respectively. Similarly, mean values for dbh in case of D.sissoo and E. officinalis were 15.2-19.5 cm and 10.2-11.6 cm, respectively.

Studies on the effect of different treatments of filling material in trenches of CCTs at Rahuri showed the treatment, 5 kg wheat trash + 25 kg FYM as filling material recorded maximum plant height while collar girth was highest in 10 kg wheat trash + 20 kg FYM treatment after 4 years of establishment of different tree species.

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Livestock and Poultry Improvement and Management

ANIMAL GENETIC RESOURCES

Livestock Information Management System

At the NBAGR, Karnal, menu driven Livestock Information Management System was developed for animal resources. All the date tables and report forms are designed in the form of a single package. The database has information on livestock population, genetic resources, infrastructure, production, products and utilization, farms, etc. Separate table has been defined for each parameter. The master tables have names and codes of fields, which are repeatedly used in other tables, and there are data tables, which are linked to master tables and contain actual data.

Poultry Informatics: Data on national poultry informatics from 18 states/UTs of the country were collected and computerized. First hand information on product specialties and further scope of progress by the Indian Poultry Industry was also collected.

- Database on Indian livestock resources, infrastructure, animal production,products and utilization available
- Evaluation and characterization of several breeds of cattle ,buffalo, sheep, goat, equines, camel and poultry completed
- Polymorphism of growth hormone gene in Karan Fries cattle and Murrah buffalo was revealed first time
- Immune response characteristic of poultry breed was used as criterion for selection
- RAPD-PCR was effective in detecting the polymorphism between breeds of cattle
- Buffalo ovary –released protein identified as marker for oestrous and pregnancy detection
- Riverine buffaloes showed farthest genetic distance from African buffalo
- Nali and Chokla sheep are genetically closer while Garole sheep is a distinct population
- Special conservation efforts are needed for Nicobari and Kashmir Favorolla poultry
- Neighbour-joining tree of Indian goat breeds with wild goats was constructed first time
- A project on molecular genetic studies of experimental brown egger population initiated
- CARI- Nirbheek and CARI- Shyama developed from Aseel and Kadakanath for backyard poultry
- A preliminary attempt was made to grow embryonic stem cells in buffalo
- Double window embryo culture system for production of embryos of turkey, developed first time in world

Livestock Information Management System

- The System has the following modules:

Master module:	facilitates entry of new records (species, breeds, states, district) in the master tables
	Data entry & updating: facilitates entry of data in data tables
Data view:	facilitates display of data available in any of the data tables
Contact:	contact addresses of organizations dealing in animal resources
Report:	facilitates retrieval of data through selection of desired parameters

Data in the Information System

- Names and codes in the master tables i.e. States, Districts, Species and breeds
- District-wise data on infrastructure and production of animals from 1990 onwards for Bihar, West Bengal, Andhra Pradesh, Karnataka, Uttar Pradesh, Orissa, Tamil Nadu, Punjab, Haryana, Rajasthan, Maharashtra, Goa, Gujarat, and Madhya Pradesh. State/UT data for Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Andaman & Nicobar, Chandigarh, Daman & Diu, Delhi, Lakshadweep and Pondicherry
- District-wise livestock population data for all the species and for all the census years from 1961 onwards. Data for 1997 has been entered for 17 states
- Breed data for all breeds of cattle, buffalo, sheep and goat
- Photographs for all the breeds of cattle, buffalo, sheep, goat and a few of sheep

Evaluation and Characterization of Breeds

Bachaur cattle: Bachaur population in Sitamarhi, Darbhanga and Madhubani districts was estimated as

Home tract of Bachaur cattle is Sitamarhi, Darbhanga and Madhubani

Dangi bulls are slow draught animals

Body measurements of Amrithmahal cattle of Karnataka, were taken

Nagpuri buffalo is famous for long horns extending up to or beyond the shoulders

Production and reproduction traits of Arunachali mithun were recorded

Age at slaughter was 8.7 months and weight 20.7 kg in Deccani sheep

Greasy wool production was 0.96–1.80 kg annually

10,948.The female population is largely available in Nepal or its adjoining areas. The floor of animal house was mostly *kutcha* (84%) and sanitary condition was poor in 59% cases. More than 90% animals were bred through natural service.

Dangi cattle: The breed is distributed in Ahmednagar, Nasik and Dang district of Maharashtra. The estimated population of the breed is 108,197. Information on physical characteristics, native environment, housing, feeding and management practices was compiled. The average lactation yield varied from 450 to 550 kg. The animals were bred through natural service (91.9%) and through AI (8.1%). The age at first oestrus was 41.3 months and inter-calving period 551.5 days. Dangi bulls are slow draught animals.

Amrithmahal cattle: Animals (14,073) maintained under field conditions at Chickmagalore, Chitradurga, Davanagere, Shimoga, Hassan and Tumkur districts of Karnataka, were surveyed. The average number of animals per household was 3.43. The body measurements of males and females below 3 years of age and above three years of age (total 2,622 animals) were recorded. Milk yield recording of 286 cows is in progress.

Nagpuri buffaloes: Survey, in the breeding tract confined to 60 villages spread over districts Nagpur, Akola, Amravati and Yavatmal, was carried out to collect information on morphological, production and reproduction parameters of buffaloes, and socio-economic status of farmers rearing Nagpuri buffaloes. The breed is reputed for very long horns extending up to or beyond the shoulders (52.86 cm in adults), flat and curved and carried back on each side of the neck. The average age at first estrus, age at first mating (female), first calving, service period, service per conception, calving interval were, respectively, 44.94 months, 45.8 months, 56.2 months, 123.7 days, 2.14 and 480.5 days.

Arunachali mithun: Under the project 7,547 mithuns of different age-groups of both the sexes were covered. Physical body measurements of adult mithuns (below 3 years), and 50 calves, were taken in three districts. The production and reproduction traits (maturity age, pregnancy period, total life span etc.) were recorded.

Deccani sheep: The breeding tract of this breed is spread in Pune, Ahmednagar, Kolhapur, Sholapur and Aurangabad districts of Maharashtra. Estimated population is approximately 149,942. The body weights at birth, 3, 6, and 12 months of age were 2.8, 9.9, 13.5 and 19.8 kg respectively. Adult body weights of males and females were 37.9 and 28.6 kg. The age at first estrus and first lambing were 9.6 and 14.1 months. The age and weight at slaughter were 8.7 months and 20.7 kg.

Changthangi sheep: The breed is distributed in Leh district of Jammu and Kashmir at an elevation of 3,340-4,560 m above mean sea level (msl). The animals are reared in the pastures up to 2,000 m above msl and the estimated population was approximately 66,822 with flock size in the range of 5-30. The chest girth, body length,

height at withers and weight in males were 70.5 cm, 66.1cm, 63.6 cm, and 30.6 kg, and in females was 75.6 cm, 64.3 cm, 65.5 cm and 34.3 kg respectively. The body weights at birth, 3, 6 and 12 months of age were recorded as 2.5 kg, 11.0 kg, 15.1kg and 21.4 kg, respectively. The greasy wool production was 0.96-1.08 kg; the staple length 9.3 cm and crimps 1.23/cm.

Malpura and Jaisalmeri sheep: Malpura sheep go for a short migration and Jaiselmeri for a long migration

Jaisalmeri sheep go for long migration from their breeding tracts

from their respective breeding tracts. Malpura and Jaiselmeri sheep are kept in open houses in the breed tract but no housing is provided during migration and no supplementary feeding, except that three loppings are provided in lean season. Data on greasy fleece production was collected for Malpura breed and is being collected for Jaiselmeri breed. Staple length was 4.47 and 4.62 cm, fibre diameter was 45.86 and 34.71 micron and medullation percentage was 58.96% and 40.21% in Malpura and Jailsalmeri breeds respectively.

Gaddi sheep and goat: Geographical and demographic distribution of the Gaddi sheep and goats were studied in Kullu, Chamba and Kangra districts of Himachal Pradesh. The migratory routes of these breeds were traced and followed for data recording. In winters, they graze in valleys and in summer go to alpine pastures. Both graze in summer but some dried grasses are given in extreme winters. Majority of Gaddi sheep (56 to 79.64%) and

Parbatsari and Sirohi goats

Parbatsari goats are light brown or dark brown colour with no patches. The breed is mixed with Sirohi breed (with light or dark brown patches) in Ajmer and Nagaur districts of Rajasthan. Surveyed flocks were 33% brown with patches (Sirohi) and 67% solid brown (Parbatsari type). Goats are reared purely on browsing resources in rangeland and hardly any supplementary feed is provided, except for the household wastes to lactating goats. Parbatsari goats have body size and body weights lower than Sirohi goats.

Sirohi goat

Parbatsari goat

Gaddi goat (52.69 to 82.28%) are white. Other colour variants may be pure black, brown or white with black/ brown patches. Horns are present in both sexes of Gaddi sheep and goat. In Gaddi sheep, body length varied from 64.7 cm to 69.3 cm and in Gaddi goat from 68.3 cm to 73.2 cm in different districts. Adult body weight varied from 29.9 kg to 34.0 kg in Gaddi sheep and 33.3 to 36.9 kg in Gaddi goats. The average live weight was 25.2 and 31.1 kg in adult male and female sheep, respectively, and dressed weights were 12.5 and 15.7 kg respectively. The corresponding live weights in Gaddi goats were 27.1 and 31.0 kg in males and females, and the dressed weight were 13.6 and 15 kg respectively. Wool is shorn three-times in a year and clip yield varied from 437 g to 696 g in different age groups of Gaddi sheep.

Gaddi sheep

Gaddi goat

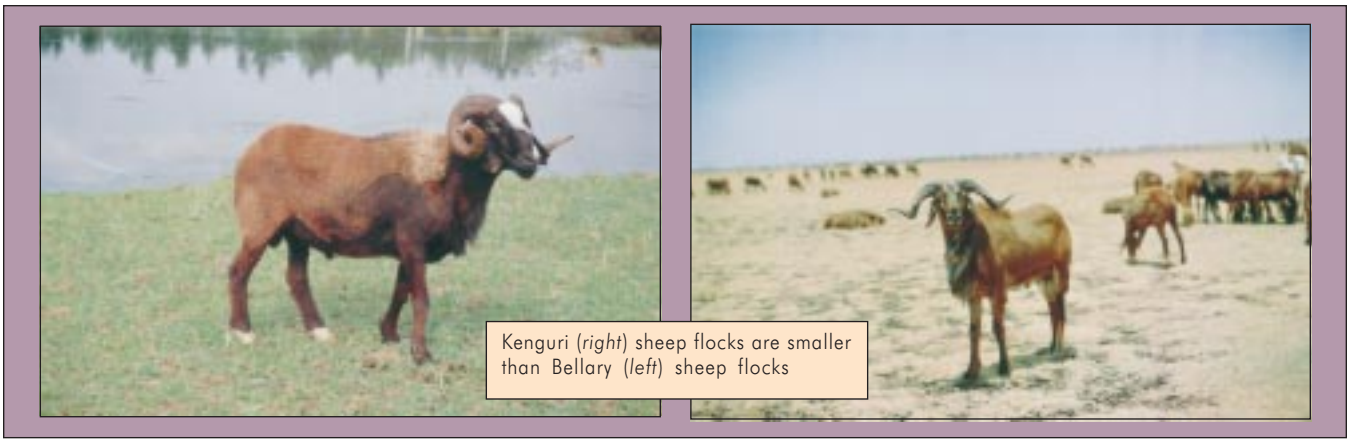
Gurej and Karnah sheep: Gurej sheep had much wider distribution but now their small population has been restricted to Gurej Tehsil of Baramullah district in the basin of river Kishan Ganga at an elevation ranging from 3,200 to 4,100 m amsl. The breeding tract of Karnah sheep breed is now restricted to Tangdar and Teetwal blocks of Kupwara district in North Kashmir at an altitude ranging from 1,260 to 2,630 m amsl. Both Gurej and Karnah sheep go for seasonal migration. They move to alpine pastures in April and come down to valleys in September-October. In both the breeds, animals are flocked in open, surrounded by logs or temporary stone wall in grazing camps on migration, but in villages these are kept in huts made of wood with *kutcha* flooring. In summer, animals of both breeds are kept on grazing. In extreme winter when no grass is available, animals are fed with boiled maize or potatoes in Gurej area and with dried grasses or hay in Karnah area. Major breeding season in both Karnah and Gurej sheep is September-October. Lambing is in March-April. Birth weight in Gurej varied from 2.43 to 2.35 kg in males and females. Body weights at 3, 6 months of age and adults were 6.68 and 6.42 kg, 16.84 and 17.15 kg and 40.59 and 38.20 kg in male and female respectively. Gurej sheep are shorn twice a year, and wool yield ranged from 317 g at 6 months to 806 g at adult age in autumn clip. Average staple length was 4.56 cm in Gurej sheep and 3.47 cm in Karnah. The average crimp/cm was 1.61 in Gurej and 1.82 in Karnah. Both the breeds are highly endangered. Four horned sheep were discovered in Gurej breed for first time in India. Their number is 14 at present.

Kenguri and Bellary sheep: Survey was carried out in the villages of Kustagi, Yelburga and Gangavati taluks of Hospet district for Kenguri sheep, and Hospet, Sandur and Bellary taluks for Bellary sheep. Kenguri (synonym: Tenguri; after the name of coat colour, 'Teng' meaning coconut) sheep are well built and large sized. The body is covered with short, dark-brown and shiny hair, which is never shorn. Animals mostly have a white patch on forehead; the white patches on some other body parts are seen rarely. About 70% breeding males are horned, females are generally polled but about 5% of the females have rudimentary/small horns. About 80% animals have wattles.

Karnah sheep

Gurej sheep

The animals are maintained in large flocks in good condition. Bellary flocks were larger compared to Kenguri flocks. Animals graze in open fields and supplementation of feed is rare. Flocks are generally purebred. Only about 5% animals were non-descript. Breeding males are selected on the basis of body size and conformation. September to November is the main lambing season and February to March the minor. Lambing rate is about 80%. Age at first lambing was 18-24 months. Ewes, on an average, produce 7-8 lambs in their lifetime. Twinning is rare in both the breeds. Bellary animals are well built and medium to large in size, and body colour comprises various combinations of white and black or black; complete white



Kenguri (*right*) sheep flocks are smaller than Bellary (*left*) sheep flocks

animals were not reported. About 90% males were horned whereas, about 25% females had horns and their horn length was much smaller compared to males. The tail is thin and short. Fleece is extremely coarse, hairy and open. Both breeds are maintained for mutton, however, Bellary sheep produce hairy and coarse fleece that can be used for making rugs etc.

Spiti horse: The distribution of the breed is confined to Lahul and Spiti, Kinnaur, Kullu, Mandi and limited areas of Kangra and Shimla districts of Himachal Pradesh. The total population was estimated as 4,000. The entire breeding tract of the Spiti horse falls in cold desert region with very little vegetation.In April – May foaling occurs followed by rebreeding, mostly during foal heat in May. The coat colour of Spiti horses range from chestnut to black, however, most of the animals were gray (36.41%) followed by black (26.01%) and brown (15.16%). Some animals (6.19%) were of bay colour pattern. Majority of animals (80%) do not have head mark, in 10.40% animals star was the most prominent marking whereas, few animals also had stripes, white face, snip and blaze marks. Similarly, limb markings were also present in few animals (28%); white fetlock (7.17%), white pastern (6.01%), white heels (4.75%) were the prominent markings. Muzzle colour pattern was — white muzzle (10.40%) or no marking (89.6%). In 40% animals, the tail was of different colour than the body, and whorls were seen in almost half of animals surveyed. The ear length, tail length, chest girth, height at withers, body length, body weight and circumference of canon was measured. The age at first estrus was 15-24 months, age at first covering 30-34 months, age at first foaling 41-46 months, and foaling interval as 345-380 days. In males, age at first ejaculate was 24 months, and age at first covering 30 months.

Mewari: The Mewari camel is well adapted to the Arawali hills. This breed is also known for the production of milk as camel milk is sold in the Mewar and adjacent Malwa region of Madhya Pradesh. Breed descriptor was prepared for this breed, and biometry of 14 body parameters was done. An adult Mewari camel has 159.27±2.61 cm body length, 196.08±3.50 cm heart girth and 194.31±2.38 cm height at withers.

Breed descriptors for camels: The breed descriptors of the Bikaneri and Jaisalmeri breeds were prepared. Information on 14 body measurements along with socio-economic status, breed and nutritional status, and other relevant data regarding camel husbandry in the breeding tract were collected.

Ankaleshwar poultry: The estimated population of Ankleshwar birds, distributed in Bharuch and Narmada districts of Gujarat, was approximately 4,500. The average flock size was 5-10. The comb shape was single and rose type. The egg shell varied from cream to brown. The egg production of the breed is 80.6 eggs/year with an average age at first egg of 181.3 days and average egg weight as

The entire breeding tract of the Spiti horse falls in cold desert region

34.3 g. The fertility was 91.3% and hatchability on fertile egg basis 92.4%. The weights of shell, albumin and yolk were, respectively, 4.8g, 16.4g and 13g. The body weights in males and females at 8 weeks, 12 weeks and slaughter (72 weeks) were 542g and 450g; 885g and 772g; 1800g and 1,578g respectively, whereas, body weight at hatching pooled over both the sexes was 28.5g.

Immunogenic, Biochemical and Cytogenetic Studies

At the Indian Veterinary Research Institute, Izatnagar, a technique for high resolution banding of chromosomes was modified based on enzyme digestion and staining for analyzing bovine chromosomes, and cytogenetic markers like translocation, trisomy X, nullisomy, etc were identified for various reproductive disorders.

Single nucleotide polymorphisms in α-lactalbumin gene in cattle: Indigenous cattle breeds of Southern India (Amrithmahal, Krishna Valley, Hallikar, Deoni, Ongole and Malnad Gidda) and Holstein crosses (HF × Sahiwal) were screened for single nucleotide polymorphisms (SNPs) in the coding sequence of the bovine alpha lactalbumin (α-LA) gene. SNPs at 772, 775, 792 and 857 positions in exon 1, and at 1231, 1264 and 1335 positions in exon 2,

Egg production is 80.6/year and body weight of males at 8 weeks of age is 540 g in Ankleshwar birds

were detected. The crystal structure of bovine α-LA provides a basis to interpret the influence of the SNPs on the structure and function of the mature protein. The first two observed SNPs S3T and F4L are located within the signal peptide sequence. The sequence and structure of the signal peptide can be expected to have a regulatory effect on the rate of lactose biosynthesis and consequently on milk production.

Polymorphism of growth hormone gene: Polymorphism of growth hormone (GH) gene with PCR-RFLP (Alu-I as restriction enzyme) was revealed for the first time in Karan Fries (26) and Murrah (23) bulls. Polymorphism was observed in Karan Fries bulls with genotypes LL and LV. Murrah bulls were monomorphic with only LL genotype. LL genotype containing KF bulls were better in terms of birth weight, 3 and 6 months body weight, libido score, mass activity, individual fresh sperm motility, post-thaw semen motility, EPD; whereas, LV genotype animals were better in reaction time, Flehmen's response, mounting stimulus, semen volume and seminal consistency. Murrah bulls with LL genotype were better than that of KF bulls in body weights, reaction time, requirement of mounting stimulus for mounting, semen mass activity, individual fresh sperm motility and post-thaw sperm motility. LL genotype of GH gene of KF bulls could be considered as an aid in selection of KF bulls under progeny testing programme for better body weights and individual fresh sperm motility.

Characterization of yak genetic resources: At the NRC on Yak, haemoglobin polymorphism of yaks was studied. Cytogenetic investigations on yaks and their hybrids were

Haemoglobin polymorphism of yaks was studied

conducted, and the normal chromosomal profile of pure yaks of Arunachal Pradesh was studied.

Immune response in poultry: In Synthetic broiler dam line (SDL) the overall mean for SRBC (sheep red blood cells) response (Log_2 of titre), CMI (% thickness), serum lysozyme (µg/ml) and IgG (mg/ml) levels were 6.203±0.112, 44.57±0.88, 4.95±0.11 and 7.08±0.14, respectively, in G_0 generation. The procedure for RAPD-PCR was standardized, and scorable bands were obtained.

Deoni cattle were screened for single nucleotide morphisms in the coding sequence of bovine alpha lactalbumin gene

The amplification procedures of BL-bII region (267 bp) and promoter regions of IFNg (670bp) and IL-2 (659 bp) genes using specific forward and reverse primers, were also standardized at the CARI, Izatnagar. The immunocompetent traits, viz. response to SRBC, serum lysozyme level, MER (mercaptoethanol resistant) and MES (mercaptoethanol sensitive) were analyzed. The two treatment groups did not differ significantly in their body weights, serum lysozyme level and antibody response to SRBC, MER and MES antibodies on 5 dpi (days post immunization).

At the Project Directorate on Poultry, Hyderabad, the immune competence of purelines was profiled primarily for breeding purposes. Adults of Vanaraja female line were randomly tested for immune response against Ranikhet disease vaccine, using ELISA. They revealed adequate protection from the disease. Profiles of immune competence were also determined using SRBC antigen in 7 test crosses, and this information was effectively utilized in selection process of breeders. Vanaraja birds fed normal diet showed better titers than those fed deficient diets. Dietary influence was apparent in the nutritionally depleted line.

Antibody titers of naked neck layers, crosses of broiler male line and dwarf, Krishibro (Pb1 × Pb2) and Pb1 × crossbred dwarf, were also determined. These profiles were useful for incorporation of information in breeding programmes.

Molecular Genetic Characterization of Indigenous Breeds

Cattle: RAPD-PCR was effective in detecting the polymorphism within as well as between Rathi and Tharparkar cattle. Within breeds, genetic similarity was higher in Rathi, and PCR-RFLP analysis revealed restricted sites for *Hae III* enzyme. PCR-RFLP analysis of insulin like growth factor binding protein 3 (IGFBP3) gene in Hariana and F × H (HF × Hariana crossbred) cattle revealed that Hariana cattle were homozygous for allele A (genotype AA) while crossbred cattle were

Genetic similarity, within breeds was higher in Rathi cattle

heterozygous (genotypes AA, AB and BB) possessing both A and B alleles.

Buffalo: A buffalo ovary-released protein (29 kDa) was identified as a marker for oestrous and pregnancy detection.A 39 kDa protein from embryos was found pregnancy specific.

Cloning and sequencing of cytochrome b gene: Cytochrome-b gene from Jaffarabadi and Murrah buffaloes was PCR amplified from the mitochondrial DNA template using deep vent DNA polymerase enzyme, and was cloned in pBluescript KS+ vector. Comparison of sequences with other buffalo species was carried out. After establishing the fact that nucleotide sequence of cyt-b showed similarity in riverine buffaloes, the full length of the cytochrome protein sequence in the gene bank was searched and downloaded. This was compared with all available sequences. An average distance tree was constructed. Riverine buffaloes showed highest degree of similarity (98%) with *Bubalus depressicornis* and *Bubalus mindorensis*. Amongst various buffalo species compared, riverine buffaloes showed farthest distance from African wild buffaloes.

Assignment of individuals: Assignment of individuals to a breed was attempted at the NBAGR, Karnal, using multilocus genotypes in 4 poultry, 3 buffalo and 2 goat breeds of India, utilizing data generated on microsatellite loci. The unknown individuals were then assigned on the basis of reference allelic frequencies of the breeds. Genetic data analysis methods like frequency method, Bayesian method, and genetic distances like Nei's standard, Nei's minimum, Nei's D_A, allele sharing and chord distance were utilized. All the individuals were assigned to the populations correctly with 100% accuracy in poultry and goat breeds. The values obtained in buffalo varied from 84 to 98%. Population exclusion method was also used with the above three methods using exclusion threshold of 0.01. The average probability of wrong assignment was very low. The likelihood method performed better than the frequency method for assignment of unknown individuals. Among genetic distances DAS and chord distance gave better assignments than the Nei's genetic distances.

Genetic distances among buffalo populations

The relationship among local buffaloes of Kerala, Bhadawari and Tarai populations was calculated using the genetic distances/ identities utilizing allelic frequencies at the NBAGR, Karnal. The Kerala buffaloes were a distinct entity and the Bhadawari and Tarai populations were genetically very close to one another. The inter-individual genetic distances were estimated using allele sharing method and the dendrogram of three buffalo populations was prepared.

Tarai buffalo

At the NBAGR, Karnal, genetic relationships based on genetic distance measures revealed close similarity between Nali and Chokla as they were grouped together first, than with Muzaffarnagri sheep. Garole appeared to be a distinct population. The result is in accordance with the geographical distribution of these four breeds of sheep.

The data of microsatellite loci was generated for indigenous poultry, buffalo and goat breeds at the NBAGR, Karnal. Data were subjected to statistical analysis to test for heterozygosity since any bottlenecked population would undergo transient heterozygosity excess. Sign-rank test, standardized differences test and Wilcoxon test were utilized in each of the three models of mutations, IAM, SMM and TPM. SMM revealed significant heterozygote excess for Nicobari and Kashmir Favorolla rejecting the null hypothesis of mutation drift equilibrium. The two populations showed recent genetic bottleneck. The Miri and Aseel poultry did not reveal significant heterozygote excess under SMM in all three tests and thus the populations are supposedly in mutation drift equilibrium. The mode shift-test revealed recent genetic bottleneck only

Pair of Kashmiri Favorolla

in Nicobari fowl. Special conservation efforts are required for Nicobari and Kashmir Favorolla poultry.

Chegu and Black Bengal goats revealed genetic bottleneck and require conservation efforts. There is a need to implement a planned breeding programme for Black Bengal goats, which are very large in number and do not seem to be facing any demographic bottleneck.

Buffalo breeds did not exhibit recent genetic bottlenecks in the conservative SMM model. However, Tarai and Kerala buffalo populations revealed genetic bottlenecks under IAM and TPM model of microsatellite evolution.

Biotechnological studies in sheep: At the Central Sheep Wool Research Institute, Avikanagar, DNA isolation protocol was standardized, and isolation of genomic DNA from Malpura, Garole, Chokla, Avikalin and Kheri breeds was completed.

Genetic variants of polymorphic traits and gene markers: Sequencing of mitochondrial (mt DNA) HVRI (hyper variable) region was carried out in 363 samples of 10 Indian goat breeds. The pattern of molecular diversity in Indian goats was analyzed by mismatch analysis. The neighbour-joining tree of Indian goat breeds along with wild goats was constructed for the first time. The Indian goats were placed into three different groups: first group – Jamunapari, Sirohi, Marwari, Pashmina; second group – Jakhrana, Black Bengal, Osmanabadi, Barbari and Kutchi; and third group – local (non-descript) goats of Mathura region. There were additional lineage observed in Indian goats indicating that considerable additional diversity exists within Indian domestic goats. Evidence for population structure and novel divergent lineage in Indian goats indicated a more complex origin for domestic goats.

Estimation of genetic relationship between Camel breeds: Blood samples from 50 unrelated individuals of Bikaneri, Jaisalmeri and Kachchhi camel breeds were collected from farm and field areas. Microsatellite loci, viz. LCA-56, LCA-66, LCA-63, YWLL-08 and VOLP –67 were amplified and analyzed. At LCA-56, LCA-66 and LCA-63 loci, respectively, 2,3, and 5 alleles were amplified in the three breeds of camel. The genetic distances between the three Indian breeds were estimated. The consensus arrived from observed data indicated close phylogenetic relationship between Bikaneri and Kachchhi breeds. The Jaisalmeri breed joins subsequently.

Marwari horse: At the NRC for Equines, breed characterization was initiated using biometrical, biochemical and molecular approaches in the potential Marwari horses. Microsatellite-based PCR studies indicated the existence of genetic variability within Marwari breed.

Genetic characterization of an egger type population vis-a-vis indigenous homogeneous chicken stocks: A project was initiated at the PDP, Hyderabad, on molecular genetics studies of an experimental brown egger population with emphasis on building of a resource-population. Various genetic sub-groups of varying genetic

Genetic variability was observed within Marwari horse breed

homogeneity within the experimental population were established, and a back-cross (BC1) population originating was developed for detailed molecular dissection.

The genomic profiling of the experimental chicken strains and the resource populations based was undertaken on the AP-PCR patterns using randomly amplified polymorphic DNA segments (RAPDs). A set of 30 random decamers was used for the analysis, out of which at least 15 were polymorphic and useful. The technique was capable of eliciting genetic homogeneity state of the purelines and the inter-strain genetic distances conclusively as conforming to the breeding history of the said lines. The technique also provided for the estimation of allelic and genotypic frequencies from amongst test samples for numerous polymorphic loci.

The genetic analysis of the above two lines was further confirmed by dice-coefficient-based similarity matrices using multiple primers. The overall intra-line genetic similarity indices varied significantly from one line to the other upon use of primer 56F, indicating that the line H was more genetically homogeneous than the Px. This fact was further ascertained by subjecting the said two lines to primer 40F and again the difference between the two was confirmed to be significantly different variant from each other. The above findings were corresponding to the breeding histories of the said two lines, which explained for the fact that the line H was closed for more number of generation than the line Px though both were subjected to almost equal intensity of selection.

Randomly amplified polymorphic DNA (RAPD) analysis was carried out on IWI,IWH,IWF,IWD and Dahlem Red layer pure lines using a series of selected primers for examining their genome level constitution and evaluating inherent population parameters. Genotypic pools for these representative pure lines were generated and profiled.The Dice-UPGMA (unweighted pair group method) results showed that IWH and IWI exhibited the highest genetic similarity (86%) to each other, while the next similar (83%) were the IWD and IWF line-pair. The Dahlem Red (brown egger) line, as expected, was singled out as an

outlier line with least genetic similarity (74 to 76%) to the lines IWH, IWI and IWD and with moderate similarity of 80% to line F. The study concluded that because of unidirectional selection for number of generations, the genetic variation within these lines has considerably reduced (in proportion with the selection intensities). It may be desirable to change the recommended combination of H and I to other possible ones, to produce commercial crosses (like ILI-80) in view of the reduced genetic distance between them *vis-a-vis* other pure lines.

Molecular genotyping of the PDP pure lines: The inter simple sequence repeat (ISSR) based polymorphism studies were attempted using random oligoes of 17 or 18 primers containing dinucleotide repeats as the core units. The AT and TA based primers failed to yield any amplicons, while the (CT) n primers gave rise to isomorphic amplicons following the ISSR- PCR. Promising leads in diversity analysis could be possible using the primers consisting of AG and TG cores. All the amplicons of ISSR analysis conformed to the expectations and parameters relevant to the distribution of microsatellite loci in the chicken genome as published from contemporary studies.

Molecular genetics and diseases resistance: At the CARI, Izatnagar, using microsatellite markers the BC1 progenies were selected for least genetic similarity with the naked neck grand sire. The BC2 progenies were generated by mating the selected BC1 individuals and White Leghorns. Two types of BC2 populations were developed. Type A BC2 population was the cross between BC1 naked neck selected males with WLH females, while mating of BC1 selected females with WLH males produced the type B BC1 population. The BC2 progenies were genotyped with 10 microsatellite marker. The BS estimates ranged from 0.44 to 1.00 in BC2 population. The overall mean genetic similarity between the grand sire and BC1 progenies in type A, type B and overall BC1 populations was 0.693 ± 0.176, 0.671 ± 0.020 and 0.682 ± 0.013 from pooled over all markers in type A, type B and overall BC1 populations respectively.

The characterization of Kashmiri commercial layer was done using biochemical, cytogenetic and molecular tools. The gene frequencies of HbA and HbD alleles were 0.86 and 0.14, respectively. Allele AlbA had lower (0.033) frequency than AlbB (0.967). The allelic frequencies of TfA and TfB alleles were 0.97and 0.83, respectively. The overall within KCL BSF estimate was 0.831±0.044, which demonstrated a higher level of genetic similarities. The KCL birds showed minimum genetic distance from IWG-WLH (0.073) and maximum from guineafowl (0.231), on the basis of pooled DNA analysis.

Conservation and Improvement

Jamunapari goat: The effective population size is an important concept in the management of threatened species like goat. The effective population size (Ne) varied from 7.3 to 48.24 over the years. The major problem is that all the males are sold at very early age and very few farmers keep a buck for breeding purpose. If required they purchase the bucks during breeding season and again sell them. Similarly, the per cent genetic diversity preserved varies from 92.3 to 98.3% in this breed. The average fertility percentage was 70.38%, ranging from 59.15 to 78.09%, and the variation over the years is because of environmental variation.

Indigenous poultry germplasm

Aseel (Peela and Kagar varieties) and Kadakanath breeds were regenerated, conserved and were utilized for the production of CARI-Nirbheek and CARI-Shyama for backyard poultry production. The body weight increased by 162 g and 134.2 g at 15th week of age in males of *Aseel* and Kadakanath, respectively. Corresponding values for females were 151.4 g and 136.7 g. A small flock of Silky having pool of other major genes was developed.

Kadaknath

Aseel

World's first turkey embryo culture chick in laboratory

Simple and efficient double window embryo culture system for production of embryos of turkey in National Fellow's laboratory was successfully carried out for the first time at the CARI, Izatnagar. These techniques could be used for transgenesis, production of chimeric birds, production of pharmaceutical proteins with egg gene promoters and will also provide appropriate tools for conserving rare and endangered poultry species.

World's first turkey embryo culture chick was developed at the CARI,Izatnagar

Marwari horses: At the NRC for Equines, Hisar, work was initiated to standardize frozen semen technique for *ex situ* conservation of Marwari horses. Various physical and biochemical parameters of the semen were defined during breeding seasons in the stallions.

Establishment of embryonic stem cells from buffalo embryos: At the Animal Biotechnology Centre of the NDRI, Karnal, a study was conducted to establish the cultural competence of morulla cells from buffalo embryos grown on mice embryonic fibroblasts (MEF) feeder layer developed from skin cells of mice embryos. The morulla cells were quiescent for first 24 hours when there was no apparent development. The cells started proliferating subsequently and tended to grow as a group of small, round and tightly adhered cell chunk, which after 4 days in culture appeared to be detaching from the feeder layer surface. The study represents a preliminary report of growing embryonic stem cells in buffaloes. Characterization of the proliferated cells for their stem cell specific markers is, however, yet to be established.

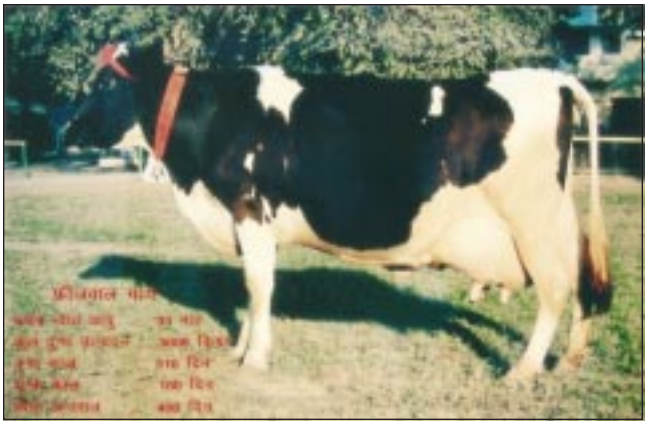
ANIMAL BREEDING

Cattle

Frieswal: The aim of this project is to develop a new cow strain called Frieswal for the country, which will produce 4,000 litres milk in a mature lactation of 300 days with 4% butter fat. This project is in operation at Project Directorate on Cattle, Meerut, in collaboration with 45 Military Farms located in different agro-climatic zones of the country. The herd strength of Frieswal females was 17,031 including 10,185 adult animals and 1,786 calves. The total Frieswal population has increased by 48% in last 3 years. More than 0.12 million doses of Frieswal semen have so far been produced at the Semen Freezing Laboratory. At present 735,089 doses of Frieswal semen are available in the gene bank.

The age and weight at first calving (AFC, WFC) averaged 1,005 days and 364 kg, respectively. Cows born at Military Farm, Lucknow,had the lowest AFC (863 days) followed by those born at Ahmednagar (893 days) and Dimapur (909). Average milk production (300 days) in the entire lactation was 2,887 and 3,081 kg, respectively. Lactation milk yield in 300 days was the highest at Military Farm, Massimpur (3,570 kg) followed by Lucknow (3,544 kg) and Ahmednagar (3,492 kg). Total milk production improved from first (2,893 kg) to second (3,066 kg) lactation and declined thereafter. Year and season of calving significantly affected lactation milk yield in 300 days and in the entire lactation. Peak yield and lactation length in Frieswal cows averaged 14.27 kg and 315 days, respectively.

Average service period, dry period and calving interval were 161, 112 and 426 days, respectively. All reproduction characteristics have shown improvement in desirable direction.Young bulls were evaluated for their genetic merit based on the first lactation (300 days) yield of their daughters. Top 10 bulls had breeding values between 2,835 and 2,926 kg. Their superiority over the herd average ranged from 136 to 227 kg i.e. 5.04 to 8.41%. The semen of these bulls is now being used on elite females for production of young male calves.



Frieswal cow—Age at first calving, 33 months; total milk yield, 3000 kg; lactation period, 310 days; dry period, 100 days; calving interval 400 days

Indigenous Breeds: The objective of this project is conservation and genetic improvement of indigenous breeds. Presently, the programme covers Hariana, Ongole, Gir and Tharparkar breeds in collaboration with the State Agricultural Universities.

- In Frieswal cows lactation milk yield in 300 days was 3,570 kg, peak yield 14.27kg and lactation length 315 days
- Genebank has 735,089 doses of semen of Frieswal bulls
- Hariana,Gir,Ongole and Tharparker breeds are being studied for conservation and genetic improvement
- Average milk yield of Murrah buffaloes was 2,928kg
- Twin lambing was 45 % and triplet was 2.5 % in Garole × Malpura cross
- Bharat Merino sheep is a promising dual type breed useful for improving both wool and weight of indigenous sheep
- Chokla, Marwari and Magra sheep are being studied for carpet wool production
- Madras Red, Ganjam, Muzaffarnagari, Nellore and Deccani sheep are being studied for mutton production
- Genetic improvement and sire evaluation are being done in Barbari and Jamunapari goats
- National Research Centre on Pigs was established at Rain, Guwahati
- Rabbit kit survival was highest in White Giant followed by New Zeland White
- White Leghorns birds were improved for egg production
- Caribro Tropicana ranked third in19th RSPPT,Gurgaon as it attained 1,750g body weight by 7-weeks of age
- CARI strain achived top position in hen housed egg production at 31st RSPP,Hessarghata
- CARIBRO- Dhanraj achieved 1,875 g at 7 weeks of age

Friswal bull—reproduction age, 24 months; adult weight, 600 kg; body length 160 cm; body height, 155 cm

Hariana cow—Age at first calving, 55 months; total milk yield, 1200 kg; lactation period, 250 days; dry period, 180 days; calving interval 500 days

Hariana bull—reproduction age, 37 months; adult weight, 500 kg; body length 150 cm; body height, 140 cm

Ongole cattle: The conception rate was the highest (65.7%) at Associated Herd, Lam, followed by at Germ Plasm (GP) Unit, Lam (59.5%) and the lowest at Associated Herd, Chintaldevi (30.09%). Under test mating in four sets 33 bulls (8+8+8+9), have so far been used and about 941 daughters were born. The semen doses available on closing date at Germ Plasm Unit were 68,412. The age at first calving averaged 53.83 months. The average lactation milk yield and peak yield were 624.92 and 3.23 kg. The highest lactation milk yield (1010.8 kg) and peak yield (3.60 kg) were recorded at Associated Herd, Chintaldevi. The dry period and calving interval averaged 301.79 and 474.83 days. Bulls of first and second sets were evaluated based on first lactation records of their daughters. Draught power varied from 0.59 to 1.00 HP among the bulls.

Hariana cattle: The breeding population comprised 813 females and 30 young bulls (above 2 years). The highest conception rate was 74.58%. Under test mating 44 bulls (9+8+9+9+9), in 5 sets have so far been used, resulting in birth of 1,158 (348 + 213 + 238 + 207 + 152) daughters. On closing date 40,456 doses of frozen semen of test bulls were available. Average age at first calving, first lactation milk yield and peak yield were 53.9 months, 1,031.70 kg and 5.91 kg, respectively. First dry period, service period and calving interval averaged 235.22, 178.63 and 474.6 days, respectively. Nine young bulls were put to training for draught took on an average 37.66 days for training.

Field Progeny Testing: Under this project semen of Frieswal bulls is being progeny tested under field conditions at the PAU, Ludhiana; KAU, Mannuthy; and BAIF, Urulikanchan.

At the Punjab Agricultural University, Ludhiana, about 7,200 inseminations were done from fourth set of bulls. Progenies born from earlier three sets of bulls have completed their first lactation records. The average age at first calving of these progenies was 37.0±0.54, 33.9±0.61 and 31.8±0.95 months, and the average first lactation (305 days) milk production was 2,711.4, 2,831.2 and 2,980.8 kg, respectively. The average fat percentage of the progenies was 3.7±0.02, 3.8±0.02 and 3.8±0.01, respectively.

At the KAU, Mannuthy, 5,036 semen doses were received out of which 3,735 doses were used for AI. About 979 pregnancies were confirmed. The average milk yield from progenies of these three sets was 2,018.79, 2,107.32 and 2,073.4 kg, respectively, and average age at first calving 1,015.96, 1,016.37 and 1,380.5 days, respectively.The fat percentage increased with the advancing stage of lactation.

At the BAIF, Urulikanchan, Pune, out of the total 3,839 inseminations, 2,641 were followed for pregnancy diagnosis and 1,223 pregnancies were confirmed. The average progeny performance for first lactation yield was 2,911.91 kg.

Buffalo

Network Project on Buffalo Improvement: Under the project, work on improvement of various buffalo breeds is being undertaken. Associated progeny testing of Murrah breed is continuing at centers located at the PAU Ludhiana, CCSHAU Hisar, CIRB Hisar, NDRI Karnal, IVRI Izatnagar, and CCBF Alamadi. Murrah breed test mating from seventh set of 12 genetically superior breeding bulls was continued up to December 2003. Average age of the bulls at the time of selection was 34.3 months. Average of dams best yield was 2,928 kg. Bull number 761 from CIRB, Hisar, ranked first with sire index of 1,988 kg based on 15 daughters spread in 6 participating centers.

A germplasm repository of more than 30,000 frozen semen doses from the progeny tested bulls, is available at various participating centers, simultaneously, more than 250,000 frozen semen doses from progeny tested bulls are also available.

Improvement in weighted average in lactation milk yield of over 0.5% was estimated from all the participating herds of Murrah over the previous year. Elite herds of Bhadawari, Godavari and Surti breeds were established. Superior bulls of Pandharpuri and swamp buffaloes were also generated at the participating centers.

Performance recording and improvement work for

Elite herd of Bhadawari buffaloes was established

Jaffarabadi (GAU Junagadh), Bhadawari (IGFRI, Jhansi), Surti (MPUAT Vallabhnagar), Nili Ravi (CIRB Sub Campus Nabha), Pandharpuri (MPKV, Kolhapur), Godavari (ANGRAU Venkataramanagudem) and swamp buffaloes (AAU, Khanapara) is also continuing under this project. These centers aim to undertake progeny testing of bulls with the participation of farmers' buffaloes for test mating.

Sheep

Reproductive efficiency of Malpura × Garole: Overall means for birth, 3-,6- and 12- month body weights were 3.07,12.86,20.55 and 32.37 kg, respectively, in Malpura lambs. The corresponding figures for Garole Malpura lambs (G × M) were 2.21, 10.26, 17.26 and 26.19 kg, respectively. Crossbreeding of Garole rams with Malpura ewes was continued. The twin lambing percentage in G × M ewes was 45.00% and triplets 2.5%.The average number of lambs born per ewe lambed was 1.5 in G × M cross and 1.02 in Malpura. The survivability of all the genetic groups were almost at par. Reproduction results in G × M ewes indicated that Garole crosses might prove to be a valuable germplasm for evolving a new prolific strain of sheep. Average litter size on the basis of total lambing obtained was 2.05. The adult survivability was 92.11%.

Bharat Merino - a promising dual breed: Bharat Merino is a promising import substitute for exotic fine wool breeds as it has expressed better growth, reproduction and survivability and wool quality almost similar to that of exotics. The annual lambing and survivability were 85.84 and 95.76%. The annual greasy fleece yield (GFY) was 2.008 kg, and the 6-monthly body weight was 22.96 kg. The hot carcass weight of lambs, kept under feedlot experiment at the age of 3-months and slaughtered at 6 months, was 10.6 kg and their dressing percentage on empty live weight was 52.53%. The Bharat Merino is getting popularity for improving wool and weight of sub temperate sheep of the country.

Network Project on Sheep Improvement

Sheep for Carpet Wool

Chokla sheep: The overall least-square means for first greasy fleece yield, adult 6 monthly and adult annual wool yields were 0.803,1.029 and 2.103 kg, respectively. Average body weights at birth, 6-months and 12-months of age were 2.72, 18.56 and 26.77 kg, respectively. Preweaning (0-3 months) and post weaning (3-6,6-12 months) daily weight gains were 109.33, 55.85 and 33.13 g, respectively. Overall survivability of the flock was 96%. Annual lambing (based on ewes available) was 86%.

Avikalin sheep for meat and carpet wool

Avikalin has the potential to be developed as dual type sheep for carpet wool and mutton production. The overall survivability was 94.15%. Birth weight of lambs was 2.73 kg. The overall means for 3-,6-,9- and 12-month body weights were 10.24,20.17,25.64 and 30.09 kg, respectively. Tupping was 98.18%. Lambing per cent on ewes available and tupped basis were 83.64 and 85.19 respectively. Overall least square means for first-, second-, adult six-monthly and adult annual greasy fleece yields were 0.682, 0.511, 0.642 and 1.400 kg, respectively. The selection differential for 6-month body weight and 6-month greasy fleece yield was 4.53 and 0.254 kg, respectively.

Marwari sheep: At the ARC Bikaner, Marwari sheep is being improved through selection for carpet wool production. The average birth, 3-,6-, and 9-month weights were 3.02, 18.83, 22.24 and 27.70 kg respectively. The tupping percentage was 82.30. The overall least-squares means for first clip and adult annual clip were 482 and 1,185 g respectively. The overall survivability was 98.7%.

Magra sheep: At field based unit, Bikaner, the Magra sheep is being improved for carpet wool production. Four centres were established at Norangdesar, Gadhwala, Kilchu and Kodemdesar. The Kodemdesar center was identified as ram rearing centre. The average body weights at birth, 6 and 12 months and adult stage were 2.73, 19.33, 27.89 and 36.97 kg respectively. Average greasy fleece weight at 6-months of age was 991 g.

Sheep for Mutton Production

Madras Red sheep: At Kattupakkam, Madras Red sheep is being improved through selection for mutton production. Madras Red sheep is one of the important meat breeds of Tamil Nadu. The breedable ewes were identified through tattooing. Overall mean of body weight for birth, weaning, 6, 9 and 12 months were 2.86, 10.01, 15.16, 17.91 and 21.78 respectively. Pre-weaning and post-weaning daily weight gains were 80 and 43 g respectively.

Ganjam sheep: At the OUAT, Bhubaneshwar, Ganjam sheep are being improved for mutton production. Overall mean of body weights for birth, weaning, 6, 9 and 12 months were 2.48,10.52, 14.92, 19.13 and 21.35 kg for males, and 2.26, 9.45, 13.50, 17.51 and 18.95 kg for females respectively. The lambing per cent on the basis of ewes available was 77.36. Distribution of breeding rams is in progress.

Muzaffarnagari sheep: At the CIRG, Makhdoom, the

Overall survivability of Chokla sheep was 96%

The Madras Red sheep is one of important meat breeds in Tamil Nadu

Muzaffernagri sheep is being improved through selection for meat

Muzaffarngari 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 yields. The least-square means for birth, 3-, 6- and 9- months body weights of lambs were 3.25, 15.35, 21.49, 26.74 and 31.42 kg respectively. Tupping was 96.64%. Lambing% based on ewes available and tupped was 95.09 and 98.43 respectively. Replacement rate was 28.46%. First 6 monthly GFY was 491 g and adult annual yield was 1,250 g. Overall survivability was 97.43%.

Nellore sheep: At the ANGRAU, Palamner, the Nellore sheep is being improved through selection for mutton production using selection index incorporating body weight at 3 and 6 months of age. Overall mean body weight at birth, weaning and 6 months of age were 2.80, 12.37 and 17.23 kg respectively. The annual tupping per cent was 96.47 and lambing per cent on the ewes available during the main season was 82.55. The mortality and culling percentages were much lower than permissible limits fixed. Selection differential for weaning and 6-month body weight were 2.2 and 2.9 kg respectively.

Deccani sheep for dual purpose: At the MPKV, Rahuri, development of elite flock of dual purpose Deccani sheep is in progress. Average body weight at birth, weaning, 6-, 9- and 12-months of age were 2.97, 13.95, 19.26, 20.13 and 22.07 kg respectively. The tupping percentage was 95.51 while the lambing based on ewes available was 85.14%. Average age of ewes at first lambing was 652 days. Overall greasy fleece yield in first, second 6 monthly and adult 6 monthly clips was 0.452, 0.403 and 0.464 kg. Overall mortality in the flock was 3.49%. The selection differential for 6 monthly body weight and GFY 1 was 4.10 kg and 0.106 kg respectively.

Goat

Jamunapari goats: Production performance in Jamunapari goats is being improved through selective breeding. About 164 elite goats were distributed for breed improvement programme to different parts of country. Jamunapari goats attained body weight of 29.60± 0.44 kg at 12 months of age, an increase of 1.85 kg over the last year. The average milk yield in 90 days was about 83.20 kg. The multiple birth percentage was 35.63%. The heritability of 9- and 12- month body weight was 0.25± 0.08 and 0.26± 0.09 respectively. The heritability estimates for 90 and 140 days milk yield were 0.27± 0.19 and 0.36± 0.20, respectively. The Government of Madhya Pradesh is using the breed for breed improvement programme, and the CIRG is supplying elite germplasm.

Barbari goats: The Barbari is one of the famous dual purpose goat breeds of semi arid zone of the country. While the breed can be successfully maintained in flock, it is also well adopted in urban area where no grazing facility is available. A flock of genetically superior goats was developed. The breed has shown 76% population growth. The breed is early maturing with age at sexual maturity of around 209± 14 days and average weight of female 15.68± 0.21 kg. The kidding interval ranged between 217± 0.25 and 335± 13.5 days. The 90 days milk production was 78.82± 1.95 litre during the year. The body weight at 9 and 12 months of age showed significant improvement over the years and increased to 20.59± 0.36 kg and 24.44± 0.46 kg, respectively, with highest individual body weight of 33.00 and 39.00 kg at 9 and 12 months of ages, respectively. The milk yield in 90 days and in a lactation period was 164.00 and 203.35 litre, respectively.

Pig

Under the All-India Coordinated Research Project on Pigs, work is being undertaken to develop upgraded pig with 75% exotic inheritance having higher litter size at birth and weaning (7.6% and 7.00%). The National Research Center on Pig, was established at Rain, Guwahati, Assam, to undertake research on various aspects of pig production, take up region specific pig improvement programme, and coordinate work at various centers of AICRP on Pigs, and to extend technical support to pig growers in hilly and backward areas.

Rabbit

Meat and fur production: New Zealand White (NZW), White Giant (WG), Grey Giant (GG) and Soviet Chinchilla (SC) were maintained in sub temperate climatic conditions at North Temperate Regional Station (NTRS),

The National Research Centre on Pig, was established to work on all aspects of pig husbandry, and give technical know how to pig farmers of tribal and hilly region

CARIBRO–Tropicana attained 815.6 ± 13.76 g body weight at 5 weeks of age

Garsa. Weaning weight (28th day) in different breeds were — 543.4 g (New Zealand White), 532.7 g (White Giant), 465.8 g (Grey Giant) and 496.2 g (Soviet Chinchilla). Pooled 84-day body weight was 1.85 kg in NZW, 1.88 kg in WG, 1.74 kg in GG and 1.77 kg in SC breed. Kit survival was 95.83% in NZW, 98.83% in WG, 99.24% in GG, and 95.23% in SC.

Angora wool production: In German Angora rabbits maintained at the North Temperate Regional Station, Garsa, the average litter weight at birth was 335 g. The average pooled wool yield of breeding flock of German Angora were 152.84, 157.49, 159.50, 165.26 and 177.89 g in I, II, III, IV and V clips, respectively. The pooled wool yield of British, Russian Angora and German × Russian Angora Cross (A-1) were 99.48, 107.25 and 95.0 in first clip; 119.28, 108.32, 113.21 in second clip; 103.57, 110.81 and 91.42 in third clip and 117.67, 107.16 and 96.42 in fourth clip respectively. The pooled staple length (cm), fiber diameter (µ) and guard hair (%) of German Angora rabbits were 6.09, 13.06 and 3.16 respectively.

Poultry

Poultry for egg: The White Leghorn strains were improved at the CARI, Izatnagar, for egg production. While H and I lines were improved for annual egg production, the G and J lines were further selected for high part period egg production and egg production up to 40th weeks of age. The random bred control population (C) was also generated and evaluated simultaneously with H and I lines. Fertility% among various selected and control strains of WLH, ranged from 81.97 to 85.68% respectively. In WLH (I and H) strains, after 26th generation of selection significant genetic gains for part period egg number were 0.83 and 1.06 eggs/generation respectively. The average significant changes per generation for ASM ranged from –0.40 to –0.66 days, for 20-week body weight 3.00 to –44.57 g and for 40-week body weight –3.36 to 4.14 g/generation respectively.

Poultry for meat: At the CARI, Izatnagar, the selection programme continued in the specialized synthetic sire lines (SML-2 and CSML) and dam lines (SDL and CSFL) to develop white and colour commercial broilers. The% fertility in SML-2, CSML and CSFL were 77.60, 77.6 and 78.69 respectively. The H% (FES) was 77.43, 77.3 and 81.8 in the respective lines. The average 5-week body weight in CSML, CSFL and SML-2 were 1,001.67±4.28, 957.74±3.43 and 1,019.61±8.59g respectively. The per cent fertility was 83.7, whereas H% (TES) and H% (FES) were 70.6 and 84.2, respectively, in SDL. The mean body weight at 5 weeks of age in SDL, CARIBRO-Tropicana, IC-3 and IR-3 were 903.5± 7.7, 815.6± 13.76, 611.53±5.86 and 613.44±-5.75 g, respectively.

Improvement of colour pureline broiler population: The genetic characterization and improvement of broiler male and female lines with respect to economic traits was continued at the PD on Poultry, Hyderabad. The performance of male line (Pb.1) was recorded up to 40 weeks of age and the least square means for 4- and 5-week body weight was 767g and 1,065g, respectively. The adults matured at 163.8 days of age and produced 66.7 eggs up to 40 weeks with the egg weight between 56.5 and 59.3g for 32 and 40 weeks of age respectively. The heritability estimates of 5-week body weight, age at maturity, egg weight at 32 and 40 weeks and egg production up to 40 weeks were, respectively, 0.46, 0.30, 0.42, 0.52 and 0.07. Egg weight showed negative genetic and phenotypic correlation with egg production. In the female line (Pb.2) of S.13 generation 4- and 5-week body weights were 723 and 1,030g respectively. The female line matured at 166.6 days of age and produced 16.4 eggs up to 40 weeks of age. The egg weight at 32 and 40 weeks of age was 54.9 and 58.7g, respectively. The heritability estimates of 5-week body weight, sexual maturity, 32- and 40-week egg weight and egg production were, respectively, 0.25, 0.26, 0.81, 0.53 and 0.14. Both the lines showed improvement for economic traits over the previous generation.

Field performance of crosses: At the CARI, Regional Station, Bhubaneshwar, chicks hybrids CARI-Debendra (CSML×RIR), CSML×B-77 and B-77×CSML, were evaluated under backyard system of rearing. Body weight of CSML×RIR, CSML×B-77 and B-77×CSML at 12th weeks of age was 936±6.99, 829±10.3, 1,130±20g, respectively. Corresponding body weight at 16 weeks of age were

CARI-Debendra were evaluated under backyard system of rearing

1,405±10.11, 1,291±12.03, 1,620±12.18g, respectively. Body weight at 20 weeks of age was 2,072±12.91, 1,893±12.24 and 2,324±17.75g in CSML×RIR, CSML×B-77 and B-77×CSML, accordingly. Body weight of B-77×CSML crossbreed was significantly higher than the other crossbred. Body weight of CSML×B-77 was lowest amongst the three crosses at all the ages of measurement. Under the backyard poultry B-77×CSML performs better for higher body weight followed by CSML × RIR and CSML × B-77.The net profit for a 5-bird unit was highest in B-77×CSML followed by CSML×B-77 and CSML×RIR.

Introgression of Naked neck gene into a White Leghorn pureline: The performance evaluation study of first back cross generation heterozygous population revealed that mean age at sexual maturity; egg weight at 28, 32 and 40 weeks of age; body weight at 20 and 40 weeks of age and egg production up to 40 and 64 weeks of age in naked neck and its normal counter parts were — 132 and 136 days; 46.77 and 46.89g; 49.09 and 48.88g; 50.62 and 50.44g; 1,347 and 1,521g; 1,606 and 1792g; 113 and 114 eggs; and 219 and 219 eggs, respectively. As compared to normal control, the naked neck line matured 4 days earlier and produced eggs that were slightly heavier, but there was no significant difference in egg production.

Dwarf gene line (dw) for tropical broiler production: The juvenile and production performances of dwarf gene line were evaluated in DG01 generation. Since the population was segregating for naked neck, a sub-population of birds carrying both dwarf and naked neck gene was produced to study the complementary effect of these two major genes on various production traits. The mean 4- and 6- week body weights were 498g and 900g in males, 445g and 762g in females and 470 g and 825g on combined sex basis, respectively. In birds carrying both dwarf and naked neck gene, the average body weight at 4 and 6 weeks of age on combined sex basis was 441g and 793g respectively. Frequency distribution of egg production up to 40 weeks of age indicated that 29% birds laid less than 50 eggs and there is enough scope for further improvement of this line. The usefulness of complementary effect of dwarf and naked neck gene in a dwarf broiler dam line was evident from the fact that the dwarf naked combination birds laid eggs which were 1-2g heavier at early ages — a major advantage that can be exploited in the development of dwarf broiler dam line with better early egg weight. Heritability of egg production was low to moderate in magnitude with the evidence of sex-lined effect in the inheritance of egg production.

Dwarf line

Economical broiler production: The comparative performance of a purebred dwarf, crossbred dwarf vis-à-vis a normal broiler dam line was studied. The pure and crossbred dwarf dams matured 17.17 and 20.81 days earlier; produced eggs, which were 2.71 and 1.76g lighter at 32 weeks, and 3.81 and 1.77g lighter at 40 weeks and produced 5.77 and 11.88 eggs more up to 40 weeks of age than the normal broiler dam line. The body weights recorded were 11.17 and 8.69% less at 20 weeks and 18.79 and 17.24% less at 40 weeks of age in purebred and crossbred dwarf dam lines, respectively, as compared to its normal counterparts. The weekly body weights up to 28 days of age were significantly higher in the commercial broilers developed utilizing normal broiler dam line. But at 35 and 42 days of age, no significant difference in body weight was observed. Between 2-4 and 2-6 weeks of age the commercial progeny developed utilizing dwarf dams (both pure- and cross- bred) were more efficient than commercial broilers developed utilizing normal broiler dam line. The cell-mediated immune response measured as response to PHA-P, indicated that there was no significant difference between genotypes. The humoral immune response measured against SRBC at fifth day post inoculation after 21, 28 and 35 days of age, did not show any significant difference between different genotypes. The immune response was the highest up to 5 days post-inoculation. These results suggested the utility of dwarf dam line for production of commercial crosses from the point of economization on feed cost, conservation of housing space and production of more settable eggs per dam.

All-India Coordinated Research Project on Poultry Breeding

Under Poultry for Egg component intra-population selection for egg production up to 64 weeks of age, was undertaken to achieve the set target of 300 eggs in layer stocks. The project included IWD and IWF strains at the ANGRAU, Hyderabad; IWN and IWP strains at the KAU, Mannuthy and GAU, Anand; and IWH and IWI strains at the CARI, Izatnagar. The response to selection for egg production was in the desirable direction in IWD and IWF strains as they laid 11 to 13 eggs more than the control up to 40 weeks of age. The hen-housed production in IWD and IWF lines was 111.6 and 109.8 eggs, respectively, by 40 weeks of age. The hen housed egg production was 31 eggs more in IWD and 39 eggs in IWF lines as compared to the control lines up to 64 weeks of age. Similarly, the hen-housed production was more by 17 eggs in IWN and 22 eggs in IWP lines over the control up to 40 weeks of age. The increase was continued up to 64 weeks but to a lesser extent (4 eggs in IWN and 13 in IWP). The same

Performance of Naked Neck gene line

At the PDP Hyderabad, the juvenile and production performance of NG.01 generation of naked neck gene line was evaluated. On combined sex basis, heterozygotes were around 36g heavier at 4 weeks of age and 50g heavier at 6 weeks of age. The control normal birds laid around 2 eggs more up to 40 weeks of age but the egg weight was less by 2.25g over the naked neck counter parts indicating favorable effect of naked neck gene on egg weight. Around 45 % of birds laid less than 50 eggs up to 280 days of age, suggesting that there is enough scope for improvement of this trait through selective breeding.

lines maintained at the Anand centre for feed efficiency, produced 115.2 and 108.4 eggs up to 40 weeks of age, respectively. As compared to the control line the hen-housed production up to 72 weeks was 49 eggs more in IWN and 32 eggs more in IWP line.

At the CARI, Izatnagar, the estimate of phenotypic response in hen-housed egg production up to 40 weeks was 1.70 egg and 1.40 eggs; for 64 week egg production, 0.85 and 1.25 eggs; and for age at first egg was 1.75 and, -1.42 days in IWH and IWI strains, respectively. The realized genetic gain estimated for 40 week egg production was 1.25 eggs in IWH and 0.99 eggs in IWI, which was statistically significant. The realized genetic gain estimated for 64-week egg production was 1.33 eggs in IWH, 1.74 eggs in IWI.

At the KAU, Mannuthy, the culling level for egg weight with selection for egg number was followed in IWN and in IWP strains. The egg weights at 28 and 40 weeks of age for IWN strain were 50.63 and 54.26g, respectively. The corresponding egg weights for IWP strain were 50.42 and 54.01g respectively. At the ANGRAU, Hyderabad, the four generations of selection for egg number to 64 weeks increased the annual egg production by 10 eggs in IWF and 31 eggs in IWD. Switching over of selection to 64 week egg number reduced the age at maturity and increased egg weight in IWN and IWP strains. The feed consumption of individual birds at the GAU, Anand, was only 107 and 109g/day for IWN and IWP, respectively, till 64 weeks of age. In this generation, the feed consumed to produce a kg egg mass was reduced by 431 g in IWN strain and 409g in IWP, as compared to the previous generation. The HDF and HFD crosses were superior and produced 293 and 282 eggs, respectively, up to 72 weeks of age. The line IWH was found to be an ideal male line for production of three-way crosses in combination with DF and FD crosses. Whenever IWK line was used in the cross the egg weight showed an improvement of 2 to 3 g. The NP and PN crosses generated at the GAU, Anand, were, respectively, superior for part period egg number and egg weight. The average egg production was 298 eggs in NP cross and 293 in PN cross combination.

The Poultry for Meat Component of the project included synthetic broiler lines CSML and CSFL and corresponding control at the CARI, Izatnagar, a synthetic dam line each at the OUAT Bhubaneshewar, PAU Ludhiana and UAS Bangalore. The development and evaluation of purebred dwarf dam line was assigned to the JNKVV Jabalpur. The dwarfing gene line was subjected to mass

Random sample laying test results

- At 31st RSPP Test, Hessarghata, Bangalore, the CARI strain achieved top position in hen-housed egg production under cage house system.This layer from CARI centre produced more than 300 eggs on hen-day basis with a feed efficiency of 1.77 kg/dozen eggs with an average feed consumption of 116g per bird/day. The average egg weight of 57.41g was also ideal from commercial point of view. In deep litter system the performance of the layer from the CARI centre ranked among the best commercial layers available in the country.
- The cross, ILM-90 developed at the KAU, Mannuthy, secured fifth position at Random Sample Test, Hessarghatta, Bangalore, and Bhubaneshwar. At Bangalore, the cross produced 266 and 287 eggs on hen-housed and hen-day basis, respectively, with an average egg weight of 57g and a margin receipt of Rs 5.01 under cage system of management. Under deep litter, this strain cross produced 299 and 288 eggs with an average egg weight of 57g.
- The Anand center participated in the tests conducted at Mumbai, Gurgaon and Bangalore. At Mumbai the cross laid 290 and 291 eggs on hen-housed and hen-day basis, respectively. The feed consumption was 98.5g/bird per day.
- The cross, ILR.90 evolved by the ANGRAU, Hyderabad, participated in Bangalore test and recorded 267 and 278 eggs on hen-housed and hen-day basis, respectively. The average egg weight was 57g with a margin receipt of Rs 7.16 under cage system of management. Under deep litter the strain cross produced 273 and 279 eggs with an average egg weight of 56g. In Mumbai the same cross laid 286 and 287 eggs on hen housed and hen day basis with a feed consumption of 102g/day. This cross has showed a high feed efficiency of 1.578 kg feed/dozen eggs.
- In RSLT at Bhubaneshwar centre, CARI strain achieved the third rank based on hen housed egg production.

Random Sample Broiler Test

- In RSPPT, Gurgaon, the CARIBRO-Dhanraj from CARI achieved 1,430 and 1,875g body weight at 6 and 7 weeks of age, respectively, with corresponding feed conversion ratio of 1.78 and 2.008. The dressing per cent at 7 weeks was 70.92%. The margin of receipt at 6 and 7 weeks was Rs 28.07 and Rs 33.20, respectively.
- Cross from PAU, Ludhiana, achieved 1,480 and 2,005 g body weight at 6 and 7 weeks of age, respectively, with a feed conversion ratio of 1.782 and 1.929 for both the ages. Dressing yield at 7 weeks of age was 72.41%.

CARI–Dhanraj

- The entry from the OUAT, Bhubaneshwar, attained a body weight of 1,325 and 1,700 g at 6 and 7 weeks of age, respectively. The corresponding feed conversion ratios were 1.930 and 2.239.
- In 19th RSPPT at Gurgaon, CARIBRO-Tropicana (cross of naked neck and frizzle broiler lines) ranked third on the basis of 7-week body weight (1,750 g) with an FCR value (0-6 week) as 1.9, dressing % as 73.1 and margin of receipt at 7 weeks as Rs 29.41.
- CARIBRO-Dhanraja ranked second in 19th RSPPT for broilers held at Gurgaon, on the basis of 6-weeks body weight (1,430g) and 7-weeks body weight (1,875 g).

selection for 5-week body weight. Egg production and hatchability were also considered for improvement, as this population is meant for the development of a suitable broiler dam line.The average body weight at 3 and 5 weeks of age in S-8 generation was 532g and 511g at 3 weeks of age in CSML and CSFL populations and 1,002g and 957g at 5 weeks of age, respectively, at the CARI centre. At the OUAT, Bhubaneshwar, work was continued on evaluation and regeneration of the synthetic dam line (SDL). The body weight at 5 weeks of age was 1,141g in males and 1,024g in females. The average egg production up to 40 weeks of age was 50.14 while at the PAU, Ludhiana, the body weight of Pb.2 at 5 weeks was 900g. At the UAS, Bangalore, evaluation and re-generation of the synthetic Pb.2 was continued. The pureline body weight of female line (Pb.2) at 5 weeks of age was 867g. The average egg production up to 40 weeks of age was 77 eggs in S-7 generation.

Rural Poultry

Performance of Vanaraja and Giriraja, is being evaluated at the AICRP Centre, Agartala. Giriraja recorded more body weight (384 to 1,389g) than Vanaraja (352 to 1,168g), at 4 and 8 weeks of age. At farm and the household level, Vanaraja birds matured earlier than

Beneficiaries of Vanaraja

Giriraja. Age at sexual maturity was highly variable and ranged between 160 to 210 days at different locations. The Vanaraja birds produced more eggs compared to Giriraja on farm (38.13 vs 32.63) and at farmers' door (29.64 vs 23.74 eggs) up to 40 weeks of age. Farmers accepted both varieties of birds and were able to generate double the amount through sale of these birds than the local birds, at any given age. Giriraja had marginally higher mortality than Vanaraja and it was primarily (30-40%) due to predators. Absence of flightiness and bulky structure were the reasons for mortality in both varieties. Farmers preferred to retain these birds for short durations for meat purposes, rather than for longer duration for egg production.

Giriraj birds attained 1, 168 g body weight at 8 weeks of age

Germplasm for backyard/free range farming: In male parent line, the production performance of S-4 generation was measured at the Project Directorate on Poultry, Hyderabad. The production performances were analyzed separately for high, medium and low SRBC titres. Better production was recorded in the low titre group, followed by medium and high titre groups. The birds from high titre group matured late and were lighter in weight at both 4 and 6 weeks of age. The mean egg production up to 40 weeks of age and egg weight at various ages was also significantly higher in the low titre group as compared to medium and high titre groups. Egg production improved by 11 eggs as compared to the previous generation. The mean SRBC titre in high,

medium and low groups was 9.81, 7.15 and 2.75 log2 units, respectively. After completion of 40 weeks of age, parents for the next generation were selected to produce S-5 generation. Fertility was 90.33% and hatchability on total and fertile eggs set was 73.02 and 90.03%, respectively. The birds of low titre group were slightly heavier compared to the medium and high titre groups. After 6 weeks, proportionate number of birds was selected and the average intensity of selection was 0.416 for body weight and 0.52 for shank length.

Development of female parent line for production of suitable germplasm for backyard farming was undertaken on multi-colour meat type birds. Egg production did not show any significant change compared to the previous generation but egg weight significantly improved by 2-3g during laying period. The naked neck genotype had slight advantage (1.5 eggs more) over its normal counter parts for egg production up to 40 weeks of age. The heritability for egg number was low to moderate in magnitude with evidence of maternal effect. Based on 40 weeks production, shank length and antibody titres against sheep RBC, parents were selected to produce the S-3 generation. Fertility was 92.06% and hatchability on total and fertile egg set was 73.80% and 87.37%, respectively. During selection at 6 weeks of age, due importance was given for juvenile body weight and shank length, and required body weight in the terminal cross remained acceptable for backyard farming.

Evaluation of crosses developed for rural poultry production: Based on the juvenile performances, 4 crosses were identified for development of dual type of birds and 3 crosses for development of predominantly layer type of birds. Production performances recorded up to 40 weeks of age indicated that White Legorn × Dahlem Red could be utilized for commercial exploitation as a brown egg layer type of stock. The two-way cross Dahlem Red × Vanaraja pure line or its reciprocal cross could be utilized as a crossbred female line for production of commercial Vanaraja utilizing Cornish as a male line.

Dahlem Red

Dahlem Red, compared to the corresponding control line, laid 5 eggs more, with comparable egg weight. More than 30 % birds laid over 100 eggs up to 40 weeks of age. Egg mass was lowly heritable as that of egg production. Egg mass was negatively correlated with age at sexual maturity, egg weight at 28 and 32 weeks of age, but positively correlated with egg weight at 40 weeks of age, body weight at 20 and 40 weeks of age and 40 week egg production. This indicated that any attempt to improve egg mass up to 40 weeks of age will bring concomitant improvement in both egg production and egg weight. The magnitude of association of egg mass with egg production was comparably quite higher than that with egg weight, indicating that egg production is more important than egg weight in determining egg mass in chicken.

Female line (Dahlem Red)

SUCCESS STORY

Caribro-Tropicana

A heat tolerant broiler stock, which can perform better with least inputs, under hot and humid conditions, for a tropical country like India was much needed for a long time. The scientific efforts were made in this direction at the CARI, Izatnagar, and two major genes, viz. the naked neck and frizzle were introduced in synthetic broiler stock. These naked neck and frizzle broiler stocks were crossed to develop CARIBO-Tropicana, which has both naked neck and frizzle phenotype. At the home farm juvenile body weights at 3, 5, 6 and 7 weeks were 526, 914, 1,300, and 1,800 g, respectively. Outside farm, mean body weights and FCR at 6 and 7 weeks, dressing per cent and livability at 7 weeks were 1,280 and 1,750 g, 1.9 and 2.11,and 73 and 97%, respectively.

Quail

The selection programmes were continued to improve the egg type and broiler quail lines. In 12th generation the overall means of fifth week body weight in broiler quail line CARI Uttam, were 194.65±0.89g (males) and 201.03± 0.67g (females). The body weight of CARI Pearl, after eighth generation of selection in layer quail line, were 139.70± 1.27 (males) and 153.06± 1.23g (females). The 18th week egg production and egg weight were 65.08±0.53 and 11.89±0.4g respectively.

Guinea Fowl

The improvement programme in guinea fowl varieties continued for 12-week body weight and general immuno-competence traits. The average body weight at 12th week in Lavender, Pearl and white varieties were 754.69 ± 4.21, 904.59 ± 6.50 and 848.31 ± 5.99 g respectively. Performance of guinea fowl was better under the semi-intensive rearing system than the intensive rearing. The divergent selection continued in guinea fowl for developing the lines having high and low titre against SRBC. In S4 generation the HA line revealed significantly higher titre (7.14 ± 0.16) than LA line (5.68 ± 0.15).

ANIMAL HEALTH

Foot-and-mouth Disease

Significant achievements in molecular epidemiology and antigenic analysis were made. A large number of FMD outbreaks due to type 'O' followed by type A were recorded in most of the states in endemic form specially during winter and early summer (Oct-April). In the North Eastern states, type A caused most of the outbreaks followed by type O. Type Asia- 1 accounted for very small number of outbreaks. Reverse transcription, polymerase chain reaction and cycle sequencing are routinely used for

obtaining the nucleotide sequence of the FMDV field isolates. In type O, the new strain, which overtook Pan-Asia strain re-established itself as the predominant strain in FMDV type O outbreaks in India. In Asia-1, the previously identified novel subgroup (>10% nucleotide divergence) within the widely circulating lineage was responsible for disease outbreaks in both cattle and buffaloes and was present in six states in the country. Type A outbreaks were encountered due to involvement of two different genotypes identified previously. The field isolates of type O and Asia-1 in two-dimensional micro neutralization test were antigenically related (r > 0.4) in relation to the respective vaccine strains. In type A, majority of the isolates showed divergence with vaccine strains in relation to genetic and antigenic make-up. Selection of some of the new candidate vaccine strains for serotype is in progress. Antigenic variation occurs both in the presence and in absence of antibodies. These results have strong implications on efficacy of the vaccine, as the antigenic variants generated in partially immune animals can evade hosts immune response. In addition, serial passaging of the vaccine and challenge strains, which are usually required for vaccine production and testing, may result in the generation of variants, which may affect the immunogenicity of the vaccine strain.

The complete nucleotide (nt) sequence of a foot-and-mouth disease virus (FMDV) Asia–1 vaccine strain (IND 491/97) was determined and compared with more established vaccine strain IND 63/72. It revealed that all portions of the genome of two viruses are variable and supported the previous finding of their belonging to separate lineages of Asia-1 virus. Seromonitoring of post vaccine immune response is important to assess the efficacy of a vaccine. During the period under report ~2900 sera samples (paired/ post vaccination/post infection/random sera) that were subjected to determination of anti-FMDV antibody titers using liquid phase blocking ELISA, revealed that compared to previous year more animals had protective titre following vaccination. The national repository of the Project Directorate on FMD has 1,120 (714-type O, 212-type Asia-1, 180-type A and 14-type C) field isolates recovered from various parts of the country.

To differentiate the vaccinated animals from the naturally infected FMD carrier animals, a non-structural protein 3AB of FMD virus was identified, cloned and expressed for production of viral protein, which is having a good potential for differential diagnosis as a serological reagent in an ELISA system.

Extraction of RNA genome and RT–PCR (reverse transcriptase–polymerase chain reaction) of the virus specific sequences can be accomplished without eluting the virus from vaccine. Competitive PCR with an internal standard may help in quantification of the genome in terms of number of molecules. Use of RNA as an internal standard is ideal compared to DNA competitors. However, the transcribed RNA has to be free from DNA contamination. To achieve this, poly (A) was cloned at the 3' end of the 430 bp fragment of the competitive plasmid construct. The construct was transcribed and the RNA was

- Vaccine for bluetongue virus is under trial
- Diagnostic test developed for porcine reproductive and respiratory syndrome (PRSS) in pigs
- An indigenous killed vaccine using EHV-1 strain showed better immune response than commercially available vaccine
- PCR-ELISA developed for differential diagnosis of capri-pox virus
- PCR is the test of choice in regard to surveillance and monitoring of camel surra or trypanosomiasis
- Non-isotropic DNA probe developed for detectin of swine fever
- A primer pair was synthesizes to detect duck plague virus detection by PCR
- Genomics research was conducted on causal agents of economically important diseases
- Diagnostic kits were developed for rinderpest and peste des petits ruminants
- Live attenuated vaccine developed for peste des petits ruminants
- Recombinant antigen based diagnostics developed for detection of bovine viral diarrhoea virus

SUCCESS STORY

Diagnostic kits for the sero-surveillance and diagnosis of rinderpest and PPR

Diagnostic Kit for Rinderpest (RP)

Rinderpest had been one of the most important viral diseases of cattle and small ruminants since long. A monoclonal antibody based competitive ELISA kit was developed which specifically detects antibody to rinderpest virus and not to the PPR virus. The kit is ideally suitable for active sero-surveillance (disease surveillance) and sero-monitoring (vaccine antibody monitoring) of rinderpest virus antibodies. World Reference Laboratory (WRL) of *OIE* has validated this kit. Rinderpest specific competitive ELISA test is the only accepted system globally for rinderpest antibody detection where International trade is involved on livestock and livestock products. The kit is commercially viable,and is based on all the critical reagents developed indigenously. The production cost of this kit is 1/4th compared to the one commercially available.

Diagnostic kit for *Peste Des Petits Ruminants* (PPR)

PPR is one of the important viral diseases of small ruminants associated with high rate of mortality. The clinical surveillance can be done using a sandwich-ELISA kit, which is comparable to other international kits. Competitive-ELISA kit for PPR sero-surveillance and sero-monitoring is ideally suited for vaccine sero-monitoring and monitoring of antibodies to natural infection. The test is commercially viable and can be used for monitoring of PPR virus antibodies. The production cost of this kit is 1/5 compared to the one available commercially.

purified by oligo dT column. The purified RNA was used as competitor RNA in RT/PCR. Standard curve was prepared using the known concentration of RNA purified from virus preparation.

cDNA for bovine gamma interferon gene was synthesized from mRNA and cloned into yeast transfer vector pPIC 9k. This was subsequently, electroporated into yeast cells and the recombinant cells were induced for expression. SDS-PAGE analysis of the cell supernatant revealed specific protein band of 32kDa, which refers to the molecular weight of BGIF dimer. This was further confirmed by sequencing the BGIF gene being tried as a genetic adjuvant.

SUCCESS STORY

Diagnostics for detection of Bovine Viral Diarrhoea (BVD) virus

The NS3 (p80) antigen is a non-structural protein, which is largely conserved among the pestiviruses infecting animals. Therefore, this antigen is routinely used for detection of antibodies against BVDV, which is one of the economically important viral diseases of ruminants world-wide. Precise detection of BVDV antibodies in sera of cattle and buffaloes was possible by using recombinant antigen based ELISA. Till now, detection of BVDV antibodies was being carried out using kits.

Software for Animal Disease Monitoring and Forecasting

- India.admasEpitrak–Dynamic Interactive Veterinary Epidemiology Software to store, transmit, retrieve and generate Disease Forecasts, Epi reports, graphs and maps
- Offline module of above software for State Animal Husbandry Department, Field, databank and NATP.
- Online module for NADRES with website development (www.wbadf-nadres.org)

The survey was conducted for studying the prevalence of nationally important animal diseases like IBR (21%), brucellosis (16.52%), PPR (15%), bluetongue (44%) and other diseases.

Animal Diseases Monitoring and Surveillance

National sero-epidemiological surveys were conducted for brucellosis and IBR. The overall incidence of brucellosis was 14.72% and of IBR 18.86%.

About 350 isolates of leptospira were maintained and diagnosis was given for leptospirosis on referred samples from animals and human cases.

The Institute has also collected national disease database for the past 15 years and meteorological and agro-ecological data from all the agro-climatic zones of the country. As a part of National weather based animal disease forecasting for 15 animal diseases, forecasting was made with 75 to 98% accuracy of prediction for various agro-climatic zones. This formed the basis for animal disease forecasting for future and also the development of NADRES (National Animal Disease Referral Expert System).

Blood Protista

The immuno-protective glycoproteins of 34 and 29 kDa were isolated from the larvae of *Hyalomma anatolicum anatolicum* vector of bovine tropical theileriosis, and *Boophilus microplus* vector of bovine babesiosis. Immunization of experimental crossbred cattle by isolated antigens was simulated with application of insecticides and tick challenge. Data were analyzed statistically for active seasons of these two ticks and significant protection was achieved against them. A 40% reduction in the frequency of application of insecticides was noted. Besides the effect on tick biology, a partial reduction in the growth rate of *Theileria annulata* ticks feeding on immunized calves was observed.

Haemorrhagic Septicemia

Collection and serotyping of different isolates of *Pasteurella multocida* resulted in identification of various serotypes from cattle, buffaloes, sheep, goat, pig, chicken, quail, duck, lion, tiger, dog and leopard. All the field isolates were characterized by biochemical test,

Genomics Research In Animal Health

- P32 gene (969 bp) of goat-pox virus, Mukteswar isolate; goat-pox virus Uttarkashi isolate and sheep-pox virus Rumanian FANAR Station were completely sequenced and submitted to NCBI *GenBank* with accession number AY159333, AY382869 and AY38684.
- VP2 (2926bp), VP5 (1538bp) and VP7 (1156 bp) gene of bluetongue virus, serotype 23 (Rahuri isolate) was completely sequenced.
- Nucleocapsid (N) (1575 bp), phosphoprotein (P) (1657 bp), matrix protein (M) (1466 bp), and haemagglutinin (H) (1852 bp) genes of peste des petits ruminants virus (vaccine virus) were completely sequenced.
- Complete genome sequencing of foot-and mouth-disease virus (FMDV) – Asia I Indian isolate (IND 63/72) was determined (Gi/32140992/gb/AY304994) and the viral was of 8161 bases.
- To elucidate the genetic variability of bovine viral diarrhoea virus (BVD), six representative isolates were studied in N-pro (autoprotease) gene.
- The entire nucleocapsid protein gene (ORF 7) of PRRSV virus was amplified by PCR, gene was cloned in pGEM-T easy vector, and nucleotide sequence was carried out to confirm the sequence.
- Complete genome of one lightly virulent infectious bursal disease (IBD) virus was sequenced and submitted to EMBL database under accession numbers AJ 427340 for segment A and AJ 496637 for segment B. Sequence analysis revealed that Indian virus was close to very virulent viruses reported from Europe and Asia.
- Sequence data were generated from nine hog cholera virus from clinical samples and three vaccine strains from E2 gene regions for molecular epidemiology.

SUCCESS STORY

Development of live attenuated vaccine for *Peste des Petits Ruminants* (PPR)

The annual loss due to PPR in the small ruminant population of 200 million is approximately Rs 1,800 million in India. Rinderpest vaccine though provides protection against PPR, but cannot be used in India in this phase of rinderpest eradication campaign, which does not allow vaccination of animals against rinderpest. Therefore, there was a need for a homologous vaccine to protect small ruminants against PPR infection. The vaccine developed is a vero cell based live-attenuated indigenous vaccine, and is safe for use even during pregnancy. The vaccine induces antibodies even at 1/100th of recommended dose. The duration of immunity is over three years. The vaccine was safe, potent and acceptable. There is a huge potential for export of PPR vaccine to countries having PPR.

antibiotic sensitivity pattern, toxin production and pathogenicity studies.Polymerase chain reaction (PCR) assays, viz. *P.multocida* specific-PCR, HSB-PCR, serogroup-A specific PCR and multiplex capsular PCR typing system, were successfully used for the rapid identification and capsular serogrouping of field isolates directly from bacterial colony, bacterial culture lysate, mixed colony and infected clinical materials.Molecular typing techniques viz. REA, REP-PCR, ERIC-PCR, RAPD-PCR, ribotyping and AFLP were carried out on all isolates to study the homogeneity/heterogeneity at molecular level. HS and fowl cholera outbreaks were also investigated effectively by using conventional and molecular techniques to unravel the mysteries of disease outbreaks under natural conditions.

A low volume saponified HS vaccine against cattle and buffaloes was developed, which is currently under trial. Bivalent saponified vaccine comprising serotypes B:2 and A:1 showed satisfactory results at 6 months post-vaccination challenge test. The repository on *P.multocida* isolates now has more than 300 isolates.

Gastro-intestinal Parasitism

PCR-based identification techniques were standardized for identification of species specific gastrointestinal parasites from faecal samples of cattle, goat and yak. The primer for identification of *Oesophagostomum coumbianum, O. venulosum* and *Bunostomum trigonocephalum* was developed for the first time. For development of primer, one gene sequence from ribosomal DNA of the parasite was downloaded from NCBI gene library (www.ncbi.nlm.gov.in). The primer was developed using primer premier software. Other primers sequences were collected from the published documents.Temperature ranging between 25-33ºC and rainfall more than 600 mm during rainy season favoured gastrointestinal nematodiasis in sheep and goat as indicated by seasonal worm burden in sheep and goat.

In ELISA, sera of sheep infected with benzimidazole-resistant strain of *Haemonchus contortus* showed peak OD value at 4-week post infection with partially purified adult somatic antigen, whereas with excreatory secretory antigen of *H. contortus*, it was observed at fifth week PI. In ELISA cross-reactivity was recorded with experimental sera (1:100) of goat infected with *Paramphistomum epiclitum* and adult somatic antigen of *H. contortus*. In western blotting 25.5 kDa polypeptide was recognized by experimental sera of sheep at third week PI.

Bluetongue (BT)

Serum samples (313) received from different parts of the country were screened for BT antibodies in agar gel precipitation test and 51 serum samples were found positive for BT antibodies. A c-ELISA was adopted to screen the serum samples collected from different animals for the presence of BT antibodies. Agarose gel precipitation kit was also developed to use it in field for screening of antibodies against BT virus.The culicoides samples were characterized mostly as *Culicoides actom, C. oxystoma, C. imicola* and *C. clavipalpis*.An RT-PCR based assay to type the isolates of BT was also standardized for BTV-1 and BTV-23 only. The genomic RNA of all the BT virus isolates collected from different parts of the country revealed the standard 10 genomic segments in RNA-PAGE analysis.A repository of different serotypes of BT virus originated from various animal species belonging to different geographical regions of the country, was established. RT-PCR assay was standardized to detect the BT virus isolates using the VP-3, VP-7, VP-5, NS-1 and NS-3 specific primers and exhibited satisfactory results. The full length of VP5 and VP2 genes of BT virus serotype 23 was sequenced, and the sequence data would help in the molecular epidemiological study of BT virus.

An inactivated, concentrated and saponin gel adjuvanted vaccine was formulated using vero-cell adapted BT virus 18 (Bhopal isolate), which is currently under trial in experimental sheep.

Exotic Diseases

Enzyme immunoassay and nucleic acid based diagnostic tests for the detection of porcine reproductive and respiratory syndrome (PRSS) in pigs were developed. The entire nucleocapsid protein gene (ORF 7) of PRRS virus (PRRSV) (DK 111-92, European type) was amplified by PCR from a clone. The gene was cloned into pGEM-T easy vector and nucleotide sequencing was carried out to confirm the sequence. It was subcloned into expression vector pTriex -2 Neo. Plasmids containing inserts in desired orientation were transformed into Origami (D3) plac1 competent cells for expression of the recombinant protein. The induced cell lysates and pellets were analyzed by SDS-PAGE. The recombinant protein was present in soluble form in the cell lysate. The presence of His tag and the specificity of the recombinant protein were

confirmed by western blot analysis. The fusion protein was purified by affinity chromatography using nickel columns. The recombinant antigen was tested for use in indirect-ELISA to detect antibodies to PRRSV in pigs. Preliminary optimization study using referral positive and negative sera was encouraging. This will greatly reduce the cost of diagnosis of PRRSV, which at present is being done with imported ELISA kits.

Aujeszky's disease (pseudorabies), an economically important disease of swine, is caused by alpha-herpes virus. Serum samples collected from various parts of the country were screened for the presence of antibodies to pseudorabies virus. Sera samples from pigs and rabbits showed antibodies. Sera samples screened from sheep, goats, cattle and buffalo, however, did not show antibodies. The infection is prevalent mainly in *desi* and crossbred pigs maintained under backyard conditions. Dot-blot hybridization and polymerase chain reaction were standardized for detection of pseudorabies virus infection using reference clones spanning the regions of *Bam*H-1 fragment -7 and *Kpn*-1 fragment C of the pseudorabies virus.

The hybridoma clone specific for BIV 'gag' antigen, was used to produce single chain fragment variable (ScFv) DNA by PCR using primers specific for heavy chain and light chain region of mouse immunoglobulin gene. The ScFv DNA was cloned in expression vector pCANTAB for production of recombinant antibodies (soluble form in HB2151 strain and phage displayed form in TG1 strain of *Escherichia coli*). The recombinant antibodies were reactive with 'gag' antigen of BIV in ELISA.

Cattle and Buffalo

A new design of external fixator, a hybrid construct of circular and linear fixators was designed using two circular rings and two opposing detachable side bars (vertical) fixed to each ring. The fixation of 2-ring hybrid constructs was relatively easier than that of 4-ring fixator, more so in radius. It provided more rigid fixation than 4-ring circular fixator, as indicated by early full weight bearing and fracture healing with relatively less callus formation in radial and tibial osteotomies in four bull calves weighing about 200 kg. A unilateral dynamic axial fixator (DAF) comprising a single side bar with two clamps (movable) on either end was developed using stainless steel. It provided satisfactory reduction but immobilization failed in the immediate post-operative period because of bending of pins and comminution of bone fragments. The bilateral DAF comprising two side bars with two movable clamps (in each side bar) with multiple holes in each clamp was developed and tested for fixation of radial osteotomy. It was easy to apply and provided very rigid immobilization of bone fragments with full weight bearing and functional recovery of the limb.

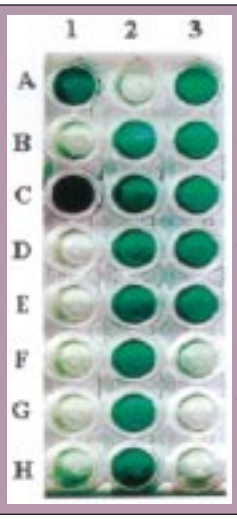
Fixation of bilateral dynamic axial fixatory in the radius of a bull calf showing good functional weight bearing by the animal

Equine

An indigenous killed vaccine using local EHV-1 strain (Hisar-90-7) emulsified with mannide mono-oleate elicited significantly better immune responses than commercially available vaccines. Major components of *Lawsonia inermis* exhibiting antitrypanosomal activity were identified using a solvent system containing chloroform and methanol under HPLC system. Sero-monitoring of diseases among indigenous equines in India against equine influenza, equine infectious anaemia, *Salmonella abortus equi* and glanders using 353 sera samples from across the country, revealed negative status. The 422 sera samples collected from Katra (Jammu) revealed that 52 sera samples were positive for EHV-1 and 108 samples for *Babesia equi* infections.

Sheep and Goat

PCR-RFLP technique for differential diagnosis of sheep-pox and goat-pox from other viral conditions causing similar lesions and also for differentiation of the specific disease due to sheep pox virus in sheep and goat-pox virus in goats, was developed,and it is targeted to attachment and fusion gene of the capripox virus. A multiplex PCR targeted to attachment gene of pox viruses was developed for differential diagnosis, which was more sensitive, and simpler than the PCR-RFLP technique. For the diagnosis of PPR, a PCR-ELISA was standardized with known quantity of peste des petits ruminants virus using N-gene specific biotin-labeled probe. The PCR-ELISA was 100-times more sensitive than a monoclonal antibody

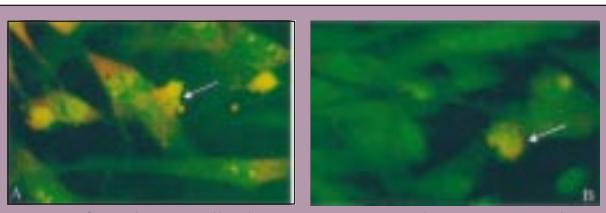


PCR-ELISA for the detection of PPR virus in the clinical samples Well A-1 PPRV positive control; B1-PPRV negative control; C1-positive (kit), D1-Beta actin PCR control; E1 to H3- (Remaining wells) Nasal swabs collected from day 0 to day 19 from goats experimentally inoculated with PPRV. The green colour indicates the PPRV positve samples while absence of green colour indicates PPRV negative samples. PCR-ELISA detected the PPRV in nasal wabs from day 5 (B2) to day 16 (E3) and negative for PPRV from day 17 (F3) onwards in experimentally infected goats

based sandwich-ELISA for the diagnosis of PPR. The test is specifically useful for disease diagnosis at an early stage and in the later stage of PPR infection compared to conventional diagnostic techniques.

Camel

The IgG fraction of rabbit anti-camel serum was purified through protein G counter, to develop anti-camel conjugate. This purified IgG was coupled with horse-radish peroxides enzyme used as conjugate. ELISA was



IBDV infected CEF cells showing apoptotic changes (A) nuclear fragmentation and release of apoptotic bodies (B) membrane blebbing

used to analyze blood samples for detection of trypanosoma antibody. Some of the higher ELISA sample could not show any active infection which otherwise also showed no amplification on polymerase chain reaction. This may be due to effective responses against chemotherapy advocated. In these animals the level of antibody still persists even after the elimination of infection. Thus PCR was considered as the test of choice in regard to surveillance and monitoring of camel surra or trypanosomosis.

Swine

A non-isotopic DNA probe using PCR based diagnostic technologies, was standardized for the detection of classical swine fever (CSF). A cold probe for detection of CSF viral genome in spleen, lymphnodes and tonsils of CSF infected pigs, was also developed. The probe can be used as a diagnostic tool to identify CSF virus and study the epidemiology of the disease.

Poultry

Duck plague is difficult to be monitored and controlled because the virus establishes an asymptomatic carrier state that is detectable only during periods of intermittent virus shedding. To detect the viral genome by PCR, a primer pair (Forward: 5'-GGC TGG TAT GCG TGA CAT-3'; reverse: 5'-GTA TTG GTT TCT GAG TTG GC-3') was synthesized based on the published sequence of DNA polymerase gene of DPV. PCR was standardized for detecting the viral sequences from tissue culture fluids, isolated DNA and heat-denatured virus. Four different isolates were tested using the specific primers.

To understand the infectious bursal disease virus (IBDV) pathogenesis, the non-structural protein VP5, both complete and C-terminus truncated, gene was amplified through RT-PCR and cloned in expression vector pBK-RSV. Transfection of vero and chicken embryo fibroblast (CEF) cells with these gene constructs resulted in expression of VP5 proteins, which could be confirmed with SDS-PAGE and western blot analysis. Further, transfection resulted in morphological changes in the cells. It is concluded that besides C-terminus, other regions in IBDV-VP5 are also involved in virus induced cell death.

ANIMAL NUTRITION AND PHYSIOLOGY

ANIMAL NUTRITION

Data base of animal feed resources: The availability and requirement of animal feed resources for all the districts of Karnataka state was worked out. The total ruminant livestock units (RLU) in the Karnataka state remained unchanged over the last three censuses, but cattle and sheep population decreased in most of the districts. Population of cattle was highest followed by sheep, goats and buffaloes. The overall availability of feed resources in the state was 40.3 million tonnes (crop residues 29.9 million tonnes, greens 7.8 million tonnes and concentrates 2.6 million tonnes). Crop residues constituted the major share of the dry matter and for the state as a whole, sugarcane tops accounted for the largest contribution for the crop residues (32%) followed by maize stover and rice straw. Even though in the state the overall dry-matter availability (7.98 kg /RLU/day) was sufficient, a wide variation was observed across the districts. The feed resources availability in Karnataka increased over the last 15 years, consequently increasing the potential dry-matter availability to the ruminant livestock population.

Feed resources availability: The crop cutting survey data appear to be the most ideal source for obtaining authentic grain-straw ratio. A common grain - straw ratio for the entire state / country for any particular crop is not feasible due to varietal differences and crop growing conditions. However, data generated for Karnataka state

- Potential dry-matter availability has increased in Karnataka
- Grain straw ratio could be used to determine dry fodder availability
- Cellulase gene from *Ruminococus albus* cloned in *Escherichia coli*
- Feeding of chaffed maize improved body weight in crossbred calves
- Orphinomyces Sp.(C-14) improved nutritive value of wheat straw based diet
- Rumen acetic, propionic, butyric and isovaleric acid estimation method developed
- Ragi straw better source of dry matter, crude protein and fibre
- Area-specific micro-nutrients supplementation improved heath and reproductive efficiency of buffalo
- Chelate minerals preparation technology developed
- Vitamin E and carotene are lost after fodder preservation

have showen that a grain - straw ratio of 1:1.2 to 1.8 for paddy, 1:1.5 to 1.8 for maize, 1:2.0 to 2.3 for ragi and 1:2.7 to 3.0 for groundnut, could be used for estimating dry fodder availability.

Cattle

Genetically modified bacterium develoed for treatment of roughages: Ruminococcus albus, an anaerobic cellulolytic bacterium, produces highly active cellulolytic enzymes. Studies were conducted to—prepare a genomic library of *Hind* III fragments of *Ruminococcus albus* DNA in *Escherichia coli*, screen the recombinants for cellulase activity, isolate the cellulase gene, and study its expression in *E. coli*. The cellulase gene from *Ruminococus albus* was cloned in *E. coli*. The gene cloned encoded the activity of endo-B-1, 4 glucanase. The maximum activity of this enzyme was in the periplasmic protein fraction in *E.coli.*

Total mixed rations (TMRs): Total mixed rations (10) were formulated by blending roughage to concentrate in the proportion of 50:50. Roughage component comprised equal parts of wheat straw and green fodder (maize/oats) on dry matter (DM) basis. To partially replace mustard-cake in ration numbers 6-10, 1% urea was added. The effective DM degradability ranged from 43.23 (TMR 10) to 48.3% (TMR 8), at 0.05 outflow rate effective OM degradability was highest in TMR 6 (48.03%), CP degradability was highest in TMR 10 and 3. On the basis of *in sacco* DM, CP degradability and cost of ration TMR 2 (wheat grains 25, maize grains 10, deoiled rice bran 22, mustard-cake 40, mineral mixture 1.5 and common salt 1.5 parts – group 1) and TMR 7 (wheat grains 30, maize grains 12, deoiled rice bran 27, mustard-cake 27, urea 1, mineral mixture 1.5 and common salt 1.5 parts – group 2) were selected for further studies along with another standard ration (group 3). CP of rations varied from 19.5 to 21.81% and EE from 4.62 to 5.11%. Rumen fermentation of TMRs indicated that group 3 had the lowest NH_3-N concentrate (13.2 mg/dl) and higher TVFA concentrate (10.4 meq/dl) than remaining groups.Total bacterial count was the highest in group 2 (11.1×10^{11}) and total protozoal count was the highest in group 3 (4.3×10^5). Average daily gain (g) in group 3 was the highest (788.6) followed by group 2 (688.6) and group 1 (609.3). DMI (kg) /kg BW gain was lower in group 3 (5.89) than group 1 (6.35) and group 2 (5.97). CPI g/kg BW gain was higher in group 3 (895.2) than group 1 (848.6) and group 2 (862.5).

- Dairy cattle nutrition survey was conducted different agro eco zones and nutritional remedies were suggested for sustainable milk production
- Low cost non-cereal ration developed for buffalo
- Citric acid and neem bark powder prevented fungal infestation of stored feeds
- Methane production was lowest on sorghum feeding and high on maize feeding
- Sheep manure improved biological yield of fodder production
- Prosopis juliflora replaced barley in sheep diet satisfactorily
- By-products based kid starter ration developed
- Feed pellets developed usin leaves of subabul,neem,ber,peepul,sirus,mulberry and desi babul
- Entolobium timbova eliminated rumen protozoa
- Improved pasture has better biomass,energy,crude protein compared to natural pasture
- Milk replacer containg CP24% is cheaper than mother's milk
- Decaffeinated tea waste suitably replaced wheat bran up to 50% level in pig feed
- Mulberry fed rabbits showed better crude protein digestibility than robinia fed
- Leaf samples of local trees of Arunachal Pradesh analyzed for minerals and nutrients composition
- Approximately 15 species of of rumen ciliates identified in mithun
- Nutrient requirement of various avian species updated
- Methionine supplemented red sorghum diet improved growth in birds
- Feed supplement zeosil plus countered the adverse effect of aflatoxin
- Metabolizable energy regulated body weight gain and helped in achieving optimum gains

Thresher-cum-treatment unit for improvement of poor quality straws

A machine was fabricated to treat poor quality straws for improving their nutritive value. Farmers can thresh and treat straw simultaneously in their field without increasing extra labour cost and without wasting any extra time. This is fitted with electric motor but can also be driven by tractor/diesel engine with slight modification. For urea-ammonia treatment of wheat straw, 4% urea and 50% moisture is required. So a provision is made for 200-litre capacity water tank, and accordingly urea is dissolved in relation to output of wheat straw from thresher. Generally, in 1 hr 6-8q of wheat straw is passed out from this device. Moreover, molasses, mineral mixture, salt, yeast, etc. can also be used for treating/improving the poor quality roughages.

An indigenously fabricated thresher cum treatment unit for improvement of poor quality straws

Improving Energetic Efficiency in Ruminants

Manipulation of rumen fermentation and kinetics: A model to predict the kinetic rate of digestion and related parameters based on cell wall intake (25-7%) of animals,

was developed. This information will help in diet formulation. The quantitative data collected for digestion kinetics and nutrient pools based on the levels of cell-wall intake would enable to minimize the error component in prediction and also to improve predictability through graphical means.

Conservation of biological energy: Feeding of chaffed green maize decreased the energy expenditure by 27%/kg dry matter intake (DMI), and the DMI was higher by 24% as compared to feeding unchaffed maize. The bolicount/ kg DMI was reduced by 7.42%, and there was significant increase in body weight of crossbred cattle because of feeding chaffed maize. Chaffing had a beneficial effect on energy expenditure, dry matter intake and body weight gain in crossbred animals by lowering the time spent on chewing per kg dry matter intake.

Utilization of cottonseed hulls: Cottonseed hulls, showed higher protein, fiber, lignin and bulk density than wheat straw in growing crossbred calves. It could be incorporated in complete diets (CP 12%, TDN 55%) up to 60% level. Processing of cottonseed hulls based complete diet in flaked diet appeared to be advantageous in terms of its handling and transportation.

Bioenriched soya and cottonseed hulls: Crude protein value was higher in bioenriched hulls of soybean (TSBH) and cottonseed (TCSH). Total mixed ration (TMR) was prepared by taking wheat straw and concentrate in ratio of 60:40 for *in vitro* digestibility studies. In TMR, the roughage part (wheat straw) was replaced by TSBH or TCSH in proportion 33, 66 and 100%. Improvement in digestibility was more in TSBH compared to TCSH. Soybean hulls were better than cottonseed hulls because their palatability was poor than soybean hulls. Treatment had no effect on milk yield, and dry matter intake during 50 days of observation.

Influence of ruminal fungi on in-vitro degradation of cereal straws: Ruminal fungal isolates, *Orpinomyces* sp. C-14, *Piromyces* sp. C-15, *Orpinomyces* sp. B-13 and *Anaeromyces* sp. B-6, were incubated anaerobically in finely milled cereal straws as the source of fermentable carbon with and without strained rumen liquor (SRL). These had no significant effect on the degradability of the substrate along with SRL compared to SRL free environment. Double log dose (10^6 cfu ml^{-1}) of the isolates compared to single log dose (10^3 cfu ml^{-1}) had maximum degradability of straw after 48 hr with maximum acetate production in all the treatments, followed by a decrease in propionate and butyrate

- Krishibro chicks performed well even on low lysine diets
- Natural agents minimized production losses due to aflatoxin in feeds and improved cellular immune response
- Optimum calcium and phosphorus supplements did not affect the growth or bone mineralization
- Sesame and sunflower protein –meal resulted in lean broiler meat

Ranking of top feeds

On the basis of composition, *in sacco* kinetic parameters for nutrients, *in vitro* gas production data and the estimated DOM, ME and intake potential, the ranking of the top feeds is as follows:

very good — *Leucaena leucocephala, M. azedarach, Zizyphus jujube*
good — *Carissa spinarum, Z. nummularia, Hippophae rhamnoides*
average — *Ficus raxburghii, Robinia pseudoacacia*
poor — *Quereus incana.*

production. Strain C-14 appeared to be a better fungal isolate for *in vitro* degradation of cereal straws.

Growth rate of crossbred calves increased by 15.73% with the fungal culture (*Orpinomyces* sp. C-14) administration along with wheat straw based complete feed mixture. Per cent feed efficiency also enhanced by 14.1% and nutrient digestibility including that of crude fibre increased significantly with the weekly administration of culture. TDN of wheat straw based complete feed mixture also increased significantly. Rumen pH (7.01 vs 7.18), NH_3-N (7.93 vs 15.52 mg/100ml) were lower, whereas TVFA (13.02 vs 11.57 mM/100 ml), total-N (109.2 vs 84.0) and TCA-N (87.97 vs 57.50 mg/100 ml) were higher significantly in fungal culture administered group, indicating more microbial protein synthesis.

Quantification of the toxins: A bacterial strain (Gram-negative bacillus) was isolated by enrichment from the soil from the vicinity of the *Ageratum* plants. The organism utilized precocene I as well as II, the latter was utilized to a higher extent. Methods were standardized and validated for the quantification of tannins and their biodegradation products.Method for estimation of acetic, propionic, butyric, and isovaleric acids produced in the rumen, was validated and standardized.

Environmental pollutants and toxic elements: Fluoride was higher in both borewell and open well water (4.3-5.9 ppm) in Gadag district of Karnataka. High fluoride in drinking water was not reflected in blood plasma and milk samples. Calcium levels in blood plasma of animals were very low suggesting the interference of fluoride on calcium utilization. Adult cattle were more affected with symptoms of joint enlargement and lameness.

Detoxification of aflatoxins in feeds: Drying at 120°C for 2-3 hr resulted in maximum aflatoxin reduction in compound cattle feeds. Exposure of contaminated feed to sunlight (27-37°C) reduced aflatoxin in feed linearly with increased duration of drying in sunlight.

Strategic supplementation for increasing animal productivity

Micronutrients: Ragi straw was a better source of crude protein, calcium, phosphorus, magnesium, zinc and

manganese as compared to paddy straw.Digestibility of dry matter, crude protein and fibre was significantly higher in cows fed ragi straw. Utilization of most of the micronutrients was superior in animals fed ragi straw. Calcium has to be supplemented while feeding paddy straw as sole roughage to dairy cows as this may be one of the limiting micronutrients for milk production.

Macronutrients: Optimum level and source of limiting nutrients in the form of supplements is essential for enhancing digestibility of cereal crop residues. On farm trial by strategically supplementing maize grains (50%) in place of wheat bran showed that the milk yield increased by 1.24 litres/cow/day and the feed cost reduced by Rs 2.80/cow/day. This increased income by Rs 15.23/cow per day to the farmer.

Preparation of chelated minerals

The chelated minerals are more bioavailable to animals than inorganic resources and improve productivity of animals. Protein from milk whey and soybean were used to prepare chelated minerals.These proteins were subjected to enzymatic hydrolysis to break them into small peptides and free amino acids. The mixture was filtered using ultrafiltration to remove all unhydrolyzed proteins and bigger peptides. The permeate was made to react with some essential trace minerals i.e. Cu, Mn, Zn at some specific pH and temperature. After chelation, the unbound minerals were removed using reverse osmosis process and the mixture was dried and ground. Pancreatin, a mixture of enzymes from pig pancreas was better for the hydrolysis of soy protein and this protein source was more suitable for production of chelates. The chelates produced by this procedure contain about 10-11% mineral, 40-45% crude protein and 35-37% total ash. The chemical composition of these chelates was quite similar to the imported ones.

A village level model was developed and tested for improving the reproductive efficiency of crossbred cattle in IVLP adopted villages. Strategic supplementation of area-specific micronutrients could improve the general health and reproductive conditions in 90% animals as perceived by the farmers. Supplementing deficient minerals either through area-specific mineral salts or through feeds rich in these minerals corrected almost 80-90% of the reproductive problems, resulting in increased productivity and profitability.

Tannins profile in some agro-industrial byproducts: Total phenols, non-tannin phenols, condensed tannins, hydrolysable tannins and total tannin phenol were analyzed in mango seed kernel, *babul* pods, *vilayati babul* pods, *sal* seed-meal, *mahua* seed-cake, tea waste, tamarind seed-meal, *babul chuni* and cottonseed-cake. Total phenols and hydrolysable tannins were the highest in *babul* pods. Mango seed kernel and *sal* seed-meal contained medium level of tannins, total phenols and hydrolysable tannins. *Babul* pods contained the highest condensed tannins followed by tamarind seed-meal, cottonseed-cake and *mahua* seed-cake.

Losses in fodders during preservation: Berseem and oat were processed and preserved as hay, while maize and sorghum were stored as silage. The loss of ß-tocopherol in berseem hay was 57.12, 72.76. 84.50 and 90.87% in the first, second, third and fourth month, respectively, while the loss of ß-carotene was 31.50, 44.36, 59.51 and 70.10% in the respective 4 months. Similarly in oats, the losses of vitamin E and ß-carotene in 4 months were 88.50 and 73.62% respectively. The losses of the vitamin E in maize and sorghum silage after 4 months were 78.44 and 76.54%, whereas, in ß-carotene, losses were 58.99 and 56.61% respectively.

Dairy Cattle Nutrition Survey

Dairy cattle nutrition survey was conduted in Agro-ecological region-9 (Indo-Gangetic Plains: Patna and Gaya), -12 (eastern plateau comprising Chattisgarh and southwest Jharkhand), -13 (Chhota Nagpur Plateau of Bihar, western parts of West Bengal, Eastern Ghats of Orissa and Bastar region of Chhatishgarh) and -19 (eastern coastal plain, extending from the delta of Cauvery to the Gangetic delta). Survey reports revealed some common practices in these areas:

- Landless farmers maintain only *desi* non-descript cattle and/or buffalo mainly on grazing, cut grass, straw, kitchen, vegetable and fruit wastes collected from various sources. Hardly any concentrate is fed.
- Marginal and small farmers maintain *desi* cattle and buffaloes mainly on home grown feeds and grazing and/or cut grass. Green fodder is available in the form of natural vegetation. Animals are sent for grazing in fields during day time and stall fed in the morning and evening with small amount of dry fodder, kitchen wastes, cut grass and sometimes tree leaves. Lactating cows and buffaloes are supplemented with small amount of home made concentrate (cake/wheat bran/maize/rice bran/*dal chuni*). Mineral mixture is not fed but salt is fed only occasionally. Cultivation and feeding of green fodder is hardly practiced by this group of farmers. A few small farmers maintain crossbred cows.

Landless farmers maintain only *desi* cattle

- Large landholders keep *desi* cattle, crossbred cows (both Jersey and Holstein crosses) and buffaloes. Cut grass, kitchen wastes and straws were fed. These farmers cultivate maize, cowpea, oat, berseem, sorghum etc. though quantity of cultivated greed fodder feeding is very low (3-10 kg) depending on season and area under cultivation. They also feed branded ready mix concentrate mixture to cattle.
- Kitchen wastes constitute a good part of the daily ration of animals in the villages. It contains unutilized vegetable parts of the kitchen, surpluses of the kitchen, rice gruel and also vegetable wastes, fruit wastes etc. The following nutritional remedies are recommended for sustainable milk production:
- Cultivation of low cost green fodder
- Nutritional enrichment of straw with urea
- Supplementary feeding of balanced concentrate mixture from locally available feed ingredients.

Micro minerals profile of some commonly fed roughages

Samples of green fodders and dry roughages were collected by the NDRI, Karnal, from farm and farmers' field of Amargarh, Gorgarh, Shekhupur, Mahmadpur and Nabipur villages located in Karnal district of Haryana. These samples were analyzed for iron, copper, zinc and manganese. Zinc was invariably deficient in all the roughages screened, whereas copper was highly deficient in paddy straw.

	Average mineral content (mg/kg DM)				
	Fe	Cu	Zinc	Mn	I
Wheat straw	250.35	26.80	17.08	41.74	1.25
Paddy straw	114.1	2.02	16.74	128.21	1.11
Berseem	453.07	17.91	36.56	84.72	0.71
Oats	422.75	18.51	32.61	97.66	0.60
Jowar	208.20	13.0	17.53	73.67	0.78
Maize	169.45	12.14	18.18	55.91	1.10

Buffalo

Low cost ration: Low cost non-cereal rations based on complete feed diets utilizing poultry droppings, urea and molasses along with cheaper byproducts like deoiled rice bran (DRB), were tried in buffaloes. Studies were also conducted by feeding maize/sorghum silage as basal diet along with non-conventional concentrate mixture containing DRB, urea and molasses Growth, and nutrient utilization in buffaloes fed non-conventional ration was satisfactory and at par with control group. The cost of feeding or the cost per kg body weight gain was about 20-30% less as compared to control group.

Detoxification of aflatoxins: Citric acid and neem bark powders prevented fungal infestation of feeds during the storage.

Methane emission: Murrah lactating buffaloes (3 groups) were fed green berseem and wheat straw (90:10), or green berseem + wheat straw + concentrate (59:17:24) or wheat straw +concentrate (38:62) on DM basis. CH_4 emission per kg DMI was higher on diet containing higher percentage of NDF, and average methane emission per kg DMI was 17.47 g/c.

Metabolisable energy (ME) and methane production: Methane production was studied in heifers fed maize and sorghum fodder during July; and green oats, berseem and maize silage as the main fodder from January to March (winter). Total methane production in female calves was lowest on sorghum feeding. Digestibility of maize and sorghum fodder during rainy season was 59.93±1.92 and 51.49 ±1.81. The methane value per kg of DDMI was 13.52, 14.76, 26.76 and 16.19 on oats, berseem, maize and sorghum feeding. Every meal intake of metabolizable

Dairy cattle management practices in Nadia, West Bengal

In the co-operative and non-co-operative villages, majority of sheds had tile roof and dairying was mostly found with the mixed farming community. Percentage of brick floor was more in co-operative villages and was mostly found with the landless farmers. Shed having no walls was commonly seen in co-operative villages and was mostly found with the landless farmers. During winter such sheds were covered by polythene sheets to protect animals from cold. Cattle shed having tile roof, brick floor and no walls appeared to have some positive impact on milk production.

Package of Practices for Management of Dairy Cows

The following package of practices was developed for management of dairy cattle in the Nadia District of West Bengal:

- The newborn calf should be fed colostrum within 1 hr of the birth. It is helpful for the survivability and growth of the calf
- Disinfection of the naval chord soon after birth reduces the chance of infection and increases survivability of the newborn calf
- The calves should be protected from extreme weather conditions by appropriate shelters
- The cattle should be provided with adequate green fodder
- Full hand and dry hand milking should be practiced for maintaining better udder health
- Routine deworming and vaccination should be undertaken to ensure better health and productivity
- Open shed with tile roof and brick floor is suitable for the cattle in the study area

energy resulted in 3.87, 4.51, 8.08 and 4.04 g of methane, respectively. Methane production per kg DDM (digestible dry matter) did not differ among oats, berseem, sorghum, however the values were high on maize feeding.In male animals methane produced per kg of dry matter consumed was higher on maize fodder as well as on maize silage.

Sheep

Fodder production and nutritional studies: Dry matter yield of cenchrus at harvest was higher in two-and three-tier system of land use in comparison to open space. Application of sheep manure resulted in increase in growth and yield parameters and dry matter production of both, cenchrus and pearl millet. Planting methods and moisture conservation measures significantly influenced the survivability of fodder trees. *Babul* registered the higher survivability. Inside V ditch planting of fodder tree sapling recorded the highest survivability in comparison to without contour bunds. The highest survival of tree species was recorded with pond mud plus sheep manure. The highest dry fodder yield of sorghum variety HG-75 was obtained in association with *ardu*, which was significantly higher to *neem* and *babul* association with any of the varieties.The maximum increase in production of grain, straw and biomass was with fertilization to both (crops and *aonla*). Cowpea-oat gave maximum green fodder. Sheep manure produced the highest green and dry forage with application of 5 tonnes/ha in comparison to no sheep manure.The yield of moth (grain and dry fodder and biological yield) was not affected due to association of fruit trees. The grain and dry fodder yield and biological yields on moth increased significantly because of sheep manure @ 10 tonnes/ha.

Housing and nutrition: Studies on effect of housing on nutrient intake and utilization during different seasons showed that during grazing the diet had 42.0, 85.8 and 91.9% dry matter during monsoon, winter and summer, respectively, and the CP was 13.4, 9.8 and 14.8%, respectively. Physiological responses of sheep housed under shed and open corral indicated no difference in rectal temperature and skin temperature both during morning and evening hours in all seasons. The energy expenditure during monsoon in morning hours was 36.05 vs 36.88 k cal/hr but during evening hours, they spent more energy in shed (53.58 K cal/hr) vs open corral (49.64 K cal/hr) indicating sheep are more comfortable in open during monsoon.

Newer feed resources: Under hot arid region, the effect of replacement of maize/barley with *Prosopis juliflora* pods in the diet of sheep showed that digestibility of feed DM increased with increase in level of pods in the diet but feed intake and daily gain was not affected. *P. juliflora* pods were found as good substitute of barley in the diet of sheep. Comparative growth performance of weaner lambs on feed containing *pala* leaves and groundnut fodder in different rations showed that feed intake was not affected by the type of roughage and its level in the diet. Groundnut fodder at 60% roughage did not affect live weight gain but at 70% level higher gain and higher DM digestibility was recorded.

Protein and mineral contents of buffalo colostrum

Protein was 6-7 times more and other essential minerals (like Ca, P, Zn, Mn, Fe) were 3-7 times more in the first day buffalo colostrums compared to that of normal milk, thus boost the nutritional needs growth of the new born calf.

Studies on production of lignin degrading enzymes by *P. sanguineus* revealed that the enzyme levels ranged between 1.33 to 18.49, 0 to 1.97, 52.49 to 392.00, 0 to 153.70 and 0 to 69.44 units per 20 ml of culture fluid respectively for Lip, RNNR oxygenase, *Laccase*, MnP and peroxidase. The data suggested that a longer time of fermentation may be needed to obtain higher degree of lignin degradation associated with higher level of lignin degrading enzymes.

Goat

Complete feed pellets were developed using tree leaves (subabul, neem, ber, *peepal*, sirus, mulberry and *desi babul*) and concentrates. Forest tree leaves (*Entrolobium timbova*) were used to eliminate rumen protozoa (defaunation) for higher growth rate of goat kids. Three goats per hectare could be maintained on natural pasture of *Heteropogan* type grass and bushes like *hens*, *hingota*, *khadyar*, *anni* and *gokhru;* and 8 goats/ha could be maintained on improved pasture (*subabul*, *desi babul*, *brij babul* and *anjan* grass). There was 2.6-, 3.3- and 8.0- folds increase in harvestable biomass, energy and crude protein, respectively, on improved pasture as compared to the natural pasture.

By-products based kid starter ration

Rations containing different CP and TDN (Ration 1:18CP-65TDN; ration 2:18CP-70 TDN; Ration 3:20 CP-65 TDN; Ration 4:20 CP-70 TDN) were fed to kids.Following observations were made:

1. Body weight at the fourth month of experimental feeding was recorded similar in all the groups
2. Average daily gain (ADG) in all four treatment groups was statistically similar
3. Total volatile fatty acids (mm 01/100 ml SRL) in the rumen liquor were maximum in group 1 and minimum in group 4
4. Starter rations 2 and 3 were more economical. Maximum by-products were used in these rations and ration 3 had minimum cost of feed per kg body weight gain as compared to other rations.

Fodder conservation: Berseem fodder was conserved in the form of hay and silage and hay was found superior to silage.

Economic ration: The ration having CP 12%, TDN

60%, was recommended for post weaned Barbari kids (4-9 months of age) keeping in view of the higher quality and quantity of meat production from kids fed this ration.

Milk replacer/substitute for pre-weaning goats: Palatable milk replacers were developed. Feed conversion efficiency was recorded better in milk fed kids, however, kids were maintained well in replacer fed groups.Replacer containing up to 24% CP was cheaper than mother's milk. For high yielding does, surplus milk may be diverted for human consumption, if this replacer is used for rearing such kids.

Nutrition in rangeland

The nutrient intakes of sheep on range land indicated that the dry matter intake of dry, pregnant and lactating sheep was 1,195, 1,569 and 1,081 g /day during monsoon, and 456, 651 and 505 g/h/day during winter. Average digestible crude protein (DCP) intake of sheep in dry, pregnancy and lactation stages was 45.34,56.92 and 52.33g/head/day during monsoons and 24.02, 39.19 and 27.29/head/day during winter. Sheep diet constituted of *Tribulus terrestiris* (8.90%), *Indigofera cardifolia* (16.24%), *Crotolaria burhia* (12.64%), *Satha* (16.91%), *Zizyphus nummularia* (11.40%), *Dactyloctenium aegypticum* (21.81%), *Melilotus indica* (9.31%) and other native grasses, during monsoon. During winter, *Crotolaria burhia*, *Zizyphus numularia*, dead litter and *Azardirachta indica* leaves constituted 9.75, 40.34, 24.61 and 23.94% of the diet. The average daily gain of male and female lambs was 118 and 113 g during 0-3 months of age. Lambs born during September - October attained higher weaning weights (15.80 kg) than those born in spring (11.70 kg). These lambs were supplemented with 100-150g commercial concentrate mixture, dry and green *khejri* leaves and weeds harvested from the crop fields.

Crop based animal production system

Among the four grazing systems (rotational, deferred rotational, continuous and cut and carry), deferred rotational grazing system is the best in terms of biomass and animal production.

Saline water tolerant silvipasture

Desi babul survived well under irrigation with saline water, grasses like napier and anjan, and fodders like barley and oats were most tolerant under saline water irrigation.

Camel

Camel production and management system: Purpose of camel rearing varies significantly in different agro-ecological zones of Bikaner and Pali districts of Rajasthan. The camel keeping patterns significantly influenced the feeding management system in both Bikaner and Pali. The incidences of migration were more in Pali (65.00%) as compared to Bikaner (56.52%) region. The camel rearing practices of Bikaner and Pali region were significantly influenced by categories of farmers of that area. In Bikaner region seasonal migration was maximum whereas in Pali region prolonged migration was maximum. In both types of migration cases, short distance (up to 50 km) covered was more in Bikaner region, whereas long distance covered (more than 50 km) was more in Pali area. In both regions camel rearing was considered to be a way of revenue.

Equine

Balanced ration for equines: Nutritional imbalance is a widely prevalent problem of equines in India. This limits its performance and reproduction. Majority of equines is deficient in some kind of nutrient, and it is largely due to ignorance at farmers' level. Balanced ration could be prepared from local farm produce of the area. The feed back from the farmers indicated improvement in the health, reproduction and performance of their equines because of adoption of balanced feed recommended by the scientists of the NRC on Equines.

Pig

At the Centres of AICRP on Pigs, locally available feed stuff were identified for pigs to minimize production cost. Requirement of fish-meal in the ration could be replaced with silk worm pupae or cuttle fish waste silage. Similarly, decaffeinated tea waste was also found suitable to replace wheat bran up to 50% level.

Rabbit

In Soviet Chinchilla rabbits feed gain was best in group fed 50 g concentrate but deteriorated with increasing level of concentrate supplementation.Mulberry (*Morus alba*) and robinia (*Robinia psuedoacaia*) leaves were evaluated as rabbit feedstuff. Digestibility of nutrients indicated highest digestibility of DM, CF, EE, NFE and cellulose (70.1, 33.05, 32.46, 81.29 and 62.77%) in diet containing mulberry leaves. The digestibility of crude protein in mulberry fed group was significantly higher than robinia fed rabbits.

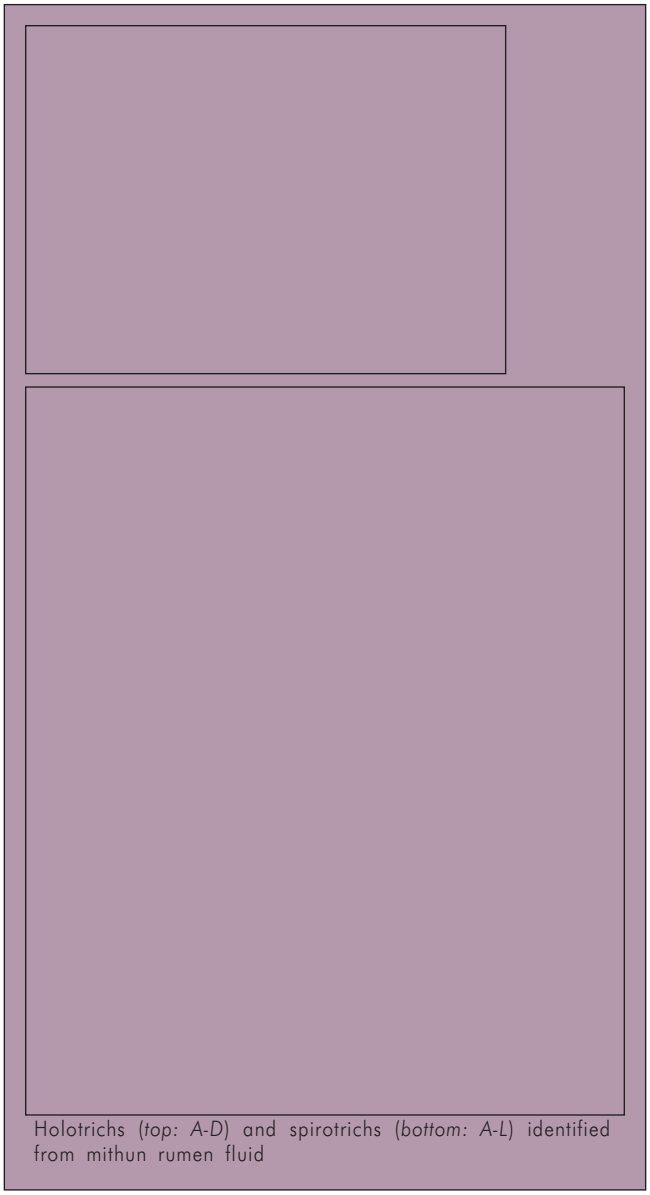
Yak

Leaf samples from locally available trees were collected from different parts of West Kameng and Twang district in Arunachal Pradesh and Sikkim. A herbarium is under process. These samples were analyzed for OM, CP, EE, CF, NDF, ADF, ADL, total ash and NFE etc. The palatability of

different locally available tree fodders was studied. SGOT, SGPT, SAP, glucose and protein etc. were estimated. Plant species (14) were identified in this grassland of which five were from Poaceae family (from SeLa, 4242m above msl). The chemical composition (% of DM) of the mixed pasture grass was 11.9,1.65, 22.89, 45.96, 8.71 and 7.84 for CP, EE, CF, NFE ADL and silica respectively.

Mithun

Mithun rumen fluid: The pH, total N_2 (mg/ 100 ml), TCA precipitated N_2 (mg/ 100 ml), total soluble N_2 (mg/ 100 ml), ammonia N_2 (mg/ 100 ml) and TVFA (meq/ 100 ml) of rumen fluid of mithuns were, respectively, 5.83 ± 0.10, 91.00 ± 14.20, 61.25 ± 7.48, 29.75 ± 7.54, 20.80 ±3.61 and 8.15 ± 0.05. The total rumen ciliates count (× 10^5/ ml), count of holotrich (× 10^5/ ml) and spirotrich (× 10^5/ ml) were 1.435 ± 0.210, 0.029 ± 0.017 and 1.405 ± 0.207, respectively. Approximately 15 species of rumen ciliates were identified.



Holotrichs (*top: A-D*) and spirotrichs (*bottom: A-L*) identified from mithun rumen fluid

Poultry

Updating nutrient requirements of poultry: A dietary energy level,CP, lysine, methionine and threonine for pullets (during 12-20 weeks of age) and layers was suggested for birds.

Nutrient requirements

	Kadakanath		Aseel		CARI
	Pullets	Layers	Pullets	Layers	Priya
Dietary energy requirement (kcal ME/kg)	2,500	2,600	2,700	2,600	2,850
CP (%)	14	16	14	14	14.6
Lysine (%)	0.66	0.86	0.67	0.70	0.62
Methionine (%)	0.30	0.31	0.30	0.30	0.28
Threonine (%)	0.54	0.63	0.55	0.54	0.56

NRC (1994) levels of amino acids and energy (3,200 Kcal ME/kg) were optimum for naked neck broiler chicks for better growth and feed efficiency in hot climates.

The dual-purpose CARI Debendra starting chicks need 1% calcium and 0.35% available phosphorus in their diets for optimum skeletal status. Significantly better phosphorus utilization was at 50 and 75% depletion of dietary phosphorus during finishing phase of broiler chickens. Vitamin E @ 300mg/kg to broiler chicks, 10 days prior to sacrifice improved the keeping quality of meat. Higher dietary levels of vitamin E (225-300 IU/kg) were more effective in retarding oxidative deterioration of quail meat stored at –18°C. Dietary supplementation of vitamin E did not affect egg production performance but egg weight increased with increase in dietary vitamin E.

New feed resources for poultry: Inclusion of 30% w/w pearl millet, 5% w/w rapeseed-meal and 10% w/w sunflower seed-meal or 30% pearl millet, 10% rapeseed-meal (RSM) and 10% sunflower seed-meal (SSM) replaced maize and soybean-meal (SBM) and proved an economic ration for broiler production. Sorghum (replacing 75% maize) along with 10% RSM and 5% SSM or 10% RSM and 10% SSM (w/w) resulted in economic broiler production. Addition of methionine to diets containing red sorghum replacing maize, improved growth. Raising starting chickens on diets containing pearl millet and/or sorghum replacing maize partially or completely (50 and 75%, respectively) or sunflower seed-meal and mustard-meal replacing soybean-meal partly were economical.

Augmenting nutritive value of poultry feeds: An apparent improvement was observed in shell thickness and egg production on sodium bi-carbonate supplementation.Feeding live cultures of *L. acidophilus* or *S.cerevisae* substrates @100 g/kg diet enhanced the nutrient utilization and immune response with reduced serum cholesterol content in quail broilers.

Feed supplements: The feed supplement zeosil plus

Control of obesity in broiler breeders

Decrease of ME input by 10 and 20% significantly reduced weight gain by 11 and 20%, respectively, compared to the controls. By increasing ME input by 10%, the body weight improved by 14% over controls.Restriction of ME significantly delayed sexual maturity by 10 days (162-172 day) between the two extreme levels of feeding. But, the egg production remained statistically unaffected. However, with higher egg number the feed conversion efficiency per kg egg mass was better at the end of 56 weeks of age in the group fed 10% less ME. ME could be utilized as the primary nutrient to regulate body weight to a desirable level in grower phase and, achieve optimum performance.

was beneficial in counteracting the adverse effect of 0.5 ppm level of aflatoxin and it helped partially in reducing the toxicity. The birds fed diets fortified with zeosil plus had these pathological lesions but with less severity. Addition of zeosil plus was effective in protecting birds from FEN (50 ppm) toxicity.

Impact of VFA and lactic acid feeding on GIT in broilers: Chicks were offered different VFAs and LA in drinking water *ad lib*. Initially (one week of age) the weight gain was significantly lower in all VFAs and LA treated groups. Significant differences in pancreas weight were seen that narrowed as the age of chicks advanced. Feeding of propionic acid and acetic acid at an early age (1 week) resulted in significant increase in pH of chyme in all segments.This difference also narrowed in all segments except jejunum as the age advanced (3 week) and by 6 weeks of age no significant difference in pH in intestinal segments was noticed. Protein was higher in jejunum at 7 days of age. DNA in all the 3 regions declined with age. DNA and RNA between regions were dependent on age. RNA of jejunum decreased with age. Propionic and acetic acid affected growth of certain segments of GIT at an early age and weight gain in broilers.

Dietary requirement in colour broilers: The parents of colour broiler, viz. Krishibro, showed optimum performance during juvenile age with low dietary inputs of energy, protein and methionine. Serum protein increased significantly as the level of lysine increased from 0.8 to 1.0% but further increase of lysine level to 1.2% showed no change. Liver fat was significantly low and liver protein was significantly higher at higher levels of lysine supplementation. Male and female line chicks of Krishibro performed well even on the lowered level of lysine (0.8%) than that is normally prescribed (1.2%). The dietary levels of Ca and NPP did not affect body weight gain, feed intake and feed conversion efficiency. Serum alkaline phosphatase activity decreased when Ca and NPP were increased, whereas no differences were seen with further raise in Ca and NPP levels. The levels of two elements did not affect bone strength and its Ca and P contents. Copper in pancreas increased with the enhancement of Ca and NPP supplementation in contrast to manganese (Mn) which was higher at the lowest and highest levels of Ca and NPP, respectively. Mn in kidney also showed a similar response. Cu of liver also increased at the highest level of Ca and NPP. The pure line chicks did not require more than 0.45 and 0.225% of Ca and NPP, respectively, for showing optimum performance. However, certain variations noticed in mineral profile of vital organs suggested that retention of trace minerals was dependent on dietary levels of Ca and NPP.

Vanaraja chicks require low Ca and P: Ca requirements for optimum growth were between 7.3 and 7.5g/kg, while for leg strength and leg health, the levels were, respectively, 8.7 and 8.8g/kg diet. The NPP level of 2.5g was adequate for growth.

Effect of natural agents on losses due to aflatoxin in broiler: Spirulina platensis, blue green algae, (SPN) @ 0.02% in diet significantly improved body weight gain in AF fed groups (300ppb), and was similar to that of control group at early age (32 day) but at the market age (45 day) it was lower than the control. Feed conversion efficiency and leg scores remained unaffected. *Spirulina* improved ready-to-cook yields in AF groups, while no effect was seen on the weight of liver, giblets, spleen and abdominal fat. Immune response to sheep red blood cells and PHA-P improved by SPN, indicating a positive effect of the algae on immunity and carcass traits. Dietary supplementation of *Saccharomyces cerevisiae* (SC) at 0.1% level showed no effect on body weight gain and feed intake in broilers fed AF (300ppb), while beneficial effects were seen on cellular immune response (PHA-P), serum cholesterol concentration, weights of liver and kidney, dressing yields and liver fat content. Esterified-glucomannan (EGM), an extract from the cell wall of *Saccharomyces cerevisiae*, at 0.1% level in diet significantly increased body weight (10.6%) and feed intake in birds fed AF (400ppb). The activity of gamma glutamyltransferase in serum was the highest in toxin fed group and intermediate in the group fed EGM-supplemented AF feed. EGM showed no effect on protein concentration while cholesterol level improved moderately as it was statistically similar to both the AF and control groups. EGM supplementation to the AF group increased the thymus weight, which was intermediate to those of AF and control groups and showed no influence on any slaughter parameter, except for marginal reductions in the weight of gizzard, giblets and kidney.

Optimization of Ca and P in broiler diet: The recommended levels of Ca (10g/kg feed) and phosphorus (4.5g/kg) were, respectively reduced by 40 and 33% (6 and 3 g/kg feed) with no loss in growth or bone mineralization. Ca and P levels in broiler diets could be further reduced to 5 and 2.5g/kg feed, respectively, but only after fortifying with cholecalciferol (1,200 ICU/kg) or supplementation with lactic/citric acid. The excretion

levels of Ca, P and trace minerals (Mn, Fe, Zn and Cu) declined by 30%, minimizing the pollution due to these minerals. The reduction in Ca and P reduced the cost on feed by Rs 200/tonnes.

Effect of sunflower and sesame protein meals on broiler meat: Soybean-meal was replaced up to 67% with sesame-meal and 100% with sunflower meal, without affecting the growth and carcass yields. These two protein sources also decreased cholesterol (1.9 to 48.5%) and triglycerides (22.3 to 23.3%) in serum, liver fat (26 to 28.1%), excretion of nitrogen (30.4 to 36.7%), fat (29.2 to 35.8%), calcium (14.6 to 28.8%) and phosphorus (30.4 to 48.0%) compared to broiler fed soybean-meal. A combination of sesame (33%) and soybean-meal (67%) had complimentary effects to improve broiler performance more than those fed only soybean-meal as the source of protein.

PHYSIOLOGY

Cattle

Ionophore feeding effect on calves: Supplementation of monensin sodium provided nutritional and metabolic advantage to the calves over non-supplemented calves. The supplemetation of monensin sodium @ 200 mg/day for 75 days resulted in significantly higher average daily gain. Feed conversion efficiency, glucose, blood urea nitrogen (BUN) and insulin were higher in the treatment group as compared to control group.

Buffalo

Laboratory tests for bull fertility testing: A laboratory procedure to accurately predict fertility of breeding bulls at an early age, which will help in selection of breeding bulls, is being developed. *In-vitro* fertility evaluation for 4 bulls of set VII is in progress. Cleavage rates in 229 *in-vitro* matured oocytes with semen of these bulls ranged from 65 to 85% for individual bulls, which needs to be correlated with field fertility results.

Improvement of semen cyropreservation: Effects of altered osmolarity of the extender and stage of glycerolization following diluting of semen, were studied. The glycerolization done at room temperature during initial stage of semen dilution, prior to cooling, reduced the incidence of post-thaw backward motility of spermatozoa to negligible level as compared to 40-60% in most of the ejaculates which were glycerolized after cooling to 5°C. The modified protocol reduced rejection rate of ejaculates by 20%.

Sterols and in vitro *capacitation and acrosome reaction of buffalo spermatozoa:* Cholesterol efflux is the earliest event initiating cell signaling events like rise in C_{AMP}, rise in intracellular pH, Ca^{+2} and expression and suppression of membrane bound enzymes. *In vitro* standardization of buffalo sperm capacitation vis-à-vis the cholesterol efflux was achieved. The cholesterol efflux was also substantiated by using radio labeled (3_H cholesterol) spermatozoa and by transmission electron microscopy. The buffalo sperm capacitation was inhibited by enriching media by exogenous cholesterol and also by using media devoid of cholesterol acceptor like BSA. These effects were also studied by replacing the BSA with cyclodextrins in the medium. Intracellular Ca^{+2} (2.3-times) and intracellular pH (0.16 units) increased during normal capacitation while no such changes took place in presence of medium containing high cholesterol. Ca ATPase inhibitor quercetin addition reduced the time for *in vitro* capacitation in the normal medium. But addition of quercetin in cholesterol enriched medium did not achieve the normal capactiation. Cholesterol efflux seems to be the crucial event accompanying the early phase of buffalo sperm capacitation to affect the membrane fluidity.

Embryo resource generation: Use of different sera (foetal bovine serum, buffalo serum and steer serum) in the culture media significantly increased the maturation and fertilization rates in *in vitro* maturation and fertilization of buffalo oocytes. No differences in the maturation and fertilization rates were observed between the different sera supplementation. Heparin, caffeine and calcium ionophore significantly affected individual motility, viability, head to head agglutination and sperm-oocyte attachment. The combination of heparin and caffeine or calcium ionophore resulted in maximum head-to-head agglutination and sperm-oocyte attachment.IGF-I @200 ng/ml was optimum for *in vitro* maturation of buffalo oocytes. IGF-I at different levels did not stimulate the motility of buffalo frozen sperm, but stimulated the protein uptake by the sperm and phosphorylysis in seminal plasma.

- Milk progesterone profile revealed reproduction status of cattle that helped in timely remedy of reproductive disorder in animal
- Laboratory procedure developed to accurately predict fertility of bulls helping in selection procedure
- Improvement in cryopreservation helped in reducing rejection rate of ejaculates by 20%
- Physiological basis of thermo-adaptability in different age groups of goats studied
- Estrogen,progesterone,T3,T4 and cholesterol estimated during various physiological stages
- Synchronization of estrus in Malpura ewes resulted in 75% ovulation
- Scientific management practices reduced loose housing system calf mortality
- Causes of reproductive failures in camels were studied to improve reproductive efficiency in camels
- Camel lactoferrin has dual fuction
- AI and pregnancy diagnosis perfected in equines
- Yaks were successfully induced into heat
- Elements estimated in muscles of yak
- Enzyme immuno assay was developed for determination of growth hormone in mithun
- Antibiotics reduced bacterial count in foam of quails
- Acetylcholine esterase activity at central nervous system was found affected due to immobilization stress

Embryonic losses: intra uterine protein profile and hormone receptors: Role of uterine proteins and hormone receptors in signalling between conceptus and mother was studied.The level of protein and RNA was more in the uterine fluid during luteal phases as compared to follicle phases. Acid and alkaline phosphatase activities were more during luteal phases. Buffalo uterus obtained from slaughterhouse revealed that the estradiol receptor concentration was high in follicular phase compared to luteal phase. The rising concentration of estradiol receptor concentration in peripheral plasma shortly before estrus may be the physiological cause of increased concentration of estradiol receptor in the follicular phase. The low concentration of receptor during later half of estrous may reflect saturation of available binding site by proestrus estrogen surge. Progesterone may either reduce the uptake of estrogen by cell nucleus or it may affect the later stages of receptor protein synthesis once estradiol has entered into the nucleus.

Reproductive status monitoring in buffaloes by milk progesterone determination

Milk progesterone was assayed from samples collected twice weekly from lactating buffaloes for monitoring their reproductive status.

Estrus: Milk progesterone profiles revealed estrus 37%. The incidence of unobserved estruses was the highest in April (70%) followed by May (58%), June (55%), August (47%) and July (43%). The lowest incidence of unobserved estruses was recorded from December (10.9%) to February (22.2%). The overall incidence of anovulatory estruses was 9%. Incorrect AI was recorded in only 4 animals (2%).

Cyclicity: Out of 27 animals for which milk progesterone profiles were monitored beginning immediate postpartum, cyclicity had commenced at 68.27±9.9 days postpartum. An animal was declared acylic when it had exhibited constantly low milk progesterone concentrations over at least 5 weeks after initial cyclicity commencement postpartum. The incidence of acyclicity was 8%.

Pregnancy/non-pregnancy: Animals calving in the first two quarters of the year (Jan-March and April-June) had significantly higher service periods. Buffaloes calving in July-Sep and Oct-Dec had lower service periods.

Therapeutic application: The milk progesterone analysis and reproduction was also useful in identifying animals suffering from cystic ovarian conditions, abnormal cyclicity, etc., and were referred for timely treatment.

Goat

Thermo-adaptability in different age groups: Rectal temperature of the Marwari male kids (average age of one month) in the morning in the first month of birth was 1.46°C higher than the rectal temperature of bucks. The rectal temperature of the kids remained higher than that of bucks up to about 9.5 months of age. After that the rectal temperature of the kids stabilized almost equal to the rectal temperature of the bucks. The respiratory rates of the kids in the morning at 1.0, 1.5 and 2.0 months of age were 95.45, 37.42 and 26.33% higher than that of bucks. The mean respiratory rate of the kids was higher up to the age of 5.5 months compared to bucks. The heart rate of the kids in the morning at one month of age was 147.00±10.48 against 72.78±2.94 in bucks. The heart rate declined up to 7.0 months of age in kids and then it stabilized almost equal to the heart rate in the bucks. In kids heart rate in afternoon was higher up to 5 months of age then it decreased from 11.15 to 21.08% up to the age of 7 months and after that heart rate of kids was similar to that of bucks.

Hormonal and biochemical profile during various physiological stages

- Estrogen decreased after conception, and remained low up to 60 days of gestation period. Estradiol started increasing from 75 days of gestation period and remained higher up to 142 days of gestation period. Estradiol was 335.70±38.08 pg/ml on the day of kidding. Significant rise in estradiol during mid pregnancy is attributed to placental synthesis of estrogen.
- Progesterone was lowest on the day of oestrus, highest on ninth day of oestrus cycle, and increased on conception. The progesterone up to 45 days of gestation ranged from 2.92±0.22 to 3.48±0.27 ng/ml, which further increased up to 90 days of gestation. After that it decreased up to 142 days of gestation period. Progesterone was 0.59±0.06 ng/ml on the day of kidding.
- T_3 was highest (2.42 ± 0.8 ng/ml) on the day of estrus, lowest (1.87 ±0.9 ng/ml) on fifth day of estrus cycle, and decreased up to 1.31±0.29 ng/ml during first month of gestation. It decreased up to three months of gestation period but started increasing from fourth month of gestation, and attained the highest level on day of kidding. It remained high up to one week of postpartum period, and decreased up to one month of lactation.
- T_4 was lowest (59.55± 6.02 ng/ml) on ninth day of oestrus, while it was highest (112.78±1.60 ng/ml) on the day of oestrus cycle, and decreased up to 95.50±9.82 ng/ml during first month of gestation. It decreased up to three weeks of prepartum period, but slightly increased at two weeks prepartum. On day of kidding it decreased to the lowest level (38.50±4.20 ng/ml). During postpartum it increased, and attained the level of 77.30±5.51 ng/ml after one month of lactation.
- Cholesterol remained static throughout oestrous cycle. During fifth month, cholesterol significantly decreased and attained significantly low level on day of kidding. During lactation, it further decreased significantly.
- Activity of transaminases was significantly high during the follicular phase. On day of estrus, SGPT was

significantly low (2.91 ± 0.61 units/ml), while SGOT attained significantly high on day of oestrus. Transaminases remained significantly low up to third month of gestation. Activity increased significantly during fourth month, thereafter, it decreased in fifth month. It attained significantly highest level on day of kidding, thereafter, it declined throughout lactation period.

- Zinc was significantly higher on day of mating, it decreased during first month of gestation period, and remained low up to third month of gestation period. It increased significantly during fourth month of gestation period and remained high up to first week of postpartum period. Thereafter, it decreased and attained significantly low level after one month of lactation.
- Copper level increased from third month of gestation and attained significantly higher level in the middle of fourth month of gestation. Thereafter it decreased and remained low up to first week of lactation. It attained significantly higher level during second week of lactation and remained high up to one month of lactation.

In-vitro *production of caprine oocytes: In vitro* maturation and fertilization of caprine oocytes were done using oocytes collected from ovaries of slaughterhouse and a cleavage rate of 10% was obtained.

SUCCESS STORY

Fat lamb production technology

Production of fat lamb is a promising commercial mutton production program that can prove a boon for meat industry. Malpura weaner lambs (2 months age) achiev 25 kg body weight at about 5 months of age under intensive feeding on composite ration of the ratio of 60 concentrates and 40 roughage. The major advantage of this technology is that sheep owners need to rear the animals only for about 5 months and not for the whole year. Further, farmers will get the handsome profit after 5 months and this profit would be at par

or even more than when the lambs that are reared for 12 months under extensive grazing system. By considering all the inputs required for raising the lambs to attain finishing weight of 25 kg, it is estimated that net profit of about Rs 370/lamb on slaughter basis and Rs 100 on live animal sale basis can be obtained. These figures are based on prevailing prices in local market. This technology would be helpful to the clientele for reducing the time period from 12 to 5 months in getting almost same profit per animal in addition to avoiding the mortality risk and unnecessary rearing of lambs up to yearling stage.

Fertility trial in sheep

A fertility trial was conducted for one cycle in 28 adult Malpura ewes using freshly diluted semen samples obtained from 4 Garole rams. Ewes exhibiting natural estrus on previous evening and were inseminated in next morning with 0.1 ml of freshly diluted semen by single per-os insemination. Thirteen ewes returned to oestrus in the second cycle and 15 lambed.

Sheep

Estrus was synchronized in Malpura ewes by injecting two doses of PGF. First group was given PMSG (folligon @ 200 IU (1 ml/ewe)) on day 8 post first PGF injection and FSH (ovagen @ 2.7 mg (3 ml) /ewe in four doses over 2 days), and second group received PMSG on day 8 post first PGF injection and GnRH (receptal @ 1 ml/ewe) at the onset of estrus.This resulted in ovulation in 75% ewes in both group. Cooling of ram spermatozoa under controlled conditions prior to controlled freezing was beneficial for post-thaw survival of ram spermatozoa.

Camel

Environmental stress and shelter management: Under loose housing system calf mortality could be reduced by adopting scientific management practices during calving and care of neonate. Semi-intensive management was better than intensive condition for calf and adult camel management because of higher time involvement in feeding and other related activities and less time involvement in idling like activity. Temperature humidity Index was lowest under thatched roofed open type *kuchcha* shelter followed by loose housing and asbestos roofed close type concrete shelter. Thatched roofed open type *kuchcha* shelter and loose housing were better than asbestos roofed close type concrete shelter.

Improvement of reproductive efficiency: Female camels, which were administered hCG to induce ovulation after ascertaining the follicle in the ovaries, were

Improvement of working efficiency of camel

Trials were conducted on recently designed camel-drawn agricultural implement viz. 3x2 dish harrow and 5- tyne cultivator. Total working time before fatigue with harrow and cultivator for 4 camels averaged 42.93 ± 2.32 and 43.26 ± 2.06 min, respectively. The best performance of individuals recorded were 61.27 ± 5.02 and 57.85 ± 2.63 min, respectively. The force exerted in pulling these implements averaged 127.02 ± 4.94 and 164.57 ± 6.50 kg, respectively. The land ploughed averaged 1,730.48 ± 79.40 and 1,569.5 ± 76.76 m^2. These implements were rather heavy for camels to pull upon and need redesigning. The pulling force needs to b e

SUCCESS STORY

Generation of electricity (Light) by camel cart

Camel cart is an important means of communication/ transport in desert and areas adjoining the desert. Since last few year there is an immense increase in road accidents involving camel carts. The main factor responsible for the increase in accidents is absence of light reflectors on camel carts. The National Research Centre on Camel, Bikaner, has devised a system by which traditional two wheel camel cart is decertified like other motorized vehicles. In this device a 22 inch diameter pulley is attached/fitted with the scan of camel cart wheel. This pulley is attached to mother small pulley of 5 inch diameter which enables the small pulley to revolve at 4.5 times of the revolving

speed of camel cart wheel, on the axis of small pulley one more pulley of 22 inch diameter is attached which in turn is connected by v- belt to small pulley of dynamo. This enables the pulley of dynamo to revolve at 22 times than the speed of camel cart wheels. Thus dynamo can revolve at 450 to 600 rpm which can produce 3-4 ampere of electric current, which is used to charge a 12 volt 25 amp battery fitted on the camel cart. This battery is sufficient for two head lights and two indicator rear lights with a total consumption of 12 volts and 1.5 ampere. This charged battery could be used by farmers to arrange lights in the remote Dhanis/villages where electricity is not available. This will help in doing the domestic work and studies in the night. The battery once charged can serve for 20-22 hours. The total cost of this system comes around Rs 2,000 to 2,500.

inseminated with either diluted-cooled or fresh undiluted semen. Pregnancy could not be established with diluted and cooled semen, whereas the pregnancy rate was low with undiluted semen. Consistent higher levels of P_4 were considered to be indicative of pregnancy. The results indicated that 5/33 inseminations resulted into successful pregnancy while 17/33, 8/33 and 3/33 were indicative of failure of ovulation, fertilization and embryo survival, respectively. High incidence of failure of ovulation may be because of oversized follicles or follicles in which degenerative processes might have initiated prior to administration of hCG. High failure of fertilization may be because of viscous form of camel semen, which might probably play role of sperm reservoir and protect viability of spermatozoa in the female genital tract by entrapping sperms. Insemination with diluted and cooled semen might disturb this property of semen resulting into failure of conception. High incidence of failure of ovulation and failure to deposit sperms in its natural entrapped viscous form are the major problems in AI in camel. Further improvement may be possible by selecting appropriate follicular size before administration of hCG and AI.

Camel lactoferrin has dual function: Camel lactoferrin is the first protein from the transferrin superfamily that displays the characteristic function of iron binding and release of lactoferrin and transferrin simultaneously. To establish the structural basis of this striking observation, the purified camel lactoferrin was crystallized. The overall structure of camel apolactoferrin folds into two lobes, which contain four distinct domains. The iron binding and releasing behaviour of the N-lobe of camel lactoferrin is similar to that of the N-lobe of human lactoferrin, whereas that of the C-lobe resembles those of the C-lobes of duck and hen apo-ovotransferrins. Hence, it correlates with the observation of the N-lobe of camel lactoferrin losing iron at a low pH (4.0-2.0) as in other lactoferrin. On the other hand, the C lobe of camel lactoferrin loses iron at higher pH (7.0-6.0) like transferrin suggesting its functional similarity to that of transferrin. Thus, camel lactoferrin can be termed as half lactoferrin and half transferrin.

Equine

The technologies for cryopreservation of good quality jack semen along with method for artificial insemination and pregnancy diagnosis were perfected at the NRC on Equine, Hisar. A serum-based ELISA based on detection of equine chorionic gonadotrophin (eCG) was standardized for pregnancy diagnosis in equines. The results of ELISA were at par with the rectal examination and ultrasonographic results. Inter-and intera-assay variability was worked out. Fluoride concentration in 22.96% of samples was more than WHO recommended physiological limits (0.20 ppm) in serum. Similarly, the sub-clinical lead toxicity was observed in 66.8% animals and 19.5% animals had toxic blood lead level (>0.50ppm). Majority of equines (78%) had normal cadmium concentration in their blood.

Role of equines as draught power in rural economy

The equine being an important animal for draught and transport, plays a significant role in rural economy and constitutes main source of income for sizeable underprivileged section of the society in many parts of the country. It also holds special position in livestock both for civil and military purposes in view of its multifaceted utility. Mules are used extensively for pack and transportation by the military forces and civilian in the hills and inaccessible terrain. Superior mules in terms of greater strength and size will be helpful in improving the socio-economic status of marginal farmers. There is an urgent need for development of mules in the field in an organized manner so that work efficiency of mules and ultimately economic returns of farmers can be enhanced.

THE JAIVIGYAN PROJECT ON HOUSEHOLD FOOD AND NUTRITIONAL SECURITY FOR TRIBAL, BACKWARDAND HILLY AREAS

Improved Livestock productivity in Tribal backward and Hilly areas

Vanaraja eggs and meat – For food and nutritional security in four NEH states

A project on backyard poultry farming in four NEH States was sanctioned under Jaivigyan Mission Mode project (MM.II['I-3) to ensure production of chicken eggs and meat at household level, for food and nutritional security. Vanaraja was utilized for this purpose by the four ICAR units located in Manipur, Mizoram, Nagaland and Arunachal Pradesh. At each centre eggs were set for hatching and, the chicks of Vanaraja were reared under confinement up to 6 weeks of age to provide protection from weather, predators, diseases and nutritional deficiencies. They were then supplied in small numbers to beneficiaries belonging to low and middle-income groups, besides unemployed youth and women.

The fertile eggs and day old chicks were also sold. The entire process of poultry farming at domestic level provided eggs for consumption and disposal, regeneration of chicks, sale of chicks and disposal of adults for meat purposes. Consumption of eggs and meat improved the nutritional status while disposal of the same provided supplementary income. On an average, each bird earned Rs 190 and Rs 27,738 were generated from the sale of birds. Fertile eggs were sold between Rs 5 to 10/egg and for table purposes between Rs 3-5.

Yak

Timing of ovulation was determined during spontaneous estrus. Induction of estrus was attempted in female yaks by ovsynch protocol and out of 8 animals, 7 were successfully induced in to heat. This protocol will have tremendous utility in setting time of artificial insemination in yak.

Concentration of Ca, Mg, Na, K, Zn, Fe, Cu and Mn were determined in different muscles of yak.

Mithun

Growth hormone determination: Enzyme immunoassay (EIA) for mithun growth hormone (GH) determination was developed and validated. Biological validation was conducted on mithun calves by injecting synthetic bovine growth hormone releasing factors (GRF: @ 10 mg/ 100 kg body weight intravenously). The peak value of GH 443.5 ng/ ml reached after 15 min of GRF administration in treated calves. The basal level of plasma GH in control animals was higher than any other livestock so far reported. To determine the possible interference of plasma with the assay sensitivity, bovine GH standard in various amounts of plasma (0, 12.5, 25 and 50 ml) were run in an assay. There was no difference in the absolute binding sensitivity among 12.5, 25 and 50 ml plasma volumes. The measurable range of GH was between 10 to 125 ng/ml and covered all possible physiological variations.

Poultry

Effect of antibiotics on cloacal gland of quail: Orally given ciprofloxacin or pefloxacin @ 10mg/kg body weight for 12 days gradually reduced foam production and area of cloacal gland in treated sexually active adult male Japanese quails. Foam significantly reduced at midnight (24:00) when compared with noon (12:00). Bacterial counts of foam drastically reduced in both ciprofloxacin and pefloxacin treated groups of Japanese quail, indicating the involvement of bacteria in foam synthesis mechanism. Ciprofloxacin was superior to the pefloxacin based on the residual effect of the drug in different tissues after tenth day of withdrawal of treatment. Mechanism of action of ciprofloxacin appears to be different from pefloxacin.

Interaction of cholinergic and nitrinergic systems under stress: AChE activity and nitric oxides (nitrite and nitrate) were studied in brain and serum samples of male Japanese quails. AChE activity was significantly higher in L-NAME group as compared to the control and SNP treated groups. The membrane bound AChE activity of the SNP and L-NAME groups decreased significantly over the control. Serum AChE activity showed similar trend. The end products of nitric oxide (nitrite and nitrate) in the brain and serum did not show any significant differences among the control and treated groups.

The brain tissues of birds kept under normal, acute stress (immobilized once for 2 hr) and chronic stress

(immobilized every day for 2 hr), were studied. The AChE activity (membrane bound plus cytosolic) in acute group was significantly low compared to the control and chronic groups. AChE activity increased significantly after 5 days of chronic stress, which subsequently dropped to the normal level (equal to control group). The acute stress did not cause any change in the cytosolic AChE activity. Prolonged stress for 10 and 15 days reduced the cytosolic AChE activity significantly. The metabolites of nitric oxide (NO_2 and NO_3) did not show any significant change in acute and chronic stress groups. Immobilization stress, one of the sevear types of stress in birds, affected the acetylcholine esterase activity at central nervous system level. This clearly indicated that the cholinergic system is very much involved in stress-mediated physiological responses.

Enhanced egg production in birds: Effect of immunization of chicken prolactin by administering Vaso active intestinal peptide (CVIP) and bromocryptine through feed, on egg production was studied. Birds immunized against CVIP had higher egg production than control. Providing bromocryptine @ 350 mg per 60 kg of feed yielded higher egg production and was cost effective.

DAIRYING AND ANIMAL PRODUCTS TECHNOLOGY

Milk and Milk Products Technology

Whey based jaljeera drink: Whey based jaljeera drink was standardized using stabilizer, sugar, jaljeera powder and clarified cheese/paneer whey. The addition of synthetic lemon flavour further increased the flavour of jaljeera drink. The whey jaljeera drink contained 14-15% total solids and 0.5-0.7% proteins. The in-bottle pasteurized whey jaljeera drink remained acceptable for 2 months at 25°C. The manufacture of jaljeera-whey drink will not only solve the problem of whey utilization effectively but also bring the valuable nutrients of whey such as minerals and water-soluble vitamins into human food chain.Whey based jaljeera drink was also developed in dried form to increase the convenience of the product. The instant dried formulation is based on spray dried whey powder, sugar, jaljeera spice mixture, citric acid, stabilizer and had very good shelf stability with good reconstitution property.

Whey based lassi: Lassi of acceptable quality was prepared from a blend of cheese whey and buffalo milk. Whey was used to a concentration of 60% using suitable stabilizing salts. Concentrations of whey above this level led to thin consistency in the product. The lassi thus prepared had normal flavour and was of acceptable quality. The value addition of lassi in terms of enhancement of its nutritive value and as a possible means of utilizing maximum quantities of liquid whey, which otherwise, would have to be processed and treated using extremely expensive techniques, offers an alternative to dairy entrepreneurs.

Symbiotic yogurt: The compatibility of probiotic strains of *L. acidophilus* (*L. acidophilus* NCDC 291 and *L. acidophilus* NCDC 13) with two combinations of yogurt starters (*L. bulgaricus* NCDC 09 and *S. thermophilus* NCDC 74; *L. bulgaricus* NCDC 305 and *S. thermophilus* NCDC 311) was studied to select a suitable *L. acidophilus* strain. The growth and activity of *L. acidophilus* NCDC 13 was studied in the presence of different concentrations of inulin, oligofructose and honey (0%, 0.5%, 1%, 3% and 5%) at 6 hr interval up to 24 hr. Use of inulin at 3% level resulted in better growth and acid production. A symbiotic yogurt was developed by incorporating *L. acidophilus* NCDC 13 at 1% level and inulin at 3% level. The sensory evaluation of the product showed better acceptability than the plain and probiotic yogurt. Viability of *L. acidophilus* NCDC 13 in the symbiotic preparation was higher than that of probiotic yogurt during refrigerated storage for one week. Therefore, inulin and *L. acidophilus* NCDC13 can be a good combination for symbiotic application. The effectiveness of this symbiotic preparation and its beneficial effects in humans have to be confirmed by *in vivo* studies.

Dahi stimulates immune system and protects against enteric infection: Peroral administration of dahi stimulated the release of α-galactosidase both in peritoneal fluid and in the supernatant of macrophage cultured *in vitro*. The release of α-glucuronidase was however, unaffected by dahi feeding. The activities of α-galactosidase and α-glucuronidase in the intestinal

- Whey-based jaljeera drink developed
- Whey based lassi provided an alternative to dairy entrepreneurs
- Inulin @3% resulted in better growth and acid production in symbiotic yogurt preparation
- Dahi stimulates immune system and protects against enteric infection
- Twin-screw plasticizer developed for production of ghee-based butter
- Model developed for pore membrane formation
- Low fat/sugar free frozen dessert developed for diabetic patients
- Energy audit developed for identifying the potential for improvements in energy efficiency in model dairy plant
- Curd rice production method developed
- Assays standardized for detection of antibiotic residues
- Withdrawal of milk for 3 days after antibiotic treatment ensured safe milk ffor consumption
- Mineral composition of goat milk was studied
- Milk and milk products technology developed for yak milk
- Process standardized for soft cheese preparation from camel milk
- Chevon pickle has good market potential
- Alcoholic extract of garlic helped in making chicken skin – meat cutlet
- Broiling and pressure cooking were effective in reducing residues of DDT,BHC and malathion in spent hen tissue

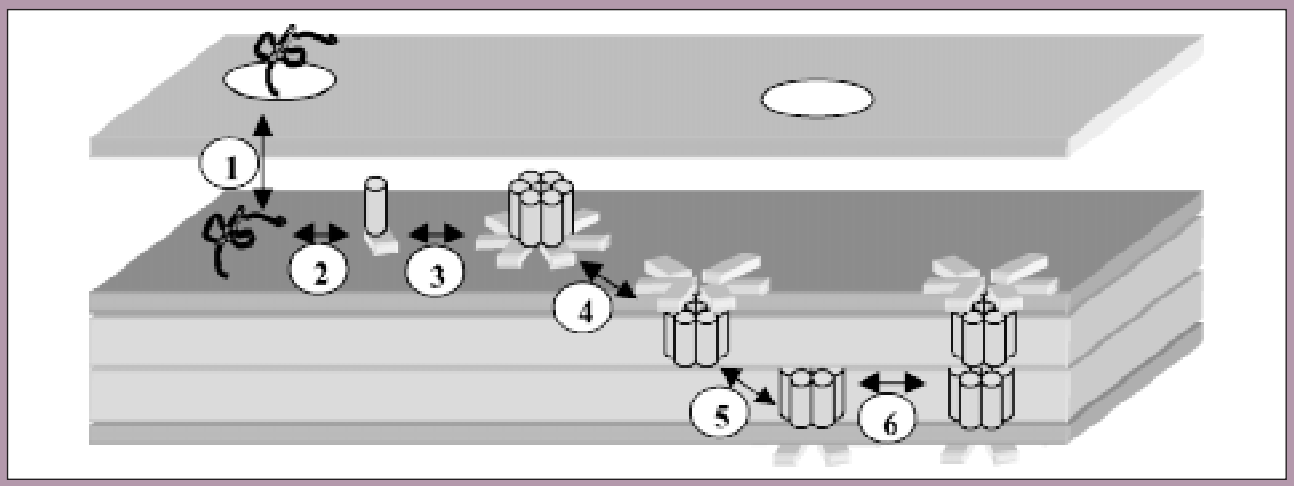
secretions of mice were also not significantly affected by peroral administration of dahi. There was a significant increase *in vitro* phagocytic activity of macrophages from dahi-fed mice. There was a sharp rise in the level of anti *Sh. dysenteriae* antibodies in the intestinal fluid at day 2 post-challenge in dahi-fed mice, and remained significantly elevated at day 5 and day 7 post challenge. The colonization of *Sh. dysenteriae* in liver and spleen decreased significantly in dahi-fed animals compared with the control.It was concluded that dahi has a good immunostimulatory effect and also helps to protect against enteric infection.

Cooling and working of butter mix using twin-screw system: A twin-screw plasticizer for the mechanized production of ghee-based butter, was developed. The effect of the operating parameters (the screw speed and discharge temperature of the product) on the mass-flow rate, residence time and cooling rate were optimized on the basis of compositional, rheological and structural characteristics of the product. The screw speed of 20 rpm and product discharge temperature of 6°C were the best for efficient plasticization of the butter-mix.

Frozen dessert technology for diabetic patients: Low fat/sugar free frozen dessert was developed by using artificial sweeteners and bulking agents. Artificial sweeteners namely aspartame, Acesulfame, sucralose and sodium saccharin were also tried. The frozen dessert with 5.0% fat, 12.5% MSNF, 9.9% maltodextrin, 9.3% sorbitol, 1.5% WPC, 0.35% stabilizer and 400 ppm aspartame was selected on the basis of sensory quality using D_6 Hokes design (Response Surface Methodology). Both maltodextrin and sorbitol are necessary to get the desirable body and texture, while sweetness can be compensated by addition of artificial sweeteners. The cost of production of developed frozen dessert was Rs 29.88/100 ml. Product kept well for 90 days.

Mechanization of burfi making: Towards the development of continuous burfi making machine, a new rotor assembly of SSHE was designed and developed for providing two skewed blades and two flat blades. The skewed blade angles selected were 20°, 30° and 40° and speed chosen were 100, 140 and 180 rpm. Minimum product accumulation was at maximum skewed blade angle and maximum rpm. The product had pastiness and

Model for membrane pore formation



Class IIa bacteriocins from Gram-positive lactic acid bacteria kill their target through pore formation in the cell membrane of sensitive bacteria. Understanding of this mechanism of action will help in the design of bacteriocin analogues with desired inhibitory spectrum in the desired pH range. A class IIa bacteriocin comprises an N-terminal sheet, a central hinge and a C-terminal amphiphilic either á-helix or â-sheet. N-terminal â-sheet has a claw of positively charged residues hanging from its bottom face, tyrosine and asparagine extending laterally in opposite directions, forming a bidentate arm. In the proposed model for pore formation, monomeric random coil bacteriocin diffuses into the periplasmic space (step 1) and folds into functional form (step 2). Amphiphilic C-termini of folded monomers associate to form a cylindrical complex resulting in outer hydrophilic surface and buried hydrophobic residues (step 3). On one end of the complex, â-sheets associate through their bidentate arms resulting in a planar ring containing positively charged claws on the bottom face, which attaches the complex onto negative membrane surface. With the planar ring remaining attached, the C-termini folds back through a rotation in the hinge region resulting in reversion (i.e. inside out) and concomitant insertion of the cylinder into the outer monolayer of the lipid bilayer (step 4). This result in water filled pore that could span only outer monolayer because the length of C-terminus in these bacteriocins is just enough to span the lipid monolayer. In the subsequent step, some of the half pores translocate across to inner monolayer to form inner half pore (step 5). Two half pores in each monolayer may occasionally align coaxially to form a conducting channel, thereby causing dissipation of proton motive force and leakage of small intracellular substances, and death of sensitive bacteria (step 6).


Yak milk paneer


Yak milk dahi

Yak milk lassi

Yak Milk and Milk Products Technology

Technologies were developed for different products from yak milk.

- Starter culture for production of yak milk *dahi*
- Production of good quality of yak milk *dahi* with higher shelf life and flavored milk
- Production of yak milk paneer and mixed milk paneer
- Utilization of paneer whey as pineapple flavored whey beverage

Small yak milk processing unit were established for production and marketing of yak milk products (*dahi*, paneer, lassi and pineapple flavored whey beverage). The unit is also used for training of yak herdsmen and women.

uncorked flavour. The preheating to 90°C for holding time of 15 min gave best attributes of product.

Large scale production of curd rice: Curd rice was prepared by mixing culture inoculated milk and cooked rice and incubating it at 37°C for 14-16 hr. This fresh curd rice had 0.54% acidity and 88 × 10^{4}/g lactic acid bacteria count. The curd rice packed in polystyrene cups and stored at 37°C had an acidity of 0.68% and lactic count of 10^{3} × 10^{4} / g at the end of 5 days up to which the product remained acceptable. The curd rice stored well up to 8 days at 5°C.

*Goat milk:*Zinc content was higher in Jamunapari and Barbari goat milk than Sirohi and Marwari breeds. Variations between morning and evening samples were more in Jamunapari and Barbari than Marwari and Sirohi. Morning samples of Barbari revealed highest (3.045mg) and evening samples had lowest (1.847mg) concentration of manganese. Copper content was highest (0.444mg) in morning samples of Jamunapari and lowest (0.258mg) in Marwari. Iron content, which varied from 2.702 – 3.308 mg, irrespective of breed, was higher in evening than that in morning milk samples.

Camel milk soft cheese: Process was standardized for the preparation of camel milk based soft cheese. Camel milk cheese contained as per cent moisture 61.07 ± 4.29, total solid 38.99 ± 4.22, fat 9 ± 1.53, acidity 0.068 ± 0.01 and yield of cheese was 12.17 ± 0.64%.

Meat and Meat Product Technology

Raw chevon quality: Meat composition of kids and lambs reared under intensive system revealed that kids meat (age 9 months) had low fat and total cholesterol than lambs (age 6 months). Sirohi meat has less fat and cholesterol than Barbari kids meat. Chevon quality of spent Marwari goats was compared with lamb meat and

Energy audit in model dairy plant

Thermal and electrical energy consumption during processing for milk processing, ice creams and ghee, were estimated and thermal energy losses through condensate were calculated.During milk processing the steam consumption per 100 liters of milk, right from milk reception to pasteurization was 2.8 kg with an equivalent energy of 1,808.44 kcal. Power consumption per 100 liters of milk was 1.668 kwh. Steam consumption per 100 liters of ice cream mix was 12.1 kg with an equivalent thermal energy of 7,831.28 kcal. Power consumption per 100 liters of mix was 19.12 kwh. During ghee preparation average steam consumption per 100 kg of ghee was 42 kg, with an equivalent thermal energy of 2,7300 kcal. Electrical energy consumption per 100 kg ghee was1.302 kwh.Thermal energy losses through condensate and equivalent savings by recovering these losses were expressed in terms of boiler fuel oil and in terms of rupees. These losses in milk processing, ice cream and ghee preparation were 8.3%, 5.14%, 10.05%, respectively. Equivalent saving in terms of fuel oil would be 4.72 kg, 1.135 kg and 2.03 kg/day, respectively. Savings per annum for these three products would be approximately Rs 38,616.

Quantitative losses of eggs and poultry meat

The magnitude of losses of eggs at layer farms, wholesalers, retail markets, egg processing units, cold storage and household (consumer) levels were 0.96%, 1.28%, 3.10%, 1.09%, 1.42% and 3.2%, respectively, which together constituted an overall loss of 11.05% between farm and kitchen. The losses were relatively more in summer than that in rainy season or winter. Loss of broilers due to mortality between 5 to 7 weeks of harvesting (marketable age) maximum at retail level (2.24%) followed by at broiler farms (1.16%) and wholesale level (0.40%), whereas, at household consumers' level, loss of poultry meat was negligible.

their combinations (50:50). The a_w, pH and total cholesterol content (mg/100g) of lamb meat were 0.995, 5.74 and 62.63. Spent goat meat had a_w 0.995, pH 5.88 and cholesterol content 48.13 mg/100g.

Goat

Chevon samosa: Chevon *samosa* using spent goat meat was prepared. Semi-fried and deep fat fried *samosa* were packed under vacuum and atmospheric conditions and stored at –20°C for evaluating physico-chemical, microbiological and organoleptic changes at monthly intervals for 4 months. Freshly prepared product had SPC log 4.62 in semi-fried and log 4.48 in deep fat fried *samosa*. Coliforms were log 0.55 in semifried and absent in deep fried *samosa*. *Lactobacilli* were log 0.33 in semifried and not detected in deep fried *samosa*. Yeast and mold counts were <log1.0 and psychrotrophs bacteria present were well below the permissible limits in cooked meat products.

Chevon nuggets: Lamb meat nuggets revealed high yield (87.18%) compared to 81.52% for spent goat meat. Nuggets had a_w of 0.988. The cholesterol was 136.25 mg for lamb meat nuggets, 120.11mg for combination meat and 110.02 mg/100g for spent goat meat. Nuggets using spent goat meat, lamb and their combination (50:50) was prepared, packed under vacuum and ordinary conditions and stored at –20°C for evaluating physico-chemical, microbiological and organoleptic changes at monthly intervals for 4 months. Freshly prepared product had SPC log 3.99 in lamb nuggets, 4.07 in goat meat nuggets and their combination had 4.34 CFU/g. Coliforms and lactobacilli were not detected. Yeast and molds and psychrotrophs bacteria were well below the permissible limits in cooked meat products.

Chevon kofta: Chevon *kofta* packed under vacuum and without vacuum in HDPE and stored at –20±2°C, could safely be stored for 4 months without significant change in physicochemical, microbiological quality and organoleptic scores except decline in general appearance at latter period of storage, irrespective of packaging methods.

Chevon patties: Chevon patties vacuum packaged using HDPE on quality and shelf-life of chevon patties stored at 4±1°C revealed that vacuum packaging had definite advantage in preserving the sensory quality of patties than ordinary packaging but did not help in extending the shelf life beyond 15 days as it was mainly contaminated by microbial growth.

Poultry

Chicken meat spread: Processing technology for the preparation of chicken spread from spent hen meat was developed. The chicken meat spread from spent (culled) hen meat had desirable spreadability and acceptability. Addition of 0.5% sodium tripolyphosphate (STP) and 100ppm α-tocopherol acetate in the formulation improved emulsion stability and inhibited lipid oxidation as measured by TBA assay. Vacuum-packed product in PFP laminate had shelf life of 12 and 60 days under refrigerated (4-5°C) and frozen (-18°C) storage, respectively.

Storage stability of poultry meat products: Incorporation of alcoholic extract of garlic at 2% level (w/v) in unspiced minced meat base containing processed chicken skin at 10% level resulted in delicious chicken skin-meat cutlet. The finished product remained acceptable till 14 and 28 days under refrigerated (4±1°C) and frozen (-18±1°C) storage, respectively.

Poultry meat preservation by phyto-products: Aqueous garlic extract at 4.0% (w/v) or ethyl alcoholic extracts of cinnamon and clove at 0.4% (w/w) and 0.15% (w/w) respectively, in combination with *Lactobacillus acidophilus* enhanced the shelf-life of minced chicken meat up to 7-8 days. The spice extracts in combination

Microbial inhibitory substances (antibiotic residues) in cow and buffalo milk

Tetracycline, gentamycin, ampicillin, amoxycillin, oxy-tetracycline, cloxacillin and penicillin are the common antibiotics used in dairy animals in Bangalore and surrounding areas. Misuse of the drugs by veterinarians and the farmers not being aware of the need to discard milk from animals treated with antibiotics could be of great concern to public health. Microbial disc and test diffusion assays were standardized for detection of ampicillin, erythromycin, lincomycin, gentamycin, ciprofloxacin, penicillin, streptomycin, tetracycline and oxy-tetracycline. Charm II test was also standardized for confirmation of b-lactams, tetracycline and aminoglycoside residues in milk. Incidence of presence of drug residues in milk from individual animals was 2.4% in cows, while all the milk samples from buffaloes were negative for antibiotics. Absence of these residues in buffalo milks may be because buffaloes are more disease resistant. Analysis of milk samples from organized and unorganized farms had b-lactams or tetracycline residues 5.3 and 2.2%, respectively. Penicillin and ampicillin contamination was observed in 3.9% tanker milk supplies and tetracycline contamination in 0.61% of market milk samples. Withdrawal of milk for 3 days after the cessation of antibiotic treatment ensured safe milk to public consumption.

Chevon pickle

The technology for chevon pickle from spent goats was developed. Goat chevon pickle is a shelf-stable value added meat product prepared using precooked spent goat meat. Pickle has pH 4.77; SPC and halophiles log<4.00; yeast and mould counts log £1.00 cfu /g. At ambient temperature, it is acceptable up to 6.0 months of storage. Product is highly acceptable among the meat eaters. The yield of chevon pickle was 23.34% on slaughter weight basis, 58.93% on carcass

weight basis and 102.83% on separated meat weight basis. Cost of production at laboratory scale was Rs 80.0/kg. The technology, which is based on traditional taste and method, is expected to be readily acceptable by even small-scale meat processors/ entrepreneurs. The product has good market potential in towns, cities and for defense forces in remote and difficult areas where fresh goat meat availability round the year is limited. This technology has been transferred to an NGO and further efforts are on to popularize it.

SUCCESS STORY

Batter-breaded egg albumen rings

Albumen rings are egg snack food and can be popularized as egg snacks at fast food outlets. A process of preparing albumen rings was standardized. Albumen rings were prepared by blending chicken egg albumen with 5% rice flour and 0.5% salt, and steam cooking at ambient pressure for 5-6 min. The rings battered in 25% wheat flour and 15% black gram flour coating mixture was most acceptable and had a formulation cost of Rs 68/ kg.

with *Lactobacillus acidophilus* culture also exerted synergistic potent antimicrobial effect against *A. hydrophila*.

Residues of BHC, DDT and Malathion in Spent Hen Tissues: BHC level in spent hen muscle ranged from 0.04 to 0.07ppm, and in liver and adipose tissue 0.3-0.7ppm and 0.07-0.15ppm, respectively. BHC was higher (50%) in adipose tissue during July-Sep. The level of DDT was 0.05-0.3ppm in muscle, 0.3-0.7ppm in liver and 0.1-0.2ppm in adipose tissue. DDT was found mostly from July to Sep. Malathion in muscle and liver tissues varied from 0.05 to 0.1ppm, and it was not detected in adipose tissue. This pesticide was more in muscles (20%) than in liver (10%). Broiling for BHC, DDT, and pressure-cooking against malathion were effective in reducing the residues of these pesticides in meat.

SUCCESS STORY

Handloom woven blankets

Handloom woven blankets had the effective softness, good colour combination which otherwise is not possible to be manufactured from Indian wools that are coarse having hetero and hairy types fibers. The blending was carried out with fine wools of around 20μ and staple length below 50 mm having insignificant heterotypic fiber component. The blended yarns prepared in the ratio of 70:30 and 50:50 of native and crossbred sheep wools were spun on woollen system and approximately 2.5±0.5 nm yarns prepared. After dyeing the yarns, the blankets of stripe and check designs were prepared on handlooms and a standard weight of approximately 2.5 kg was obtained. During milling and raising operations the short and fine fiber of the crossbred wools imparted the desired softness and warmth. These were than marketed and found wide acceptance. The cost of blanket was around Rs 285/ piece, and is cheaper as compared to market blankets of around Rs 450 to Rs 500 of similar quality. The technology is capable of producing low cost, attractive and quality produce.

Yak

In raw yak meat moisture was 74.82 – 78.15%, protein 19.10 – 22.50%, fat 1.20 – 1.97% and ash 0.96 – 1.16%

Wool Technology

Wool quality: Reflectance, fluorescence and total T values of wool samples, collected from Magra sheep (male and female) of institute, Bikaner Mandi and field area, were estimated. Bikaner Mandi wool samples had higher lusture. Chokla wool samples (125) from institute revealed average fiber fineness 29.7 m, CV 42%, hetero fibers 11% and hairy fibers 8%. March clip wool has less medullation than September clip. Four lots of Magra and Marwari sheep wool collected from the ARC, Bikaner (each 50 kg) were processed on woolen spinning system. Yarn of 4 nm linear density was prepared having a twist of about 120/m.

Wool carpets: Three types of carpets prepared from commercial wool, commercial yarn and experimental yarn, were subjected to subjective evaluation by different 10 judges. It was Commercial wool and commercial yarn carpets obtained higher value than that of experimental yarn carpets. ❑

Fish Production and Processing

CAPTURE FISHERIES

Marine Sector

Estimation of marine fish production: The marine fish landings in India during 2002-2003 was estimated at 2.64 million tonnes, which is 0.314 million tonnes (13.5%) higher than that of the previous year. The increase was primarily due to enhanced catches of sharks, oil sardines, Bombay duck, ribbonfishes, carangids, seer fishes, tunas, penaeid prawns and cephalopods. Perches and non-penaeid prawns showed a decrease in landings. The mechanized sector accounted for 67.9%, motorized sector 25% and artisanal sector 7.1% of the production. The north- west coast accounted for 0.908 million tonnes, followed by south-west coast 0.86 million tonnes, south-east 0.611 million tonnes and north-east 0.227 million tonnes. Monitoring of environmental characteristics of coastal water was continued all through the year.

- Marine fish landings improved by 13.5% over previous year
- Effects of municipal and industrial effluents on index of biological integrity evaluated
- Hilsa population declining due to indiscriminate exploitation of young hilsa by drift gill net
- Digital base map developed on water bodies of some districts of Bihar and Rajasthan
- Hatchery seed production of freshwater prawn expected to boost prawn culture in land-locked states
- Sub-adults and fingerlings of *Puntius pulchellus* were cultured on artificial feed
- A natural lake developed as conservation site for *Tor putitora*
- Maturation period of exotic carps shortened at high altitudes
- Kit developed for detection of white spot virus
- Crude extract of *Arius dussumieri* and *Osteogeneious militaris* showed haemolytic and oedematic activity
- Immune index of tiger shrimp developed to improve management of broodstock
- Broodstock of ornamental species developed
- Fishing vessel with fuel monitoring developed
- Natural genetic variation studied in important fish species
- Viable progeny produced using frozen-thawed sperms
- Polymerase chain reaction method used to detect exotic pathogens

Inland Sector

Application of an index of biological integrity (IBI) in river Hooghly: A multimetric index of fish assemblages integrity was developed for fish species in river Hooghly and the effects of municipal and industrial effluents and physical conditions on those indices were evaluated. The Biological integrity of fish assemblages from the site Hooghly ghat downstream of river Hooghly is impaired.

Ecological status of Hooghly Estuarine System: Ecology and fisheries of Hooghly and Mandovi-Zurai estuarine systems and production potential of estuarine wetlands were evaluated. Ecological studies revealed high production potentials reflecting total fish yield of 62,554.7 tonnes. Hilsa continued to be a major component contributing 10.4% of total yield from Hooghly estuary. Population of Hilsa is declining at a fast rate due to indiscriminate exploitation of young Hilsa by drift gill net.

Inventory and mapping of inland water bodies of Bihar: Geographical Information System (GIS) was developed on water bodies for eight districts of Bihar. The area was estimated utilizing LISS-III data of satellite IRS-1D. Digital base map was also prepared for six districts of Rajasthan.

CULTURE FISHERIES

Freshwater Aquaculture

Hatchery seed production of freshwater Prawn in inland saline water: The giant prawn popularly known as 'Scampi' is migratory and completes its life cycle in both fresh and coastal seawater. Seed production was done successfully in freshwater prawn (*Macrobrachium rosenbergii*) by using undergound saline water with necessary ionic amendments at Rohtak, Haryana. Haryana, Rajasthan, Punjab and Uttar Pradesh have large areas of inland saline ground water reserves and hence the present practice is expected to provide boost to prawn culture programmes of land-locked states. *Macrobrachium rosenbergii* culture was initiated in saline affected waters of Punjab and Haryana. Prawn production in the range of 872 to 2,285 kg/ha was achieved in culture ponds of culture period of 6-7 months. Efforts were also made to transfer this technology to Uttar Pradesh.

Monosex culture of giant freshwater prawn: Monosex culture of *M. rosenbergii* conducted in outdoor cement

cisterns at two stocking densities revealed higher growth rates in all-male population as compared to all-female population reared under similar rearing condition and stocking densities. Further, the male population also yielded higher proportion of marketable size of the prawn.

Breeding of peninsular carps: Seven sets of *Labeo fimbriatus* were bred successfully using a portable hatchery at Bangalore. More than 0.1 million spawn were obtained. Sub-adults and fingerlings of *Puntius pulchellus* were collected from the Western Ghats and are being cultured under captivity on artificial feed.

In vitro *culture of freshwater pearl mussel:* Primary *in vitro* cell culture of nacre secreting pallial mantle epithelial tissue explants of freshwater pearl mussel (*Lamellidens marginalis*) was carried out successfully.

COLDWATER FISHERIES

Mahseer conservation initiative in Kumaon: A natural lake Shyamlatal in Kumaon region was developed as a conservation site for the threatened mahseer species *Tor putitora*. Mahseer fingerlings stocked for first time have established themselves well in the lake with 98% return in experimental netting. The maximum size of mahseer caught during the trials in gill net operations was 700 g in weight and 260 mm in length. With the establishment of mahseer stocks in the lake, the availability of mature spawners for artificial propagation will be ensured, opening an additional resource for conservation and revival of endangered mahseer in Kumaon region. This will also promote angling tourism in Shyamlatal lake area.

Experimental fishing in Shyamlatal lake in Kumaon

Mahseer harvested from cultured ponds

Success in incubating and rearing of rainbow trout at Bhimtal

For the first time, eyed ova of rainbow trout, *Oncorhynchus mykiss* were incubated under warmer conditions at Bhimtal. Hatching was successful and fingerlings were produced within 70 days of rearing, while table size was attained just within one year of rearing. The trout is normally transported at eyed-ova stage but for the first time 600 fingerlings of rainbow trout having a weight range of 3.45-5.90g were successfully transported 200 km with no mortality. This investigation opens up the possibility of raising table trout at lower altitude and transporting the fingerlings by road in hills.

Egg stripping from female rainbow trout

Advanced maturation and breeding of exotic carps at high altitudes: Water temperature was the limiting factor for maturation and embryonic development of grass carp and silver carp at high altitudes. The experiments

SUCCESS STORY

Exotic carp farming in mid-hills

Previously standardized exotic carp farming technology for mid-hills, involving three species combination of grass carp, silver carp and common carp was successfully demonstrated in 24 farmers' ponds situated at different altitudes in two districts of Uttaranchal. One of the fish farmers from Toli village achieved highest estimated fish production of (6942 kg/ha/year) by harvesting 162 kg fish from 300 m^2 pond, with an additional income of Rs 11340 from a unit water area of 300 m^2. This supplements the income from small farm holdings, in which cereals, vegetables, and fruits are developed. This integration of crop and fish makes hill farming remunerative and sustainable. All the ponds in two districts under this programme registered an estimated average fish production of 3508 kg/ha/year with actual harvest in the range of 0.12 to 0.39 kg/ m^2/year in ponds ranging in size between 125 – 500 m^2. The programme motivated more farmers especially in districts of Champawat and Nainital to take up fish culture. A self-help group has been organized in the village Toli to transfer this technology to farmers from other adjoining villages in the region.

conducted revealed that the maturity inducing hormone treatment with HCG @ 250-300 IU and pituitary extract plus ovaprim in 3:1 ratio @ 3ml/kg coupled with insulation against low temperature by polyhouse covering of ponds, was effective in advancing maturation period by 1-2 years. Hence, by application of maturity inducing hormones and raising water temperature through polyhouse insulation at high altitude regions, the maturation period of these species can be shortened.

BRACKISHWATER AQUACULTURE

Demonstration of shrimp feed technology to the coastal farmers: Shrimp feed developed by the CIBA was successfully tested in a farmer's pond at Kalpakkam, near Chennai. The 0.52 ha pond was stocked with tiger shrimp *Penaeus monodon* seed and the farmer used CIBA shrimp feed during the culture. After 137 days of culture, the farmer harvested 1,665 kg of shrimp and obtained a production of 3,330 kg/ha.

Latex agglutination kit for detection of white spot virus: Latex agglutination kit for detection of white spot virus in shrimps was developed. This is an on-farm test with the aid of the rapid diagnostic kit which can be completed within 3-4 min. Latex agglutination kit along with the ELISA and dot-ELISA kits for the detection of pathogenic bacteria, viz. *Pseudomonas fluorescens, Aeromonas hydrophila, Vibrio alginolyticus* and *Edwardsiella tarda* of fish, were commercialized.

Wound healing, antineoplastic and antioxidant compounds from two marine crinotoxic fishes: Crude mucus extract of *Arius dussumieri* and *Osteogeneiosus militaris* exhibited toxicity when tested on mice. The crude mucus extract of *A. dussumeiri* showed the highest toxicity @ of 0.30 ml and the mice died in 50 minutes, whereas in *O. militaris*, the toxic dose was 0.50 ml, which caused mortality in 80 minutes. Haemolytic assay conducted against chicken erythrocytes showed that the crude mucus extracts and partially purified fractions of both the fishes has haemolytic as well as oedematic activity.

Immune index of tiger shrimp: Immune index was developed to assess the health status of tiger shrimp, *Penaeus monodon*, based on the characteristics of its haemolymph. There was considerable variation in the haemocyte count of the normal shrimps. During white spot syndrome virus (WSSV) infection, the haemocyte counts dropped drastically. These observations have practical implication in the maintenance of broodstock.

Mariculture

Maturation, spawning and larval rearing of groupers: Induced maturation of groupers by hormone injection using LHRha was conducted at Mandapam. Natural spawning of *Epinephelus tauvina* and *E. polyphekadion* was observed under captive conditions. In *E.tauvina*, two spawnings occurred resulting in 3.9 million eggs, and 2.7 million larvae were produced from eggs.

Development of broodstock of ornamental fish: Broodstock of five species of damsel fishes, filamentous tail black damsel *Neopomacentrus cyanomos*, yellow tail damsel, *N. nemurus*, blue damsel, *Pomacentrus caeruleus*, peacock damsel, *P. paco* and Indian dascyllus *Dascyllus carneus* were successfully developed.

Oyster farming in Kerala estuaries

The technology for the production of gourmet oysters was adopted by more than 250 farmers in estuarine areas of southern India covering an area of 2.2 ha. The total production during 2002 was 350 tonnes shell-on, yielding 3500 kg meat, worth Rs 210000/- from 9 months of farming. Oyster farming has been developed as a community-based programme in Kerala.

FISH HARVEST AND PROCESSING TECHNOLOGY

A novel design of a 15.5m OAL, 125 hp steel fishing vessel (CIFTECH –1) with split level deck constructed for trawling, gill netting and lining was developed and a vessel constructed. A fuel consumption monitor for measurement of fuel consumption rate, inflow and return flow was developed.

A simple technique was developed to reduce the chemical hazard of benzopyrene in hot smoked fishery products, particularly tuna. A product with calcium and phosphate in 2:1 proportion – an ideal requirement for human consumption – was obtained when tuna bones were hydrolysed enzymatically.

A fuel efficient deep sea multipurpose 15.5 m. OAL fishing vessel "CIFTECH –1" developed by CIFT, Kochi

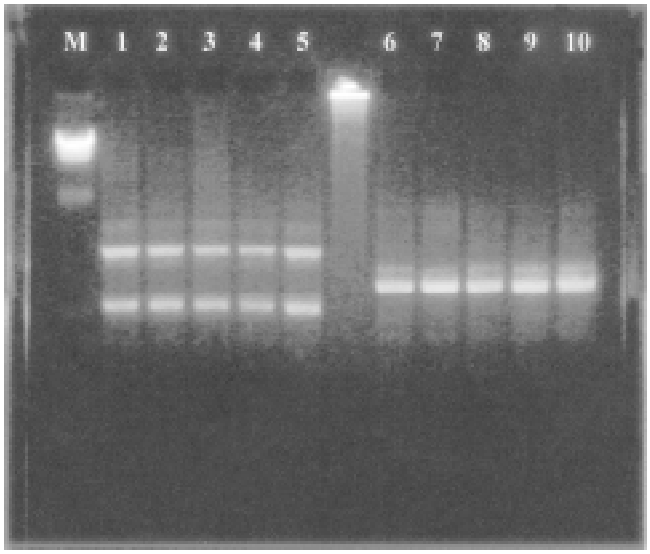
Cattle/poultry feed from fishery waste

A method for preparation of good quality cattle/poultry feed supplement by ensiling fishery waste was popularised. This has solved the environmental problem caused by the decaying waste by converting it into a useful product. A method was developed for the isolation of chondroitin sulphate, a medicinal product used in the treatment of arthritis patients, from shark bones and shark cartilage. The process and production parameters for fermented fish meal was standardized. The product has average moisture content of 22%, protein 46%, fat 1.8% and mineral content 29%.

FISH GENETICS RESOURCES

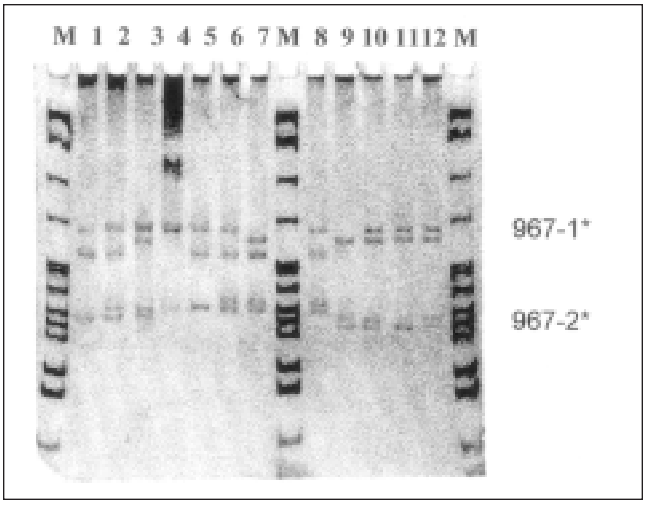
Molecular markers and natural genetic variation in important fish species

Combined genotypic data of 10 micro satellite loci of *Catla catla* were collected from rivers Sutlaj, Ganga, Ghagra, Rapti, Bhagirathi, Brahmaputra, Mahanadi and Godavari, and analyzed. Catla samples analysed exhibited significant variation at microsatellite loci. The results revealed that catla in different rivers in India has distinct population sub structure.



Species-specific RAPD profile of *Chitala chitala* and *Notopterus notopterus* obtained through OPB3 primer.

The microsatellite primers for yellow catfish Horabagrus brachysoma, an endangered fish of the Western Ghats, were developed through cross species amplification of heterologous primers. The identified micro satellite DNA markers exhibited significant potential to determine fine scale population structure of the species across its natural range of distribution. Microsatellite DNA markers studies revealed genetic variations at RAPD loci exhibiting significant divergence in *Chitala chitala* species collected from different locations. Diagnostic RAPD



Genetic variation in *Horabagrus brachysoma* at two microsatellite loci amplified through Sclerfor967 primer

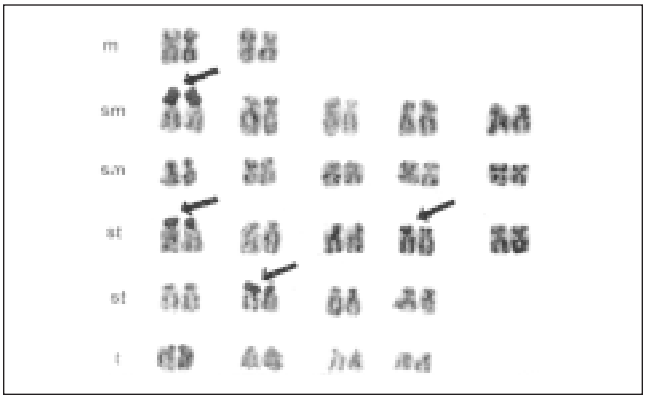
markers were developed to detect species-specific difference between *C. chitala* and *Notopterus notopterus*.

Karyological characterisation of fish species endemic to Western Ghats: Genetic characterization of *Labeo dussumeri, Puntius filamentosus, Puntius denisonii, Puntius sarana subnasutus, Horabagrus brachysoma, Horabagrus nigricollaris, Pristolepis marginata* and *Gerrus filamentosus* endemic to Western Ghats, was done.

Baseline frequency of micronuclei in Channa punctatus and *Mystus vittatus:* The frequency of micronuclei was 0.06078% in freshly collected *Channa punctatus* specimens, however, after acclimatization the frequency of micro nuclei reduced to 0.02597%. Similarly frequency of micronuclei in unacclimatized *Mystus vittatus* was 0.05674% and after acclimatization it was 0.0327%. These findings indicated that fishes of Gomti river were being exposed to genotoxicants present in the polluted river water.

Development of sperm cryopreservation protocols for Ompok malabaricus: Successful cryopreservation of *Ompok malabaricus* spermatozoa with M-HBSS extender and DMSO cryoprotectant was achieved. Viable progeny were produced using frozen-thawed sperms.

Diagnostic capability to detect exotic pathogens for



Karyotype of *Puntius denisonii* showing NORs

fish quarantine: Specific detection of *Yersinia ruckeri* and *Aeromonas salmonicida* was carried out through polymerase chain reaction. The detection of viral haemorrhagic septicaemia (VHS) was also carried out by reverse transcription polymerase chain reaction yielding. The rapid diagnosis of exotic pathogens will be used for screening the imported fish and fish products, and to prevent the entry of exotic pathogens in the country.

HUMAN RESOURCE DEVELOPMENT

At the CIFE, Mumbai, training programmes on Aquatic Animal Toxins and Pharmacological Bioresources were organised. Short term training programmes on various aspects of fish and fisheries were organised at Mumbai, 4 at Kolkata, 11 at Kakinada, 5 at Powerkheda, 2 at Rohtak and 6 at Lucknow. At the CMFRI, Kochi, training programmes were organised for Self Help Group on crab culture, mussel culture, ornamental fish culture, fish processing, mariculture, fish disease and their management. The CIBA also conducted training programmes on brackishwater finfish breeding, crab breeding and culture, finfish breeding, soil and water quality management and shrimp breeding and hatchery technology.

TRAINING PROGRAMMES FOR RURAL WOMEN

Training programmes were conducted for rural women on fish/shrimp pickle preparation in Tiruvallur District of Tamil Nadu under the NATP-IVLP project, Brackishwater aquaculture at Nellore District, Andhra Pradesh, and preparation of value added fish products at Kattur village, Thiruvallur.

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Agricultural Engineering and Technology

FARM IMPLEMENTS AND MACHINERY

Tractor-operated Machinery

Lug-wheel puddler: A tractor-mounted, lug-wheel puddler of 1880-mm width has been developed for the shallow-tilled saturated soils. Its preliminary tests have indicated its average operation speed of 2.1 km/hr and depth of operation at 126 mm, and its effective field capacity is 0.32 ha/hr and field efficiency is 80%. It cost of operation has been Rs 192/hr, including that of tractor (Rs 185/hr).

- Developed a tractor-mounted, lug-wheel puddler for shallow-tilled saturated soils and a seven-row, tractor-operated till-plant machine.
- Transplanting tomatoes with 2-row vegetable transplanter costs Rs 2,050/ha for 300 hr of annual use; this through manual method costs Rs 2,400/ha.
- Multicrop planter designed and developed by incorporating salient features of the animal-drawn Jyoti multicrop planter.
- Developed and commercialized a flail-type mower-cum-chopper for fodder harvesting. This costs Rs 17,000.

Tractor-operated Machinery

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1. Tractor-operated lug-wheel puddler. This is for the shallow tilled saturated soils. Its effective field capacity is 0.32 ha/hr and its field efficiency is 80%.
2. Seven-row till-plant machine. This machine has showed better timeliness of sowing operation, reduced fuel consumption and reduced cost of operation and its performance is comparable to conventional crop establishment operations.
3. Pneumatic planter for vegetables. Tractor-operated this planter costs Rs 40,000 and cost of planting by this is Rs 265/hr.
4. Zero till seed-cum-fertilizer drill. This machine could give effective field capacity of 0.33 ha/hr at forward speed of 3.2 km/hr.
5. MPKV multicrop planter. This tractor-mounted, multicrop planter suitable for groundnut, sunflower, chickpea and wheat has been designed and developed by incorporating salient features of animal-drawn Jyoti multicrop planter. The initial cost of the machine is Rs 15,000.
6. Flail-type forage harvester-cum-chopper. This machine has been commercialized. In this, a single operation can harvest crop and load chopped fodders like maize, *bajra*, oats in the trailer attached behind the machine.
7. Baler. Its effective field capacity has been found 0.82 ha/hr at the field efficiency of 87.2%.

SUCCESS STORY

Tractor-mounted hydraulically-controlled wetland leveller

It consists of a frame to attach it to a 3-point linkage system of a 35-hp tractor. A swinging blade is fixed at the bottom of the frame. This blade is fixed with a hydraulic cylinder, which in turn is connected to auxiliary hydraulic system of the tractor. With this arrangement, tractor-driver from his seat itself can operate blade by moving the auxiliary hydraulic system control lever. The blade can be moved to any angle from 0° to 90° to horizontal angle. This arrangement facilitates to operate blade in a vertical position to move soil from the upper side to lower side. For smooth levelling of field, the blade is made nearly horizontal. During field operation, blade (3.2-m wide) covers entire width of tractor, including cage-wheels.

Levelling need to be done within 36 hours after last puddling. At puddling, 3-5 cm of water should be maintained in the field and blade should be kept nearly vertical in the first operation, moving soil from the higher level to lower level. During second operation blade should be kept nearly horizontal for getting smooth levelled surface.

The unit has been tested and found satisfactory for shallow puddling. The weight of the puddler is 220 kg and its cost is Rs 8,500.

Seven-row till-plant machine: A seven-row, tractor-operated till-plant machine has been developed and was field evaluated in *kharif* and *rabi* 2002-03 for sowing soybean and chickpea. Its performance has been compared with the conventional practice of crop establishment, i.e. tillage by tractor-operated, five-row duck-foot cultivator, followed by seeding by tractor-operated seed-cum-fertilizer drill. This new machine has showed better timeliness of sowing operation, with reduced fuel consumption and reduced cost of operation, and yields under 2 systems were comparable.

Pneumatic planter for vegetables: Tractor-operated pneumatic vegetable planter has been found with the field capacity 0.5ha/hr and field efficiency of 72.5% for peas (Arkil variety) in farmers' fields. About 90% of the seeds were within ±5 cm of the desired spacing of 20 cm. Seed rate of 50 kg/ha with this was 15-20% lower than the rate usually used by farmers. Its cost is Rs 40,000, and cost of planting by this is Rs 265/hr.

Two-row vegetable transplanter: A tractor-mounted, 2-row vegetable transplanter developed at the CIAE, Bhopal, has been tested for transplanting tomato, cabbage, cauliflower and brinjal seedlings in the farmers' fields in 3.15 hectares. Its field capacity has been found at 0.10 ha/hr with the field efficiency of 65-75 %. And cost of machine is estimated at Rs 26,500. With the manual method, 30 man-days per hectare are required for transplanting tomato at 60-cm row-to-row spacing and 45-cm plant-to-plant spacing. The operation cost of the transplanter for tomatoes comes to Rs 2,050 per hectare for 300 hr of annual use, and for manual method, it is 2,400/ha.

Zero-till seed-cum-fertilizer drill: Trials on tractor-mounted, zero-till seed-cum-fertilizer drill were conducted for sowing wheat, covering 20.5 hectares at 14 farmers' fields in Allahabad (Bastar, Kabara, Birpur and Panasa) and Pratapgarh districts. The machine gave an effective field capacity of 0.33 ha/hr at the forward speed of 3.2 km/hr. During trials, average soil moisture content (wb) was 23.9% and number of weeds were 10/sqm. The average depth of sowing and field efficiency were 580 mm and 63.4%.

MPKV multicrop planter: The tractor-mounted, multi-crop planter has been designed and developed by incorporating salient features of animal-drawn Jyoti multicrop planter. This is suitable for groundnut, sunflower, chickpea, soybean, *jowar* and wheat. A plate in vertical plane with cells on its periphery is used for metering seeds for each row. A fluted roller is used for metering granular fertilizers. Depending upon the crop, number of rows can be adjusted from 5 to 9. Furrow openers are spear-head type. Drive for metering mechanism is through a ground-wheel. The machine is mounted on a 3-point linkage system of the tractor of 35-hp or above. The initial cost of the machine is Rs 15,000.

UAS, Raichur centre, could carry out prototype feasibility testing of this for sowing mungbean. Its field capacity has been found 0.42 ha/hr with a field efficiency of 59%, and the germination percentage of the crop was 89%.

Strip till drill: Demonstrations on tractor-operated, strip till-drill for sowing wheat (PBW 343) were conducted in Semara, Birpur, Mugari and Ghoredeeh villages, covering a total of 7.7 hectares. At soil depth of 540-mm and soil-moisture content (wb) of 21.3 %, machine could give effective field capacity of 0.34 ha/hr, corresponding to the forward speed of 3.4 km/hr. In the delayed sowing, farmers could combine operations of tillage and sowing in a single pass by this machine.

Semiautomatic potato planter: It consists of a belt-cup-type of metering mechanism with 37 cups, spaced at 60 mm. The holes are provided on the frame for changing ridgers. Its hopper capacity is 140 kg. Machine's overall dimensions are 1.98 m × 1.83 m × 1.18 and its weight is 250 kg. With this, seed spacing can be changed by changing sprockets provided with the ground-wheel. Machine can be operated with 30-hp tractor. The CCSHAU Hisar centre had conducted trials on the planter, covering 6.2 hectares in Bhatala and Lalpura villages. The seed rate for potato (variety 222) was 3,000 kg/ha and no. of plants per 5-m length were 32.6.

Bed planting of wheat: This machine for bed planting consists of a drive-wheel, fluted, roller-type seed mechanism and shoe-type furrow openers and furrowers for making bed. Its overall dimensions are 2,080 mm × 1,870 mm × 1,350 mm and can be operated with a 35-hp

tractor. The machine has cup-feed-type fertilizer metering mechanism. It weight is 270 kg. The unit cost of the machine is Rs 17,000.

Flail-type forage harvester-cum-chopper: A flail-type, mower-cum-chopper for fodder-crop harvesting has been developed and commercialized. This in a single operation can harvest, chop and load chopped fodders like maize, *bajra*, oats in the trailer attached behind the machine. The machine consists of a rotary shaft mounted with blades to harvest crop, an auger for conveying cut crop, and cutters for chopping and conveying chopped fodder through outlet on to trailer. The blades on the rotary shaft are staggered in 3 rows of 13 blades on each row on the horizontal axis, perpendicular to the direction of the motion. After the crop is cut by blades, it comes to auger which conveys it to chopper unit. The chopping mechanism having 3 blades, cuts crop into pieces, and chopped material is thrown out with high speed and is filled into hitched trailer.

Its field capacity, labour requirement and fuel consumption varied from 0.44 to 0.52 ha/hr, from 3.84 to 4.54 man-hr/ha and from 4 to 4.5 litres/hr. The cost of machine is Rs 70,000 and its cost of operation is Rs 1,113/ha.

Baler: Trials on tractor-operated baler (MK-55 Model) have been conducted. Its effective field capacity has been 0.82 ha/hr at the field efficiency of 87.2 %. Its bales (60 cm × 38 cm × 48 cm) output and average fuel consumption have been 1584 number/hr and 3.83 litres/ha.

Post-hole digger: Tractor-mounted post-hole digger has been field tested by the ANGRAU, Hyderabad centre, at Moinabad and Samshabad villages and at the University farm with 30-and-23 cm diameter augers for making holes for tree plantation. The field capacity with 30-cm auger varied from 12 to 15 pits/hr for digging 230 holes to the depth of 60 cm with the field efficiency of 80%. Its cost of operation is Rs 159/hr and Rs 19/pit in Red Chalka soil with 10% moisture (db).

Power-tiller-operated Machinery

Sweep cultivator: It is suitable for interculture operations in crops having row spacing of more than 300 mm. This machine of 40-kg weight has overall dimensions of 930 mm × 1580 mm × 1,370 mm. It gives field capacity of 0.18-0.25 ha/hr for different crops.

Trials on the power-tiller operated sweep cultivator were conducted in tobacco, covering total 1.3 hectares in Balua, Mirpur and Neemopur villages (Bihar). For average tobacco-plant of 220-mm, cross-interculture operations gave weeding efficiency of 72-80 %. Its fuel consumption and labour requirement were 0.7 litre/hr and 4.5 man-hr/ha.

Zero-till drill machine: This machine developed by the NDUAT, Faizabad, is suitable for 10-12-hp power-tiller. It can directly drill seeds and fertilizers without seed-bed preparation. It is suitable for wheat, barley, lentil, chickpea, pea, paddy etc. Machine size is 5 cm × 20 cm. Its cost is Rs 10,000, and its cost of operation is Rs 420/ha. It saves 68% in time, 85% in cost of operation compared to conventional practice, and increases yield by 6%.

- Zero-till drill machine is suitable for wheat, barley, lentil, chickpea, pea and paddy. It saves 68% in time and 85% on the cost of operation compared to the conventional practice.
- HPKV multicrop planter consists of a rotor-type metering mechanism with holes of different sizes on its periphery for different crops.
- Designed and developed a two-bottom, V-shaped blade digger for groundnut. Its effective field capacity is 0.052 ha/hr with field efficiency of 78%.
- Developed a power-tiller-operated chipper shredder for cotton-stalks and other agricultural waste materials like *neem* and *subabul* branches.

Power-tiller-operated zero-till drill. This NDUAT developed machine is suitable for 10-12-hp power-tiller. This saves 68% in time and 85% in cost of operation compared to conventional practice

Air-assisted seed-drill: Power-tiller-mounted, air-assisted seed-drill has been modified by providing stand for mounting blower assembly. One more furrow-opener with square-box holder has been fabricated and fitted on to the already fabricated tool-bar. For increasing seed-carrying capacity, seed entry place in the air pipes has been modified. Final adjustments have been made to get blower outlet speed of 0.5-4 metres/second.

HPKV multicrop planter: It consists of a rotor-type metering mechanism with holes of different sizes on its periphery for different crops. It can be used for two rows in maize and soybean and for three rows in wheat. It is operated at a speed of 2-2.5 km/hr in small terraces. Its feasibility test was conducted for wheat, covered in 1 hectare. Its effective field capacity and labour requirement have been found at 0.10 ha/hr and 19 man-hr/ha. Trials on it were also carried out covering a total of 2 hectares at Parei village of Kangra district; its effective field capacity and fuel consumption have been 0.10 ha/hr and 0.9 litre/hr. And the cost of the seeding with this planter has been 30-40 % lesser than *Kera* method.

Orchard sprayer: It consists of a horizontal triplex pump, working in an oil-bath. This pump gives discharge of 36 litres per minute and works at a pressure of 35 kg/sq cm. It has on the main-frame chassis, chemical tank, rubber wheels and operator's seat. This unit can also be conventionally used in pandal-type as well as Y-type of grape cultivation. For spraying in pomegranate and citrus, the booms, one each on the right and one on left side, are made up from GI pipe. Its field capacity is 0.80-0.90 ha/hr and gives droplets of 200-250 mm and their density is 20-35 nos./sq cm. The height of the sprayer is 6 m and its operating cost is Rs 52/hr.

Orchard sprayer. Its field capacity is 0.80-0.90 ha/hr and gives droplets of 200-250 mm, and their density is 20-35 nos/sq cm.

The orchard sprayer equipped with turbo-nozzles, developed at the MPKV, Rahuri centre, was used to conduct field tests in pomegranate and sweet orange. Its maximum number of droplets were in the range of 0-150 microns with droplet density of 6-54 droplets/cm^2. The values of number mean diameter and volume mean diameter varied from 51 to 73.31 and 51 to 217.94 microns.

OUAT groundnut digger: A two-bottom, V-shaped blade-digger for groundnut has been designed and developed with 200-mm width and 38° rake angle of each bottom. The blade spacing can be adjusted according to the row-to-row spacing of the crop. Two bottoms have been provided with shank and tyne for increasing or decreasing shank height by loosening clamps. Inclination angles of the tynes to the ground level could be increased or decreased by rotating pipe-frame inside another clamp attached to hitch bracket. The digger (120°C V blade) was tested at 2.1% soil moisture (db) at Paniora village in Khurda district in 1 hectare. Its effective field capacity has been 0.052 ha/hr with 78% field efficiency. Harvesting efficiency of the digger was 98%. Its cost of operation has been Rs 1,375/ha compared to Rs 2,500/ha in the conventional practice.

Chipper shredder: A power-tiller-operated chipper-shredder for cotton-stalks and other agricultural waste materials like *neem* and *subabul* branches and leaves has been developed. Its shredder, flywheel cutter has been transmitted power through main clutch pulley of the power-tiller. The observed speed of the cutter flywheel has been 3,000 rpm. It was also evaluated for shredding coconut and *chikoo* branches. Its output capacity was 180-200 kg/ha, and shredded material size was1-15 mm.

Self-propelled Machinery

Two-row cultivator for biasi operation: A self-propelled, 4.5-hp diesel-engine powered, 2-row cultivator for *biasi* operation for dry-seeded rice (broadcast/row seeded) has been developed. When this machine was tested, 35 days after rice sowing under standing water, its effective field capacity was 0.06 ha/hr with a field efficiency of 80%. This field capacity is twice as much as that of animal-drawn, 2-bottom *biasi* plough and 3 times that of farmer's practice of single-bottom wedge plough. Estimated cost of this cultivator is Rs 50,000.

- Developed a self-propelled, 4.5-hp diesel-engine-powered, 2-row cultivator for *biasi* operation for dry-seeded rice and a self-propelled riding-type rice-seeder for sowing pregerminated rice.

Two-row cultivator for *biasi* operation. This self-propelled cultivator has been developed for dry-seeded rice (broadcast/row seeded). Its field capacity is twice as much as that of animal-drawn, 2-bottom *biasi* plough and three times that of farmer's practice of single-bottom wedge plough.

Riding-type (10-row) rice-seeder: Self-propelled, riding-type rice-seeder (10-row) has been developed for sowing pre-germinated rice. It consists of a main-frame of self-propelled (5-hp) unit of rice harvester mounted with rice-seeder (10-row). A wooden float has been attached to it and a seat has been provided to ride on the machine. The drive is taken from the ground wheel of the seeder to drop seeds.

Eight-row rice transplanter: It is a self-propelled, riding-type rice transplanter suitable for transplanting mat-type seedlings. It saves 65% in labour and operating time and 35-40% on the cost of operation, besides

Riding-*type rice-seeder.* This seeder has been developed for sowing pre-germinated rice.

PAU walking-type sprayer. This could save 70-80% hr of labour and 45-50% in cost of operation compared to knapsack sprayer.

increasing yield 5-10% of the conventional method of manual transplanting. It costs Rs 120,000 and its cost of operation is Rs 1,000/ha. It was used by farmers who could afford to purchase costly machine to do away with scarcity of manual labourers. Mat type of seedlings helped in growing more number of tillers per hill. Its feasibility testing was done with Pant 12 rice in 2.35 hectares. Its field capacity was 0.13 ha/hr and field efficiency was 68%; with this missing hills were 2.7% and floating hills were 0.6%. Number of seedling per hill were 3-5 at a 140-mm hill-to-hill spacing.

Power weeders: CIAE design: A self-propelled interculture equipment has been developed utilizing chassis of 1-m self-propelled, vertical-conveyor reaper by replacing the present diesel-engine with a light weight petrol-start kerosene-run 1.1 kW engine having rated engine speed of 1,500 rpm (at the cam shaft). This is a light machine and can operate with 3 sweeps of 150 mm for weeding operation in crops sown at 300-350 mm row-to-row spacing. If row spacing is 400 mm or more, only 2 sweeps of 150-200-mm size can be operated. A set of narrow wheels of 150-mm width has also been developed to facilitate operations of machine during weeding. Its feasibility trials have been conducted in groundnut and soybean.

ANGRAU model. This self-propelled rotary weeder is run with a 6.5-hp diesel-engine. Drive to rotary weeder is taken through two sets of V-belts and pulleys. A multiple-plate clutch is provided to cut-off drive to ground-wheel and weeder unit.The rotary weeding unit has two gangs of 300 mm each. Both gangs are mounted outside wheel tread of prime mover.

In its feasibility trials, machine was operated at 60-cm row spacing and 120-cm spacing between pairs. At 30-40% soil moisture (db) and 30-40-mm depth of tilling, its weeding efficiency was 76%. The machine speed was 2.5 km/hr.

TNAU model. It consists of a power unit equipped with 5.4-hp diesel-engine of 34-kg weight, power transmission gear-box, ground wheels, weeding unit handle and clutch. The width of coverage is 350 mm. The overall dimensions of 90 kg weeder are 2,100 mm × 640 mm × 1,170 mm. The machine can be used in maize, sugarcane, cotton, tapioca and grapes. The cost of equipment is Rs 55,000 and its cost of operation is Rs 770/ha. After one pass with rotary weeder, a ridger can be attached for earthing-up.

Balram II model. In cotton, with this, field capacity, field efficiency, weeding efficiency and cost of operation have been found as 0.23 ha/hr, 84 % and 53 % and Rs 45/hr. And for sugarcane, these have been 0.116ha/hr, 59%, 38% and Rs 47/hr respectively.

PAU walking-type sprayer. The self-propelled, light-weight boom sprayer fitted with 5-hp diesel-engine consists of a spraying unit at the back. The spraying unit has a boom with 12 nozzles, spray pump, tank for liquid and a pressure gauge. Ground clearance of the machine is 500 mm. The boom height can be adjusted from 600 mm

SUCCESS STORY

Manually-operated single-row garlic planter

A manually-operated, single-row garlic planter has been developed at the PAU, Ludhiana. This is simple in design and weighs only 12.0 kg. In this machine, planting mechanism is attached over existing design of the PAU wheel hand-hoe, which is used for interculture operation, and is already commercialized. The machine with a hopper capacity of about 3.0 kg is operated by 2 persons. One person pulls machine from front through a rope attached to hook on the machine and the other steers machine by holding it from the handle. Machine is also provided with markers for maintaining specific row-to-row distance. Plant-to-plant spacing can be varied by varying number of spoons on the periphery of the vertical plate. It can plant 0.3-0.4 ha/day with the help of 3 persons. The approximate cost of this machine is Rs 1,000 and this can be recovered from only 0.4 hectare. Labour requirement for sowing garlic with machine is only 83.0 man-hr/ha in comparison to 520 man-hr/hr by the traditional method. Also cost of sowing with machine is Rs 858/ha in comparison to Rs 5,200/ha with the traditional method.

- CIAE developed animal-drawn machinery planter is suitable for planting groundnut, maize, pigeonpea, sorghum and pulse crops. It saves 64% on operation cost compared to the conventional method.

to 1,300 mm. The unit controlled by the operator is provided with two narrow wheels and one supporting wheel at the back. The unit has provision to adjust track width from 900 mm to 10,50 mm. The swath-width of the sprayer is 6,300 mm. The capacity of tank, spacing between nozzles and pump speed are 1,00l, 1,000 mm and 630 mm.

Its feasibility trials were conducted on 26 hectares for wheat. The unit operated at operating pressure up to 400 psi.The machine sprayed weedicide which gave field capacity of 1 ha/hr at the forward speed of 3 km/hr. The fuel consumption varied from 0.4 to 0.6 litre/hr. It could save 70-80% hr of labour and 40-50 % in cost of operation compared to knapsack sprayer.

Vertical conveyor-reaper: This walking-type harvester for wheat, rice and safflower is suitable for cutting and windrowing crops. The engine power is transmitted to cutter-bar and conveyor belts through belt-pulleys. The prime mover of the machine is 5-6.5-hp diesel-engine. And the cost of the machine with prime mover is Rs 50,000.

Demonstrations were conducted with this for safflower-crop covering 6 hectares at 25 farmers' fields in Janwada and Markhal villages of Bidar district (Karnataka). Its effective field capacity was 0.2 ha/hr and labour requirement was 40 man-hr/ha.

Frontline demonstration of this for wheat covering 3 hectares at Keshavpur village, conducted at 2.7 km/hr forward speed, showed 0.22 ha/hr, 68% and 1.16 litres/hr effective field capacity, field efficiency and fuel consumption, respectively. The working width, height of the cut and the average moisture content of the crop-stem were 1,140 mm, 54 mm and 12.7% (wb). And the total losses during harvesting were 2.14%.

Animal-drawn Machinery

CIAE planter: It is suitable for planting groundnut, maize, pigeonpea, sorghum and other oilseed and pulse crops. It saves 64% on the operation cost compared to conventional method of sowing behind the country-plough with manual seed dropping. It costs Rs 6,500 and its cost of operation is Rs 390/ha. The trials at the UAS, Raichur, for sorghum, chickpea and sunflower showed its field capacity varying from 0.12 to 0.15 ha/hr.

Stationery Machinery

Indigenous seed counter: Bio-scientists in the country were using imported machines for counting seeds. At present, an indigenously built machine has been developed which can count seeds of several varieties of

CIAE planter. Animal-drawn this machinery saves 64% on the operation cost compared to conventional method of sowing behind the country-plough with manual seed-dropping.

soybean and wheat with 99% accuracy. Its cost is Rs 20,000.

CIAE solar-tracking device: Sun tracker developed for 450Wp SPV panel has been modified to be adopted for 900 Wp SPV panel to make it more reliable and user friendly. It consists of an electronic vibrator circuit to produce 38 electric pulses per minute, which activates an electromagnetic relay and ratchet and pawl to produce precise rotation of the shaft, mounted on the ball-bearings. The modified tracker has been extensively evaluated by tracking panel (from morning to evening) for 700 hr of operation and has been found to give satisfactory performance. The power output from the panel increased by about 30% under tracked condition (6000 Wh) as compared to non-tracked condition (4500 Wh) on the typical sunny day. The peak power output was observed to be 660 W (74% of peak installed capacity) during noon time on a typical sunny day in summer.

High-capacity pigeonpea thresher: A high-capacity pigeonpea thresher (10-hp capacity) has been designed and developed for the crop-length of more than 750 mm at the CIAE, Bhopal. It consists of an automatic chain-conveyor type feeding mechanism, a tapered spike tooth-type threshing cylinder, a woven wire-mesh concave, two aspirator blowers, a shaker assembly and transport wheels.

With this, stalks are broken into big pieces which can be easily used by farmers for domestic use. Threshing and cleaning efficiencies of this varied from 96.59 to 96.74% and 92 to 94.22%. The average broken grain, blown grain and sieve overflow were 1.21%, 0.31% and 0.13%.

High-capacity multicrop thresher: Frontline demonstration for this was organized for 21 hours at Siddanbhavi and Rampur villages of Raichur (Karnataka) for *jowar* (M 35-1). The threshing capacity varied between 2.13 and 2.41 tonnes/hr. Threshing and cleaning efficiencies were 99-99.5% with total losses of 1.98-2.35%. Fuel consumption and cost of operation were 3-3.25 litres/hr and Rs 165-310 per tonne.

And demonstrations for wheat (HD 2285) were

Modified solar tracking device. Sun tracker developed for 450 Wp SPV panel has been modified to adopt for 900 Wp SPV panel, to make it more reliable and user-friendly.The peak power output has been observed to be 660 W during noon time on a typical sunny day in summer.

organized at village Kareha for 20 hr. During trials threshing capacity, grain damage and straw size were 0.8-1.05 tonne/hr, 0.5-1% and 25-30 mm, respectively. Grain moisture and straw moisture (db) were 8-10% and 12-14%. The fuel consumption was 4-4.5 litres/hr.

Maize dehusker-cum-sheller: Modified peg-tooth thresher has been developed for maize-crop. For better shelling efficiency varying height pegs have been provided in staggered fashion. The pegs have been placed in 6 rows with 6 pegs in each row. In sheller sieves of 12.5 mm are used. The front and rear concave clearances are 50 and 25 mm, respectively.The concave grate has openings of 50 m × 50 m. The sieves of 12.5-mm size holes have been provided.

Test trials conducted for maize sheller have showed grain-straw ratio and moisture content of grain (wb) as 4.2 and 12.1%. At threshing cylinder speed of 678 rpm and feed rate of 1,440 kg/hr, threshing efficiency was 99.26% and cleaning efficiency was 99.96%. The output capacity and broken grains varied 0.63-0.67 tonne/ha and 2.6-3.02%, respectively.

ANGRAU sugarcane leaf stripper: The stripper equipped with 3-hp diesel-engine has been developed for

ANGRAU sugarcane leaf stripper. During trials at Hyderabad, its effective field capacity and fuel consumption were 1,300 kg/ha and 0.40-0.50 litre/hr.

- For counting seeds of crops, scientists were using imported machines. Now an indigenous seed-counting machine has been developed which costs Rs 20,000, and counts with 99% accuracy.
- Modified sun tracker to adopt 900 Wp SPV panel, instead of 450 Wp SPV, to make it user-friendly.
- High-capacity pigeonpea thresher designed and developed to break stalks into bigger pieces for domestic use.
- Modified peg-tooth thresher for maize.

estimated output capacity of 2 tonnes/hr. The equipment consists of 2 upper adjustable rollers and 2 lower fixed rollers. Rollers are covered with EPDM material on the circumference. Stripper is also provided with two brush carriers over which 4 nylon brushes are fixed at equal angles (90° each). The gap between two rollers is adjusted according to canes size; diameter of input rollers is kept lower than that of output rollers to enable canes to come out quickly after stripping leaves. The speed of the brush holder is 2,000 rpm and of feed roller input and feed roller shaft is 1,000 rpm and 375 rpm. Sugarcane is stripped by passing cane between 2-hand rubber rollers. Two brushes with hand-nylon strings are provided to strip cane-leaves. During trials at Hyderabad, effective field capacity and fuel consumption were 1,300 kg/hr and 0.40-0.50 litre/hr, respectively and the breakage of canes, efficiency of machine and labour engaged were 12.15%, 65% and 5.

Ergonomic Studies

Anthropometric and strength survey of agricultural workers: Seventy-nine body dimensions and 16 strength parameters useful for farm-equipment design have been identified. Till date anthropometric data have been collected for 293 (215 males and 78 females) agricultural workers in Madhya Prdesh, and collected anthropometric data for 1,587 (1,000 males and 587 females) workers and strength data for 421 (182 males and 239 females) agricultural workers in Tamil Nadu. The mean values for stature, weight, push strength and pull strength of male and female workers of Madhya Pradesh were 164.2 cm, 51.0 kg, 253 N, 231 N (Newton) and 151.4 cm, 45.0 kg, 177 N, 185 N,respectively. For Tamil Nadu, the values were 162.9 cm, 56.1 kg, 198 N, 241 N for male workers and 150.8 cm, 47.3 kg, 134N and 168 N for female workers.

Anti-vibration devices for comfort of power-tiller and tractor operators: Vibrations if transmitted to body parts not only cause discomfort to operator but also reduce efficiency of the operator. Vibration isolators for engine, handle-bar and handle of the power-tiller have been developed and tested for their efficacy for attenuation of vibrations transmitted to operator. The isolators resulted in reduction of handle vibration by 50%.

Besides these, vibration isolators have been developed

Strength measurement set-up

A strength measurement set-up for agricultural workers has been developed. As per the protocol of the strength data collection, it has been required for a worker to reach his peak strength within first 2 seconds and then maintain this peak strength for the next 3 seconds. It was difficult for the workers to maintain peak strength for the desired time without stimulation in the light or sound form. To take care of this, a timer alarm of 5 seconds has also been developed for guiding workers. Seventy-nine body dimensions and 16 strength parameters

A strength measurement set-up for agricultural workers. Strength data of male as well as female agricultural workers have been collected to test working of the strength measuring set-up and to chalk-out protocol.

useful for agricultural equipment design have been identified and a document showing pictorial presentation and definitions has been prepared. Strength data of male as well as female agricultural workers have been collected to test working of the strength measuring set-up and to chalk-out protocol. The set-up has been found satisfactory for the data collection. The cost of the set-up is Rs 14,000 and cost of the timer alarm is Rs 2,000.

for seat and tractor-trailer hitch points and have been tested for their efficacy. The isolator below the seat helped in reducing vertical vibrations transmitted to operator by 30-80% in different operations at speeds ranging from 2.5 to 4.5 km/hr.

Optimum locations for tractor-control pedals for Indian operators: Right and left leg strength data for 20 subjects were collected at 5 horizontal (35, 40, 45, 50 and 55% stature) and 6 vertical (10, 13, 16, 19, 22 and 25% strature) locations of the foot-pedal from the seat reference point (SRP), keeping lateral distance from mid-line 200 mm for each pedal combination. It has been observed that a 5th percentile operator could reach vertically up to 370 mm below and 810 mm in front of the SRP. The maximum leg strength of 655 N for right leg and of 613 N for the left leg was observed when pedal was located at 55% stature in front and 10% stature below SRP. The optimum locations for brake and clutch pedals have been at the horizontal distance of 623 mm in front of the SRP, vertical distance of 296 mm below the SRP and 200-mm lateral from mid-line. It will be suitable for

- Developed a strength measurement set-up for agricultural workers.
- Identified 79 body dimensions and 16 strength parameters useful for farm equipment design.
- Developed and tested vibration isolators for engine, handle-bar and handle of power-tiller for their efficacy for attenuation of vibrations transmitted to operators.

the 90% of the user population. The range of dimensions presented in IS: 12343 (1998) is very large and actuating force limits as given in IS:10703 (1992) are very high compared with leg-strength data of the Indian operators. Both these standards need to be revised in the light of the data generated to make the tractor work-place safe and comfortable for operators.

POST-HARVEST ENGINEERING AND TECHNOLOGY

Post-harvest management of oranges: An orange grader fabricated could grade fruits into 5 grades at a time on the basis of the size. This has been found effective for smaller grades. The theoretical capacity of the grader is 13.89 tonnes/day.

Cleaner for reduced dust emission in dal *mills:* A prototype of the cleaner equipped with suitable ducts, a forward curved centrifugal blower and a cyclone separator to arrest dust emission in *dal* mills has been developed. The diameter of the blower impeller is 300 mm with an inlet diameter of 150 mm. Its volumetric airflow rate is 22 m^3 /min and air velocity at winnowing section is 10

Cleaner for reducing dust emission in *dal* mill. A prototype of the cleaner equipped with suitable ducts, a forward curved centrifugal blower and a cyclone separator to arrest dust emission in *dal* mills has been developed. This is 68-87% screen effective unit, and purity of cleared grains is over 98%.

m/s. The blower housing has a diffuser angle of 5 degrees. Test results indicate that power requirement at load is 500 W and its input capacity is 900-1,000 kg/hr. The estimated cost of the cleaner with two prime movers (½ and 1 hp-electric motor) comes to about Rs 20,000. The screen effectiveness of the unit is 68-87%, and the purity of the cleaned grains is over 98 %.

Fermented banana beverage: A process for fermented banana beverage has been developed from banana pulp, water and sorghum flour in 1:4:0.83 ratio. A pre-grown, fresh-yeast culture suspension (*Saccharomyces cerevisiae*) was inoculated for fermentation. The average

- To arrest dust emission in *dal* mills, a prototype of the cleaner has been developed. The screen effectiveness of the unit is 68-87% and purity of the cleaned grains is over 98%.
- Developed process for making fermented banana beverage. The bottled product can be stored safely for 45 days at 30-35°C (room temperature).
- IISR designed improved cane-crusher gave maximum of 64% juice extraction.
- Developed juice filtration system

Rice storage losses in Punjab warehouses

The rice received at the 6 warehouses (Amritsar, Nabha, Moga, Fazilka, Pathankot, Ludhiana) in Punjab showed moisture content from 13.5 to 15.2 %. The final moisture content of stacks after 6 months of storage was 12.5 – 13.6%. And after 12 months, it was 13.2 to 14.2%. During first 6 months the rice lost on an average 1.0% in moisture and after 12 months loss was about 0.8%. Since losses are based on the initial moisture content and storage period, the losses on actual weighment basis and formula basis were compiled and analyzed for rice for less than or equal to 14% of the initial moisture and more than 14% of the initial moisture.

The data shows that for 6 months storage, the rice up to 14% moisture suffered storage losses of 0.62% and with more than 14% suffered 0.95% losses. Similarly, for 1 year storage rice with moisture less than 14% suffered 1.35% losses and that with more than 14% suffered 2.29% losses on weighment basis. It could be seen that losses on weighment basis were lower than on the formula basis for the first 6-7 months, and then the trend got reversed.

yield of the beverage has been 58% of the total mixture, which was equivalent to 65 bottles of 800 ml each. The final product contains 5-8% alcohol with *p*H of 3.5, which is suitable for beverages. The beverage has sour-sweet taste and beer-type flavour. The bottled beverage can be stored safely for 45 days at the room temperature (30-35°C).

Fermented banana beverage. A process has been developed for banana beverage from banana pulp, water and sorghum in 1:4: 0.83 ratio. The final product contains 5-8% alcohol with pH of 3.5. The bottled beverage can be stored safely for 45 days at room temperature.

Management of Jaggery and Khandsari

Improved IISR horizontal cane-crusher: The IISR designed, improved, horizontal power cane-crusher gave maximum of 64% juice extraction at 3.7-mm roller-gap at 3.3m/min. roller speed. At this roller setting, power requirenment for crushing 1 tonne of sugarcane was 7.9 kwh in 1,020 seconds.

Double stage filtration system for sugarcane juice: To obtain quality product, clean juice free from adulterants, dust and any other foreign materials, a filtration system for juice has been developed. In this, first-stage filter is made up of stainless steel 304 of 20 gauge sheet. It contains 3-mm round-hole sieve and has 29 holes/sq inch. Similarly second-stage filter is also made up of the same material with 0.5-mm sieve. For cleaning from very small particles, of insoluble impurities, third filter of 500 micron size has been provided on the top of the juice-tank.

Electronic thermometer for striking point in jaggery-making: Digital thermometer developed for judging striking point in jaggery-making has minimized risk of charring and of sub-optimal condition to remove concentrated mass from the pan. The instruments costs Rs 800 to Rs 5,000.

Ready-to-use vegetable clarificant for sugarcane juice: Optimum clarification of juice with deola seed powder was achieved at 0.1 to 0.5% concentrations. Apart from being good in physical appearance, jaggery obtained was hard crystalline and light-yellowish because of the instrinsic properties of the seed powder for enhancing efficiency of juice clarification. The clarificant could be effectively used for preparation of syrup and vinegar.

Improved 3-pan furnace for jaggery manufacture: This consists of a combustion chamber with an improved

SUCCESS STORY

Commercialization of vegetable-washing machine

A stainless-steel, 1-hp, electric-power-operated, vegetable-washing machine (drum water), which washes carrots, potatoes and spinach, has been tested and evaluated for washing, okra, turmeric and radish. The machine could wash effectively 0.2-0.25 tonne of okra and turmeric/ha and 0.15-0.2 tonne of radish/ha. The optimum performance parameters for washing for speed and time were 35 rpm for 4 min. for okra, 40 rpm for 5 min for turmeric and 50 rpm for radish. There was a significant microbial load reduction, and during washing microbiological washing efficiency ranged from 97.0 to 99.0%, which fulfills recommended international standards (80%), thus indicating adequacy of washing system. An improved model of the washing machine has been developed with increased capacity by 1.5 times, and with this washing has been improved by providing additional, pressurized sprays of water, through a central, perforated inner shaft. Five prototypes of this latest model of machine have been fabricated and tested.

grate design, a middle chamber for tapping heat from the flue-gases coming out of the combustion chamber and also to work as an air inlet chamber, and a flue-gases passage/channel rectangular in shape, 3 juice-boiling pans, a chimney made of masonary for taking out flue-gases, a bagasse feeding platform and an ash pit below the platform. The specially designed and fabricated juice-boiling pans were placed on the respective chambers. The first 2 pans are circular with convex bottom having 11/4" and 1" thicknesses and the third one is known as the gutter pan, it is rectangular with convex bottom (1/2" thick) along the length. The middle juice boiling pan has 11/2" × 11/2" hole/opening in its centre which connects with 2" and 35" long g.i. pipe from the bottom of the pan for draining-out juice. A gate valve has been provided at the end of the juice pipe. Also a protective cover of the thick m.s. sheet has been provided for this juice pipe. In additional to fuel-feed hole, the fresh air is supplied to combustion chamber enrouting middle chamber through two m.s. pipes (3") connected with two side openings of the chimney near its bottom and at the middle chamber. The chimney height is kept at approximately 12' with the base chamber of 5'3"×5'3"×2' and chimney of 2'9"×2'9"×12' with a hollow outlet opening of 1'3"×1'3".

The test results have indicated that per batch approximately 20-25 kg of bagasse could be saved. In addition, it reduced human labour, drudgery and inconveniences.

Packaging of jaggery in vacuum and nitrogen environment: Brix of jaggery obtained from sugarcane CoLk 8102 changed from 13.67 to 11.87, 12.3 and 12.0 when stored in the desiccator, nitrogen and vacuum respectively in 2 months. Similarly pol reading changed from 77.4 to 48.8, 72.3 and 70 g while reducing sugar increased from 5.7 to 8.5, 6.2 and 6.7% in desiccator, nitrogen and vacuum storage. Moisture content of jaggery changed from 7 to 16.5, 8.9 and 3.9% when it was stored in desiccator, nitrogen and vacuum. Jaggery solution *p*H changed from 6.5 to 5.5, 5.9 and 6.2 and colour reading changed from initial value of 190 to 275, 220 and 252 in desiccator, nitrogen and vacuum stored jaggery. This suggests that packaging of jaggery in nitrogen environment will be more suitable.

PLASTICS IN AGRICULTURE

Mulching of Strawberry

At the CSKHPKV, Palampur, and the CIPHET, Abohar, plastic mulch (black polyethylene sheet of 100 gauge) has recorded 30-40% higher yield of strawberry over straw and eupatorium mulch. Yield-attributing characters like berry weight, length and diameter were also significantly higher with plastic mulch. Runners planted at 15-cm row-spacing produced significantly higher yield (25 tonnes/ha)

- Turning-red tomatoes stored in perforated polybags with ethylene absorbent at room temperature had shelf-life of 10 days, it increased to 18 days if stored at 18°C.

Vegetable cultivation in polynet house

Polynet house was covered with UV-stabilized plastic sheet from November to February and thereafter was replaced with plastic net. Sweet-pepper yield in polynet house was 106 tonnes/ha, which was 25% higher than polyhouse (87 tonnes/ha) and 45% higher than net house (57 tonnes/ha).

Fish production in greenhouse covered ponds

After 20 days of rearing of carp it was observed that its mean growth in open and polyhouse covered ponds was 21.95 mm / 0.202 g and 19.7 mm / 0.139 g. The survival rate of the fry from spawn was 61.5 % in polyhouse pond and 40.2 % in open pond. The desirable plankton density was higher in polyhouse ponds compared to open pond. Average maximum and minimum air temperatures inside polyhouse ponds were found 10°C and 5°C higher than the open pond.

Perforated Polybags for Tomatoes

Turning-red tomatoes stored in the perforated polybags with ethylene absorbent at room temperature had shelf-life of 10 days, and it increased to 18 days when tomatoes were stored at 18°C at the PAU, Ludhiana. Mature green tomatoes with ethylene scavenger could be stored for 16 days at room temperature and 19 days at 18°C. The lycopene content and TSS have been found significantly higher for tomatoes packed in polybags without perforations. Tomatoes harvested at mature green or turning-red stage have better shelf-life.

COTTON TECHNOLOGY

Light weight cotton-gin: The CIRCOT has developed a light weight gin. The weight is reduced by about 60%, keeping output at 5 kg seed-cotton per hour. This gin can be operated with a remote control as well.

Heap-making machine for cotton: The CIRCOT has designed and developed a mechanical heap-maker that is able to throw cotton into well-formed heaps at the rate of 3,000 kg/hr. Efforts are on to increase heaping rate and bulk density of heap.

- Developed a light-weight cotton-gin, which can be operated with a remote control as well.
- CIRCOT designed and developed a mechanical heap-maker for cotton.

SUCCESS STORY

Variable speed double-roller gin

The two most important machine parameters that influence productivity of lint in double-roller gins are the speed of the roller and the oscillation frequency of the beater. Almost all commercial double-roller gins employ a fixed roller speed of 90-100 rpm while beater itself oscillates with a frequency of 900-1000 rpm; the ratio of these speeds is 1:10.

The operational efficiency of the gins depends on the adjustment of the speeds based on the staple length of the cotton, requiring relatively higher roller speeds for cottons of longer staple lengths. The existing arrangement in gins does not permit alteration in speed ratio as any increase in the roller speed correspondingly affects frequency of the oscillation of the beater, affecting quality and quantity of the lint delivered during ginning.

Speciality of VS gin

- Has flexibility for adjusting speed of roller and beater independently according to the staple length of the cotton.
- Faster ginning.
- Higher lint out-turn with uniform lap.
- Easy way to change speeds by use of step pulley and V-belt.
- All important fibre parameters are preserved, and there is no deterioration in lint quality.

To overcome this problem the CIRCOT has come up with a *Variable Speed Double Roller Gin* that leaves ample room for adjusting roller and beater motions to desired speed ratio appropriate for cotton staple under the process. This has helped to increase in the productivity of gin to 60-80%, without affecting lint quality. The production of lint per inch of the roller is between 1.5 and 2 kg/hr compared to the existing rate of less than 1kg/hr.

To obtain higher out-turn of longer staple cottons higher roller speeds up to 140-150 rpm are used and for medium staple cottons up to125 rpm; keeping the beater frequency steady at 1,000 rpm. The short staple cottons are best processed with beater frequency of 750 rpm, keeping roller speed as 100 rpm. The VS Gin technology of the CIRCOT has been patented and sealed having serial No. 189878.

A comparative trial of VS Gin and that of the conventional gin was conducted at the factory level at M/s Uday Cotton Industries, Khadi, Mehsana District, Gujarat. Extensive factory trials gave 72 kg lint output/hr as against 52 kg lint/hr from conventional gin.

The CIRCOT has transferred this technology to M/s U. D. Patel and Company, Mumbai, for commercial exploitation in ginning Industry.

Yarn count predicted accurately using neural network: Highest Standard Count (HSC) is a single integrated index that provides an easy way to express quality of cotton and is considered a unique mean of expressing the maximum spinning potential of the given cotton. The CIRCOT has developed an Artificial Neural Network model (ANN) using fibre properties such as 2.5% span length, uniformity ratio, micronaire value, bundle strength and percentage of mature fibres as input to predict highest standard count (HSC) value. This model is able to predict HSC within an error of ± 4.23 counts. Since the spinning industry is very familiar with the concept of count, understanding and using HSC as an index for characterizing spinnability would not pose any problem and would be more favoured than the current Fibre Quality Index, which is used to indirectly assess spinnability of cotton.

CIRCOT's improved microspinning system

Miniature spinning assembly of the CIRCOT consists of carding, drawframe, sliver to yarn ring-frame and roving to yarn computerized ring-frame. These machines are gearless and run smoothly and are designed incorporating the most modern technology like electronic drive system. The main machine parameters like draft, speed and twist can be set easily from the machine panelbox. These machines have better design features and are available approximately at one-fourth the cost of the imported ones.

Coir-cotton composite yarns for conveyor-belting

For the first time, coir-cotton composite yarns have been developed through friction spinning technology for the industrial end-uses. From coir-cotton composite yarns, conveyor belt material has been fabricated. As a cheaper fibre, replacement of cotton-fabrics with coir will help in bringing down the cost of conveyor-belting.

Production of xylanase from Penicillium funiculosum: Xylanase is an enzyme that can biodegrade lignocellulosic substrates to useful end-products. Fungus *Penicillium funiculosum* could secrete xylanase simultaneously when cultivated for cellulase production using cellulose as the carbon-source. The maximum yield of xylanase could be obtained 72 hr after incubation when substrate on which organism was cultivated had 1.0% cellulose and 0.25% peptone. The enzyme thus produced had maximum activity equivalent to 33.3 units/ml at a *p*H of 6.0 and temperature 50°C that is considered optimum for use in textile finishing applications.

Angora rabbit hair blends with cotton: Angora rabbit hair with cottons like Suvin and DCH 32 have been blended. Since Angora fibres are shorter compared to

wool, they cannot be effectively utilized through long-staple woollen and worsted spinning systems for manufacturing consumer acceptable textiles. This novel blending in cotton system is beneficial way of utilizing rabbit hair. Knitted fabrics produced from blended yarns are found to possess adequate bursting strength, whiteness, softness and bulkiness. Several innovative end-products like low-shrink knitted fabrics, single jersey and light weight soft feel women's wear have been prepared.

LAC TECHNOLOGY

Habitat management in lac eco-system: Vegetables growing as an intercrop in the plantation of *Flemingia semialata* has showed significant improvement on the growth attributes of the lac-host plants such as height, basal girth, canopy spread and shoot length, and this will help to meet diversified needs of lac growers.

Flemingia semialata propagation through stem-cutting

Vegetative propagation technique for *Flemingia semialata*, a recently identified quick-growing, potential brushy lac-host, through planting of stem-cuttings in trenches under high humid conditions, has been successfully attempted. This technique shall now be used in raising plantation of true-to-the type, high-yielding plants in a large scale for intensive lac culture.

Water-thinnable coating compositions for cementitous surfaces

Water-thinnable coating compositions from lac have been developed for cementitous surfaces. They possess most of the desired properties as per the BIS specifications. They can be diluted to desired consistency and can produce hard, smooth and matt-finish on application by brush. The air-dried films have showed good adhesion on metal, tin, plate, glass, wood, concrete, masonry and limited surfaces with good resistance for water as no effect could be observed even after dipping for four months in water.

Identified and collected rare variants of palas (Butea monosperma): Three rare variants of palas (*Butea monosperma*), with unifoliate flowers, yellow flowers and white flowers have been identified, collected and planted in the institute plantation for conservation of plant biodiversity.

Synthesis of some bio-active compounds from aleuritic acid: Aleurityl hydrazide was synthesized from methyl aleuritate by treating it with hydrazine hydrate in methanol. The compound showed antifungal activity. A sex pheromone of *Helicovoerpa armigera* (cotton bollworm), (Z)-9-Hexadecenal, was synthesized in quantity from aleuritic acid, the major component acid of the lac, with an overall yield of 20%.

New cyclic thioureide has been synthesized from aleuritic acid adopting simple reaction sequences.

Shellac-based can-lacquer formulations for packaging. Various can-lacquer formulations developed have been applied on the aluminium foil by spray, with/without suitable pigments, for possible use in packaging of sweets and confectioneries. The results obtained are quite satisfactory with regard to flexibility, attractive appearance and adhesion

JUTE TECHNOLOGY

Minimal water for extraction of jute fibres: Because of acute shortage of retting water, farmers are compelled

Value-addition of safflower petals

Natural dyes from petals

Safflower petals yield a water-soluble, yellow dye and an alcohol-soluble red dye. An appropriate technology has been developed for extraction and application of yellow dye on the cotton goods. It is possible to create a spectrum of shades ranging from yellow to olive-green by using right proportions of appropriate ecofriendly mordants. The dyed fabrics possess an acceptable level of washfastness (3-4) with a very good colour uniformity and reproducibility. It is estimated that around 0.5 lakh tonnes of yellow colourant valued around Rs 5,000 million can be generated annually in the country.

Herbal tea from petals

A recipe has been successfully formulated for herbal tea preparation from safflower-petals. The proportion of various ingredients has been optimized and subjected to an extensive organoleptic evaluation trials.

Petals as food additive and colourant

A technology has been developed to incorporate safflower-petals in powdered form in various popular food items like *barfis, pedas, jalebis,* shrikand, and in a number of bakery and dairy products. The acceptability of the petal-incorporated food items has been demonstrated through extensive organoleptic trials. The non-toxic safflower petals on account of the presence of the polyphenolic and other molecules transform food items into herbal health-care products.

to ret jute-plants for fibre extraction in roadside ditches, ponds and canals. As a result, quality of the extracted fibres is reduced and farmers fail to get the remunerative price from their produce. With the NIRJAFT technology, retting is effected in just water-soaked conditions by the application of a specific fungus belonging to *Sclerotium* group, thus reducing substantially water requirement. Bench-scale trials have found that with this retting could complete in a shorter time than traditional retting.

Blending jute and allied fibres: The NIRJAFT has worked on blending of coir and jute successfully in jute-spinning system in 20:80 ratio. Better results could be obtained when coir fibre prior to blending was steamed under 15 psi pressure. The blended products are much better in productivity, strength and extension properties than 100% coir products.

Blending ramie with tasar waste: Tasar waste has been blended with varying proportions of ramie ranging from 100 to 25%. Spinnability and regularity of the blended yarns (51-104 tex) improved due to higher fineness of tasar, which provides higher number of fibres in the same cross-section of yarn. The blended yarns have been found suitable for manufacturing garments, apparels and decorative fabrics.

Jute blended with sisal: About 20% sisal could be blended with 80% jute. Strength and durability of these blended yarns increased significantly. And these yarns can be used for making scrubber, matting and floor covering.

ENERGY IN AGRICULTURE

Crop residue conversion to liquid fuel. Pretreatment of paddy-straw (400 micron) with 2% NaOH for 1 hour at 15 psi pressure in autoclave could result in 88% delignification and 100% increase in cellulose content. Hydrolysis of alkali-treated paddy-straw with 75% (w/v) sulphuric acid resulted in release of 30% (w/w) sugars. And hydrolysis with crude culture filtrate of *Trichoderma reesei* (5FPU/g) and commercial cellulase (1.5% v/v) resulted in 48 and 81% saccharification of cellulose. Fermentation of hydrolysates of alkali-treated paddy-straw obtained after treatment with acid, crude culture filtrate and commercial enzyme and supplementation with 1.24% yeast nitrogen-base using *Saccharamyces cerevisiae* (1% w/v) could produce 78, 139 and 224 ml ethanol/kg paddy-straw.

- Fermentation of hydrolysates of alkali-treated paddy-straw obtained after treatment with acid, crude culture filtrate and commercial enzyme and supplementation with 1.24% yeast nitrogen-base using *Saccharamyces cerevisiae* (1% w/v) could produce 78, 139, 224 ml ethanol/kg paddy-straw.
- Developed an improved CIAE stove for biomass charred briquettes.
- An unglazed solar air-heater has been developed which works as the roof of the building.
- Designed and developed solar refrigerator.

Bagasse-based gasifier. Developed an open-core gasifier of 700-mm internal diameter. This system has been installed at the site of the sugarcane-farmer for jaggery preparation. Its burner efficiency is 52% compared to 16% of the conventional system.

Bagasse-based gasifier: An open-core gasifier of 700-mm internal diameter and 1,860-mm height has been developed. This has been fitted with a continuous ash removal mechanism. Outer surface of the reactor has been provided with glasswool insulation to minimize heat loss. The gasifier has been tested with bagasse briquettes of 30-mm diameter and with an air-flow rate of 200 m^3/hr, which could generate producer gas at the rate of 257 m^3/hr. The flame temperature of 657°C could be obtained. The system has been installed at the site of the sugarcane-farmer for jaggery preparation. Burner efficiency has been 52% as compared to 16% for the conventional system. The system could save 40% of fuel and 45% in time compared to conventional system for jaggery-making.

Roof integrated unglazed solar-air heater: An unglazed solar air-heater has been developed, which also

Roof integrated unglazed solar-air heater. This costs around Rs 1,000/m^2. Its single module evaluation recorded a temperature rise of 15°C.

works as the roof of the building. This heater has been made using hollow black colour PVC section in one mm wall thickness. One module of the heater has 1.75 m^2 surface area (2,730 mm × 300 mm × 25 mm). Single module of the heater was evaluated and a temperature

rise of about 15°C was recorded. Thereafter, a large system measuring 21m^2 surface area, which formed roof of the small shade, was erected and its performance was evaluated during summer and winter. The increase in air temperature varied between 18.9° and 13.2°C during summer (solar insolation 917 to 1069 W/m^2) and 16.6 to 10.2°C during winter (solar insolation 750-930 W/m^2), and air-flow rate varied between 441 and 1,075 m^3/hr. The heater did not shown any discolourization or wear and tear during 18 months of its exposure to outdoors. It costs around Rs 1,000 per m^2.

Solar refrigerator designed: A SPV system for operation of a top-opening, 73-litre capacity DC refrigator

Solar refrigerator. This refrigerator has been used to store animal vaccines and other medicines in a village veterinary clinic.

has been developed. This refrigerator system was used to store animal vaccines and other medicines in the village veterinary clinic. Performance of the system has been found satisfactory over 9 months. Keeping in view the requirement of the rural industry, a 80-litre capacity, top-opening refrigerator mainly to store single products has been designed and developed. This refrigerator is equipped with Danfoss make DC compressor of 12 V/24V. And thermostat with seven settings enables user to obtain a wide range of temperature varying between –4.6 and 1.5°C. Its daily energy consumption varies between 450 and 875 Wh.

Natural draft gasifier for thermal application: The cylindrical gasifer (700-mm diameter and 1,260-mm height) has been provided with 4 air-tiers located above the grate at the intervals of 90° at the periphery. Gas outlet of diameter of 300 mm (located 800 mm above grate) is fitted at an angle of 30° on the periphery of the gasifier with chimney at the height of 126 mm from the grate. An ash removal system has been provided for agitating fuel-bed and removal of ash from the grate. The gasifier also has a light-weight, fire-brick inner insulation of 50 mm.

The gasifier has performed satisfactorily with a thermal output of 106.7-121.3 kW. Its biomass consumption rates ranged between 35 and 40 kg/hr for wood-chip and 24-37 kg/hr for soybean-straw. The respective grate temperature was 1258-1380°C for wood-chips and 1154-1234°C for soybean straw. The provision of insulation could increase the grate temperature by 1.6 to 3.9%. The outer surface temperature of the gasifier near the grate remains 65-98°C, with surface temperature decreasing with the height to around 50°C at 300 mm from the gasifier-top.

Animal Energy

Animal-operated zero-till drill: The single-row, zero-till drill developed requires a draught of 35 kgf and its field capacity has been found at 0.03 ha/hr. The two-row,

Improved cookstove for low pollution

A CIAE improved stove has been developed for biomass charred briquettes. It has provisions for supplying adequate air for burning and reducing heat losses due to radiation and convection. It consists of two concentric mild steel grates with small holes which are supported on a mild steel grill. About 0.5-kg briquettes can be fed at a time in the stove that lasts around 1 hour. The stove is ideal for cooking requirement of a family of 4-5 members.

CO emission level in typical rural kitchen of Madhya Pradesh with single mouthed traditional *chulha* and CIAE Improve stove

Kitchen type	Type of *chulha*/stove	Average CO level (ppm) in breathing zone (0.3 m to 0.6 m radius around the *chulha*/stove)	
		Sitting zone (0.5-m height)	Standing zone (1.5-m height)
Conventional thatched roof: type (18-20 m^3 volume)	Single-mouth traditional chulha	12	15
-do-	CIAE improved stove with briquettes	2	3

CIAE improved stove has been developed for biomass charred briquettes. About 0.5-kg brigquettes can be fed at a time and that lasts around 1 hr.

zero-till drill has a field capacity of 0.05-0.06 ha/hr and its draught requirement has been 45+10kg for light soils and 75+10kgf for heavy clay soils. Zero-till drill had resulted in 5% increase in yield as compared to conventional method.

Modified adjustable collar harnesses: Pantnagar-adjustable collar harness and Allahabad harness have been modified to increase yoke-contact area for providing comfort to animals during work. The increased output has been utilized for operation of 100-150-mm plough with a single animal harness using buffaloes with a work-rest schedule of 4 hours work and 7 hours rest for the field preparation during *rabi*. The animals could operate plough without showing any additional fatigue symptoms. The collar harness intervention has resulted in 20-25% more power output. The contact area could increase to 17% in modified harness. The improved implements matching draught capacity of animals under farmer's field could increase command area from a pair of buffaloes by 22-40% in various crop rotations, when buffaloes were used as a power source in *tarai* region.

Bullock-operated generator: The device consists of an improved design of bull-gear coupled to generator for electricity generation. The bull-gear consists of spur and helical gears and all gears are arranged vertically. The gear and shaft and key are made of EN 19 and EN 8 steel for its mechanical strength, longer life and also for amenability to surface hardening. The magnification ratio of a bull-gear has been 310-08. The bull gear coupled to 1 KVA alternator operating at 750 rev./min could give the power output ranging from 500 to 750 watts.

TECHNOLOGY TRANSFER

- The success rate of starting soy-processing technology has been found 70% and 100% in Haryana and Punjab.
- A manufacturing package for serrated sickle that has edge over plain sickle consisting of dies and punches for blade, blade-holder, holder bending die, and a compact-serration making system using milling process to produce 0.8-mm deep, 10-mm wide serration over 180-mm sickle-blade length, has been developed for small manufacturers. The complete system costs Rs 60,000 with Rs 9.40 lakh of total investment. A total of 72,000 sickles per annum as production capacity can earn about 7.20 lakh per year at Rs 10 per sickle. The break-even point has been calculated as 35% with the adoption of this package.
- A low-cost design of natural convection, flat-plate type solar water-heater has been developed. This consists of 2-flat plate collectors, each of 1 m^2 aperture area. A plate-type simple heat exchanger has been provided in water-store tank to avoid scaling of collector pipes. Heat losses from storage tank have been reduced by using 20-cm thick composit insulation of glass-wool and thermocole. The heater heats 100 litres of water up to 55-60°C on sunny days in winter at Ludhiana. Overnight drop in temperature of hot water has been less than 5°C. It is now commercially available at a cost of Rs 13,600 from M/s Vishiv Karma Solar Energy Corporation, Phillaur.
- A simple to use electronic temperature controller, for using with natural convection solar dryers, has been developed. The controller is now available at Rs 2,500.

Flat-plate type solar-water heater. This heats 100 litres of water up to 55-60° on sunny days in winter at Ludhiana. Overnight drop in temperature of water was less than 5°C.

❑

- Pantnagar adjustable collar harness and Allahabad harness have been modified to increase yoke contact area for providing comfort to animals.

Agricultural Human Resource Development

A mutually shared goal and commitment on improving the agricultural education binds the ICAR, State Agricultural Universities and other institutions together in a close professional relationship. Strengthening and development of agricultural education is being done primarily to make agricultural education better through Centres of Advance Studies, professional chairs, infrastructure upgradation, faculty competence building, scholarships to students, and their practical training in laboratory and real life field situations.

CAPACITY DEVELOPMENT

State agricultural universities

Chaudhary Charan Singh Haryana Agricultural University, Hisar: The recommendations made by a Committee headed by Dr A. L. Chaudhry (formerly Chairman ASRB) have been implemented. Accordingly, necessary reorientation and adjustments have been made to avoid duplication across faculties and colleges. Not only the courses have been restructured but also the research programmes have been revamped and surplus staff redeployed to enhance efficiency of inputs and effectiveness of their output. Workload of teachers was reviewed and revised. In order to better curricular delivery, the faculty prepared and published 20 manuals for practical aspects of education and skill development. Faculty members received partial or full financial support to participate in international and national conferences/ seminars/workshops and training programmes. Additionally, 238 faculty members received refresher training in diverse subjects of teaching in agriculture and allied subjects.

- With the new arrangement, every Professor is required to teach at least one UG course during a calendar year. The practical component across degree programmes has been strengthened and facilities provided in terms of laboratory supplies and repair and replacement of old equipments.

The University organized an All-India Interstate Agricultural University Festival. More than 600 participants from 25 SAUs participated in this 4-day mega-event to foster deeper understanding of diverse cultures, inculcating a spirit of national integration.

A series of training programmes were organized to improve student communication skills and personality development. During the year, laboratories, library and instructional farms were strengthened to build practical training, a strong component of teaching and learning. As a consequence of distinct emphasis on skill improvement, 115 graduates got placements through campus interviews.

Bidhan Chandra Krishi Viswavidyalaya, Mohanpur: In order to bring overall academic improvement, the existing laboratories were renovated and developed with all modern equipments and infrastructures. All the departments were linked by establishing Local Area Network (LAN) and also making Agricultural Research Information System (ARIS) operational through internet connectivity. A Mustard Oil Producing Plant has been established under the Revolving Fund Scheme. This facility apart from producing good quality mustard oil and revenue for the University would also be utilized for training of students and small-scale private entrepreneurs.

Chandrashekhar Azad University of Agriculture and Technology, Kanpur: Some significant achievements of the university have been:

- Admissions in the newly established Departments of Forestry, Agri-Business Management and Vegetable Science in the College of Agriculture were made for the first time.
- Post graduate teaching in three new departments viz., Home Science Extension Education, Human Development and Clothing and Textiles in College of Home Science began during 2002-03 session.
- On the basis of number of students selected for ICAR JRF, CSUAT ranked fifth on the all-India basis.
- College of Agriculture organized three training programmes on mushroom production, multimedia and integrated pest management.
- During 2002-2003, 34 graduate and postgraduate students were selected by private firms through campus interviews organized by the Directorate of Placement.
- Two Assistant Professors in the Department of Plant Pathology have been awarded with the Young Scientist Award by UPCAR, Lucknow for her outstanding contribution in the field of Plant Pathology.

Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur: In its silver jubilee year, the University has released 15 varieties of different crops for the farmers of Himachal Pradesh. A building named Trilokinath Bhawan was inaugurated for the benefit of

farming community of the area. Five regional Research and Extension Centers viz., Hill Agricultural Research and Extension Centre, Dhaulakuan, Hill Agricultural Research and Extension Centre, Bajaura, Highland Agricultural Research and Extension Centre, Kukumseri, Mountain Agricultural Research and Extension Centre, Sangla and Shivalik Agricultural Research and Extension Centre, Kangra were established during the year under report.

Govind Ballabh Pant University of Agriculture and Technology, Pantnagar: The University has taken up coordination of RAWE activities with stress on overall development of women. Propelled and facilitated by faculty and students, 60 Self Help Group (SHG) were constituted. Renovation of PG lab for the students/ scientists in the department of Aquaculture was undertaken during the year. University established Model Circulatory Hatchery for the experimental trials by students on fish breeding and seed production. During the year, more than 90% of the final year B. Sc. students were selected for ICAR – JRF on all-India basis competitive examination.

Gujarat Agricultural University: The University implemented the recommendations contained in the third Deans Committee Report for bringing uniformity in admission procedures and course curriculum with other SAUs. It also introduced Common Entrance Test for admissions at M. Sc. and Ph.D. levels and established new departments of microbiology, tissue culture, bio-technology and computer application. For enhancing the scope and facilities for literature search, library was upgraded in terms of books, journal, networking for online access, digitilization etc.

Kerala Agricultural University, Thrissur: The PG programme on Forest Management and Utilization was started at College of Forestry, Vellanikkara, Thrissur with two seats. In addition, the CPBMB, College of Horticulture, Vellanikkara, Thrissur received the Biotech Product and Process Development and Commercialisation Award for the year 2003.

- The Kerala Agricultural University ranked first by securing 61 JRF in the All-India Examination held in Agriculture and allied subjects to fill the 25% seats through a combined entrance examination conducted by the ICAR in 2002.

Maharashtra Animal and Fishery Sciences University, Nagpur: The MAFSU has established under Prime Minister's Jai Vigyan Technology Mission the country's first Veterinary Nuclear Medicine Centre at the Bombay Veterinary College to facilitate research in new drug development, drug delivery, radio-pharmaceuticals and new prosthesis.

A pilot project to develop training modules and the software has been taken up with financial support from 'Commonwealth of Learning', Canada to produce IT-enabled continuing education material for field veterinarians.

The University has developed software (Breed Com) for breed herd registration in collaboration with a private industry. As a part pf educational strengthening programme, with the funding under NATP l, the University has taken up an intensive programme for library modernization and automation and also provided internet facilities to the students and teachers for global interaction and documentation.

The prestigious Jawaharlal Nehru Award for Post Graduate research for the year 2002-2003 was awarded to Dr M.D. Deore, Assistant Prof., Department of Pharmacology at BVC, Mumbai. The Vasantrao Naik Smruti Pratishthan Award for the year 2002 was awarded to Dr N.P. Dakshinkar in recognition of his significant contribution in Animal Sciences.

Narendra Dev University of Agriculture and Technology, Faizabad : The university established a College of Agricultural Engineering and Technology. The admissions were made and teaching of first batch of B. Tech. Programme has already started at the main campus at Kumarganj from July 2003 with 30 students.

Ninth Convocation of NDUAT held on 8 March, 2003

Punjab Agricultural University, Ludhiana: The PAU revised the B.Sc. Home Science (Hons) curriculum in accordance with the guidelines of ICAR and introduced a new M. Sc. programme in Post-Harvest Technology. During 2002-03 a total of 747 students were admitted to undergraduate, postgraduate and diploma programmes and 515 students successfully completed their degrees.

- Besides academics, university students also excelled in various sports and co-curriculum activities. PAU Badminton team (men & women) was the winner of the 4th All-India Inter Agricultural Universities Games for 2002-2003 held at Parbhani, Maharashtra. The students participated in North Zone Inter University Youth Festival at Allahabad University and won third position each in group folk dance, clay modeling and miming events.

A number of faculty members got recognition through prestigious awards and honours at National / International levels. The notable ones included

membership of World Food Prize Nominating Academy for 2003 by World Food Prize Foundation Iowa, U.S.A.; Chairmanship of International Union of Soil Sciences; Fellowship of National Academy of Agricultural Sciences; Visiting Professorship to Hiroshima University; Japan, Rafi Ahmed Kidwai Award; Gurdev Singh Khush Distinguished Professor Award; and Punjab Government *Parman Patars*.

Tamil Nadu Veterinary and Animal Sciences University, Chennai: The University offered technical expertise to fish and shrimp farmers in the formation of fish and shrimp farms and their maintenance and disease identification in finfish and WSSV (White Spot Syndrome Virus). Diagnosis in shrimps was done in samples brought by fish and shrimp farmers; and water and soil samples from fish culturists, ornamental fish farmers, sea food processors and industries concerned with environmental management were tested for physio-chemical characteristics on charge basis.

Through the Students Placement and Career Guidance Cell the graduates of TNVASU have been guided for their employment soon after graduation. The Cell has been functioning in this University for the past five years. The Cell also advises and helps the students in their search for higher studies in and out of the country.

University of Agricultural Sciences, Dharwad: During the academic year 2002-03, University of Agricultural Sciences, Dharwad admitted 239 students in B.Sc. (Agriculture). 57 in B.V.Sc. & AH, 25 in B.H.Sc., 33 in B.Sc. (Forestry), 34 in Ag. Engineering, 45 in B.Sc. (Horticulture) and 31 in B.Sc. (Ag. Marketing and Cooperation) programmes. In addition, 264 students joined various Master's degree and 58 joined doctoral degree programmes. During the year, 37 postgraduate students and 50 undergraduate students from other States including one from Mauritius were also admitted in various programmes.

Students of the University not only excelled in academic activities, but did well also in co-curricular activities. They participated in the fourth All-India Agricultural Universities Sports and Games Meet held at Parbhani, and in All-India University Debate competitions organized by National Cooperative Union of India at New Delhi, and secured two medals and one prize, respectively.

Dr M.B. Chetti, Department of Crop Physiology, was awarded the J.J. Chinoy Memorial Gold Medal for outstanding research and D Subramanyam Award for being an outstanding teacher. Dr K.A. Kulkarni, Department of Entomology was awarded National Environmental Science Academy Award as Scientists of the year 2002. Dr B.V. Patil was awarded Sir C.V. Raman Award for Young Scientist and Putta Ruddaraiah Memorial National Award for outstanding contribution in the field of Plant Protection. Dr B.M. Khadi was awarded Sir C.V. Raman Award and Dr A.B. Joshi received National Award for outstanding achievements in the field of cotton development. Dr (Mrs.) Sarojini Karakannavar was awarded Jawahar Lal Nehru Award by ICAR for outstanding Ph.D. thesis.

University of Agricultural Sciences, Bangalore: The students of the university performed well in JRF examination conducted by ICAR and secured 46 fellowships. The university had deputed 49 teachers to attend workshops/seminars/training programme within and outside the country. It identified and recognized eight institutes (ICAR and GoI) for PG collaborative research. The training programmes were conducted on-Forestry resource economics, Medicinal and aromatic crops and seed quality testing and marketing for the staff of SAU and ICAR institutes.

MANPOWER DEVELOPMENT

Accreditation of Agricultural Universities

In the continuing process of accreditation of 16 SAUs and 3 DUs, the Peer Review Teams visited 7 SAUs and one DU after receipt of their self study report. Six Peer Review Teams have submitted their reports. The comments of the CIFE, Mumbai and KAU, Thrissur on their Peer Review Team Reports have been received from the Director and Vice Chancellor, respectively. NDRI, Karnal and IVRI, Izatnagar have submitted draft of the self study report.

Implementation of UG and PG Curricula and Syllabi, Model Course Curricula and Syllabi of 8 UG and 44 PG Programmes were developed and provided to all SAUs, DUs and CAU along with the academic regulations. Majority of the SAUs and DUs have implemented these courses since academic year 2002-03.

Norms for UG and PG Colleges offering different academic programmes were developed. Details desired by the Sectoral Committee on Norms and Standards about the department, faculty members, building space, equipments, library and quantifiable standard have been obtained from the experts. The reports on Agriculture, Agricultural Engineering, Horticulture, Home Science and Fisheries have been compiled.

Admission of Foreign Nationals

ICAR jointly with SAUs has developed a strong agricultural education system in the country and is facilitating human resource development by offering undergraduate programmes in 11 major disciplines, and post-graduate and Ph.D. programmes in 65 disciplines to the overseas students. In the year 2003-04, 127 students from 22 countries have been provided admissions in ICAR Deemed-to-be Universities and State Agricultural Universities.

Summer/ Winter Schools/ Short Courses

To enhance the faculty competence in new and emerging areas as a part of skilled human resource development and recognizing the need for training of large number of scientists, the ICAR over the years has supported substantially increased number of training programmes. This year 90 Summer/Winter School and

Short Courses were organized through which approximately 3000 scientists were trained in diverse subjects of agriculture and related fields. Courses on Biotechnology and Information Technology received special preference. Likewise, a course on water quality monitoring and surveillance was a highlight of this year's Summer/Winter Schools.

- Efforts are underway to place all the instructional course material on ICAR website. Once operational, this facility will enable both scientists and students to have easy accessibility to the latest literature in the specialized areas of agricultural science and technology

Summer/Winter Schools and Short Courses Organized

Discipline	Number
Crop Science	14
Natural Resource Management	10
Agricultural Economics	3
Statistics	6
Extension	7
Animal Science	14
Agricultural Engineering	8
Horticulture	9
Fisheries	8
Education and Home Science	11

All India Entrance Examinations for Agriculture and Allied Science

To reduce inbreeding and enhance a spirit of national integration, Education Division, ICAR conducts an All-India Entrance Examination to admit students across all SAUs, DUs and Central Universities in undergraduate (UG) and postgraduate (PG) courses. Like in the previous years, this year also this entrance examination was conducted in a highly successful and professional manner to fill 15% of the total available seats in ten diverse subject groups of UG programmes including award and selection of candidates for National Talent Scholarships (NTS). Through this combined entrance test out of a total of 12,881 candidates, 970 were admitted. Of these, 52% belonged to rural areas and 48% were from urban areas. Among the admitted candidates, 76% were boys and 24% were girls. For candidates belonging to the SC, ST and Physically Handicapped category, 15, 7.5 and 3% seats were kept reserved for admissions.

- For award of NTS based on the students' merit and those desirous of studying in States other than that of their domicile, 218 candidates were recommended for the award

For admissions to 25% seats in postgraduate programmes, 8,786 candidates appeared for the common entrance test. Of these 2,663 qualified for counseling and of which 1,177 were admitted. Four hundred thirty eight candidates were awarded Junior Research Fellowships (JRF). Based on the merit performance of eligible candidates in the All-India Competitive Examination conducted by the ICAR, 202 Senior Research Fellowships were awarded for a period of three years. Among the admitted candidates, 42.5% belonged to rural areas, and 57.5% came from urban territories. The percentage of girl students among the admitted candidates was 24. The Council thus contributed in facilitating multicultural shade in educational institution and provided opportunity to meritorious students for seeking education in an institution of their choice.

CENTRES OF ADVANCED STUDIES

The 31 Centres of Advanced Studies (CAS), sponsored by the Council, offer facilities for continuing capacity building of faculty engaged in teaching at UG and PG levels. Each Centre conducts at least two trainings each year in the area of its recognized competence and in subjects of topical and emerging relevance. Each training lasts for three weeks and admits 20 participants drawn both from SAUs and ICAR institutes. In all, 62 programmes, conducted during the year, trained 1250 scientists and faculty members in several diverse and upcoming disciplines of agriculture and allied subjects. Following are the major areas in which trainings were conducted:

- Biochemical and molecular techniques for plant pathogen characterization
- Advances in horticulture plant resistance to insects
- Undergraduate teaching of agricultural meteorology
- Emerging trends in medical nutrition therapy
- Breeding plans for genetic improvement of farm animals
- Techniques in biochemistry and molecular biology
- Multimedia teaching of clinical medicine
- Recent concepts in management of diseases of farm animals
- Management of microbes as an instrument of sanitary and phyto sanitary compliance and international livestock trade.
- Efficient designing of experiment and analysis of experimental data
- Impact assessment of technologies for sustainability in agriculture via econometric empiricision

PROFESSIONAL EXCELLENCE RECOGNITION

University Level Textbook Writing

This year six books were completed and sent to DIPA

for publication. Once these publications are available for teaching and learning, these will be a boon for both teachers and taught to impart and gather knowledge, respectively with Indian background, experience and data.

National Professor and National Fellow

- The report of the Project of the Census of Scientific Manpower in Agriculture undertaken by Dr D Jha revealed that average age of ICAR scientists is now 45 years, and 43% are above the average age. The high average age necessitates induction of young scientists in the research cadre. In ICAR 12% are women scientists. About two-thirds of them are below 40 years of age and only 5% are in 50 to 60 years of age. There are very few women scientists in management positions. Crop sciences (including horticulture) account for about 45% of total scientists. Each institute has on an average 48 scientists.
- Professor Anupam Verma, IARI has developed an *in-vitro* translation system which provides an alternative mechanism of producing such molecules like-trichosanthin, an inhibitor of viruses, and epitopes for vaccine production. Dr Varma has demonstrated that

> • Four of the ICAR institutes share about 22% of the total scientific strength, with an average size of about 300 scientists. These numbers suggest the need for some rationalization in allocation of scientists to improve research efficiency. Further analysis has been in progress

sandal spike is caused by a phytoplasma, mango malformation by *Fusarium moniliforme* var. *subglutinans*, brown blast by a viroid and bunchy top by a very small multi component DNA virus. These findings have been very useful in developing diagnostic procedures and management strategies. The other major areas of work relate to viruses transmitted through seeds, which are of considerable economic importance and ecological relevance particularly in grain legumes like urdbean, cowpea, pea, etc. even when present in small amounts (less than 100 ng/seed). Serological and electron microscopical techniques for the detection of viruses like chickpea mottle, cowpea aphid-borne mosaic, cowpea (vein) banding, cowpea chloritic spot, pea seed-borne mosaic and others in seeds of different grain legumes have been developed, and R-PAGE method developed for detecting viroids in seeds of plant like coleus. These technologies are very useful for the seed industry in producing virus-free certified seeds. Similarly, ELISA based technology has been developed to detect cassava mosaic virus infection even in apparently healthy plants, which are used for propagation. Methods have also been developed to cure the virus-infected seeds of cowpea by heat and chemotherapy.

- Professor B R Yadav at IVRI established a laboratory genome analysis in Animal Sciences. The outcome of his researches has been: (i) In the DNA repository over 870 DNA samples of different breeds and types of animals from three species has been made. Molecular markers viz. DFP, RFLP, RAPD, and microsatellites and the sequence of primers were selected and synthesized. Methodology was standardized and used in these to characterize various breeds in three species.
- Professor B.P Singh, IVRI developed the first millennium embryo culture chick-2000. He has also reported success in developing the world's first guinea fowl culture chick. The other salient findings in his project include: Development of single stage *ex-vivo*

> • Chicken, guinea fowl and turkey chicks were produced using double window embryo culture system and protocols for the above were also developed

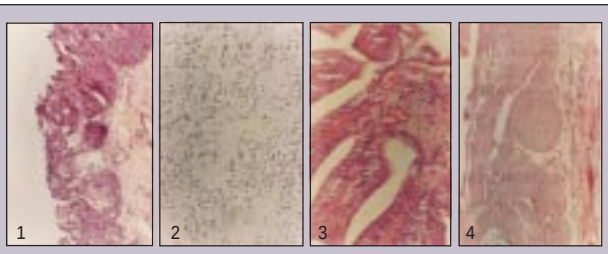
embryo culture system, success in developing world's first turkey embryo culture chicks in laboratory, development protocol for single stage embryo culture system to minimize the losses, development of caribro-naked neck (caribro-mritunjai) commerical broiler stock (naked neck), experimental comparison of feed efficiency versus high growth rate selection program in broiler sire line (SG and SF Lines) for 11 generations, introgression of heat tolerant naked neck gene in specialized broiler male and female population, broiler stocks exceeded the targets in performance in term of growth rate, feed efficiency, livability and economic return at home farm, farmers door and at different RSPPT centres.

- Dr I.M. Santha, National Fellow, IARI isolated and characterized some of the major genes in the lipid biosynthetic pathway from *Brassica juncea*. Omega-3 desaturase is the enzyme responsible for the conversion of linoleic acid (18:2) to linolenic acid (18:3). Using designed gene specific primers 3 partial cDNA sequences corresponding to three fatty acid desaturase (*fad*) genes namely *fad* 3, *fad* 7, and *fad* 8 have been PCR amplified, cloned and sequenced. By screening a cDNA library of *B.juncea* developing seed with *fad* 3 cDNA sequence recombinant clones have been identified.

> • In the work done by Professor I M Santha, a full length genomic clone corresponding to *fad* 7 has been isolated from a genomic library of *B. juncea* prepared in laboratory and characterised along with its promoter sequences.

- The National Fellow Dr R. Somvanshi, IVRI studied etiopathology and development of ameliorative measures in bovine haematuria, and a high prevalence of EBH was recorded in hill cattle in Uttranchal. Young fronds of *O. contiguum* collected from Joshimath,

district Chamoli contained 498.5 mg/kg ptaquiloside. Bracken fern samples collected from Coonor and Kothagiri, Tamil Nadu, Pauri-Garhwal and Phata, Uttranchal revealed 1028, 399, 94.3 and 61mg/kg.



1. Urinary bladder from EBH affected cow showing transitional cell carcinoma grade II (non-papillary and non-invasive type) along with cystic hyperplasia. H & E
2. Urinary bladder from EBH affected cow showing Islands of acinar pattern of urothelium in mucosa. H & E
3. Urinary bladder from EBH affected cow showing papillomatous growth and engorged blood vessels. H & E
4. Ureter from EBH affected cow showing nodular hyperplasia of urothelium. H & E

ptaquiloside, respectively, which was higher than samples collected from Mukteswar (2.55mg/kg). Freeze dried samples of young fronds of *P. squarrosum* collected from Mukteswar and *C. dentata* collected from Izatnagar failed to show ptaquiloside by HPLC method. High level of ptaquiloside showed positive correlation with high incidence of EBH in these areas.

- Professor K. Naskar, CIFRS, Kolkata studied the impact of mangrove ecosystems of the Sundarbans (West Bengal) in estuarine fisheries development with special reference to identification and estimation of different mangroves and algae. On survey of the floral diversity of all the 15 blocks and 71 compartments of the Sundarbans Tiger Reserve, 78 species of mangroves, mangrove associates and back mangroves were encountered. When classified according to Raunkier's Abundance Classes 44.9% of the 78 species belong to Class A, 7.7% of the species belong to Class B, 3.8% of the species belong to Class C, 10.3% of the species belong to Class D and 33.3% of the species belong to Class E. These 78 species were also classified according to their relative abundance.

Emeritus Scientist

Eleven diverse species of VAM fungi were screened for their symbiotic efficiency involving two medicinal plants under glasshouse conditions. With plant biomass, P and alkaloid as the criteria, *Glomus bagyarajii* was selected as the most efficient strain for inoculating both *Coleus forskohlii* and *Piper longum*.

- Liming of pepper growing acid soils @ half the lime requirement enhanced the dehydrogenase activity, microbial population and nutrient availability in soil and crop productivity.
- A cost free surge irrigation design was found feasible for cassava, groundnut and cassava-groundnut comrade cropping. On-farm demonstrations proved the simplicity and feasibility of cost-free surge irrigation.

- Of the 28 currently filled positions of emeritus scientists, 5 are in Plant Sciences, 6 in Plant Protection, 5 in Horticulture, 4 each in Natural Resource Management and Animal Sciences, 3 in Fisheries and 1 in Agricultural Engineering

- Fifteen genotypes of boro rice were identified as highly cold-tolerant with more than 90% survival.
- A refined design of manually pulled, walk backward type, pre-germinated paddy seeder for wet field conditions was developed suiting small rice fields of eastern India or of other regions where farmers use animal power and human labour for raising rice crop. The unit weighs 11 kg and costs merely Rs. 750/.

ALL INDIA COORDINATED RESEARCH PROJECT ON HOME SCIENCE

AICRP on Home Science aims to conduct research in the areas of nutritional security, value addition to low quality fibrous materials, comprehensive childcare and reducing drudgery of farmwomen. Important findings of different scientists in these areas of research were compiled.

Sustainable Approaches for Nutritional Security

- A total of 6,387 food samples representing diverse food groups along with water samples were collected from at least three different agro-climatic zones of each state and analyzed for their fluoride content.
- Fluoride content of food sample was generally higher in rural areas compared to that from urban areas. Even among the urban areas, fluoride content was found to be highest in Rajasthan and Himachal Pradesh and lowest in Punjab.
- Within food groups, cereals, pulses and legumes exhibited maximum fluoride content in rural and urban areas of all states. In comparison, nuts and oil seeds from rural areas of Rajasthan had relatively higher fluoride content.
- The fluoride content of water samples in rural and urban areas were highest in Punjab and lowest in Karnataka.

Value Addition to Agro and Animal Based Fibres

- Around 1296 fast shades and wide variety of shades that can fill the gaps in the spectrum were produced on wool and silk.
- The dyeing procedure involving thirty-six dyes was standardized for wool and silk. Results demonstrated good to excellent colourfastness and perspiration-

tolerance on wool and silk. The pigments present in barks, leaves, seeds, pods etc. were found to be faster than pigments present in flower dyes. Bark sources proved most effective for producing darker shades. Based on colour analysis of natural dyes, shade cards were prepared both for wool and silk separately.

Value added products with natural dyes

Dyeing fabric with natural dyes

- Mordant concentration of 5 – 15 % was found to be effective dye with alum on wool and silk. In comparison, their concentrations in the range of 1-3% proved effective in case of chrome, copper sulphate and ferrous sulphate.
- Software and a compendium were developed on the data of 36 natural dye sources and the technologies developed with regard to dyeing by using natural dyes. These findings are being transferred to weavers, interested women groups and handicraft makers. The extension activities have been undertaken in adopted village to train adolescent girls and women groups to use the technologies of natural dyes for textile handicrafts.

Comprehensive Child Care through Farm Crèche

- The impact of educational intervention to mothers in providing conducive home environment to infants was studied for different parameters. The consequence of intervention revealed a significant impact on a sample of 397 infants.
- The case studies were simultaneously conducted on six infants each in the category of regular, irregular and poor intervention with the follow up of infants over a period of one-and-a half to three years. The intervention revealed that the stimulation programmes were effective in enhancing the psycho-motor, mental, social and emotional development as there was a positive change in the temperament of the infants.
- Situational analysis of 13,100 girl child through focus group discussion with the school and non-school group/ married girls revealed a need to empower the girls for quality life because of lack of encouragement opportunities and callous attitudes on the part of parents, traditional gender role, more idealism among male children, low socio economic status of the family and lack of knowledge on vital issues like health, nutrition, ill effects of consanguinity, ideal child bearing age, menarche and hygiene during menstruation.
- The prevalence and causes of exceptionalities in children was higher in males than females and the percentage of congenital cases was higher than acquired cases.
- An awareness of preferal services had been created by

Conducive home environment for infants in the farm creche

Group discussion with the school and non-school group and married girls revealed a need to empower the girls

- The women and rural girls have been empowered with scientific child care through establishment of early childhood education centers. They have been economically empowered by encompassing activities such as candle production, *agarbati*, *rotis*, mushroom cultivation, making of foot mat,chalk, manufacture of office stationary etc

supplying handouts to the children with special needs and a software on child status has been developed by utilizing the data/ observations collected between 1980 – 2003.

Ergonomics of Farm Women's Drudgery

- Physiological, cardio-vascular and muscular stresses of farmwomen involved in the performance of drudgery prone activities showed that ergonomic cost while performing the activities was very high and above the acceptable limits for the women.
- Impact of improved technologies in drudgery reduction was studied for multi-purpose decorticator, cotton stalk puller, trolley for carrying fertilizer to the field, tubular maize sheller, foot operated maize sheller, improved cotton bag and improved sickle. On the whole, use of improved tools proved beneficial for increasing the work efficiency of the farmwomen. The impact of the improved tools in reducing the postural changes, angle of deviation of the back, grip fatigue and musculo-skeletal pains was also found positive and significant.

Cotton stalk pulling activity with the help of cotton stalk puller

Data Base On Rural Women and Indigenous Knowledge

- The qualitative database, generated through 630 case studies representing large, small and land less categories of households from 42 agro-climatic zones, revealed the clear role of women in ecology regulated farming systems. A fidelity of partnership exits when women work as joint partners with men in various farming activities.
- Women of differing land size groups and across diverse ecological locations and seasons carry out strenuous and health hazard prone farming activities where age does not restrict the participation of females. The women workers and managers in agriculture reflected the capacity to articulate and envision their multidimensional roles for creating role homogeneity and building self-actualization.
- The database on indigenous knowledge focused on Medicinal Plants for Health Security, has revealed the wide scale use of medicinal plants, for instance treatment of respiratory disorders involved 72 diverse plants; digestive disorders depended on 160; ailments and diseases covered 110; and general health care involved 106.

NATIONAL ACADEMY OF AGRICULTURAL RESEARCH MANAGEMENT (NAARM), HYDERABAD

NAARM is entrusted with the primary responsibility of inculcating professional management in agricultural research and education, through innovative human resource development (HRD) programmes and by providing appropriate policy support to the NARS.

The curriculum of the foundation course was revised and updated taking into account the recommendations of the 4th QRT. The updated training programme lays special emphasis on sensitizing the ARS probationers on the status of contemporary agriculture, new opportunities arising from international free market access, issues pertaining to IPR management techniques, as well as policy planning for food security and nutritional adequacy. The new-look curriculum also includes modern management methods on qualitative and quantitative methods of decision making, conceptualization of research projects and their prioritization, monitoring, project based budgeting for infusing excellence in scientific endeavour. Beside, training lays special emphasis on skill development through hands-on training and experiential learning through exposure to real life situations. A distinguishing feature of this year's training was a week long interaction with the senior agricultural policy makers, administrators and managers of research and development at New Delhi. This format provided the young scientists an insight into the current and emerging priorities and obligations of R&D initiatives and the activity roadmap to achieve the goals.

- The properties of plant have been correlated with specific action and method of preparation of indigenous medicine, form of use as liquid, paste, juice, decoction, collirium etc. and the dosage has been documented

- As part of its HRD activities, NAARM organized 36 programmes through which 828 scientists were trained in various aspects of agricultural research and education management

The Academy hosted three Summer/Winter Schools in the areas of Agricultural Research Project Management, Educational Methodology and Instructional Technology and Management of Human Resources in Agriculture. A total of 70 scientists from ICAR institutes and SAUs benefited from these Summer/Winter Schools.

In collaboration with the National Academy of Agricultural Sciences (NAAS), New Delhi, NAARM organized a two-day policy planning brainstorming session on export potential of dairy products. The discussions were held against the backdrop of liberalization of world economies coupled with the emergence of WTO and their potential impact on the Indian dairy industry. The deliberations recognized that India produces milk at the most competitive prices and possesses tremendous possibilities for enhancing milk availability for exports. The brainstorming discussions came out with recommendations suggesting guidelines for export of milk and milk products, infrastructure development, R&D support and building human resource capacity. Various recommendations are being published as a policy document by NAAS.

Towards realizing sustainable performance and enhanced accountability of agricultural research organizations, a methodological framework was developed with the support received through NATP. In order to validate the applicability of methodology thus developed, it was tested on a pilot scale in selected ICAR institutes and Research Stations belonging to State Agricultural Universities. Results revealed that organizational effectiveness is possible to sustain by laying greater stress on critical areas like development and management of human resource, internal finance mobilization, infrastructure development and research project management. Though the methodology essentially assesses performance through self-introspection, it can also complement the externally commissioned evaluation by bodies like QRT.

In recognition of the expertise available at NAARM, international programmes on Agricultural Research Management were held for training of the scientists and officers belonging to administrative and financial cadres of Sri Lanka. Organization of these training programmes was in fulfillment of a part of the ICAR and CARP approved Work Plan.

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AGRICULTURAL ECONOMICS

Emerging trends in the consumption of livestock products: Implications for Research

Consumption of various livestock products in India has increased considerably over the last two decades. Per capita consumption of milk and egg almost increased by one-and-half times. Growth in per capita consumption of meat and fish was relatively low. There is a wide gap in the consumption rates of different food items between the rich and poor, and it is higher for milk, compared to meat and fish. This however has been narrowing down. Similarly, the gap in consumption levels of urban and rural population is also heading towards a convergence. A strong positive relationship exists between income and per capita consumption of livestock products. With sustained growth in rural incomes and reduction in poverty, demand for livestock products is expected to increase faster. This implies a need for faster growth in production of livestock products.

At present, productivity of Indian livestock is low compared to the world average. Average milk yield of Indian bovines is about 50% of the world average, and mutton yield is about 70% and pork yield is about 50%. This indicates that there is a considerable scope to raise the production through yield improvement measures. The emerging trends in meat consumption imply that the structure of meat production will gradually shift towards monogastrics (poultry and pig) with the rising per capita incomes. Research and development systems have to keep in view these trends while planning their activities.

- Demand for livestock products increased with improved rural income
- Coping mechanism was developed to reduce the impact of climate-induced natural disasters
- Integrated technology package developed for food security in tribal, backward and hilly areas
- A new mechanism is to be developed to protect farmers' income
- Regional trade agreements to be forged and potential sub-regional grouping to be identified to have mutually beneficial trade
- Dissemination of available technology needs more attention in future

Trends in the annual per capita consumption of livestock products in India

(kg/person/year)

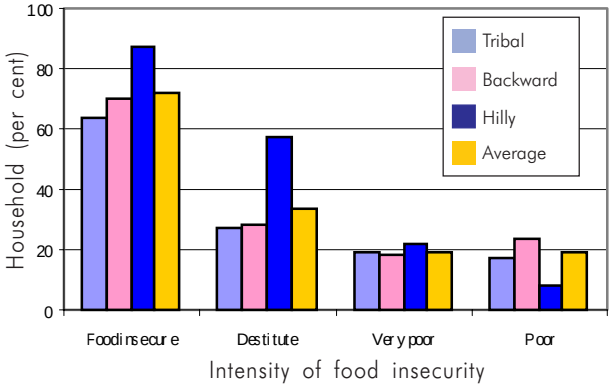
Commodity	1980	1990	2000
Milk	40.4	54.9	66.9
Meat	3.7	4.5	4.5
Egg	0.7	1.2	1.5

Technology intervention and food security status in tribal, backward and hilly areas

An integrated technology intervention approach under the Household Foods and Nutritional Security Project was followed to improve the food and nutritional security status of poor people of underprivileged regions of tribal, backward and hilly areas of India. The food security status of sample households was assessed on the basis of calories intake through food items consumed and it was compared with NIN standard. About 71% households faced food insecurity. On an average almost 33% households were destitute (poorest of the poor), followed by 19% each, very poor and poor. Hilly area is more adversely positioned in terms of calorie intake than that of backward and tribal areas.

In the backdrop of this situation, an integrated

Food insecurity status of the target households in rural India



(i) Destitute families (poorest of the poor); ≥5000 k calories deficit/family/day (ii) Very poor; ≥2500 to <5000 k calories deficit/family/day (iii) Poor; < 2500 k calories deficit/family/day as per NIN standard

intervention of various technologies involving adoption of nutritional crops; improved practices of horticulture; improved breed, feed and health care of migratory sheep, piggery and backyard poultry; pen culture and carp polyculture in fishery, and post harvest management were initiated under NATP, and their initial impacts are assessed. Benefits-cost ratio is higher in minor millet namely *kutki* (2.99) at Jagadalpur district, and *ragi* (1.80) at Ranchi. In migratory sheep in Himachal Pradesh, the benefit-cost ratio was 2.25. Pen culture and carp polyculture technologies in fishery have increased production and productivity by 194%. The overall benefit cost ratio is 2.5 and 1.87 for carp polyculture and pen culture, respectively.

Government Intervention in Food grain Markets in the New Context

The government's procurement, distribution, and buffer stocking programmes during 1990s have had negative impact of repressing private food grain marketing, undercutting its potential contribution to long term food security. Attempts by the Commission for Agricultural Costs and Prices (CACP) to raise support prices of edible oils and pulses (in which India is deficit) relative to support prices for rice and wheat (which are in excess supply), may not necessarily result in shift of resources from rice and wheat to the deficit crops.

In the long run, India needs to develop new mechanism to provide protection to farmers' income. Government should provide support to develop viable crop insurance for protecting crop income. When the emphasis of production is shifting from food security to market led production, it is not justified to base MSP on cost of production. One way to address this kind of situation is to compensate farmers through "deficiency price payment" a part of the difference between actual price received by farmers and MSP. The system of "deficiency price payment" can help in achieving economy in procurement and regional equity in implementing guaranteed price.

Regional Strategic Framework for Liberalization of Agricultural Trade Policies in Asia

The challenge thrown by low level of international prices in the recent years to domestic production is being used to oppose the process of further integration and liberalization. Available evidence shows that reversing the process of liberalization and raising protection would be a big setback to Asian economies. Asian countries should face the challenge thrown by low international prices by improving efficiency and competitiveness of their produce. This requires strong commitments to undertake further reforms in trade and domestic policy. There is a need to identify domestic regulations that restrict markets and access to improved technologies and foreign capital, and replaces these with innovative and more open regulations. System of incentives to encourage efficiency and quality has to be put in place.

Asia as a region is showing economic dynamism and intra Asia agricultural trade is growing faster than world

Vulnerability to climate change and coping strategies: Experiences of rural poor from Coastal Orissa

Climate induced natural disasters (CINDs) like drought, flood and cyclone have become serious problems to Orissa, with regular occurrence particularly in coastal Orissa. The farmers and fishermen who are the traditional food producers living in such fragile environments have been ecologically, geographically and economically marginalized and among those, the poor are the worst affected. In most years, adjustment in household activities combined with relief works provides the minimal succours. Hence, the rural households have evolved certain coping mechanisms to reduce the impact of such CINDs. The common strategies (in order) are :

- diversifying food and income sources;
- adjustment in crop practices;
- adjusting livestock keeping practices;
- risk minimization through share- cropping and building up stocks and inventories; seeking institutional support like demanding relief;
- managing scarce water resources; etc.

All such strategies have reduced the adverse impacts, but the poor continued to be the worst affected.

Post T & V innovations in extension delivery in India

Keeping in view the wide diversity in terms of agro-climatic conditions, socio-economic conditions of rural producers and infrastructure for agricultural development, a country- wide model for agricultural extension would be counter productive. Reform process in agricultural extension should consider the following key lessons that have emerged from an analysis of the post Training and Visit (T & V) innovations.

- The main public sector extension agency, the state Department of Agriculture, need to partner with a number of different organizations in the public and private sectors to access the wide range of skills related to business and market analysis, market development, value addition, community mobilisations and group formation.
- Districts need to be supported with skills and resources to develop extension plans. Organisational and management reforms are essential in public sector extension.
- Organisations should provide a greater degree of flexibility to field level officers at the block and circle levels.
- Group approach has a number of advantages, but farmer SHGs need to be supported technically and managerially to make them sustainable and economically viable organisations.
- Extension clearly needs more funding support.

trade. However, fast growth of intra regional trade in Asia has not been followed by any regional integration in the form of trade blocs. This is depriving Asia of vast potential benefits and opportunity for trade creation and improvement in welfare of Asian countries. Besides, regional trade agreements are also very effective mechanisms to take benefits and also to safeguard from much of the WTO commitments. It has thus become extremely important for Asia, in the globalising context, to forge regional trade agreements, and identify potential sub regional groupings for mutually beneficial trade.

Impact Assessment of Technologies

A number of technologies are being refined, sharpened and developed under NATP. Impact assessment of these technologies would indicate early socio-economic impacts of projects under NATP. The results for few selected technologies like zero-tillage in wheat indicate that farmers are realizing significant economic benefits, whilst promoting sustainability of the production system. The work on impact of vegetable research also shows that a number of useful technologies have been developed, benefiting many vegetable growers in India. Rainwater harvesting in sub-mountainous regions has led to increase in wheat yield and also increase in cropping intensity with inclusion of tomato, which is highly remunerative, as an additional crop. High quality cotton variety (e.g. NHH 44, DCH 32) in cotton growing areas of Maharashtra and Madhya Pradesh, is more stress tolerant, eco-friendly (less chemicals are required) and produces high quality cotton fibre. Returns to investment in dissemination of available technologies are substantial, and should therefore receive due attention in future.

AGRICULTURAL STATISTICS AND COMPUTER APPLICATIONS

Research Achievements

In the study on development of GIS based technique for identification of potential agroforestry areas, important factors responsible for growth of agroforestry in Yamunanagar district of Haryana State were identified. Area under agroforestry was predicted for all the villages of the district using these identified factors. The district map with village boundaries was digitized and the predicted area under agroforestry were attached with the map so that area under agroforestry of any particular village can be seen by clicking on that particular village on the map. A GIS based technique named Objective Spatial Analytic Hierarchy Process was developed for identification of potential areas of agroforestry. An agroforestry suitability index map, depicting high, moderate and Low potential agroforestry areas, was obtained using this technique. A composite development index with respect to agroforestry at village level was developed. The village development index was compared with the suitability index of the village. Most of the developed villages lie in the category of potential agroforestry villages. This study is useful for the farmers as well as planners.

In India the land use statistics are obtained as per 9-fold classification compiled with the help of village revenue agency, i.e. *patwari* in the temporarily settled states of the country, which cover about 86% of the geographic area. The National Statistical Commission while deliberating the means to improve the agricultural statistics of the country, recommended that crop area estimates be obtained on the basis of only 20% sample of villages. A study of land use statistics through integrated modeling using GIS was formulated to examine the use of remote sensing and GIS technologies in improving the agricultural statistics based on a sample of villages. The study was undertaken in the district Lalitpur in UP as this district has considerable area under most of the land use classification categories. Quality of revenue records was quite reliable. The land use statistics obtained through remote sensing were restricted to 5 classes, which could be identified using single date digital data. The land use statistics obtained through remote sensing were used as auxiliary information in spatial and non spatial models to predict the land use statistics of the (non sampled) remaining villages of the district. The results of the study showed that (i) the data quality of the records enumerated by *patwaris* were quite satisfactory, (ii) the prediction of area under different land use categories based on satellite data using spatial models was satisfactory, and (iii) the spatial models were found quite satisfactory at the village level. Hence, the land use statistics at small area levels like village panchayat/ blocks/tehsils can be easily developed using only sample of villages as recommended by the National Statistical Commission.

In a study on planning, designing and analysis of experiments relating to AICRP on Soil Test Crop Response (STCR) correlations, all the experiments were analyzed. In almost all the cases the response surface methodology produced the stationary point as saddle points i.e. neither maxima nor minima. In such cases exploration of the response surface in vicinity of stationary point was attempted. The optimal values of fertilizer nutrients N, P and K obtained by response surface methodology, was closely related to that obtained by targeted yield approach adopted by the STCR project. Thus one could advocate the adoption of the Targeted yield approach as was tested by sound statistical system of response surface methodology. The use of various regression diagnostics, which could be

- An agroforestry suitability index map depicting potential agroforestry areas developed
- Spatial models developed to generate land use statistics using remote sensing and GIS technologies
- Adoption of targeted yield approach was advocated
- *Agricultural Research Data Book 2003* was released

used in these experiments, was carried out for detection of outliers and the subsequent remedial measures were discussed in the report. The design of experiments division of IASRI was approached by the AICRP on Soil Test Crop Response, IISS, Bhopal, to propose a design, which includes the contribution of organics and bio-fertilizers along with inorganic fertilizers to study the relationship between yield of crop and added soil fertilizers for developing optimal and balanced fertilization recommendation to farmers. Subsequently a new design was proposed by the IASRI in which all the requirements could be met with a provision of incorporation of organic fertilizer. The QRT for STCR project has recommended this design and has expressed: "the design and the corresponding procedure to process the data may be discussed in the next workshop and adopted for future experimentation".

Software and Information System Development

The Institute has developed a Statistical Package for Factorial Experiments (SPFE 1.0). This software essentially generates the randomized layout of the designs, with or without confounding, for symmetrical and asymmetrical factorial experiments. The users have to define the set of independent interactions to be confounded for the generation of the design. Different sets of interactions and different number of independent interactions may be confounded in different replications. The package is also capable of generating regular fractional factorial plans for symmetrical factorial experiments. It also gives the analysis of the data generated from these designed experiments. For the analysis, the treatment combinations are written in lexicographic order and then renumbered from 1 to N, where N is the total number of treatment combinations in the experiment. The data generated are analyzed as per the usual procedure of designs for single factor experiments. Contrast analysis is then carried out to obtain the sum of squares of main effects and interactions. A null hypothesis on any other contrast of interest can also be tested. This package is also useful for teaching the subject of factorial experiments to the post-graduate students in the class. This can also be useful for the researchers in Statistics with interest in experimental designs particularly in factorial experiments. This package is user – friendly, interactive, Password protected, completely Menu-Driven and can also be operated using the TOOLBARS of SPFE. Complete Help with Index, Contents and Search facility is available. The package runs on WINDOWS Platform.

The following information systems were also developed.

- Integrated National Agricultural Resources Information System (INARIS) under NATP Project
- National Information System on Agricultural Education (On-line Version)
- Institutionalization of Research Priority Setting, Monitoring and Evaluation and Networking of Social Scientists (Sub-project under NATP, O & M)

(i) Project Information and Management System (PIMS) –standalone version and (ii) Project Information and Management System (PIMS) Internet version PIMSNET were developed and implemented.

❑

Agricultural Research Data Book 2003

Agricultural research is a vital input for planned growth and sustainable development of agriculture in the country. The Council being an apex scientific organization at national level, plays a crucial role in promoting the accelerated use of science and technology programme relating to agricultural research and education. It also provides assistance and support in demonstrating the use of new technologies in agriculture.

The *Agricultural Research Data Book 2003,* which is seventh in the series comprises 211 tables, and eleven sections namely, Natural Resources, Environment, Agricultural Inputs, Fisheries, Horticulture, Production and Productivity, Produce Management, Export & Import, Indian Position in World Agriculture, Investment in Agricultural Research & Education and Human Resources under National Agricultural Research System (NARS). It also contains at the end, list of important National and International Institutions associated with agricultural research and education along with their addresses and contact points. The Data Book was compiled through the joint efforts of the Indian Agricultural Statistics Research Institute (IASRI) and the Computer Centre of the Indian Council of Agricultural Research.

Training Activities

The Institute organised 26 training programmes/courses for 361 participants comprising officials of SAUs, ICAR Institutes and others, which includes 19 training programmes under Revolving Fund Scheme (RFS), 1 programme under Centre of Advanced Studies (CAS) and a short course on 'Small area estimation techniques in agriculture'.

Technology Assessment, Refinement and Transfer

The activities of Division of Agricultural Extension include technology assessment, refinement, and transfer, aiming to bridge the gap between the technology developed at research stations and its adoption at field level. Major projects of the Division are Krishi Vigyan Kendra (KVK), Trainers Training Centre (TTC), Technology Assessment and Refinement through Institution-Village Linkage Programme (IVLP), and Agricultural Technology Information Centre (ATIC). The council have established one National Research Centre for Women in Agriculture (NRCWA) at Bhubaneshwar (Orissa). At present, there are 329 KVKs including 53 Zonal Agricultural Research Stations (ZARSs) strengthened to take up the additional functions of KVKs, 10 TTCs, 70 IVLP Centres, and 44 ATICs in State Agricultural Universities, ICAR Institutes, NGOs and other institutions under frontline extension programmes of the council.

- KVKs organized 19,880 training courses for farmers, 6,073 vocational and skill-oriented training courses for rural youth, and 2,591 training programmes for in-service personnel; also organized 18,355 extension activities to accelerate dissemination of technologies
- Frontline demonstrations resulted in yield increase in oilseeds, pulses, cereals, horticultural and commercial crops
- KVKs identified 333 technologies for on-farm testing to evaluate and assess its impact on specific locations
- Zero-tillage sowing of wheat decreased the population density of *Phalaris minor*
- TTTs organized 216 training courses, benefiting 4,140 participants
- Under Mission Mode Project 3 publications, viz., *Inventory of ITK in Agriculture – Document 1*, *Inventory of ITK in Agriculture — Documents 2* and *Supplement 1 of Document 2*, brought out

Krishi Vigyan Kendras

The activities of KVK include skill training of farmers; on-farm testing; in-service training of extension

Training courses for in-service personnel

Area	No.of courses	No.of beneficiaries			SC/ST		
		Male	Female	Total	Male	Female	Total
Agricultural extension	274	5,311	1,527	6,838	630	205	835
Agricultural engineering	158	2,592	664	3,256	536	151	687
Agroforestry	82	1,389	151	1,540	246	35	281
Livestock production and management	216	3,523	638	4,161	753	274	1,027
Crop production	612	14,390	2,066	16,456	2,349	241	2,590
Fishery	50	869	123	992	115	85	200
Home science	320	1,578	5,713	7,291	481	1,410	1,891
Horticulture	346	5,727	759	6,486	1,479	255	1,734
Plant protection	312	6,471	812	7,283	937	135	1,072
Soil fertility	67	1,390	114	1,504	235	39	274
*Others	154	4,334	770	5,104	1,016	275	1,291
Total	2,591	47,574	13,337	60,911	8,777	3,105	11,882

*Rural crafts, soil and water conservation, and biotechnology, etc.

Extension activities

Activities	Number	Number of beneficiaries
Field days	1,273	1,28,442
Kisan melas	320	4,08,325
Kisan gosthies	1,882	97,839
Exhibitions	478	3,10,605
Ex-trainees sammelans	131	6,527
Advisory services	12,824	85,129
Film shows	421	23,861
Diagnostic services	592	1,18,689
Clinic centre	265	3,443
Farm science clubs	142	4053
Self-help groups (SHG)	27	296
Total	18,355	11,87,209

Newsletter

75 KVKs have started publication of quarterly newsletters in local languages as well as in English and Hindi for the benefit of the farming community. These newsletters contain information on agricultural operations for the coming three months, besides useful articles on crop production, vegetable cultivation, horticulture, animal sciences, home science, agricultural engineering, etc. The newsletters also carry the schedule of training programmes of the KVK in the ensuing three months. These newsletters are widely circulated to the farmers, gram panchayats and line departments.

Vocational Training for Rural Youths: The training courses for rural youths were organized in agricultural extension, agricultural engineering, agroforestry, animal science, apiculture, crop production, fishery, home science, horticulture, agri-business, mushroom production, plant protection, rural crafts and other income generating activities. As many as 6,073 vocational and skill oriented training courses were organized for 110,000 rural youths.

Frontline demonstrations on oilseeds

Crops	No.of farmers	Area (ha)	Demonstration yield (tonnes/ha)	Local yield (tonnes/ha)	Increase (%)
Castor	422	191.00	1.683	1.226	37.26
Groundnut (*kharif*)	1,519	673.34	1.442	1.090	32.31
Groundnut (*rabi*)	1,110	419.60	1.961	1.386	41.47
Niger	580	163.60	0.407	0.250	62.80
Sesamum	1,064	372.27	0.509	0.343	48.41
Soybean	1,225	516.50	1.515	0..117	29.10
Sunflower	648	303.66	1.565	1.200	30.48
Linseed	324	110.50	0.928	0.619	50.00
Mustard	2,052	691.26	1.444	1.070	34.96
Safflower	58	29.50	0.877	0.653	34.38
Toria	284	90.00	1.010	0.627	61.13
Total	9,286	3,561.23			

personnel; and organizing frontline demonstrations to establish production potentials on farmers' fields and provide feed back.

Farmers' Training: A total of 19,880 training courses were organized benefiting 0.47 million farmers and farm women in various aspects of agricultural extension, agricultural engineering, agroforestry, livestock production and management, crop production, fisheries, home science, horticulture, plant protection, soil fertility and others.

Training Programmes for In-service Personnel: A total of 2,591 training programmes were conducted covering 60,911 participants. The training was imparted through participatory training methodologies, field visits and other interactive methods.

Extension Activities: The KVK organized 18,355 extension activities covering 1.18 million farmers and rural youths to accelerate the process of dissemination of technologies. These include field days, kisan melas, kisan gosthies, exhibitions, ex-trainees sammelans, advisory

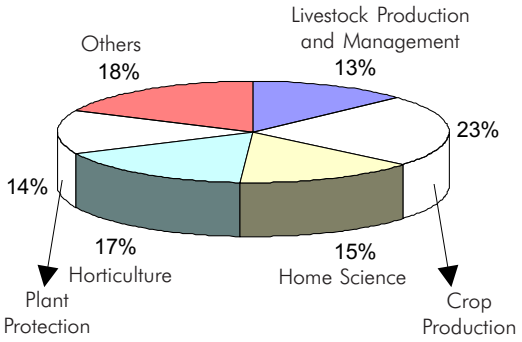
Frontline demonstrations on pulses

Crops	No.of farmers	Area (ha)	Demonstration yield (tonnes/ha)	Local yield (tonnes/ha)	Increase (%)
Blackgram	1,565	407.53	1.204	0.882	36.49
Greengram	833	356.92	1.015	0.726	39.80
Mothbean	39	22.50	0.481	0.338	42.27
Redgram (pigeonpea)	1,237	464.50	1.290	0.970	32.96
Chickpea (Bengalgram)	1,525	572.17	1.995	1.372	45.40
Lentil	778	236.10	1.683	1.113	51.18
Pea	455	106.67	1.669	1.035	61.26
Total	6,432	2,166.39			

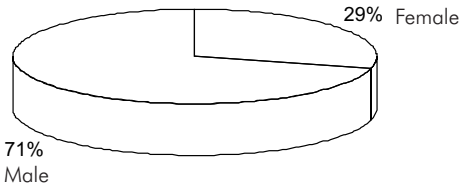
Frontline demonstrations on other crops

Crops	No.of farmers	Area (ha)	Demonstration yield (tonnes/ha)	Increase (%)	Local yield (tonnes/ha)
Jowar	115	50.80	2.333	1.420	64.26
Maize	605	222.68	3.917	.2.90	45.65
Paddy	1,381	470.85	4.707	3.535	33.15
Wheat	1,791	750.98	4.109	2.855	43.89
Pearl millet	202	76.70	1.513	1.144	32.27
Barley	109	38.40	3.432	3.044	12.77
Finger millet	15	4.00	1.162	0.801	45.07
Horticultural Crops					
Bitter gourd	10	1.00	23.500	20.300	15.76
Brinjal	110	15.79	21.093	16.886	24.91
Cabbage	79	11.36	26.695	16.267	64.11
Chillies	77	16.13	4.812	4.162	15.64
Cluster bean	41	7.75	6.619	5.102	29.72
Cucumber	56	4.50	18.944	14.311	32.38
Fennel	13	6.00	2.340	1.607	45.61
Okra	81	23.85	8.925	6.765	31.93
Onion	33	2.55	23.871	16.202	47.33
Pea	49	6.80	11.926	9.413	26.70
Potato	113	19.00	22.423	15.970	40.40
Tomato	139	15.68	32.294	23.053	40.08
Watermelon	14	4.75	31.436	23.168	35.68
Marigold	12	5.00	5.666	3.500	61.89
Turmeric	35	1.35	15.300	5.733	166.88
Commercial Crops					
Cotton	399	191.20	14.11	1.156	24.53
Sugarcane	11	4.40	45.600	39.000	16.92
Total	5,490	1,951.52			

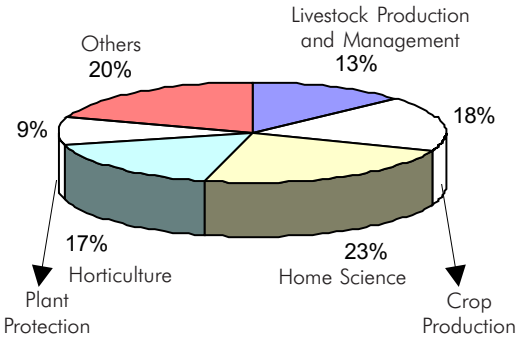
1. Distribution of training courses for farmers



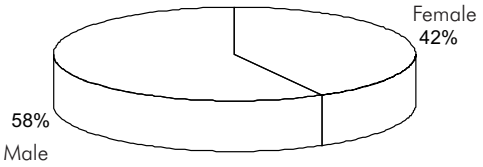
2. Participation of farmers and farm women in training programmes



3. Distribution of training courses for rural youth



4. Participation of male and female in rural youth training programmes



1. Distribution of training courses for farmers (others included are Agricultural Extension, Agricultural Engineering, Fisheries, Soil Fertility, Mushroom Production, Bee Keeping, Watershed, Rural Crafts, etc.)
2. Participation of farmers and farm women in training programmes
3. Distribution of training courses for rural youths (others included are Agricultural Extension, Agricultural Engineering, Fisheries, Apiculture, Mushroom Production, Vermi Compost, Hybrid Seed Production, Saffron Production, etc.)
4. Participation of female and male in training programmes

Summary of on-farm trials by KVKs

Crops	Varietal/feed evaluation	Nutrient/ feed management	Cropping systems	Zero tillage	Weed management	Insect/ disease management	Total
Cereals	53	44	16	8	18	10	149
Oilseeds	7	16	5	—	9	8	45
Pulses	6	10	5	1	4	9	35
Commercial crops	5	3	2	—		5	15
Vegetables, fruits and flowers	15	25	3	—	—	30	76
Animal science	4	8	—	—		4	16
Total	90	106	31	9	31	66	333

services, film shows, diagnostic services, clinic centres, farm science clubs and Self-help groups (SHG).

In addition the activities of KVKs were highlighted in 4,173 newspapers. The KVKs published 879 popular articles, 13,388 extension literature and delivered 1,792 radio and TV talks.

Frontline Demonstrations: The Frontline demonstrations (FLDs) were conducted to demonstrate the production potential of the newly released production technologies in a given farming system. The training and field days were organized for extension workers and farmers for dissemination of technologies.

FLD on greengram variety PM 9339 during *kharif* at KVK, Jalgaon, Maharashtra

A group of farmers purchasing technology products from sale counters of ATIC at BCKVV Nadia, West Bengal

Frontline demonstration on *kharif* groundnut (TAG 24) at KVK, Kolhapur, Maharashtra

Training of rural youth on cotton pest scouting at KVK, Jalna

Oilseeds: During the year, 9,286 demonstrations were conducted covering 35,61.23 ha on 10 oilseed crops including castor, groundnut (*kharif* and *rabi*) niger, sesamum, sunflower, linseed, mustard, safflower and *toria*. The percentage increase in yield varied from 29.10 in soybean to 62.80 in niger.

Pulses. During the year, 6,432 demonstrations were conducted covering 2,166.39 ha in 7 pulse crops including blackgram, greengram, mothbean, redgram, chickpea, lentil and pea. The percentage increase in yield varied from 32.96 in redgram to 61.26 in pea.

Other crops. During the year, 5,490 demonstrations were conducted covering 1,952 ha on different cereals, horticultural and commercial crops.

On-farm Trials: A total of 333 technologies were identified for on-farm testing by the KVKs to evaluate and assess its impact on location-specific basis in different farming systems including varietal/feed evaluation (111), nutrient/feed management (101), cropping systems (31), zero tillage (5), weed management(31) and insect/disease management(66).

Performance of zero-till-seed-cum-fertilizer drill (ZTD): For enhancing the productivity and sustainability of the rice-wheat system, zero tillage has been becoming popular among the farmers. The increasing cost of cultivation has made the farming business less profitable, the only way to increase profitability is by reducing the cost of cultivation. The land preparation after paddy for sowing of wheat involves substantial expenditure. In zero-tillage, wheat is directly sown without disturbing the soil, which increases yield and reduces the cost by saving fuel, water, herbicides and labour. Zero-tillage also helps in suppressing *Phalaris minor*.

Zero-tillage trials were conducted by 15 KVKs with the objective to make farmers aware of the use of zero-till-drill for sowing of wheat. The trials on zero-till-seed-cum-fertilizer drill for sowing of wheat were conducted at 1,064 farmers' fields covering an area of 1,108.0 ha during the last six years in different districts of Haryana and Punjab. The results indicated that the wheat sown by zero-tillage gave 3.5% more yield than conventional method of sowing.

Economics of zero-tillage sowing of wheat at Patiala

Operation	No. of operations		Total amount (Rs)	
	ZTD	C	ZTD	C
Harrow @ Rs 375 each per ha	-	2	-	750
Cultivator @ Rs 375 each per ha	-	2	-	750
Suhaga @ Rs 100 each per ha	-	4	-	400
Wheat drilling @ Rs 625 per ha in ZTD and Rs 375 per ha in conventional method	1	1	625	375
Total	1	9	625	2,275

ZTD, zero-till-seed-cum-fertilizer drill; C, conventional method

Saving in land preparation and sowing operation Nawanshahar

Operation	No. of operations		Total amount (Rs)	
	ZTD	C	ZTD	C
Harrowing @ Rs. 525/ha	-	-	2	1050
Ploughing @ Rs 375/ha	-	-	2	750
Planking @ Rs 250/ha	-	-	2	500
Sowing @ Rs 375/ha	1	375	1	375
Total	1	375	7	2675

ZTD, zero-till-seed-cum-fertilizer drill; C, conventional method

Reduced weed population. *Phalaris minor* is an important weed of wheat crop. At 7 different locations, zero-tillage sowing of wheat resulted in 30% less population density of *Phalaris minor* than the conventional tillage.

Economics of zero-till-seed-cum-fertilizer drill sown wheat. The survey conducted by the KVKs at Hoshiarpur, Nawanshahar, Patiala, and Gurdaspur(Punjab), Kaithal, Sonipat and Panipat (Haryana) indicate that the reduction in cost by zero-tillage machine on tillage operations varied from Rs 1,650 to Rs 2,300/ha. The KVK at Patiala and Nawanshahar (Punjab) worked out the cost

Low-cost light traps in brinjal

of tillage operations. Under heavy soils, if the last irrigation to Basmati is applied about one week before its harvest during the month of early November, the wheat crop can be sown with zero-till drill even without applying pre-sowing irrigation, resulting in reduction of the cost of pre-sowing irrigation.

Integrated nutrient management (INM) in transplanted cotton: The trial was carried out in the Instructional Farm of Ramkrishna Ashram Krishi Vigyan Kendra, Nimpith, South-24 Parganas district of West Bengal under rainfed situations of Sundarbans during *rabi*-summer season of 2002 and 2003. The growth and yield of cotton significantly varied with the system of manuring. The plant height and yield attributes were significantly higher when 25% N was supplied through vermicompost along with 75% N from chemical fertilizer. The yield of seed cotton was 1.285 and 1.330 tonnes/ha in 2002 and 2003 respectively. The pooled increase in yield of seed cotton was 18.9% higher than that of 100% N as chemical fertilizer. Application of 50% N as Vermicompost + Azotobacter in combination with 50% N through chemical fertilizer produced the same yield (1.099 tonnes/ha) as for 100% N as chemical.

Net monetary return was maximum (Rs 8,670/ha) from 25% N through vermicompost along with 75% N through chemical fertilizer with the cost benefit ratio of 1: 1.49 followed by 25% N from FYM and 75% of nitrogen from chemical sources 1: 1.42.

Performance of raya: On-farm trials were conducted on three varieties of raya,viz. RH 30, Laxmi and RH 8701, in Sirsa district of Haryana during *rabi* 2002-03. Variety RH 30 performed better (1.56 tonnes/ha) than the other varieties. Laxmi and RH 8701 gave almost the equal yield (1.47 and 1.48 tonnes/ha) respectively.

Performance of gobhi sarson in Himachal Pradesh: On-farm trials were conducted on promising varieties of *gobhi sarson*, viz. GLS4 3A, ONK 1, JTC, Sheetal and Neelam, by KVK, Una during 2002-03. The results revealed that variety Sheetal and Neelam performed well in Una district over other varieties. The varieties GLS 4 3A, ONK 1 and JTC produced almost equal yield of about 0.80 tonnes/ha.

Effect of INM on growth and yield of cotton during 2002-03

Treatments	Plant height (cm)	No of branches per plant	No of bolls per plant	Wt of seed cotton per boll (g)	Seed cotton yield (tonnes/ha)		
					2002	2003	Pooled
Control (without nitrogen)	73.4	13.3	6.41	2.50	0.526	0.610	0.568
100% N	85.5	19.7	9.26	3.37	1.034	1.165	1.099
75% N + 25% N (FYM)	83.9	18.5	8.96	3.32	0.824	1.267	1.045
75% N + 25% N (Vermicompost)	88.2	21.8	11.33	3.65	1.285	1.330	1.307
50% N + 25% (FYM) + 25% N (*Azotobacter*)	79.5	15.2	8.19	3.00	0.759	1.050	0.904
50% N + 25% N (Vermicompost) + 25% N (*Azotobacter*)	81.1	16.9	9.29	3.37	1.048	1.151	1.099

Effect of INM on economics of transplanted cotton during 2002 and 2003

Treatments	Seed cotton yield (tonnes/ha)	Stalk yield (tonnes/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Cost: Benefit ratio
Control (without nitrogen)	5.68	0.40	12,775	11,520	(-)1,255	1: 0.90
100% N	10.99	0,50	15,755	22,180	6,425	1: 1.40
75% N + 25% N (FYM)	10.45	0.55	15,960	21,120	5,160	1: 1.42
75% N + 25% N (Vermicompost)	13.07	0.60	17,710	26,380	8,670	1: 1.49
50% N + 25% N (FYM) + 25% N (*Azotobacter*)	9.04	0.45	15,465	18,260	2,795	1: 1.18
50% N + 25% N Vermicompost) + 25% N (*Azotobacter*)	10.99	0.48	16,965	22,172	5,207	1: 1.30

- KVKs produced 8,301.5 tonnes of seeds of cereals, oilseeds, pulses, vegetables and other crops, in addition to 2.071 millions of saplings/seedlings of fruits, vegetables, spices, forest species, ornamental, other plantation crops and medicinal plants. Besides, 5,775 livestock strains also produced for the farmers
- KVKs (75) started publications of quarterly newsletters in local languages as well as in English and Hindi
- ATICs provided 10,26.7 tonnes seeds of improved varieties, 0.70 million nursery plants of vegetables and fruits crops, 0.12 million packets of bio-fertilizers and bio-pesticides. Other activities included soil and water testing of 16,040 samples; diagnosis of 11,437 specimens of diseased crop plants, and treatment of 64, 120 animals

Performance of different varieties of *gobhi sarson* at Una district of Himachal Pradesh

Variety	Yield (tonnes/ha)
GLS4 3A	0.792
ONK 1	0.818
JTC	0.826
Sheetal	1.000
Neelam	0.908

Performance of barseem in Punjab: The trials were conducted during *rabi* season to evaluate the performance of two cultivars of berseem at Ferozepur and Bathinda districts of Punjab BL 42 berseem produced 5% more fodder yield than BL 10.

Varietal performance of barseem cultivars in Ferozepur and Bathinda district of Punjab

Variety	Fodder yield (tonnes/ha)		
	Ferozepur	Bathinda	Mean
BL -42	89.50	44.00	66.75
BL 10	88.20	38.40	63.30

Performance of rice varieties in sodic soils of Uttar Pradesh: Out of three improved varieties of rice (Narendra Usar 2, Sarju 52 and CSR 10), Narendra Usar 2 proved to be the best one in district Raibareli, as it recorded highest grain yield of 4.150 tonnes/ha and net return of (Rs 12,025/ha), followed by Sarju 52 (3.860 tonnes/ha) and CSR 10 (3.625 tonnes/ha), compared with the yield of conventional variety MTU 7029 (3.20 tonnes/ha).

The farmers opined that Narendra Usar 2 has better compatibility than Sarju 52 and CSR 10 and their own choice variety MTU 7029 in their existing rice-wheat cropping system.

Trimming of Basmati: A trial was conducted on trimming of Basmati rice (cv Basmati 386) with two levels, viz. trimming at 45 days after transplanting and control in Ferozepur district. The data indicate that the trimming of paddy at 45 days after transplanting gave 0.47 tonnes/ha more grain yield of rice than control (2.13 tonnes/ha).

Seed/Planting Material: The KVKs produced 8,301.5 tonnes of seeds of cereals, oilseeds, pulses, vegetables and others. In addition, 2.07 million saplings/seedlings of fruits, vegetables, spices, forest species, ornamental, other plantation crops and medicinal plants were produced. Besides, 5,775 livestock strains were also produced for availability to the farmers.

Monitoring Mechanism: The Project is monitored through 8 Zonal Co-ordinating Units, located at Ludhiana (Zone 1), Calcutta (Zone II), Shillong (Zone III), Kanpur (Zone IV), Hyderabad (Zone V), Jodhpur (Zone VI), Jabalpur (Zone VII), and Bangalore (Zone VIII). The Zonal Units monitor the frontline extension programmes by organizing Zonal-and State-level Workshop, Scientific Advisory Committee Meeting and Visits. During the year, 8 Zonal Workshops were organized with the participation of the Incharges of all the KVKs to review the work done during the year and formulation of action plan for the next year. Similarly, 16 State-level Workshops were organized in order to review the frontline demonstrations on oilseed and pulses. To upgrade the knowledge and skills of KVK staff, 14 workshops were organized under HRD programme.

Trainers" training centres

There are ten Trainers' Training Centres established by

Yield performance of rice varieties in sodic soil of Raibareli district of Uttar Pradesh

Practices	Yield (tonnes/ha)	Increase in yield (%)	Net return (Rs/ha)	Cost.: Benefit Ratio
Farmer Practice MTU-7029	3.200	—	7,710	1: 1.0
Narendra Usar-2	4.150	29.70	12,025	1: 1.65
Sarju-52	3.860	20.62	10,275	1: 1.50
CSR-10	3.625	13.28	9,325	1: 1.30

Production of seeds by the KVKs during 2003

Crops	Quantity (tonnes)
Cereals	6697.458
Oilseeds	298.194
Pulses	264.271
Vegetables	78.627
Others	962.993
Total	8301.543

Production of planting materials by the KVKs during 2003

Categories	Saplings and seedlings
Fruits	3,64,262
Fodder crops	2,785
Vegetables	7,72,526
Spices	7,02,258
Forest species	1,52,813
Ornamental	31,045
Plantation crops	37,518
Medicinal plants	7,400
Total	20,70,607

Nursery plants for sale at ATIC-TANUVAS

On-farm trial on efficacy of improved sickle for paddy harvesting at CTCRI, Trivandrum, Kerala

the Council in frontier areas of technology for providing in-service training to the KVK scientists, extension officers of line departments, university teachers and entrepreneurs. During the year, 216 training courses were organized benefiting 4,140 participants.

Mission mode project under NATP

Collection, Documentation and Validation of Indigenous Technical Knowledge (ITK): The mission of the project was to collect, document and validate indigenous knowledge-based practices in agriculture and

Zone-wise varieties/hybrids demonstrated

Zone/State	Varieties	Hybrids
Punjab, Haryana,	LD 327,LD 694, F 1378,LH 556,LH 1861,HS 6, HD 123	PH 54, Dhawal 2, White Gold, Ankur 651, LHH 144
West Bengal	LRA 5156	—
Meghalya	Comilla Cotton	—
Uttar Pradesh	RG 8, F 846	—
Andhra Pradesh, Maharashtra	Turab, AKA 7, CNH 120	PK HY 4, PK HY 5, PHH 316, NH 545, Banni 145, Ankur 651, Narsima, NHH 44
Gujarat, Rajasthan	RS 810, RS 2013, F 846, LH 1556, RS 875, BN	H-10, HY 8
Madhya Pradesh, Orissa	Sarvotham, JK 4, Tapti	HY 8, DCH 32, Banni, Savitha
Tamil Nadu, Karnataka	DLSA 17, Sahna	DHH 11, NHH 44, DHH 543, BT, DCH 32, DHB 105, RACH 1049, RAHS 14, Surbhi

Integrated Piggery Development

Under the centrally sponsored scheme on Assistance to States for Integrated Piggery Development, the programme has been undertaken in 10 KVKs with the financial support of Department of Animal Husbandry and Dairying. All the 10 KVKs have completed their construction work and created other infrastructure facilities. The KVK at Ambala and Rewari districts of Haryana have been imparting 15 days training programme in pig farming production and management. The KVKs also provided technical support to the ex-trainees. The KVK in Bankura district of West Bengal has selected 14 beneficiaries from scheduled tribe with an aim to upgrade the local stock of pig population. Training programmes (9) were conducted by the KVK, Allahabad covering 164 farmers, and 21 farmers have started their piggery units. All the KVKs are providing technical information to the farmers for economic management of the pig alongwith clinical and vaccination services.

allied activities in different agro-climate zones of India. The objectives of the projects were to catalogue and characterize the information for developing database, level of use of various ITKs by the farmers in the management of their systems, validate ITKs through quick-screening and by formal experimentation method, wherever needed, and to evolve a mechanism to protect peoples property rights and facilitate the process of sharing of benefit of the farming community. The expected outcome of the project was to develop methodology for collection of information on ITK, information on ITK in agriculture and land-based activities in publications, accessible computer-based classified information, quantified efficacy of selected ITK-based practices, and deliberate the issues related to intellectual property rights.

From the inception of the project 4,033 ITKs have been documented and three publications have been brought out in the form of *Inventory of ITK in Agriculture – Document 1*(1,473), *Inventory of ITK in Agriculture – Document 2* (1,998), and *Inventory of ITK in Agriculture – Supplement 1 of Document 2* (562). The theme-wise number of ITKs documented are indicated.

During the investigation, the issues related to intellectual property rights of the ITKs have been addressed. The practices based on indigenous knowledge have been documented and printed as books. The books are being placed in public domain (Libraries of SAUs, ICAR institutes and International institutes). Geographical indicators of the trees/plants which are in use in ITKs have been documented in the publications. The location of use of the ITKs have been mentioned in the documents and the names and addresses of the disclosers have been given in the documents.

Setting up of Renewable Energy Parks

The Ministry of Non-Conventional Energy Sources (MNES) under Special Area Demonstration Programme has provided financial support for setting up of Renewable Energy Parks at 10 KVKs. Various solar devices were provided under the project including Improved chulha, PV street light, PV domestic light, PV lanterns, water heating system, cookers, solar still, family size bio-gas plant, radio, colour TV, PV pump, wind pump, crop drier, biomass gastifier, educational kit and sprayers. KVK, Satna demonstrated about the utility and use of solar energy devices to 246 farmers, 110 farm women and 65 rural youths.

Validation and Promotion of IPM Technology in Selected Crops in Different Agro-ecological Regions: Groundnut. At KVK Dausa, Gujarat, the adoption of the Integrated Pest Management (IPM) modules on groundnut resulted in increase of pod yield and net return per hectare compared with non-IPM village. In the IPM village, Mohanpura, the net return per hectare varied from Rs 8,229 to 8,617 compared with Rs 6,111 in non-IPM village of Jeetpura. Out of total 1,980 whitegrub host trees, one host tree with a radius of 15 m was selected and thus a total of 415 trees were selected. Nearly 80% of beetles were attracted and killed on pheromone loaded white grub host trees. The beetle control greatly reduced the grub population in IPM area. One deep ploughing of the fallow fields in the month of August reduced the grub by 20% in IPM village. To facilitate the process of transfer of technology 400 farmers were trained and 119 participated in field day.

Chickpea. The IPM demonstration on chickpea was taken up by the KVK, Kota, Rajasthan. The average number of nodules, root length and shoot length increased by 60.93, 54.74 and 20.16%, respectively, over non-IPM farmers. The per cent of abundance of bird species were recorded. The per cent increase in number of pods and per cent decrease in damaged pod were 17.99 and 6.45 respectively. The reduction of *Heliothes armigera* by application of biopesticides was 21.32% (NSKE-5%), 18.62% (Ha-NPV 250LE) and 76.22% (Qunailphos). The overall increase in yield of chickpea was 68.91% over non-IPM farmers.

Cotton. At KVK Bhatinda, Punjab, the IPM farmers applied on an average 9.11 sprays (8-12) in comparison to 14.34 (13-17) sprays applied by non-IPM farmers in cotton. The IPM farmers spent Rs 4,710/ha on sprays as compared to Rs 7,393/ha by the non-IPM farmers. The IPM farmers obtained on an average 1.609 tonnes/ha seed cotton compared with 0.985 tonnes/ha by non-IPM farmers. The net return of IPM farmers was Rs 29,079/ha compared with Rs 13,292/ha by non-IPM farmers.

At KVK, Nanded, Maharashtra 60 farmers having an area of 50.8 ha were given demonstration on IPM on Cotton. The average seed cotton yield of IPM plots was 0.947 tonne/ha compared with 0.381 tonne/ha from non-IPM plots. Training programmes (12) were organized with the participation of 1,207 farmers. Various extension activities were performed, i.e. kisan mela, field days, farmers' meeting and film shows benefiting 623 farmers.

Other activities included, radio/TV talks, publication of popular articles and newspaper coverages and publication of extension literatures undertaken.

Seed treatment for prevention of white wooly sugarcane aphids at KVK, Kolhapur

Frontline demonstration on soybean (PK 1029) at KVK

Redgram. In Gulbarga district of Karnataka, the demonstration of IPM was taken by the KVK. The pod borer incidence in IPM fields of 54.5 ha showed 0.61 eggs, 0.43 larvae and 5.76% damaged pods compared with 0.88, 0.66 and 8.11% damaged pods in non-IPM fields in Sannur village. Similar results were obtained in Farhatabad, Tad – Tognoor and Kota villages. Various extension activities were taken up which include training of 646 farmers, and 28 other extension activities with the participation of 5729 farmers.

Tomato. In Ranchi district of Jharkhand IPM demonstrations were taken up on tomato. The mean insect population/plant in IPM field was 0.30, 0.45, 0.75 and 0.30 for *Heliothis armigera*, *Spodoptera litura*, leaf minor and semi-looper, respectively, compared against 0.89, 1.12, 3.25 and 0.88 in non-IPM fields. The average yield of tomato from IPM plots was 24 tonnes/ha compared with 19.5 tonnes/ha from non-IPM plots. The farmers from the neighbouring villages attended the five days training programmes on IPM.

Apple. The demonstration on IPM technology for control of wooly aphid/root rot in apple was taken up in 293 farmers' fields by the KVK, Rohru, Himachal Pradesh.

FLD on mungari cotton at KVK Yagantipalle, Kurnool, Andhra Pradesh

Training programmes (6) were conducted benefiting 344 farmers.

- Twenty ATICs developed their own web-sites. Information about package of technologies for various crops and other related enterprises, weather information, markets and commodity prices and frequently asked question (FAQ) have been put for the benefit of farmers. Ten centres started telephone help-lines service during the year
- Undertaken technological interventions (1,671) under IVLP in different disciplines like crops (923), livestock (247), horticulture (306), forestry (12), fisheries (37), gender issues (53) and other related areas (93)
- Demonstrations (988) were conducted on 53 high-yielding and pest-tolerant varieties/ hybrids of cotton. 220 Training programmes for farmers (5,359) and 35 for extension functionaries (985) were organized besides 143 field days for participants (9,676). In addition, 142 other extension activities were undertaken

Agricultural technology information centres

Agricultural Technology Information Centres (ATICs) are functioning to provide as a single window support system for the availability of technological products, diagnostic services and technology information to the farmers and other end users. Out of total 44 centres, 28 are under State Agricultural Universities and 16 under ICAR Institutes. During the period, the following activities were undertaken by the ATICs.

- A two day National Workshop was organized to review the progress of activities of these centres.
- As many as 1,53,000 farmers and other stakeholders have visited these centres, out of which 80,240 farmers were provided with diagnostic services.
- The centres have provided 10,267 tonnes seeds of improved varieties of different crops, 0.70 million of nursery plants of vegetables and fruits crops, and 0.12 million packets of biofertilizers and biopesticides to the farmers.

Agro-ecosystem wise technological interventions implemented under IVLP

Agro-eco systems	No. of villages	No. of farmers	Number of interventions							
			Crops	Live-stock	Horti-culture	Forestry	Fish-eries	Gender issues	Others	Total
Irrigated	66	8,696	239	64	44	–	4	6	20	377
Rainfed	76	17,331	425	109	154	10	6	41	37	782
Coastal	33	7,042	87	42	75	1	26	3	26	260
Hill and Mountain	106	3,962	152	21	32	–	1	2	10	218
Arid	14	403	20	11	1	1		1	–	34
Total	295	37,434	923	247	306	12	37	53	93	1671

Demonstration of low-cost polyhouse technology for vegetable nursery raising for marginal farmers

Training of rural youth on mushroom recipes preparation at ZARS-KVK, Vambane

Frontline demonstration on turmeric at KVK, Kolhapur, Maharashtra

Training of rural youth on making of bamboo handicrafts of KVK, Calicut

- The diagnostic services provided by these centres included 16,040 samples for soil and water testing, 11,437 specimens of crop plants infested by diseases/ insects and 64,120 animals were diagnosed and treated by the veterinary clinics.
- 0.69 million copies of information material including leaflets/pamphlets/bulletins were produced and 0.54 million information materials were supplied to the farmers and other stakeholders.
- 20 centres have developed their own web-sites. Information about the package of technologies for various crops and other related enterprises, weather

information, regulated markets and commodity prices and Frequently Asked Questions (FAQ) have been put for the benefit of farmers. Ten centres have also started telephone help- line service during the last one year.

- The ATICs have generated a gross income of Rs 3.48 crores during the year for providing technology products and services.

Institution-Village Linkage Programme

Technology Assessment and Refinement through Institution — Village Linkage Programme (IVLP) was taken up at 70 centres under NATP, ensuring greater scientists and farmers linkage in a bottom-up approach. The programme was implemented in 295 villages, covering 37,434 farmers and farmwomen. A large number of technological interventions (1,671) were undertaken in different disciplines like crops (923), livestock (247), horticulture (306), forestry (12), fisheries (37), gender issues (53) and other related areas (93).

Frontline demonstration on Cotton

A total of 988 demonstrations covering an area of 464.8 ha were conducted. A total of 53 high yielding and pest tolerant varieties and hybrids were demonstrated under the programmes to show the production potentials on the farmers fields.

A total 220 training programmes covering 5,359 farmers and 35 training programes for 985 extension functionaries were organized besides 143 field days with 9,676 participatnts. In addition 142 other extension activities were undertaken viz., radio/TV talk, newspaper coverage, exhibitions, discussion, etc.

Interface at district level

To strengthen research – extension linkages, KVKs organized 344 interface meetings involving the scientists and development officials at district level.

❑

Women in Agriculture

The women is the backbone of agricultural workforce but worldwide her hard work has mostly been unpaid. She does the most tedious and back-breaking tasks in agriculture, animal husbandry and homes. The research efforts at the ICAR institutes have been tried to relieve her of the drudgery by providing time and labour saving tools. Vocational trainings are also being conducted, to impart skills to undertake different avocations. In extension activities the women is now the centre point and activities are being planned keeping her in view. Her enlightenment will change the face of rural India. Several programmes started at the National Centre for Women in Agriculture and Krishi Vigyan Kendras, are the right steps in this direction.

- Projects were initiated on nearly all aspects of role of women in agriculture
  - Development and testing of extension methods for farm women in Eastern India
  - Standardization of women specific field practices in rice in Orissa
  - Occupational health hazards of farm women in coastal Orrisa
  - Identification and evaluation of interactive learning modules for dissemination of homestead technologies
  - Improvement in storage practices of seeds and grains of important crops with women perspective
  - Reducing drudgery of women in agricultural operations through use of improved techniques
  - Management of coastal agro-eco system affected by super cyclone in Orrisa
  - Empowerment of women in agriculture
  - Involving women in aquaculture is a step towards ensuring economic and nutritional security
- Krishi Vigyan Kendras trained nearly 0.2 million farm women,girls and women extension workers
- Self help groups were made and took up income generating steps in home made products,dairy products, bakery products, tailoring/embroidery, goat/buffalo rearing and vermicomposting
- Innovative marketing outlets developed for Self help groups
- Five components of AICRP on Home Science moved towards empowerment of rural women.There main achievements were
  - Mobilization of self help groups and creation of learning environment
  - Strengthening empowerment process
  - Empowerment gains for women were assessed
- Cafeteria for women in agriculture was developed and offered to states to guide the development of new programmes for women in agriculture

NATIONAL RESEARCH CENTRE FOR WOMEN IN AGRICULTURE (NRCWA)

The National Research Centre for Women in Agriculture (NRCWA) has been functioning at Bhubaneshwar, Orissa, for developing methodologies, for identification of gender implications in farming systems approach and to develop women specific technologies under different production systems.

There are 16 ongoing research projects in the areas of gender study on agriculture and household economy, management of coastal agro-eco system, extension methods for farm women, standardization of women specific field practices, occupational health hazards, reducing drudgery of women in agricultural operations, improvement of farming system suited to farm women, eco-friendly pest management technologies for vegetables among farm women, evaluation of interactive learning modules, technological needs in empowering women in rural aquaculture, and improvement in storage practices of seeds and grains.

Under project on Development and testing of extension methods for farmwomen in eastern India, the extent of participation of farm women in different farming systems and farm enterprises and the role of change agents in that context, were studied. Contrary to the situation at coastal tract the male extension agents maintained higher contacts with farmwomen than the lady extension agent. The studies under *Identification and improvement of farming systems suited to farmwomen in Eastern India* project revealed that there is intense involvement of farmwomen in vegetable cultivation necessitating to take follow up supportive activities and interventions in the area of vermicomposting, natural plant pesticides, biological control and IPM.

Under the project *Standardization of women specific field practices in rice in Orissa* data were collected from women heads of 50 farm families on participation of women in relation to varying operations in rice cultivation. Women of family contributed highest hours per season (61.66) in harvesting and post harvesting operations and participated lowest in land preperation. Same pattern was observed from the paid women and total women (family + paid labour).

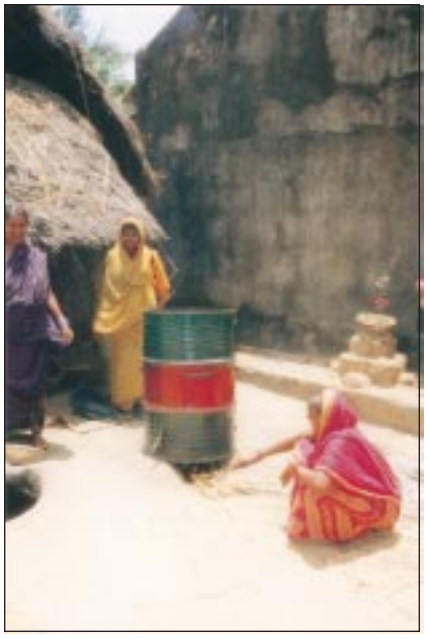
Under project on *Occupational health hazards of farm women in coastal Orissa* the health hazards faced by women in household activities, farm activities, post

Types of health hazards faced by farm women

Activities	Health hazards reported
Farm activities	
Transplanting	50%
Harvesting	26.5%
Post harvest activities	
Threshing	50%
Drying	33%
Parbolining	67%
Livestock management	
Shed cleaning	47%
Fodder collection	23%
Milching	27.5%

harvest activities and livestock management were assessed.

Under the project *Identification and evaluation of interactive learning modules for dissemination of homestead technologies* ergonomic assessment was carried out on the traditional and improved method of paddy parboiling procedures. During paddy parboiling using improved technology (paddy par boiling unit) the heart beat rate and energy expenditure were significantly reduced and the out put also increased from 35 kg per batch to 75kg per batch. The time duration of carrying out this activity also reduced from 2 days to 6 hours. Considering the significant utility of paddy parboiling unit, an interactive learning module is being developed on paddy parboiling unit, which will be useful for trainers in disseminating the technology.



Introduction of paddy parboiling unit for drudgery reduction and economic empowerment of women SHGs

The project on *Improvement in storage practices of seeds and grains of important crops with women perspective* highlighted that begunia leaf (*Vitex negundo*) treatment of mung seeds is as effective as Captan @3 g/kg of seed.

Comparision of efficacy of different ITKs for storage of greengram seeds

treatment	Parameters for testing storability of seed		
	germination 74(94) %	moisture content %	Loss in germination % than initial % after 1 storage
Seed+*begunia* leaf+ cow dung ash	82 (94)	9.6	12.76
Seed+neem leaf	74 (94)	9.7	21.27
Seed+naguria leaf	77 (94)	9.68	23.4
Control (Seeds treated with chemical)	81 (94)	9.75	13.8

Under the project on *Reducing drudgery of women in agricultural operations through use of improved equipment*, several developments were made.

(i) Design refinement in sitting type groundnut decorticator for women workers for better ergonomic performance—These refinements included increase in handle length from 32 to 37cm, increase in sitting stool height from 20 to 30 cm and change in wooden base design for easy packing and transport. The output of improved prototype was 30 kg/hr. The women workers liked the equipment as the work could be done in sitting posture and the force required for its operation was less than the standing type decorticator. This equipment has been taken up for prototype production and 55 units were fabricated and sent to various places for demonstration and use.

Groudnnut decorticator (sitting type)

(ii) Comparison of heart rate responses in three types of dibbling methods for maize i.e. traditional method, with Naveen dibbler and with rotary dibbler— The parameters used for comparison were heart rate (for evaluation of work load), increase in heart rate in beats/ m^2 of area dibbled and output in m^2/hr. The output with rotary dibbler was found highest i.e. about 9- times greater than traditional method and Naveen dibbler. The heart rate data showed no significant difference in the dibbling with traditional method and with Naveen dibbler. But the women workers liked the Naveen dibbler as the

Naveen dibbler

Rotary dibbler

workers carried out the dibbling in standing posture and discomfort due to the bending was avoided. In rotary dibbler though the output was 9-times higher, the mean working heart rate was 141.7 beats/min (ÄHR 49.7 beats/ min) thus necessitating the subject to have frequent rest pauses.

(iii) Developing equipment for dehusking and pearling of ragi (fingermillets)— The harvested ragi (fingermillet) contains thin cover of fibrous material mainly husk and bran that needs to be removed before its utilization. Presently it is done using traditional practice of pounding which is tedious and time consuming. As ragi is used in tribal areas as staple food, there is a need of a suitable manual machine for its pearling. A grain testing mill was selected to carry out preliminary investigation on ragi pearling with respect to grain moisture content, emery roller speed and residence time. The response of these parameters was studied on degree of polishing, husk and bran removal, broken grain and power consumption. The initial husk content in the grain was determined to be 3.1% (mass basis). During preliminary study trial, it was observed that with 13.2% moisture content (wet basis), the husk and bran removal increased from 3.3% to 4.7%, 3.9 to 5.6%, 4.4 to 6.6% and 4.7 to 6.6% with increase in emery roller speed from 1,150 to 1,450 rpm for the residence time of 60, 80, 100 and 120 sec, respectively. However, the broken percentage of endosperm was higher at the emery roller speed of 1,450 rpm with residence time of 120 sec.

Heart rate responses and out put of women workers for dibbling maize with three different methods

Parameters	Dibbling methods		
	Traditional method	Naveen dibbler	Rotary dibbler
Working heart rate (HR), beats/min	103.8	104.4	141.7
Increase in heart rate over rest, beats/min	15.5	17.1	49.7
Increase in heart beats/m^2 of area dibbled	7.9	7.1	2.8
Output, m^2/hr	117.2	148.1	1057.0

The project *Management of coastal agro-eco system affected by super cyclone in Orissa* was started with objectives — Nutritional status assessment of the families and intervention, intervention through development of nutritional garden in homestead areas of the families; and preparation of material for nutrition education to the farm families.

Vegetables in nutritional gardens

Under *Mission Mode NATP Empowerment of women in agriculture*, 540 farm women were grouped into 36 Self Help Groups for starting different enterprises based on the needs and preference of farm women, resources available and marketing potentiality in the area. Trainings were organized for capacity building of farm women of the SHGs in the enterprises. The members of Self Help Groups were also trained to handle different equipments. Empowerment of women Self Help Groups have been made by skill training and orientation to project management aspects. All the members of SHGs

Nursery rearing of rohu and catla

started enterprises as per their interest. The women have started generating income from enterprises.

Under the project *Involving rural women in aquaculture – A* step towards ensuring economic and nutritional security 56 backyard ponds of Puri and Khurda district were selected for fish culture and nursery raising through the active involvement of rural women. Baseline information of the participating women, water analysis of the ponds and trainings on pond preparation, nursery rearing of rohu and catla, cleaning of weeds, removal of weed fishes, manuring and lime application were undertaken. Nursery rearing of rohu and catla spawn for 1 to 1 ½ month produced healthy and quality fries.

Extension activities

The centre organized 2 trainers' training programmes for the benefit of 22 beneficiaries. Forty-nine trainings for farm women were organized through which 1,850 farm women were benefited in value addition, organic farming, nutrition and gardening. In addition one *Kisan Mela* was also organized for the 150 farm women. On this occasion exhibition, *mahila goshti* and quiz were organized. Six radio talks were also delivered by the scientists.

Krishi Vigyan Kendra (KVK)

Training: The KVKS organized 28,544 training programmes for 1.97 lakh farm women, rural girls and women extension personnel including 64,601 SC/ST beneficiaries.

Extension activities: The KVKs have organized 6,576 extension programmes including field days, *kisan melas*, exhibitions, exposure visits etc., in which 73,152 farm women participated.

Self help groups of women

Self help groups (SHG) were formed by KVK Gadag with 2,167 members from 5 blocks. It has also conducted training programmes for the members on concept of SHG and thrift besides arranging exposure visits to successful SHGs. The thrift and credit activities of the SHGs include Rs 28.50 lakh savings by the SHGs during the year and Internal lending of Rs 22.00 lakh to the members.

Self Help Groups – Viable Micro Credit Institutions in Ahmednagar, Maharashtra

The lack of knowledge resources, lack of communication, and linkages with other agencies are couses of large gaps in adoption of new technologies in crop production, dairy management, post harvest management. To provide critical skills and technologies, the KVK organized women farmers clubs.

The total amount collected by the SHGs was Rs 6.50 lakh with bank loan of Rs 2.50 lakhs with amount available for internal lending of Rs 9.00 lakh. The activities taken up by the SHGs include dairy (49), backyard poultry (13), vermicompost unit (5), tailoring unit (7), processing unit (2), goat unit (9), and other enterprises (12).

Twenty-six training programmes on various income generating activities were conducted by the KVK for 599 SHG members. Many of the SHGs were linked to the financial institutions and other government agencies (SC/ST development corporation, Zilla Panchayat etc.) for financial assistance. The total revolving fund of the groups was Rs 66.38 lakh.

The income generating activities taken up by the SHGs included home made products, backery products, small business, tailoring/embroidery, goat/buffalo rearing and vermicomposting.

Innovative marketing outlets for SHGs (Saturday and Sunday Bazars): The KVK initiated the concept of Saturday Bazar in Gadag town to encourage the SHG

Financial Linkages under Different Projects

Particulars	Zilla Panchayat	Backward Community Development Corporation	Pragatimitra (NGO)	Rural Banks	Total
No of SHGs	10	128	30	174	342
Total savings (Rs in lakh)	2.70	1.29	4.73	26.51	35.23
Bank loan (Rs in lakh)	14.03	7.20	4.51	5.45	31.19
Total revolving fund (Rs in lakh) 66.42					

Details of Enterprises in SHGs

Name of Taluka	Total SHGs	No. of members	Enterprises
Rahuri	4	50	Dairy, Goat rearing, Backyard poultry
Kopargaon	2	26	Consumer store
Shrirampur	8	127	Dairy, tailoring, backyard poultry, goat rearing
Sangmner	16	285	Gas agency, hotel, Vermicompost unit, dairy, vegetable selling, masala, noodles unit, goat rearing, bakery, general
Rahata	76	10	Flour machine, dairy, goat rearing, tailoring, backyard poultry, floriculture, processing unit
Total	106	498	

Income generating activities involved *papad* making (top) and mushroom cultivation (bottom)

Saturday and Sunday bazars–innovative marketing outlets for SHGs

Vermicomposting–An income generation activity taken up by women in SHGs

members by providing suitable market outlet. The farmers and farmwomen belonging to SHG groups only were allowed to sell the goods in Saturday bazaar after they undergo training at the KVK and the KVK home scientist verifies the quality of their products. They were also issued identity cards by the KVK. The products in the market included fresh fruits, vegetables, pickles, crisp rotis of jowar, and bajra. On an average 50 SHG members participated in the bazaar every week and the weekly transaction of the bazaar varied from Rs 15,000-20,000. Based on the consumer demand another market, Sunday Bazaar was started by the KVK at another place. Currently the KVK is performing role of a facilitator to ensure smooth running of the markets.

Women in Cyber Extension: The KVK, Ahmednagar, Maharashtra, with the support of the host organization established high-speed computer network linking its ten institutions (health, humanities, engineering, agriculture etc.,) through wireless radio frequency and the institutions located within 5km radius with a wide area network (WAN).

The Krishi Vigyan Kendra apart from having the Internet access from the Pravara Network and internal network linking all the Subject Matter Specialists (SMS)

with all the villages in the network had access to internet as well. All the SMSs of the KVK frequently build up the information repository for agriculture extension at its server, which is available for all those connected to the wireless LAN in the Pravara Network.

The local website in the wide area network provides textual information on 17 important fruits, 16 vegetables, 6 flowers, 5 improved technologies, 6 soil related problems, one IPM, 16 field crops and one on processing. Apart from this the KVK has also prepared visual material accessible for the farmers that comprises 14-multi media presentation and one audio presentation called Tomato Extension and Training Information System. The information that is required by the farmers has been compiled specifically in Marathi for the farmers to facilitate easy understanding of the improved crop cultivation practices related to various crops grown by them. In all 646 women farmers from 4 villages availed the facilities of IT Centres for information which include 246 for technology, 98 for market information, 33 for weather and 269 for other information.

Production of vermiculture by women farmers: The Andhra Pradesh Mahila Samatha Society, Karimnagar and Adilabad district has started their Samatha Dharani Programme, which is a joint farming programme of food crops by the SC, ST and weaker section women. The programme envisages production of food crops through safe methods of agriculture. Earthworms (4 kg) of mixed culture were supplied to these women beneficiaries and established units at Godishala, Husnabad, Potharam and Bejjanki; 100 women started the project and produced 128 tonnes of vermicompost.

Mango nursery—A viable alternative for income generation for women: After assessing the constraints and opportunities prevailing in the villages, the KVK, Mahaboobnagar, organized women groups in 5 mandals for raising mango nursery in the villages as a means of income generation. Prior to the initiation of the activity, the sangham members were trained intensively on different steps of nursery raising for 20 days followed by a specialized skill training on grafting technique for 15 days.

The proper marketing of the mangoes in the intra-village selling and other markets have given them profit on their investments. The profits realized were shared among the members of the group and part of the total earnings was pooled up to start nursery in subsequent years. The cost-benefit analysis of three villages to have a proper knowledge of the mango nursery activity was compiled.

Cost Benefit Analysis of Nursery Production

Particulars	Villages		
	Kistagiri	Rajapeta	Kamblapur
No. of women	40	55	45
Year of training	1995-96	1995-96	1996-97
Year initiated	1995	1995	1996
Seedlings bagged (No.)	5,000	7,500	10,000
Successful seedlings (No.)	4,500	5,500	7,000
Expenditure (Rs)	20,000	26,000	32,000
Successful grafts made (No.)	3000	3,500	5,000
Sales (Rs)	45,000	52,500	75,000
Net income (Rs)	25,000	36,500	48,000

Impact of training on farm women

The KVK, Mahboobnagar, Andhra Pradesh, conducted various training programmes for farm women of which some of the important programmes are as follows.

Dairy development: The KVK, Baramati, Pune, Maharashtra, identified 9 villages mainly rainfed villages where dairy farming was the main source of income generation for the poor farmers and where the resources were extremely poor. The KVK made collaborative efforts with the local Cooperative Milk Union and the local processing unit so as to train women.

The KVK monitored 40 dairy units, the average milk yield increased from 380 to 610 litres per dairy with a net increase in profit of Rs 3,200.00 to Rs 5,800.00 per unit per annum.

Impact of Training on Farm Women

Name of the activity	Impact
Non pesticidal management	*Heliothis* pest control on pigeonpea and chickpea with botanical pesticides is in use in 300 farms owned by women sangha.
Vermiculture	559 Vermiculture units have been established in 49 villages with production of 279 tonnes
Wasteland development	Women sanghams have developed over 1,000 acres of common land in and around their villages by raising neighbourhood forests in 28 villages. They have now owned tree pattas
Herbal medicines	Village level medicinal garden were established in 28 villages

Involvement of women has revolutionized the dairy industry of the area

Women were trained on first aid and artificial insemination in cows so that they could work as para-veterinarians in villages. Many of the participants started practicing as para-veterinarians in their villages and achieved self-reliance. They also solved the problem of non-availability of veterinary services in remote villages, and successfully managed the dairy. They diagnosed the common ailments and carried out treatments. Many of them are able to carry out insemination in cattle. They managed the fodder in a better way and even started cultivating fodder crops and have made their own well knit milk union. This has revolutionized the dairy industry of the area.

Identification of topics for training

Training	No. of programmes	No. of participants
Prevention of diseases in dairy animals	15	629
Non conventional feeds for milking animals	9	403
Reproductive health management	16	635
Clean milk production	8	343
Record keeping in dairy	8	357
Total	56	2367

AICRP ON HOME SCIENCE FOR WOMEN'S EMPOWERMENT

An important component of empowerment in Third World Countries comprises rural women who play multiple crucial roles in all spheres of development activities. In the recent past added emphasis has been laid on acknowledging and preparing database on multidimensional role sets of women where their roles have become an inbuilt factor for input–output system of empowerment. In this process, the All India Coordinated Research Project (AICRP) on Home Science aims at developing resource base of rural women for empowering them to become subsistence-generating units for sustaining development and improving quality of life.

Moving towards women's empowerment

At the initial stage of the project, the prescriptive approach was used which dealt with exploring information for providing a package of instruction regarding what rural women should do to endure health security, food security, economic security and livelihood security. Gradually the project thrust shifted towards integrated and participatory approaches for working with rural women in they're own context. For this, the nutrition component laid emphasis on nutritional security for human health in agrarian ecosystem. The component focused attention on documenting uncommon foods for its wider acceptability by determining nutritional quality of identified food sources, development of recipes and nutrition guide. The nutrition guide is user -friendly computer software for knowledge empowerment of nutrition educators and its subsequent transfer at grassroot level. The nutrition component has also strived to identify micro-nutrient deficiencies with the aim to suggest diet modifications and establish nutrition gardens as approaches to health and nutrition security.

The Human Development component which initially focused attention on data generation for developing growth norms of rural children is now empowering rural mothers for optimal development of children through interventions on scientific child care practices. The establishments of farm creche for comprehensive child care facilities in supplementary feeding and development of child through creative play materials. The training of creche workers through training materials on child care practices empowers them to be efficient caretakers.

The ergonomic management of drudgery undertaken by Family Resource Management component aims at introducing women- friendly drudgery reducing technologies related to farm, home and allied activities. The ergonomic cost is being calculated for respective tool/technology as a measure for suggesting improvements in tool/technology that will promote health empowerment.

The clothing and textile component since its inception has focussed attention on economic feasibility of use of locally available agro and animal based fibres and exploration of indigenous dyes textile product preparation. A large wealth of natural dyes has been explored for use on wool and silk and the interventions have been conducted to empower rural women and weavers with knowledge and skill. The economic empowerment is also being assured by transferring technologies of natural dyes to rural women for preparing textile handicrafts.

The database on rural women and indigenous knowledge being undertaken by Extension component has suggested several pathways for empowerment of rural women with reference to their participation and decision making roles in farming and allied activities as per indicators of qualitative data. The pathways have highlighted on empowerment of knowledge, skill, decision making; economic and social empowerment. The data base on indigenous knowledge has strongly suggested for empowering women with knowledge on locally available plant sources for ensuring health security.

Strategies used for empowerment

- Development of technology kits and media mixes for promoting knowledge and skill empowerment on various topics related to farming and household practices.
- Development of software as 'Nutriguide' based on regional foods for food and therapeutic purposes.
- Establishment of nutrition garden in rural households as cost- effective solution for micronutrient malnutrition and nutritional upliftment of rural population.
- Development of software and a compendium on natural dyes and its subsequent use in agro and animal based fibres for textile product preparation.
- Development of software and a compedium on natural dye sources for use by weavers and women entrepreneurs.
- Organizing stimulation programme in farm creche for enhancing psycho-motar, mental, social and emotional development of rural children and educational interventions to rural mothers for providing conducive home environment to children.
- Providing supplementary feeding to infants and toddlers in farm creche for healthy security.
- Conducting field trials on drudgery reducing technologies for assessing ergonomic based physiological cost and work efficiency of rural women.
- Conducting out-reach programmes through radio and television talks; publication of scientific articles in newspapers, magazines.
- Adoption of one village by each AICRP centre and using Participatory Rural Appraisal (PRA) techniques for sustainable, self reliant and people centered development that is socially just, economically efficient and ecologically sound for empowering rural women.

End result of empowerment

The five component of AICRP on Home Science have moved towards empowerment of rural women through there respective thrust of research. The end result as evident from research endeavor are as follows:

Mobilization of self help groups (SHG) and creation of learning environment: In the adopted villages the rural women have been mobilized to form SHG and opportunities have been provided to undertake

Women in agriculture

The NATP Project studies on Fisher Women in Coastal Ecosystem of Andhra Pradesh, Karnataka and Kerala was initiated to empower the fisher women technologically, to reduce their drudgery in the context of fish processing and to create an awareness on hygiene and sanitation in fish handling.

This project was envisaged for technological economic empowerment of women through training, education and participatory approach involving self help women groups. The major thrust was on health, nutritional status, economic empowerment, natural calamity management and entrepreneur development. The study covered 28 villages comprising more than 6,000 fishery families in Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

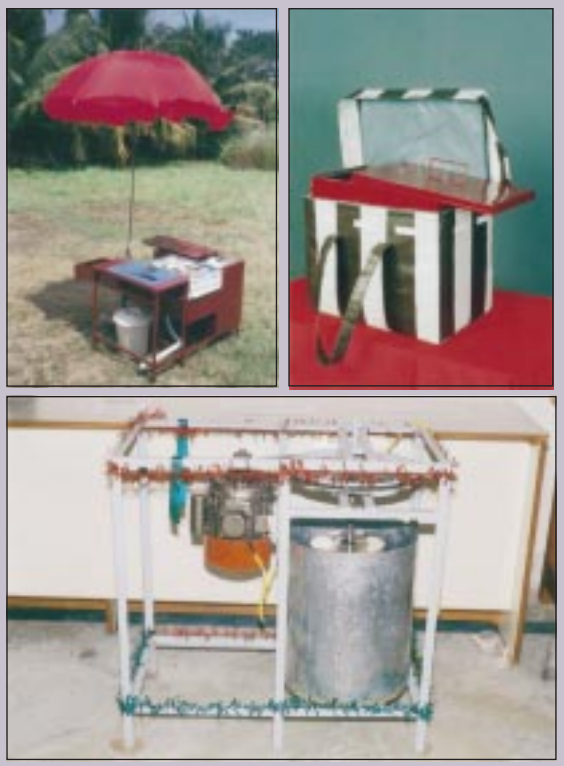
Further, low cost ice cream freezer and fresh fish vending and Display table have been fabricated under this project and the patent numbers were received. The technology has been licensed for manufacturing these two equipments for two years.

Low cost ice cream freezer

- The cost of the equipment is low (Rs 3,950)
- No technical know-how is needed
- Labour is not required as in the traditional ice cream making
- Ice cream can be prepared by a layman also
  Capacity per batch is 4.5-6 litres
- Time required per batch is 5-7 minutes

Multipurpose fresh fish vending and display table

- The cost of the equipment is Rs 5,600
- To store the leftover fish
- To cut the fish
- Also for display the fish



Fresh fish vending and display table (*top left*), Insulated fresh fish container (*top right*), Low cost ice cream freezer (*bottom*)

Cafeteria for women in agriculture

Mainstreaming gender is an important component of the Policy Framework for Agricultural extension (PFAE) developed by the Ministry of Agriculure (Government of India). The Centre developed a cafetaria for the Ministry of Agriculture for offering it to states to guide the development of new programmes for women in agriculture. New Programmes for women in agriculture should be developed based on the following key principles identified in the cafetaria.

- New programmes that are proposed should expand their definition of agriculture beyond crop production and should be based on site specific needs assessments.
- New projects that are proposed should build on groups, networks, organizational capacity and resources already in place and functioning from existing project initiatives and should take on and build on lessons from existing projects.
- Apart from extending agricultural technologies on production and post harvest to women farmers, new programmes should concentrate their efforts in providing crucial back-up services and support (backward and forward linkages) to help women groups to successfully adopt new techniques, crops and enterprises to increase their incomes and employment opportunities.
- New programmes should be planned with adequate resources for mobilizing women, forming groups, improving capacity and capability in technical, organizational and commercial (business/micro-enterprises) sectors and support systems (credit, raw material and markets).
- These should be prepared jointly in consultations with other organizations (public, private and voluntary) that can potentially complement and supplement the efforts of the state Department of Agriculture.

income generating activities and enhance knowledge on various aspects of family life. Emphasis has been also laid on increasing decision making capabilities, improving skill and thereby, the project is contributing towards women in economic, cognitive and decision making spheres.

Strengthening empowerment processes: The empowerment process through educational interventions, Transfer of technologies, the feasibility trials and the out -reach programmes has contributed to significant gain in knowledge, adoption of women-friendly technologies for improving work efficiency, acceptance of technology for economic gain and improving various parameters of quality of life are the reflections of women's environment.

Assessing empowerment gains for women: Empirical evidences have revealed that women have moved from beneficiaries to active partners in shaping empowerment. The information strategies used by different components under AICRP on Home Science have encouraged women to play key role in micro - level planning, designing community infrastructure for information dissemination and mobilization of community resources - both human and material to gain benefits from the project.

To conclude it can be acknowledged that the project is leading towards empowering rural women by broadening the trust of research of each component and expanding the horizon by including more number of Home Science Colleges in the Tenth Plan Period.

❑

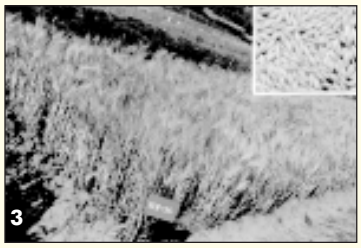
3. *Research for Tribal and Hill Regions*

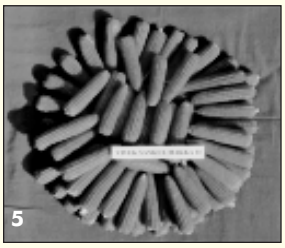
The Indian Council of Agricultural Research (ICAR) through the Vivekananda Pravatiya Krishi Anusandhan Sansthan (VPKAS), Almora, the ICAR Research Complex for North-Eastern Hills Region, Umiam, Meghalaya, the Central Agricultural Research Institute (CARI), Port Blair, and evolves technologies to meet the needs of tribal farmers in hilly areas.

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, sericulture, horticulture, animal husbandry, poultry and fisheries.

New varieties released by VPKAS, Almora

Variety	Yield (tonnes/ha)	Duration	Adaptation region/Agro-ecology
Wheat			
VL Gehun 829	2.90	Long (206-218 days)	Rainfed, low fertility and early sown conditions of Uttaranchal hills, Himachal Pradesh and Jammu and Kashmir
VL Gehun 802	2.20 (rainfed) and 4.90 (irrigated)	Medium (158-170 days)	Timely sown for rainfed and irrigated conditions of Uttaranchal hills
Barley			
VL Barley 56	2.60	Medium (160 days)	Timely sown for rainfed conditions of Uttaranchal hills
Maize			
Vivek Sankul Makka 11	5.70	Early (95-100 days)	Rainfed conditions of Uttaranchal
Pea			
VL Matar 40	1.39	Medium (143 days)	Timely sown conditions of Uttaranchal hills
Vivek Matar 9	9.56	Medium (130-140 days)	Uttaranchal hills
Toria			
VL Toria 2	0.84	Medium (150 days)	Rainfed conditions of Uttaranchal hills
Tomato			
VL Tamatar 1	22.27	Medium (60-65 days)	Uttaranchal
Okra			
VL Bhindi 1	14.46	Early (50-60 days)	Uttaranchal hills





1. VL Gehun 829 wheat released for rainfed, low fertility and early-sown conditions of Uttaranchal hills, Himachal Pradesh and Jammu and Kashmir, gives yield 2.90 tonnes/ha
2. Wheat variety VL Gehun 802, released for Uttaranchal hills, yields 2.20 and 4.90 tonnes/ha in rainfed and irrigated conditions respectively
3. Released for timely sown conditions of Uttaranchal hills, VL Barley 56 gives yield 2.60 tonnes/ha
4. A medium-duration variety VL Tamatar 1 of tomato released for Uttaranchal, gives yield 22.27 tonnes/ha
5. An early-duration maize Vivek Sankul Makka 11, released for rainfed conditions of Uttaranchal, yields 5.70 tonnes/ha
6. A medium-duration variety of toria VL Toria 2 with yield of 0.84 tonne/ha, has been released for rainfed condition of Uttaranchal hills

VIVEKANANDA PARVATIYA KRISHI ANUSANDHAN SANSTHAN, ALMORA

- Released nine varieties (wheat 2, barley 1, maize 1, pea 2, toria 1, tomato 1 and okra 1) for North-western hills One variety, each of wheat, finger millet and amaranth identified for release in North-western/Uttaranchal hills
- Eight rice genotypes identified for multiple disease tolerance
- A new strain of bacterium (*Yersinia* sp.) isolated from the infected white grub larvae
- Developed Vivek 1 Thresher-cum-Pearler for *mandua* and *madira*

Crop Improvement

Nine varieties of different crops were released for North-western hills.

In addition, three varieties, viz. VL Mandua 315 of finger millet, VL Chua 44 of amaranth and VL 832 of wheat, were identified for release in North-western hills.

Promising disease-resistant rice genotypes: Of the rice genotypes evaluated at various hot spot locations, eight genotypes of the institute exhibited multiple tolerance and showed low severity index (SI) to one or more diseases and insect pests of rice.

Promising rice genotypes with muliple tolerance

Strains	Disease/Insects
VSR 8*, VL 7045	Leaf blast, brown spot, stem-borer and leaf folder
VL 89-1190, VL 3964	Leaf blast and sheath rot
VL 4040	Leaf blast, sheath rot, stem-borer and leaf folder
VL 95-6389	Leaf blast and sheath blight
VL 90-1692	Brown spot and bacterial leaf blight
VL 3611	Brown spot, sheath blight and stem-borer

*VSR 8 possesses good quality characters and can be a potential source of multiple tolerance in the medium aromatic background.

Marker-aided breeding for quality protein maize (QPM): Three BC-MAS and one generation of selfing have been successfully completed with respect to six non-QPM × QPM crosses. The converted BC_3S_2 inbreds could be used to develop QPM hybrid combinations.

Rapid DNA isolation protocol for marker-aided breeding in maize: A rapid DNA isolation protocol suitable for PCR-MAS analysis was developed. The protocol can be worked with or without liquid nitrogen and needs only small amount of plant tissue from any of the developmental stages of the plant (young seedling to maturity). The DNA quality obtained from this protocol was satisfactory for PCR analysis. The results are reproducible and the protocol can be routinely used for PCR-based marker-assisted selection experiments in maize.

Seed Production

About 12.4 tonnes breeder seed of 37 released varieties/inbred lines (15 varieties/5 inbreds of cereals, 2 of finger millet, 5 of pulses, 3 of oilseeds and 7 of vegetables) was produced. Breeder seed (11.5 tonnes) was supplied to different seed-producing agencies for further production. About 0.85 tonne nucleus seed of 30 released varieties was also produced. Besides, around 9.1 tonnes truthfully labeled seed of 17 cereals, 8 of millets, 3 of pulses, 4 of oilseeds and 8 of vegetables was also produced.

Crop Protection

Isolation of a bacterium from diseased white grub: In order to develop suitable biological control measure for white grub, a new strain of bacterium (*Yersinia* sp.) was isolated from the infected white grub larvae and was sent for identification and preservation.

Fuscous blight in French bean: The organism *Xanthomonus campestris* pv. *phaseoli* var. *fuscans* was the causal organism for fuscous blight in beans.

Frontline Demonstration

A number of frontline demonstrations conducted involving 913 small and marginal farmers of this hilly regions have shown 24, 52, 34, 26 and 15% yield advantage with improved varieties of finger millet, amaranth, horsegram, buckwheat and barnyard millet, respectively, over their local varieties.

SUCCESS STORY

Development of Vivek 1 Thresher-cum-Pearler for *Mandua* and *Madira*

Mandua and *madira* are the important traditional crops of Uttaranchal Hills. Traditional processes of de-husking and pearling of these require pre-treatment like moistening and drying to loose the glumes of grain. Threshing of these crops is difficult, as the grains are held firmly in the glumes and require considerable pressure coupled with repetitive impact and shears, which causes drudgery to the women folk. To reduce this drudgery of hill farmers, a prototype electro mechanical thresher (Vivek Thresher) having low capacity (10 kg/hr) and light weight was designed and developed at this institute. The same was demonstrated to the hill farmers and State Department officials. Based on the feedback received from the farmers, the institute finally designed the refined version of the thresher and got it fabricated with the help of private workshop. In the first phase, of the 25 units of the thresher fabricated, 20 were sold to Uttaranchal government for large-scale demonstrations and 5 were sold to different NGOs and private farmers @ Rs 7,000/machine. The machine has been appreciated by the farmers as well as State officials of Uttaranchal government. This thresher will not only add strength to post-harvest processing of the crops but will also help in reducing drudgery of the hill farmers.

Vivek thresher 1

ICAR RESEARCH COMPLEX FOR NEH REGION, UMIAM

Horticulture

The institute has developed 10 guava hybrids. The performance of two hybrids in terms of yield and quality was better than that of the other hybrids. Hybrid 7 showed yield, total soluble solids, total sugar and ascorbic acid 28.17 kg/tree, 10.03%, 7.39% and 215.10 mg/100 g, respectively, compared with Hybrid 1 (30.93 kg/tree, 10.90%, 6.72% and 299.63 mg/100 g).

Guava hybrids developed for cultivation in mid-hills of North-Eastern Hills region. Hybrid 7 possesses white and soft flesh with greenish-yellow skin and smooth surface

SUCCESS STORY

Vegetable Production

In order to increase the cropping intensity, the institute encouraged the farmers in the adopted villages to cultivate winter vegetables, viz. tomato and capsicum. Intervention was made on an average of one ha area each under tomato and capsicum. A farmer Ms Klansis Manthoh of Mawlasni village could get a net profit of Rs 40,000/ha from tomato and Rs 35,000/ha from capsicum. This profit was an additional income during the *rabi* season. Such practices were not followed earlier. Seeing the economic benefit from this system, other farmers have now adopted similar approaches.

Preservation of Boar Semen at Ambient Temperature

To popularize artificial insemination (A.I.) in pig, a methodology for preservation of boar semen was standardized. Out of 8 semen diluents tested, BTS was found to be the best in preserving semen up to 96 hr at 18-24°C. The institute is supplying the preserved semen to pig farmers and also carrying out A.I. in pigs.

Preservation of boar semen

Pig and Rabbit Feed

Supplementation of maize-rice polish-based feeding practices by the farmer with soybean @ 25-30% could increase growth rate from 80-90 g/day to 180 g/day in pigs. Substitution of rabbit feed with soybean/rice bean fodder (60%) could maintain a growth rate of 17 g/day.

Agricultural Mechanization and Training Programmes

The institute is constantly developing efficient and easy to operate farm tools and machineries to remove drudgery. The institute took up an extensive programme to train artisans and village youths in manufacturing such tools and machineries in their specified locations, to help mass production of these tools supported by prototype-manufacturing manuals. Besides these activities, the institute developed dies and fixtures for the fabrication of wheel hand hoe, octagonal maize sheller and other improved tools.

Development of fixtures for manufacture of wheel hoe handle and wheel (*top*); batch production of wheel hoe seed drill (*middle*), demonstration of improved implement at farmer's field (*bottom*)

SUCCESS STORY

Watershed Management

In order to check huge soil erosion and water loss from shifting cultivation (bun system) areas, watershed-management approach for Shipra Watershed was undertaken, comprising 925.64 ha area under Umsning Development block in Ri-Bhoi district of Meghalaya. Data on watershed were collected through remote sensing and imagery of the watershed was made. Ground truthing or verification was done on different aspects. Based on the information so collected, six sub-watersheds were identified. A sub-watershed of 57 ha was selected in Mawpon village for integrated development as a model project. Interventions in the form of slow conversion of hill slope into terraces, cultivation of ricebean to control sun grass, congo grass on terrace riser, replacement of local cultivars with high-yielding varieties of raddish, French bean, maize, tomato, brinjal etc. were made. In the steep slope areas, horticultural crops like Khasi mandarin, Assam lemon, guava, plum etc. were planted. In the valley areas, cultivation of rice and conversion of waterlogged areas into fish ponds were adopted, where fishes like catla, rohu,mrigal, silver carp and common carp were grown @ 8,000 fingerlings/ha. The system was also integrated with pig, duck and poultry. High-yielding varieties of rice developed at the institute were grown by replacing the local ones. Gadging stations were put to monitor water flow and soil loss. The system was also supplemented by mushroom production unit.

Dugout ponds for fisheries-cum-ducks, fisheries-cum-pigs and fisheries-cum-poultry

Training programmes were organized on processing of soybean for food uses (70), preservation and processing of fruits and vegetables (20), scientific storage of foodgrains (3), manufacturing of foodgrains storage bins (2), household production and processing of honey (3), and household production of mushroom (4). Total 2,634 persons were trained under the NATP project on Household Food and Nutritional Security for Tribal, Backward and Hilly Areas.

Bamboo Shoots for Consumption

Out of 25 edible species of bamboo, 16 were found to be of commercial importance in this region. Of the 16 species, *Dandrocalamus hamiltonii* recorded the maximum productivity, contributing up to 32.70% of total consumption followed by *D. giganteus* and *D. sikkimensis*. Consumption of fermented bamboo shoots was the highest in Manipur (41.63%), followed by Nagaland (21.72%), Arunachal Pradesh (17.34%) and Meghalaya (14.74%). Young bamboo shoots showed rich content of vitamins and minerals.

Young bamboo shoots are rich source of vitamins and mineral. Edible bamboo shoots in market (*left*) and pickle for sale in market made from bamboo shoots (*right*)

Integrated Agro-aquaculture Model

The region has substantial area under marshy land which by and large is left unattended. The institute has developed Integrated Agro-aquaculture (IAA) model in such to lands utilize the same. After converting the marshy land into fish ponds for composite fish culture, the same has been integrated with pig, poultry including duck and goat besides high-value horticultural crops.

CENTRAL AGRICULTURAL RESEARCH INSTITUTE, PORT BLAIR

Field Crops

In rice, Quing Livan No.1, Nanjing 57161, Taichung Sen Yu, MTL 113 and Milyang 55 varieties were found promising (5 tonnes yield/ha) for large-scale cultivation under the humid tropics of Bay Islands. A new plant type rice IR 67964-46-1-3-2 showed the largest panicle and highest yield in *kharif*. Pokkali somaclones BTS 24, BTS 18, BTS 14-2-1 and BTS 10-5 were found promising, with yield potential of 3 tonnes/ha under saline soil.

Basmati 370 and Pusa Basmati were found to be efficient recipient varieties displaying optimum transgene expression. The protocol developed across varieties deems compatible for other *indica* varieties in developing transgenic plants with economically important genes.

- Ten guava hybrids developed for cultivation in mid-hills of NEH
- A methodology developed for preservation of boar semen
- Supplementation of pig feed with soybean increased the growth of pig and substitution of rabbit feed with soybean or rice bean fodder maintained growth of rabbit
- Dies and fixtures developed for fabrication of wheel hand hoe, octagonal maize sheller and other tools
- Young shoots of edible bamboo showed rich contents of vitamins and minerals
- Integrated Agro-Aquaculture model developed for utilizing marshy lands
- Interventions in the sub-watershed of Shipra watershed of Ri-Bhoi district of Meghalaya, proved beneficial in checking soil erosion and water loss from shifting cultivation

SUCCESS STORY

Integrated Management of Paddy Yellow Stem-borer

In Andaman and Nicobar Islands, paddy is cultivated over an area of 12,000 ha. The paddy production is constrained by yellow stem-borer, *Scirpophaga incertulas*. The pest has been found to be severe in the second season crop, causing damage 5.44 – 20.25 %. The use of pesticides is not viable, as the sprayed pesticide gets washed away due to sudden rainfall leading to water bodies.

In this context, an integrated pest management module was developed which comprises application of carbofuran 3G @ 15 kg/ha at the time of transplanting followed by six releases of *Trichogramma japonicum* (Local) @ 50,000/ha at fortnightly intervals from 45 days after transplanting. The local strain has been found to be more efficient in parasitization than mainland strain. Adoption of this technology led to 75 % and 59 % reduction in white ear heads compared to the control and conventional pesticide application respectively. This resulted in higher benefit:cost ratio of 2.17 compared to 1.83 in conventional pesticide application.

This technology has been transferred to State Bio-control Laboratory, which is multiplying and supplying to farmers during cropping season.

Fruits

Custard apple, Sel. 1 gave the highest yield (6.175 kg/tree). Kaveri passion fruit produced maximum height (3.10 m), followed by Andaman local (2.88 m). Dwarf Cavendish banana gave the highest yield followed by Red banana. Neelam and Arka Puneet mango showed the maximum canopy spread, height and girth.

Vegetables

Maximum yield was recorded in Pusa Nasdar ridge gourd, Laffa cowpea and CO 2 amaranth. Cultivation of high-value capsicum, beans, tomato was feasible and economically viable under protected cultivation. Nutritional requirement was standardized for okra and amaranth, suitable dose being 75:120 kg N:P/ha.

KS 118 tomato gave higher yield with Kinetin. However, with increasing salinity, better yield was obtained with GA_3 treatment in PP II.

SUCCESS STORY

Integrated Management of Coconut Rhinoceros Beetle

Integrated package developed at the CARI, Port Blair, was demonstrated to farmers under IVLP. It could reduce damage by 51 % showing higher benefit : cost ratio of 2.98 compared to 1.97 in conventional plant-protection measures in Andaman and Nicobar Islands. The baculovirus prevalence in local population stabilized at 62 % by 36th month of application of baculovirus. Thus, this technology is long lasting, self-perpetuating and labour-saving. This technology has been transferred to state agricultural department, which is multiplying virus for supply to farmers.

Bacterial wilt-resistant lines were found in tomato [BT 1, BT 105, BT 116-8-1 and BT 118-4-1-1 (CHDT 1)], brinjal (BB 93C, BB 64 and BB 40) and chilli (LCA 334, Pant C 3 BC 14-2, Surakta and AC 92-4). Crop rotation of *palak*–okra–*poi* gave maximum yield (78.2 tonnes/ha).

Floriculture

Red Gold gerbera gave the maximum flowers/plant/year (155) and Nilima had the maximum flower diameter (12.5 cm).

Native orchid *Eulophia andamanensis* had the maximum vase-life (49.5 days). Among the shade-loving plants, *Euphorbia epiphylloids* was the best indoor plant.

Among germplasm collection of coconut, indigenous Rangath Sweet gave the highest yield (125 nuts/palm/year) and exotic Niulekha, a dwarf cultivar, the highest copra content (245 g/nut). Elite palm arecanut G 215 was the highest yielder (1,468 nuts/palm/year).

Gliricidia was found suitable standard for black pepper cultivation in the island, as 4 years old pepper vines produced 2 kg berries on a *Gliricidia* shrub.

Natural Resource Management

The beds of 4.5 m and furrows of 6-7 m width were found suitable for BBF system. Amaranth–okra–ratoon okra was found most profitable cropping sequence for beds with higher net returns and benefit : cost ratio. Chilli–cauliflower–brinjal and chilli–cowpea–raddish sequences were also recommended for beds. In furrow, Quing Livan No.1 – ratoon was most promising cropping sequence.

Of the 11 rice varieties tested for anaerobic water seeding, 6 responded positively to water seeding at a depth of 5 cm.

Fisheries

The clown fish, *Amphiprion percula* was successfully bred in captivity. The larvae could be raised to juveniles with 90% survival. For the first time, *Amphiprion sandarocinos* could be successfully bred by giving formulated feed. Walne's medium resulted in the highest population growth of cultured microalgae in 6-9 days. Edible oysters (*Crassostrea rivularis* and *Saccostrea*

- Protocol developed in rice varieties compatible for other *indica* varieties in developing transgenic plants with economically important genes
- Promising 5 rice varieties identified for large-scale cultivation under humid tropics of Bay Islands
- Cultivation of capsicum, beans and tomato proved economically viable under protected conditions
- In tomato (4), brinjal (3) and chilli (5) lines were found resistant to bacterial wilt
- *Euphorbia epiphylloids* proved a best indoor plant
- Amaranth–okra–ratoon okra proved most profitable cropping sequence on beds

- Clown fish (*Amphiprion percula*) successfully bred in captivity
- For the first time, *A. sandarocinos* bred successfully on giving formulated feed
- Mastitis, enteritis and hump sore controlled successfully in cattle
- Management of dairy calves standardized for hot and humid climate
- Synthetic layer developed, suitable for backyard farming in Bay Islands
- Vaccine prepared for IBD
- Japanese quail reared successfully in deep litter with optimum fertility with 1:1 or 1:2 male and female in islands

SUCCESS STORY

Freshwater Fish Culture

Freshwater fish culture in the islands was challenging for the farmers during eighties, as the seed required for stocking in the ponds was to be procured from Kolkata by air. The farmers had limited knowledge in management of ponds for getting a tangible fish production. Mostly rohu (*Labeo rohita*) was cultured in the ponds and sparsely catla (*Catla catla*) for indefinite period, yielding few kilograms of fishes for occasional domestic consumption.

The first landmark achievement of the CARI was to make the islands self-sufficient in fish seed of carp (catla, rohu and mrigal) and proper demonstration of the techniques for its percolation to user level, followed by its adoption by the farmers of remote villages of South, Middle, North and Little Andamans. The technology of induced breeding of carps and seed production standardized by the CARI for Andaman environment could create an impact on the farmers for additional income generation and to meet the fish seed requirement of the locality as well as of the Andaman Islands. The availability of fish seed of the three species of carps opened the scope for freshwater aquaculture in the islands and the pond fishes which were treated as pets of farmers earlier started making their appearance in the fish market of Andamans as priced commodity.

The most important aspects of the work has been in terms of its wide acceptance not only by the farmers but also by the local development departments and defence personnel, and provided scope for self-employment.

In a nutshell, the technology of carp induced breeding and seed production has improved the freshwater fish cultures activity of the islands. Now the island environment could be kept free from the threat of introduction of fish pathogens from mainland through fish seed transport. And it also saves the cost incurred every year by the Fisheries Department for procurement of fish seed for distribution to the farmers.

cucullata) were found dominant and have culture potential in Andaman waters. Grouper catches indicated the dominance of *Plectropomus pesuliferus* and *Veriola louti*, as these were targeted owing to export value. The culture of tilapia, *Oriochromis urolepis* in brackishwater gave a production of 1 tonne/ha in six months.

Giant freshwater prawn, *Macrobrachium rosenbergii*, along with Indian major carps with a stocking density of 8,000 prawn seeds/ha gave a production of 500 kg prawn/ha in seven months. Mullet, *Liza tade* from South and Middle Andamans, showed consistent polymorphism.

Animal Science

In genetic upgradation and evaluation of indigenous cattle of Andaman, F_2 generation with 50% exotic inheritance of Holstein-Friesian and 62.5% exotic inheritance of Jersey (with local cattle) was produced after selection and culling in F_1 generation on the basis of their phenotypic performance, disease tolerance and adaptation in this climate. Mastitis, enteritis and hump sore were successfully controlled. Calf mortality was nil. Management of dairy calves was standardized under hot and humid climate.

SUCCESS STORY

Infertility Control in Bovines

Infertility, a major factor limiting the production, was as high as 70% of population at a given time mainly due to inadequate feeding in Andaman and Nicobar Islands. Mineral (mainly P) supplementation resulted in a success rate up to 85%. One village with no dairy activity earlier was converted into a dairy village with per day average supply, promoted milk co-operative to the tune of more than 300 litres.

Synthetic layer was developed, suitable for backyard farming in Bay islands. Progenies of White Nicobari × ILI 80, Black Nicobari × ILI 80 and Brown Nicobari × ILI 80 were produced. The body weight of the progeny of Black Nicobari crosses was more in the young ones than of other crosses. The feed-conversion efficiency of ILI 80 × White Nicobari was better than that of ILI 80 × Black Nicobari at young age under intensive management. The egg production was better in White Nicobari than Black Nicobari crosses.

Sera samples screened for *Salmonella pullorum*, *Mycoplasma gallisepticum*, Chicken Anemia virus, Reo virus and avian encephalomyelitis showed varied positive

SUCCESS STORY

Rural Poultry Production

The poultry production in the Andaman and Nicobar Islands was unsystematic and prices varied from Rs 90 to 130/kg and there was routine import from mainland. A technology was developed based on dual-purpose breed, broilers and Nicobari fowl and got implemented in a systematic way. Since late 1998 not a single kg meat has been imported and market prices stabilized between Rs 60 and 70/kg (retail), with variation between Rs 55 and 70/kg. This technology is very popular as self-employment venture owing to non-dependence on balance feed.

cases. Among the caprine species, 13.3% of cases were positive for *Brucella melitensis*. Out of 32 sera samples of swine, 43.75% cases were seropositive for swine fever, the maximum number of cases in the Car Nicobar Islands. ELISA and SAT screened cattle samples indicated 20.47% positive cases for *Brucella* by ELISA and 20.79% by SAT. Similarly, 23.56% cases were positive for IBR using ELISA.

Bovines (26) were found positive for TB (42.3%) and JD (46.15%). Mastitis due to streptococcal group of organisms was the main causative agent.

Vaccine against IBD was prepared. The vaccinated birds did not show any clinical symptoms during the subsequent outbreaks.

Mycotoxin in feed or food when ingested by the livestock and human being leads to reduced production, growth and immunity and also may cause mutagenic and carcinogenic effects. Chick embryos were the most susceptible followed by rabbits and ducklings, and guinea-pigs were the least susceptible. Sources rich in protein had a higher incidence of fungi infestation and thus recorded higher level of aflatoxin in the feed ingredients.

Cage and deep litter system revealed that cage-reared Japanese quail (*Coturnix coturnix japonica*) excelled deep litter-reared birds for earlier laying of eggs, early reaching the age at 50% egg production, higher egg production and significantly higher hatchability.

Blue and green lights were found better for overall production performance in Japanese quails. Garlic powder or extract @ 1% along with the diet in the bird significantly reduced plasma cholesterol.

Japanese quail could be reared successfully with optimum fertility with the male and female ratio of 1:1 or 1:2 in the hot and humid climate of the islands in deep litter. Birds with higher body weight showed decreased humoral immunity than those with lower body weight.

Social Science

Sixteen technologies in agriculture and allied fields were intervened in more than 330 farmers' fields in 8 villages in South and Middle Andaman Islands. Some of the achievements were the successful rice cultivation in saline sulphate soils, important participatory water stress management in vegetables through construction of check dam on the *nallah*, commercial cultivation of cut-flowers by the farmers and backward farming of improved Nicobari birds for higher income.

❑

4. National Agricultural Technology Project

The National Agricultural Technology Project (NATP), a World Bank-aided project, is being implemented by the ICAR and the Department of Agriculture and Co-operation (DAC) since November 1998. It has three major components, viz. Organization and Management (O&M) System, Research and Innovations in Technology Dissemination (ITD). The ICAR executes the O&M, Research and a part of ITD. The progress made during the year under different components in the NATP is presented here.

ORGANIZATION AND MANAGEMENT (O&M)

ICAR Organization and Management Reforms

- Of the 23 recommendations of the Sub-committee on Administrative Reforms, 12 have already been implemented, 7 have not been agreed to. Rest are in the process of implementation.

- Of the 23 recommendations of the Sub-committee on Administrative Reform, 12 implemented.
- Most of the reform-oriented recommendations of the National Institute of Financial Management (NIFM) on procurement system reforms agreed to.
- Major thrust put now by the Council on commercialization of technologies and revenue generation.
- The ICAR to institutionalize the PME system in its institutes.
- Developed Computer Assisted Instruction (CAI) modules on Educational Technology, Elements of Soil Science, Management of People, and Evaluation of Training.
- The NAARM developed Spatial Information System for Agricultural Production and Resources (SISAg), a user-friendly software.
- For on-line information on Indian agriculture, visit the NAARM web site *http://icar.naarm.ernet.in*.
- About 90% of the ICAR institutes and SAUs have LAN, all of them are connected to Internet and 70% of them have own websites.
- Visit the new redesigned web site of the ICAR at *www.icar.org.in*.
- *The Indian Agricultural Sciences Abstract* brought out by DIPA, released for use of the scientific community.
- Developed two joint biocontrol R&D projects on Classical biological control of *Micania micrantha* with *Puccinia spegazzinii* and Evaluation of Augmentative Biocontrol.
- Major thrust put on technological empowerment of rural women for skill development.

- Most of the reform-oriented recommendations of the National Institute of Financial Management (NIFM) on procurement system reforms were agreed to and in fact a few more reform-oriented decisions more progressive than suggested were taken.
- In addition to the implementation of the committee and consultancy reports, the Council has taken major decisions regarding O&M reforms to: explore possibility of sharing the administrative and finance officers and various facilities among the Institutes located at the same place; make package of new Agricultural Research Finance Information Systems (ARFIS) operational w.e.f. 1 April 2004; and encourage scientists to work in the North-Eastern Hill region.
- A major thrust has been put now by the Council for commercialization of technologies and revenue generation. A Task Force on Commercialization of Technologies formed at the initiative of the NATP is now in place. A Technology Commercialization Cell will be set up at the ICAR Headquarters. Technology parks will be established in selected SAUs and ICAR institutes.

Institutionalization of Research Prioritization, Monitoring and Evaluation (PME), and Networking of Social Scientists in the National Agricultural Research System

- A conceptual framework showing mechanism along with main actors of converging macro and micro priorities has been developed and proposed.
- Project Implementation and Monitoring System on NET (PIMSNET) (internet version) has been made online and is available on the web site *www.pimsnet.gen.in*.
- The ICAR has taken major decisions for institutionalizing the PME system for its institutes. Research prioritization will be pursued vigorously using PME Cell model tested under NATP at the institute level.
- Fourteen technologies of national significance were chosen by the NCAP in consultation with PIU for impact assessment. The results for these assessments indicate that farmers are realizing significant economic benefits whilst promoting sustainability of production system.
- A system for performance assessment of agricultural research organizations and accountability enhancement of Indian National Agricultural Organizations Research has been developed by the NAARM, Hyderabad.

Human Resource Development for Agricultural Research and Education Management

- Manpower demand-supply estimates for trained agricultural manpower were made for different sectors. Demand of the private sector estimated to rise.
- Computer Assisted Instruction (CAI) modules on Educational Technology, Elements of Soil Science, Management of People, and Evaluation of Training were developed and tested in field at the TNAU, and suitability revised by incorporating the feedback.
- A software *Nutriguide*, for assessing the food intake in the Indian context, was developed and demonstrated at the ANGRAU, Hyderabad, and the MAU, Parbhani.
- Spatial Information System for Agricultural Production and Resources (SISAg), is a user-friendly software developed at the NAARM, combines GIS maps with related data sets. Deployable GIS-based applications for client research organizations, which do not have the resources to invest in GIS tools, can now be developed at the NAARM.
- To meet the growing need of on-line information on Indian agriculture, the NAARM strengthened its gateway (*Agricultural Gateway to India*) to information on agri-institutions, ITK, biodiversity, gender issues, training opportunities, and so on. As there is no web site giving such information, this will bring greater visibility if the seekers of such information use NAARM website *http://icar.naarm.ernet.in*

Information System Development

- As per a survey, 90% of the ICAR Institutes and SAUs have already put LAN in place. Practically, all the institutes and SAUs (99%) are connected to Internet and 70% of them have developed their web sites. Six new SAUs have been provided funds for creation of LAN.
- The ICAR Institutes have developed various software systems, viz. (i) *Database Management Systems*: for (*a*) Genebank Management, (*b*) Identification and Management of Nematodes in India, (*c*) Poultry Disease Diagnostics and Remedy; (*d*) AGRI-IS on Animal Genetic Resources of India, (*e*) Agricultural Pest Information System, (*f*) Pulse Information System for UP, and (*g*) Potato Pests CD; (ii) *Application Software Systems*: for (*a*) Implementing the HACCP by Seafood Processing Plants, and (*b*) Identification of Eggs and Larvae of Parasites, (iii) *Expert Systems*: (*a*) Expert Systems for Grape, Cabbage, Mushroom Cultivation Expert Systems, (*b*) Cotton Insect Pest Management System, (*c*) Statistical Quality Control for Dairy Plants; and (iv) *Simulation Models*: Simulation Model RAINSIM for Rain Water Simulation.
- A new redesigned web site of the ICAR at *www.icar.org.in* has been launched with several new features. The web site includes links to Institutes and SAUs web sites. About 70% institutes and SAUs have developed their web sites, which are linked to ICAR site.
- The first issue of *The Indian Agricultural Sciences Abstracts* brought out by the DIPA released for the use of scientific community, and *The Indian Animal Sciences Abstracts* will be released shortly.
- The DIPA has revised its web-page and updated the site with database connectivity and searching facilities to Journals, Books, Ad-hoc Research Scheme database, Retired Scientists database, ICAR Telephone Directory 2003, Directory of Seminars etc.

ICAR-CABI Collaboration

- Two joint biocontrol R&D projects on Classical Biological Control of *Micania micrantha* with *Puccinia spegazzinii* and Evaluation of Augmentative Biocontrol were developed. The former project has been implemented in collaboration with the ICAR, AAU, Jorhat and Kerala Forest Research Institute, Peechi. The fungus, *Puccinia spegazzinii* has already been imported into Asia for the first time from the CABI, UK, which is being multiplied under highly controlled conditions in the Transgenic Containment Facility of the NBPGR.

Mainstreaming gender issues into NATP activities

Major thrust has been on technological empowerment of rural women for skill development and income generation. Trainings were conducted with about 3,800 participants in 155 training programmes. The maximum number of trainings planned were on post-harvest, and value-addition for mainly of fruits and vegetables and to some extent on other agricultural products. Animal husbandry and fishery have received due attention.

RESEARCH

Production System Research (PSR)

Rainfed Agro-ecosystem

- In a number of oilseed crops, moisture-conservation practices like conservation furrows, key line cultivation and soil mulching were demonstrated through a large number of on-farm trials in five states during 2003-04. Combined with Integrated Nutrient Management (INM) and best variety, these technologies resulted in 40–50%

Performance of KBSH 1 sunflower under farmers' practice (*left*) and under recommended practice of moisture conservation and fertilizer application (*right*)

additional yield over farmers' practice even during the drought year.

- In four districts (Koraput, Jagdalpur, Ambikapur and Ranchi), crop diversification in uplands by introduction of agri-horticultural system resulted in significant gains in income. After three years, income of the tribal farmers increased by 75 – 90% through the production of vegetables and fruits. The success story of Mr Pitambar Majhi of Gopalpur village in Koraput district, who could double his income from about 2 ha of rainfed upland through crop diversification, attracted the attention of the district administration in Koraput.
- In low rainfall areas of Maharashtra, Gujarat and Karnataka also the income-stabilizing potential of agri-horticulture and horti-pastural systems were demonstrated during drought years, which became models for district administration for further extension.

Rainfed ginger grown with moisture-conservation technology and tomato+turmeric in mango-based agri-horticultural system on farmers' field in Koraput district

- Promising *arboreum* varieties of cotton were identified, viz. PA 402 and PA 255 for Maharashtra, MDL 2463 for Andhra Pradesh and DLSA 17 for Karnataka. These varieties had low cost of cultivation and better adaptability to rainfed conditions. DLSA 17 has a micronaire value of 4.5 comparable to the value of 4.3 of the popular *hirsutum* variety CPD 431.Higher profits were earned by a large number of farmers who cultivated these varieties in Maharashtra and Karnataka. The fibre quality evaluation has been planned in collaboration with a leading textile exporter in the country. The quality acceptance by the Industry will result in increased adoption of and better price for *arboreum* cotton.

An *arboreum* cotton (*left*) showing superior performance to hybrid (*right*), with considerably low cost of cultivation

- Eri silk production provides income to thousands of tribal farmers in Assam and Manipur. The cocoon and shell yields of Eri silk moth were the highest when grown on the improved variety (48-1) of castor with improved management. Even with the local red castor variety, the cocoon yield could be significantly enhanced by appropriate agronomic practices. Cultivation of improved cotton variety on the hill slopes of north-east India can contribute to significantly higher eri silk production.

- Water-harvesting and drought-mitigation technologies resulted in 40-50% additional yield of oilseed crops.
- Crop diversification in tribal areas increased the income of tribal farmers by 75-90%.
- New *arboreum* cotton varieties, a new ray of hope for dryland farmers.
- Productivity of eri silk improved in North-east India by adopting improved castor for feeding.
- Post-harvest processing added value to rainfed crops especially sweet sorghum and safflower.
- The reduced and zero tillage becoming more and more popular.
- Multi-cut forage sorghum hybrid and variety with enhanced nutritional quality released.
- Cellulose-degrading rumen bacteria identified, improving the use of stovers and straws by buffaloes.
- For the first time in the world, direct sensitive micro-filter plate enzyme-immuno-assay (EIA) method developed for estimation of oxytocin, LH, GH, FSH and PGFM.
- Proper stocking of bigger size (fingerling) seed increased the productivity and production of fish reservoir by 3-4 times.
- Gayatri variety of rice proved suitable for cyclone-affected areas of Orissa.
- Backyard poultry popularized for landless and marginal farmers.
- Intercropping in oil palm during its juvenile phase proved remunerative.
- A technology developed for production of tissue-cultured pearls can manipulate colour, hue and lustre of the pearls. A process developed for manufacturing of shell-bead nucleus using indigenous materials and machinery.
- Sero-diagnostic *kit* developed for early diagnosis of basal stem rot pathogen of coconut.
- A semi-automatic mussel seeding machine developed for increasing rate of return.
- Drying due to fungal infestation of *khejri,* a life-line of arid ecosystem, could be controlled.
- About 160 antihelmintic plants catalogued.
- Skin fibroblast cell technology developed for conservations of livestock germplasm.
- A DNA repository of 5 breeds of sheep and 3 of goat established.
- Cost-effective technology developed for treatment of choes (rainy season torrents).

Introduction of castor on hill slops in Manipur

- Complete feed formulations with sunflower head have been developed which increase substantially dry-matter intake and milk yield of cows and sheep. This technology provides an opportunity to utilize an estimated one million tonne of sunflower head as cattle feed which otherwise goes waste. A technology was developed to reduce the fibre level in castor-cake and in turn increased protein content by 35 to 50% and *in-vitro* digestibility by 45-70%.
- From sweet sorghum juice, alcohol was recovered after fermentation. Bagasse was successfully used for the cogeneration of electricity (about 2,086 net calories of energy/tonne). Sixty farmers could earn a net income of Rs 2,000/0.4 ha from stalks alone in one season. Though cost of ethanol, at present produced from sweet sorghum is 56 paise/litre higher than that from molasses, the technology is beneficial for poor farmers, environment friendly and sustainable. With large-scale use of sweet sorghum for producing ethanol, the cost may come down.

Irrigated Agro-ecosystem

- Release of the high-yielding, multicut hybrid (PCH 109) and multicut variety PC 615 (SSG 601) of sorghum will boost the fodder production and provide high-quality greens even in April, May and June when other green fodders are not available for the livestock.

Breeding multi-cut sorghum hybrids and varieties with enhanced nutritional quality

- Rice–vegetable pea–wheat–mungbean crop rotation in western plain zone of Uttar Pradesh gave higher net return (Rs 64,187/ha) than rice–wheat cropping system (Rs 33,722/ha). Similarly, rice–field pea, and rice–vegetable pea–wheat and rice–potato–wheat in eastern Uttar Pradesh have been found more remunerative than continuous rice–wheat system.
- Wheat has been sown (about 0.8 million ha) with zero-tillage during 2003-04 compared with 0.05 million ha during 2000-01. This technology will add Rs 1,500 million through saving from tractor fuel and about Rs 250 million through increased yield of wheat to the total income from wheat.
- Bed planting of wheat, rice, maize and soybean has shown great promise, as it saves about 25% seed and 15-35% irrigation water depending on soil type.

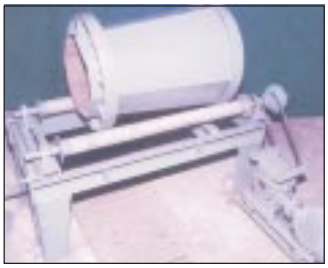
Permanent bed planting in rice–wheat production system – a new concept in crop production

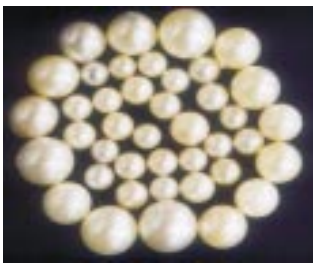
- When roots of *litchi* trees were exposed between 150 and 200 cm away from the trunk and up to a depth of 60 cm, the fruits matured six days earlier than the fruits on trees with unexposed roots. The yield also increased significantly (80 kg/tree) because of increased fruit set and retention. More than 80% *litchi* fruits were in edible condition even after 41 days of storage when the fruits were stored at 2°C after sulphitation of fruits @ 60 g S/100 kg fruits, followed by precooling at 4°C for 4 hr.
- A cellulose-degrading anaerobic bacteria B-112 isolated from the rumen of buffalo improved the degradation of cellulosic materials. Neem leaves have been found to have anti-protozoal effect in the rumen, thus, improving the nutrient utilization.
- A combination of *shatavar* (*Asparagus racemosus*), *jiwanti* (*Leptidenia reticulata*) and *bhringraj* (*Eclipta alba*) increased cellulose and NDF digestibility of a feed consisting of 75% roughage (wheat straw) and 25% concentrate mixture.
- For the first time in the world, direct sensitive micro-filter plate enzyme-immuno-assay (EIA) method has been developed for estimation of oxytocin, LH, GH, FSH and PGFM. This non-radioactive procedure has distinct advantage over the conventional radio-immuno assays (RIA).

- A baling technology of wheat and paddy straw through field baler after combine harvest has been developed. For enhancing the feed value of these bales urea treatment plant of 4-5 tonnes capacity has been fabricated. Also feed block-making machine for wheat straw mixed with molasses (20%) and urea (20%) and other nutrients have been developed.
- An intensive cage fish-culture technology has been developed. An optimum stocking density of 0.2 million/ha in reservoirs could result in higher fish production (48 tonnes/ha/year) than the fish produced in ponds and tanks (5 tonnes/ha/year).
- Autumn sugarcane intercropped with two rows of maize (cobs) or *rajmash* proved to be a highly remunerative sugarcane-based intercropping system with a net income of Rs 91,594/ha.

Coastal Agro-ecosystem

- In the cyclone-affected areas of Orissa, the rice variety Gayatri gave 200% higher yield than the traditional varieties. This variety has a non-lodging plant type and has been adopted by about 50% farmers. Another variety, Lunishree was found to have 100% higher yield than the local varieties in saline and waterlogged areas of coastal region. It was adopted by about 25% farmers in such areas.
- Hybrid maize as an intercrop in the juvenile phase of oil palm gave a high yield of 4 tonnes/ha and net returns of Rs 23,592/ha. This technology was adopted by almost 100% of the farmers working in collaboration with the National Research Centre for Oil Palm, Pedavegi.
- A technology for production of tissue-cultured pearls with chosen colour, hue and lustre of the pearls has been developed. A process of manufacturing shell bead nucleus using indigenous materials and machinery has been developed. This technology will be an import substitute.





A process developed for manufacturing shell-bead nucleus using indigenous materials

- Reduction in red weevil population (*Rhyncophorus ferugineus*) and its incidence could be achieved by mass trapping of floating populations in coconut gardens. The technology requires large-scale adoption through the involvement of trained farmers with the collaboration of voluntary agencies/state departments.
- A new IPM package has been developed for the management of coconut eriophyid mite. The National Steering Committee has recommended the package for adoption in Tamil Nadu, Kerala and Karnataka. A large number of farmers have adopted this technology.
- A sero-diagnostic kit for early detection of basal stem rot of coconut has been developed. Standardization of ELISA technique which is superior to the existing one for detection of the protein of the fungal wilt pathogen of coconut *Ganoderma,* has been done.
- A starter ration for feeding ducklings was found better than the present feeds used by the farmers. It has been adopted by the farmers of the Kuttanad area with great success. The technical know-how and the feed formula has been transferred to a firm of Kerala for large-scale production. The starter ration should have minimum of crude protein (20 %), metabolizable energy (2,750° kcal/kg), Ca (0.89 %), available P (0.45 %) and Niacin (60 mg/day). It contains mainly yellow maize, soybean meal, rice polish.
- A semi-automatic mussel seeding machine with flexible plastic strips and pre-stitched cotton tubing has been developed. It increases the rate of returns, reduces capital expenditure and labour from eight to four man-days for seeding 100 ropes.

A semi-automated mussel seeding machine using flexible plastic strips and pre-stitched cotton tubing

Arid Agro-ecosystem

- *Khejri* tree is a very important for the Arid ecosystem. Drying of *khejri* trees affected by *Acanthophorus* and *Ganoderma lucidum*, could be controlled and their growth restored by treatment with phorate @ 20 g/tree and *Trichoderma harzianum* pre-incubated in goat manure (1:40 g).
- About 160 antihelmintic plants have been catalogued. Different types of extracts were made and evaluated *in vitro* and *in vivo* for antihelmentic activity. Alcoholic extract of *Bauhinia variegata* @ 50 mg/kg reduced *Haemonchus contortus* infection by 38% on the tenth day of treatment of sheep and goats.
- To characterize and conserve pure breeds, a new and low-cost skin fibroblast cell technology has been

Vegetative measures for bund stabilization

developed for long-term cryopreservation of livestock genotypes. The protocol for study of ploidy level of skin fibroblasts has been standardized. DNA samples from skin fibroblast cells were isolated and purified for telomeric length assay for studying the phenomenon of ageing in culture.

- Microsatellite genotyping of Gaddi, Jaisalmeri and Malpura sheep and Gaddi goat have been completed. A DNA repository of the Gurej, Karnah, Malpura, Jaisalmeri and Gaddi breeds of sheep and the Sirohi, Parbatsari and Gaddi breeds of goat has been established.

Hill and Mountain Agro-ecosystem

- Area under choes (rainy-season torrents) was worked out from satellite imageries and compiled statewise. Agriculture land (27 ha) of 22 farmers has been protected as a result of construction of mechanical and vegetative spurs of 1.7 km length and considerable amount of rural employment was generated in the project.

Institution-Village Linkage Programme (IVLP) through TAR

Rainfed Agro-ecosystem

- In the rice-based production system, the rice variety, IR 36 combined with balanced nutrients gave highest grain yield and additional returns of Rs 10,910/ha in Ranchi. Line sowing in upland rice was found beneficial over broadcasting at Ranchi and Cuttack.
- Homestead farming with the Kalinga Brown variety of poultry and Barberi goat was profitable for small farmers in Cuttack.
- The variety NRC 2 and NRC 37 of soybean gave 62% and 30% higher yield, respectively, than local variety at Indore. Supplementation of mineral mixture @ 50 g/ animal in combination with grazing improved the body weight and enhanced the milk productivity 14% in cows and buffaloes at Jabalpur.
- The cotton variety PKV Rajat at Akola, and the *desi* cotton variety AKA 7 were as good as cotton hybrids in yield and profitability in Nagpur and so was the Narasimha variety in Warangal. An agri-sheep system with 10 lambs/unit of sheep and the cultivation of maize or fodder sorghum intercropped with cowpea gave additional net income of Rs 15,000/ha/unit compared to the cropping of cotton alone in Warangal.
- Conservation furrows in alternate rows of maize in Vertisols enhanced the productivity of maize by 12%. The improved variety of littlemillet TNAU 63 gave 45% higher yield than the local variety even with severe drought spells. Spraying of neem oil (2%) resulted in 20% higher yield than farmers practice in okra. The ICGS 44 variety of groundnut, PK 1042 variety of soybean, Bundel Guar 1 variety of clusterbean, CSV 15 variety of sorghum and DVR 2 variety of tomato gave 30-50% higher yield than the respective local varieties in the rainfed environment. Hybrid napier and guinea-grass grown on field boundaries, yielded 5.1 and 1.2 tonnes of green fodder, respectively, with 3-5 cuttings

- In rice-based production system, IR 36 rice with balanced dose of nutrients gave highest grain yield and additional returns (Rs 10,910/ha) at Ranchi.
- In oilseed-based production system, NRC 37 and NRC 2 varieties of soybean gave 30 and 62% higher yield than local varieties at Indore.
- In cotton-based production system, cotton PKV Rajat at Akola, *desi* cotton AKA 7 at Nagpur and Narasimha at Warangal, showed equal performance of yield and profitability to hybrids. Agri-sheep system @ 10 lambs/unit, maize + cowpea and sorghum (fodder) cowpea gave additional net income of Rs15,000/ha/unit compared to arable cropping of cotton alone at Warangal.
- In pulse-based production system, pre-emergence application of Pendimethalin @ 3.3 litres/ha reduced 70% of the weed population in pigeonpea.
- Rice responded well to zinc in light soils.
- PBW 343 excelled WH 542 under timely sown conditions.
- KRL 19 wheat performed well under salt-affected conditions.
- Pant Rituraj brinjal gave 63.6% higher yield than local variety in Bihar.
- Dairy animals treated with Piperazine 20 mg/30 kg body weight for the control of endoparasites increased milk production by 1.5 kg/ animal/day.
- Farmers (37) trained in making urea-enriched fodder to supplement the protein requirement of their cattle.
- Sheep treated successfully for different diseases like endoparasites (1,688), ectoparasites (148), sheep pox (2,428), enterotoxamia (2,455) and foot-and-mouth disease (477).
- PBW 154 wheat and Pant 12 rice varieties yielded 53.7% and 62% higher than locals.
- Tomato hybrids Rakshita and Sun outyielded other hybrids.
- Five honeybee colonies/0.4 ha enhanced fruit-set 55% in apple orchards.
- Scientific rearing of Angora rabbit at Mukteshwar helped the local farmers to generate an additional annual income of Rs 1,500 with one pair of rabbit.

in a year. The Vijaya composite variety of maize gave 3.1 tonnes/ha of green fodder.

- The IPU 94-1 variety of urdbean and the PDM 139 variety of mungbean and TKG 22 variety of sesame gave 30% additional yield compared to the respective local varieties. Incorporation of 15-20 kg oat as green fodder with wheat straw enhanced feed intake and milk yield of cow (31%) and buffalo (42%) as compared to feeding of wheat straw alone.

Irrigated Agro-ecosystem

- Zinc sulphate application @ 62.5 kg/ha significantly increased rice yield (0.372 tonne/ha) and economic returns (benefit:cost 2.38) in Zn-deficient light soils of Punjab and Haryana. Farmers save up to 60 kg N/ha also by adopting this practice.
- The PBW 343 variety of wheat is now being sown in about 80% area of Punjab, giving additional return of Rs 1,667/ha over the earlier variety WH 542.
- In Haryana, KRL 19 wheat variety gave higher yield (4.14 tonnes/ha) than variety grown by farmers and 'PBW 343', under salt-affected areas where ground water is brackish.
- Combined application of Isoproturon (75%) @ 1.0 kg/ha and 2, 4-D sodium salt (80% WP) @ 625 g/ha within 30-35 days of sowing wheat controlled the most harmful weeds, *Phalaris minor*, *Chenopodium album* and *Fumaria* sp. effectively under sufficient soil-moisture conditions.
- The newer varieties of okra, Parbhani Kranti and Azad Okra 1 yielded higher than the local varieties in Central Uttar Pradesh and Parbhani. The maximum benefit of Rs 75,000/ha was obtained from Azad Okra 1, followed by the benefit of Rs 52,500 from Parbhani Kranti in contrast with only Rs 35,000/ha from the local varieties.
- Application of NAA @ 40 ppm, 45 and 75 days after sowing resulted in 34% higher seed-cotton yield (1.195 tonnes/ha) than the farmers' practice, with net return of Rs 14,548/ha and a benefit:cost ratio of 2.17.
- Dairy animals specially the cross-breds suffer from endo- and ecto-parasites in Punjab and Haryana. When the animals were treated with Piperazine @ 20 mg/30 kg body weight for the control of endoparasites, the milk production increased by 1.5 kg/animal/day and the marginal return was Rs 8.25. Treatment of the animals with Butox @ 50 ml/animal repeated 3 times at 10 day intervals to control ticks significantly improved the milk production by 0.25–0.5 kg/animal/day and animal health. The marginal return was Rs 4.96.

Arid Agro-ecosystem

- Thirtyseven farmers were trained in making urea-enriched fodder to supplement the protein requirement of their cattle. Urea-enriched fodder is gaining popularity. Farmers were trained to blend wool with goat hair for making textile fabric.
- Insertion of sponge, impregnated with progesterone (10 mg) and prostaglandin (350 mg) improved estrus induction. Out of 34 acyclic sheep, 29 sheep came in estrus 36 to 38 hr after treatment.

Coastal Agro-ecosystem

- The Pusa Komal variety of the cowpea and T 9 variety of the blackgram were grown as catch crops in summer rice fallow. These performed well with yield of 1,850 and 1,570 kg/ha, respectively, and benefit: cost ratio of 1.69 and 2.67.
- Farmers of Chenkal village, Thiruvananthapuram, have found locally available sodium chloride as substitute (50%) for potassium fertilizer. It resulted in yield potential of 30 tonnes/ha in cassava.

Hill and Mountain Agro-ecosystem

- The wheat variety PBW 154 has spread fast in the IVLP villages (Sola Saroli, Bholapani, Kalimati and Badasi) of Raipur block, as it gave 54% increased yield over the local varieties. The HS 295 variety of wheat has shown reasonable level of tolerance against brown and yellow rusts and smut diseases in IVLP village near Shimla. In the hilly tracts of Almora, the VL 616 variety of wheat has been identified for growing with irrigation providing adequate green fodder and grain yield of about 5.3 tonnes/ha.
- The Pant 12 variety of rice yielded 62% higher than the local varieties in villages near Dehra Dun.
- The tomato varieties Rakshita and Sun outyielded other hybrids by 13% and 19%, respectively, in on-farm trials in the IVLP villages near Solan. The variety Rupali has been recently introduced in IVLP village, Umiam (Meghalaya) and has the potential of wide adoption by the farmers.
- Five honeybee colonies/0.4 ha enhanced pollination and fruit-set in apple orchards. Fruit yield was 60 kg/tree, giving an additional return of 25-30%. This technology impressed the apple farmers and they have started introducing bee-hives in their orchards.
- Feeding with urea-treated fodder and licking mineral blocks with urea and molasses (UMMB) were effective

Honey-bee pollination in apple orchard

in augmenting milk yield by 37% in cow and by 32% in buffalo in Raipur block near Dehra Dun. Similarly, uromin brick/mineral mixture as salt lick increased the milk yield by 47% over farmers' practice in IVLP village, Ranichauri.

- The improved poultry variety CARI Devendra, gave 76% higher yield than local breed.
- Scientific rearing of Angora rabbit at Mukteshwar helped local farmers to generate an additional annual income of Rs 1,500 starting with only one pair of rabbit.

Mission Mode (MM)

Plant Biodiversity

One hundred and seventy explorations trips, collection of 9,069 germplasm material (comprising crop landraces, local cultivars, trait-specific material, wild relatives of crops, selected species and wild species with economic importance), characterization of 28,751 accessions, and conservation of 13,666 accessions were made. Standard descriptors for 116 fruit crops and medicinal and aromatic plants were developed. Five special exploration trips were made to areas which were difficult and inaccessible or were not surveyed earlier.

- Developed standard descriptors for 116 fruit crops and medicinal and aromatic plants.
- Supply of quality seeds of improved varieties of life-support crops, seed and planting material of fruit and vegetable crops, improved breeds of sheep, poultry and pigs and quality seed for freshwater aquaculture and technologies related to value-addition and post-harvest management benefited over 6,000 families at 47 locations in tribal, backward and hilly areas in 15 states.
- Front-line demonstrations and awareness camps of improved technologies resulted in increased income (100-200%), and improvement in living standards of people and additional employment opportunities.
- Released 37 hybrids of different crops with improved quality, higher yield and disease resistance.
- Developed 59 hybrids of vegetable crops (tomato, brinjal, chilli and onion) having multiple disease resistance and with higher yield and better quality.
- Transgenic Bt rice and cotton developed and field tested.
- Characterized genes for protease inhibitor, a-amylase inhibitor and lectin, plant viral genomes and animal viruses.
- Validated IPM technologies in groundnut, cotton, pigeonpea, chickpea, cabbage, tomato, apple and mango.
- A technology commercialized for pouch processing for fish curry preparation.
- Fabricated prototypes of 44 agricultural implements.
- Developed equipment and technology for direct sprouted rice seeding could save labour 70-75%, operational energy 85-90% and cost of operation 80-85%.
- Development of sugarcane cutter planter, sugarcane cultivator and sugarcane trash pulveriser resulted enhanced germination and reduced drudgery in sugarcane cultivation.
- Empowered the women in tribal, backward and hilly areas with implements to reduce drudgeries in farm operations, besides with technologies related to post-harvest agro-processing and value-addition.

Household Food and Nutritional Security

Over 6,000 families at 47 locations in the tribal, backward and hilly areas in 15 states have benefited by the supply of quality seeds (48.3 tonnes) of improved varieties of life-support crops, seed (154 kg) and planting material (15,950 saplings) of fruit and vegetable crops, improved breeds of sheep (120), poultry (15,000) and pigs (562) and quality seed for freshwater aquaculture and technologies related to value-addition and post-harvest management. Front-line demonstrations and awareness camps of improved technologies increased the income (100-200%), improved the living standards of people and provided additional employment opportunities.

Hybrids

In different crops, 37 hybrids (rice 8, maize 9, sunflower 5, pearl millet 4, castor 3, cotton 5, sorghum 3) with improved quality, higher yield (15-20% higher) and disease resistance were released. In vegetable crops, 59 hybrids (tomato, brinjal, chilli and onion) having multiple-disease resistance and higher yield (15-20% higher) and better quality have been developed.

Biotechnology

Major success was achieved in development and field testing of transgenic rice and cotton with *Bt* genes and in characterization of genes for protease inhibitor, α-amylase inhibitor lectin, plant animal virus genomes. This will help in development of plants with in-built resistance to insects and viruses and in better management of viral diseases of animals. Development of diagnostic kits would help in management of plant and animal viral diseases.

Integrated Pest Management

The IPM modules have been evaluated in farmers' fields in 31 villages of eight states. The IPM technologies for groundnut, cotton, pigeonpea, chickpea, cabbage, tomato, apple and mango were validated. Impact in terms of reduction of pesticide use was 75%, and reduction in pesticide sale was 50%. Increase in use of bioagents and in yield was up to 100% and in income was up to Rs 10,000/ha. The success of IPM modules has impact not only on farmers in villages adopted but also on many other farmers who are ready to adopt IPM technology.

Value addition/Product/Technologies

Jute reinforced composite products have been developed which are cost effective in terms of strength : density ratio. A technology for pouch processing for fish-curry preparation has been commercialized.

Mechanization in Agriculture

Prototypes of 44 agricultural implements were fabricated. Equipment and technology developed for direct sprouted rice seeding could save labour 70-75%, operational energy 85-90% and cost of operation 80-85%. Development of sugarcane cutter planter, sugarcane cultivator and sugarcane trash pulveriser has resulted in enhanced germination and reduction in drudgery in sugarcane cultivation.

Women's Empowerment

Women in tribal, backward and hilly areas were empowered with implements to reduce drudgery in farm operations and also with technologies related to post-harvest agro-processing and value-addition. Training programmes were organized for technological empowerment of 4,529 women.

Teams of Excellence (ToE)

- A Decision Support System (DSS) has been developed for integrating and utilizing the knowledge base of a large number of agricultural disciplines for agricultural planning and development. The DSS has potential for examining trade-off of development with environment in regional planning.
- The indoor blue green algae (BGA) biofertilizer production in polyhouse was standardized for mass multiplication round the year. Maintenance of *Azolla* in greenhouse was optimized for soil-based and media-based culture.
- Thirty genes of eight groups of viruses and citrus exocortis viroid have been cloned and sequenced. A transgenic with the *Rep* gene of tomato leaf curl virus has been generated for imparting resistance to the virus to tomato. Gene constructs have been made for papaya ring spot and Indian citrus ringspot viruses using Coat Protein gene.
- Polymerase chain reaction assay has been developed for simultaneous detection of tungro associated rice tungro spherical and bacilliform viruses.
- Distinctness Uniformity and Stability (DUS) test guidelines for 10 major field crops have been prepared.
- Biochemical and molecular markers were identified for charaterization and their application in DUS testing in rice and pearl millet. Seed production technology for cytoplasmic male sterile (CMS) A-line parent of Pusa Basmati 1 hybrid rice was optimized. Invigoration technology for enhancement of field emergence in sunflower and maize under low temperature conditions was developed.
- Genetic material carrying the combined traits of C 306 (drought-resistant variety) and WL 711 (high-yielding variety) have been generated after overcoming hybrid necrosis through ear-culture technique.
- Groundnut bud necrosis virus, cucumber mosaic virus, banana streak virus and papaya leaf curl virus have been successfully cloned and sequenced. Complete sequencing of the n-gene of tospo virus infecting tomato (tomato spotted wilt virus) and 20 sequences of partial cDNA clones of ripening related genes in mango and banana were submitted to European Molecular Biology Genebank database.
- Using antibodies against bursal diseases and infectious bronchitis, immunity was developed in buffaloes.
- A prototype of pressurized irrigation system operating at low pressure (0.07-0.35 kg/cm^2) has been developed and modified after field evaluation.

- Standardized indoor round-the-year, mass production in polyhouse of BGA biofertilizer. Maintenance of *Azolla* in greenhouse optimized for soil-based culture.
- Thirty genes of eight groups of viruses and citrus exocortis viroid cloned, sequenced and deposited in genebank. Transgenics for resistance to tomato leaf curl virus incorporating *Rep* gene of the virus generated.
- Invigoration technology developed for enhancement of field emergence in sunflower and maize under low temperature condition.
- Effective antibodies against bursal disease and infectious bronchitis of buffalo developed.
- Royal jelly extractor, hitherto an imported equipment, now developed indigenously.
- Technology of induced breeding and pearl culture developed and disseminated among stakeholders.
- Complete range of economic ration developed for ruminants using locally available by-products.
- Developed a holistic quality management programme for production and processing of wholesome meat.
- Three Referral Laboratories established for quality assurance of plant, animal and fishery products.
- Organized 71 specialized trainings in which 954 scientists given state-of-art knowledge and skills in new and emerging areas.
- Twenty scientists benefited from trainings offered by two foreign consultants in veterinary biotechnology. ToEs helped in providing first-rate training which have started paying dividends in frontier areas of research

Low-energy water application device

- Storage life of Baneshan mango was extended under controlled atmosphere (CA) storage conditions of 5% O_2+2.5% CO_2 for 35 days at 13°C and 45 days at 8°C. Similarly, Robusta banana could be stored for eight weeks under CA conditions of 5% O_2, 5 or 10% CO_2 at 10°C.
- An extractor of royal-jelly from bee hives has now been indigenously developed for the first time.
- All progressive bee-keepers in Punjab have adopted the mass queen rearing technology and queen bee mating using small nucleus hives developed.
- Three test set ups for evaluating individual hydraulic spray nozzle and performance of spray boom with nozzles and measurement of frictional properties of fruit and draft of the tillage tools have been developed for unified testing.
- Mapping of pearl mussel resources in different agro-ecological regions of the country has been done. A technology for induced breeding and pearl culture has been developed and disseminated among stakeholders.
- A complete range of economic ration for ruminants using locally available by-products has been developed.
- Detoxified neem seed-cake (water washing + 4% urea) can be safely used as an animal feed without any deleterious effect. Neem seed-cake, presently used as manure only, can also be used for feeding animals.
- A holistic quality-management programme has been developed for production and processing of wholesome meat. The technology is being disseminated to the processors. This will improve the global competitiveness of Indian meat sector and thereby increase its export potential.
- Three Referral Laboratories have been established for quality assurance of plant, animal and fishery products, certification of export commodities and development of trained human resource. These laboratories will provide much-needed support for global competitiveness and in providing better quality products to the domestic consumer.

Human Resource Development

In total 71 specialized trainings were organized in which 954 scientists were given state-of-the-art knowledge and skills in new and emerging areas of research and technology. Under long-term training attachment programmes, 12 scientists were provided bench space in different laboratories to learn newer techniques. Trainings organized at the time of visit of two foreign consultants in veterinary biotechnology benefited 20 scientists. Forty-three training/ instructional materials both in print and electronic media were developed and distributed to the participants and supplied to the libraries of related institutions. Excellent infra-structural facilities developed under the ToE have helped in providing first-rate training and the programme has started paying dividends in terms of development of human resource in the frontier areas.

To improve upon the quality of instructional material in line with information technology development, three training programmes on multimedia as an educational tool were organized, in which 45 scientists from ICAR institutes and SAUs participated.

Competitive Grant Programme (CGP)

Biotechnology

- A cDNA library has been constructed from control and heat-stressed rice seedlings and three full length *hsp* genes (*hsp 16.9*, *hsp 17.3* and *hsp18*) have been isolated and characterized. Further, *hsp18* gene was over-expressed in tobacco by *Agrobacterium*-mediated transformation.
- For identifying tissue-specific promoters, *Arabidopsis* plants were transformed with fusion construct. T1 transformants showing expression of the GUS reporter genes in roots only were identified.The cloned 572 bp genomic region acts as a root-specific promoter, indicating successful cloning and testing of a root-

- Novel abiotic stress-responsive genes in rice identified, isolated and characterized.
- Molecular marker-assisted selection successfully used for bacterial leaf blight (BLB) resistance in rice.
- Conditional and tissue-specific promoters from *Arabidopsis* isolated and characterized.
- Rare and high-value medicinal plant species of North-eastern India mass propagated using tissue-culture technology.
- Thermostable vero cell adapted PPR virus vaccine developed.
- Protocol developed for mass production of bio-gent for integrated management of nematodes in horticultural crops.
- Pheromones of banana pseudostem-borer *Odoiporus longicollis* isolated and identified for their use in the management of the pest.
- Technologies developed for aquaculture, breeding and hatchery production of marine ornamental fishes (clownfishes and damselfishes).
- Suitable harvesting tools for oil palm developed.
- Techniques standardized for low cost off-season chrysanthemum culture in Assam.
- Computer models developed for optimal allocation of water and water table management in existing Thungabhadra irrigation projects.
- Data processing techniques developed for statistical analysis of large field variability in hilly and salt-affected soil regions.
- Infrastructural policies suggested for price stabilization for potato and onion in Karnataka.
- Post-harvest management of safed musli (*Chlorophytum borivilianum*) roots standardized.
- Process technologies developed for use of rice bran and rice bran meal in food products.
- Processes standardized for product development, value-addition and waste utilization in bananas and plantains.
- Control system developed for cardamom curing kiln, besides development hand-operated garbler for cardamom.

specific promoter from *Arabidopsis*. Like-wise, a 3.8 kb region upstream of the shoot apex-specific line was amplified and cloned in frame with a promoter-less GUS reporter gene in the binary vector, pBI101.2. Preferred expression was observed at the shoot apex and in young leaves of T1 *Arabidopsis* plants transformed with the promoter.

- Molecular markers have been identified for natural disease resistance in Nicobari fowl using RAPD–PCR. This will help in conservation of highly precious indigenous Nicobari fowl, a native of the Andaman and Nicobar Islands.
- Marker-assisted selection (MAS) was employed to develop multiple gene recombinants for bacterial leaf blight (BLB) resistance in rice in backgrounds of BLB-susceptible BPT 5204 and Triguna. Plants in advanced generations either homozygotes for the three 'R' genes or various two or single 'R' gene combinations were obtained. Three gene and two gene pyramids displayed excellent resistance against BLB. Certain two gene pyramids (*Xa21xa13* or *xa13xa5*) displayed excellent resistance against BLB.
- A large number of potted plants of six rare and high-value medicinal plant species, found in the North-Eastern parts of India, were successfully generated through micro-propagation and have been established in field conditions. Micropropagation protocol for each targetted species ensured a rapid regeneration of plants through high frequency shoot multiplication.
- Pestae Petit des Ruminants (PPR) is one of the most important wide spread diseases of small ruminants which are important for marginal farmers. The developed thermostable vero cell adapted PPR virus vaccine induced adequate levels of protective antibodies in the controlled field trials. Protective antibody levels persisted even after one year. The thermostable vaccine can be taken easily even to very remote areas without the expensive storage structures.

Integrated Pest Management

- The virus causing the yellow mosaic disease of soybean was presumed to be a whitefly transmitted geminivirus and referred to as soybean yellow mosaic virus (SYMV). However, the genomic components, DNA A and DNA B, of the virus isolate showed that it was identical to the blackgram and mungbean isolates of mungbean yellow mosaic (India) virus (MYMIV-[Bg] and MYMIV-[Mg]). Therefore the virus should be referred to as MYMIV-[Sb]. The MYMIV-[Sb] is infectious on cowpea but the blackgram and mungbean isolates are not. Sequence comparisons among the yellow mosaic virus isolates infecting legumes and the begomoviruses infecting crop plants showed that there are two species of yellow mosaic viruses, MYMIV and MYMV in India. To engineer resistance against the MYMIV (Sb), the Rep and CP genes have been cloned in the plant transformation vector in both the sense and antisense orientations. Transformation has been performed on explants of root hypocotyl region. Regeneration has been obtained both through callus and multiple shoot culturing.
- Four indigenous strains of the bio-agent *Verticillium chlamydosporium* (*Pochonia chlamydosporia*) were isolated, molecularly characterized and tested for their efficacy in controlling the nematodes *Meloidogyne* spp. and *Tylenchulus semipenatrans*. Protocols for mass production of *Pochonia chlamydosporia* alone and in combinations with other promising bio-agents using liquid and solid fermentation were standardized. Seven products of bio-pesticides, viz. Biovert*, Biovert plus (S), Pseudomonas plus*, Trichorich*, Trichovert, Bacillus plus and Bacillus plus (P), were developed. Toxicological data on the first four products were generated. Bio-intensive nematode management (BNM) strategies for root-knot nematodes (*Meloidogyne incognita* (race 1 and 2) on vegetable, flowers and fruit crops were developed in the farmers' fields conditions, using these formulations in the villages Thirumalapura, Tammarasanahally and Hessaraghatta near Bangalore.
- An aerial insect trap (AIT) which is a zero energy trap has been designed. The AIT was installed and standardized in three seasons, four locations and four *rabi* and *kharif* crops. It is suitable for detecting flight patterns of aphids in the course of their regular/ seasonal movements between the hilly regions and the plain grounds during the onset of winter season.
- Banana psuedo-stemborer (*Odoiporus longicollis*) causes crop loss up to 90%. Pheromones of *O.longicollis* were isolated and eight possible pheromone compounds were identified.

Natural Resource Management

- Methods for decomposition by cellulose-degrading micro-organisms (CDM) and efficient cycling of rice residues *in-situ* and in compost heap for rice-based cropping systems were developed. The grain yield of *sali* rice grown after *ahu* rice in the plots in which stubbles were decomposed by the application of the mixed culture of CDM 4, CDM 5, CDM 8 and CMD 19 and quarter the recommended doses of N and full recommended doses of P and K was similar to the grain yield obtained by the application of the recommended doses of N, P and K. The yield obtained with the improved compost with half recommended doses of N and P and the full recommended dose of K was 13% more that obtained with the recommended doses of NPK treatment.
- Harvesting of fresh fruit bunches (FFB) of oil palm requires special skill and much energy. A sickle attached to an aluminium pole was found to be suitable. About 4 tonnes of fresh fruit bunches/day/ person could be harvested using the device. Malaysian sickle was found better than other sickles in 5 m

height plantation. Kerala sickle performed well for harvesting tall trees (9 m height). A semi-mechanical hydraulically operated harvesting device towed by a tractor was fabricated. The cost of operation of this device was Rs 798/ha operation. This device is suitable only for large plantations with no intercropping. In case of small plantations with intercropping, harvesting using a sickle attached to a pole is easier, low-priced and efficient compared to mechanical harvester.

- In order to commercialize and ensure supply of chrysanthemum flower round the year in Assam and the North-Eastern Region, the technique for off-season flowering with quality bloom of appropriate varieties was standardized. The technique is based on manipulation of photoperiod (dark treatment) in indigenously developed low-cost dark chambers. Three spray cultivars, Prof. Harris, Yellow Decorative and Yellow Button, and the standard cultivar, Gloria Deo responded to dark treatment, and flowered up to full bloom stage. Identified cultivars were multiplied during off-season and planting material like rooted cuttings were prepared and more than 10,000 of rooted cuttings were distributed among different farmers or growers in Assam.
- Technologies were developed for hatchery production of marine ornamental fishes, especially clownfishes and damselfishes, for initiating a hatchery based marine ornamental fish trade in India. Broodstocks of eight species of damselfishes were successfully developed. Success was obtained in the larval rearing of *Neopomacentrus cyanomos*, *N.nemurus*, *Pomacentrus caeruleus*, *P.pavo* and *Chrysiptera unimaculata*. The major causes of large-scale mortality of the larvae were identified as headbutting syndrome and inadequate feeding of the larvae.

Hatchery-produced young ones of clownfish on sea anemone

Water Management

- In the selected sub-commands under the Tungabhadra Left Bank Canal contrary to the prescribed cropping pattern, more than 80% of the land is under rice. Unauthorized irrigation has led to the existing cropped area being 1.5 times the advised location-specific cropped area and as a result, less than 60% of the tail-end distributory commands are able to receive water. Computer models were developed for optimal allocation of water and water table management and apply them to the existing irrigation projects to disseminate that methodology to field water managers in Karnataka. Training-cum-workshop was conducted for 21 field water managers from four different irrigation projects.
- Techniques of Remote Sensing and Geographical Information System were applied in generating thematic maps, assessment and monitoring of agricultural drought and irrigation management to improve water-use efficiency in command and catchment areas of Rani Avanti Bai Sagar Project—a major irrigation project near Jabalpur.

Socio-economic and Policy Research

- Software for statistical studies of spatial variability and statistical techniques for construction of fertility-gradient maps were developed. Statistical methodology for treatment comparisons in the presence of spatial trends were identified. These methodologies were validated with various data sets collected from the CSWCRTI, Dehra Dun, AICRPs and CTCRI, Thiruvananthapuram. For kriging, a program under the MATLAB has been developed. The outputs generated by this program in the form of kriged maps have been obtained for various data sets.
- A market survey showed that arrivals and prices of onion and potato in the major markets of Karnataka showed an increasing trend. But productivity showed a negative trend. The farmers should reduce the burden of transportation cost by forming syndicates and by choosing appropriate markets. *Kharif* onion should not be stored for more than one month before selling for fetching the best price. Farmers may store their *rabi* onion and potato crops up to three months after harvest for getting profitable prices. Any agency interested in investing on the cold storage structure and local storage structures must be encouraged. Both onion and potato are export competitive but there is a need to increase the efficiency in production. Tiny processing units should be encouraged, as these units can stabilize the prices of potato especially during the glut season.

Post-harvest Technology and Value-addition

- Fresh root recovery of the medicinal plant, safed musli (*Chlorophytum borivilianm*), was acceptable when stored at temperatures between 10°C and the ambient, but the saponin content decreased with storage duration. Low storage temperature (2°–5°C) maintained higher saponin content in roots. Gamma irradiation of roots prevented sprouting of roots in storage and maintained saponin content (8.1%–11.22%) but caused loss in weight and fresh root recovery. Blunt end-type roots are better for storage and

saponin content (8.9%) than the tapering end types. First week of December is the best for harvest of roots. Waxol (3%) and GA_3 (150 ppm) improved the shelf-life of roots for planting material. Drying of peeled roots at 50°C maintained higher saponin with better quality.

- Microwave heating could be an alternative and effective process for rice bran stabilization.About 82.5% of the protein could be recovered from rice bran as soluble protein by viscozyme and microwave treatment followed by homogenization. About 70% of the oil present in the rice bran could be extracted by aqueous enzymatic cellulase, pectinase, neutrase, viscozyme extraction. The oil, was of excellent quality. The residual meal with 6-7% oil can be used in various food formulations for direct human consumption.
- Technologies were developed for production of various banana-based products like ready-to-serve juice, nectar, beverages, blends, chips, powder/flour, figs, wine, baby food, health drink, pickles, chutney, candy, sauce and several other innovative flour-based products like biscuits, *chapaties*, *samosa*, and cake only. Non-farming communities engaged in production of value-added products have developed tie-up with rural women and farmers for the supply of raw materials like semi-processed flower which otherwise goes as waste material.
- Mechanical threshers, both power-operated (capacity 400 kg/hr, threshing efficiency > 95% and cost about Rs 20,000) and hand-operated (capacity 60 kg/ha and efficiency 95%) models, have been developed for black pepper. A rotary sieve-type cleaner-cum-grader (capacity 200 kg/hr, efficiency 88 % and cost about Rs 5,000) has been developed for black pepper. It is suitable for removing small- and large-size impurities from the dried black pepper and grading them into three grades. A mechanical drier of 100 kg batch capacity has been developed. A dryer (capacity 5 kg/batch), has also been developed and evaluated.
- To achieve uniform and faster drying of cardamom, an instrumentation control system has been developed for maintaining uniform temperature inside the kiln and driving out the humid air from the kiln. A hand-operated rotary-type garbling unit (capacity 100 kg/hr and efficiency 98%) has been developed to reduce the drudgery of farm workers. The unit garbles one batch of about 5 kg cardamom in about 2-3 min. The broken capsules were found to be less than 5% and the cost of around Rs 60,000.
- A mechanical dryer (batch capacity 500 kg) developed for chilli could dry CO1 chilli from an initial moisture content of 68.7% to a final moisture content of 7.32% (w.b.), in 6 hr 15 min. at 65°C temperature of hot air.

Cardamom dryer

INNOVATIONS IN TECHNOLOGY DISSEMINATION—ICAR COMPONENT

The ITD–ICAR Component has made significant contribution in empowernment of farmers and stakeholders in terms of information, knowledge and material.

Zonal Agricultural Research Stations Remandated as Krishi Vigyan Kendras

- To empower the farmers, rural women, unemployed youth and other stakeholders, 1,995 training programmes were organized in different disciplines, which benefited 100,682 farmers and farm women.
- The centres have conducted 2,642 front-line demonstrations in oilseed, pulses and other crops and 149 on-farm trials related to crop production.
- In 344 training programmes, 9,756 extension personnel participated. The centres have organized 141 farmer's fair/field days, 376 field visits and 48 farmer-sceintist interaction meetings with the farmers.
- Information has been dessiminated on technologies through 422 radio programmes and 1,203 newspaper coverage, seven exhibitions, two veterinary camps and telephone help-lines.
- In total 0.173 million farmers benefited through different activities.
- About seven million copies of leaflets or pamphlets, bulletins, audio/video learning modules and computer-based information sheets were supplied to farmers and other stake holders.

Agricultural Technology Information Centres (ATIC)

- The ATICs provided 80,240 farmers with diagnostic services through plant clinic, soil-testing laboratories and veterinary clinics.

> - In total 0.173 million farmers benefited from different activities under ITD (ICAR).
> - Agricultural Technology Information Centres provided diagnostic services to 80,240 farmers and generated a gross a revenue of Rs 34.8 million.

- About 1,027 tonnes of quality seeds, 0.7 million nursery plants and packets of bio-fertilizers and bio-pesticides were sold.
- The ATICs generated a gross revenue of about Rs 34.8 million.

❑

5. *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 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 Adviser of the DARE is the Financial Adviser of the ICAR. Generally, single-file system is followed between DARE and ICAR.

The DARE has 11 Group A, 13 Group B, 14 Group C, and 6 Group D employees. The recruitment to the post in Group A, B, C is 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 7 Scheduled Caste 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) 2002-03, respectively. The detailed break-up of these financial figures is given in Appendix III of DARE.

ICAR

The Indian Council of Agricultural Research is the apex organization at the national level for promoting Science and Technology Programmes in the agricultural research and education.

The ICAR was set up on the 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 the Krishi Bhavan, and its other buildings are Krishi Anusandhan Bhavans I and II, New Delhi.

The Minister for Agriculture is the President of the ICAR, and the State Minister for Agriculture is the Vice-President. The principal executive officer of the ICAR is 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, Central/State Governments representatives of India, heads it. The members for this are the Ministers for Agriculture, Animal Husbandry and Fisheries, and the senior officers of various state governments, representatives of Parliament, industries, educational institutes, scientific organizations, 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, Accredition Board, Regional Committees, Policy 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 Science, (*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 Project Directorates in their respective fields. The members for Standing Finance Committee are Director-General (ICAR), Secretary (Agriculture), Scientists, Senior Officers, Farmers, and Members of Parliament (Appendix 3). The senior officers posted at the ICAR (headquarters) are listed in Appendix 4 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 economic status.

The Directorate of Information and Publications of Agriculture is working independently with the approval of the competent authority and brings out 1 title on every third day.

The Research set-up of the ICAR includes 47 Central Institutes (Appendix 5), 5 National Bureaux (Appendix 6), 12 Project Directorates (Appendix 7), 32 National

Research Centres (Appendix 8), and 93 All-India Co-ordianted Research Projects (Appendix 9) are also in operation through the United States-India Fund.

The ICAR promotes research, education and extension education in 37 state agricultural universities, 5 deemed-to-be-Universities and 1 Central Agricultural University for the north-eastern hills region by giving financial assistanace in different forms (Appendix 10).

For effective communication of research findings among farmers, the ICAR maintains an effective network of Krishi Vigyan Kendras, and Trainers' Training Centres 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 11.

Thus with an extensive network of research infra-structure, backed by the excellent team of scientists, technicians and other employees, the ICAR is making rapid strides in agricultural research, and provides support to the national efforts towards achieving food security and self-sufficiency.

- A meeting was held to discuss the implementation/ operationalization of recommendations on 9 September 2003 in the presence of Chairperson who is an Additional Secretary (DARE) and Secretary to the ICAR.
- Significant achievements have been made in the adjustment of outstanding advances, compliance of Audit Paras, Reconciliation of Bank Account and Maintenance of Assists Registers at the ICAR institutes.
- In DARE several activities, viz. Hindi translation of budget, Annual Reports, Hindi Workshops, meetings, reports, organizing Hindi *Pakhwada* were done for the progressive use of Hindi.
- In ICAR (headquarters) and institutes major break-through for the progressive use of Hindi includes workshops (3), *Rajbhasha Alok* (sixth issue), *Dharti 2001* of NBSS&LUP and *Shwet Swarnima* of CCRI, Nagpur which fetched award for their corresponding institutes; and many awards, viz. 'Munshi Prem Chand Award' for *Rajnigandha ki Mahak*, 'Indira Gandhi Official Language Award' etc. were given away.
- The ICAR's International Training Programme 2004 is also being brought out.
- Council has announced 44 awards in 12 different categories to honour 33 scientists and their 9 associates from our NARS, 4 extension workers, innovative farmers, innovative agricultural journalists, and 3 institutions for outstanding contribution in agriculture and allied sciences.
- Council has given financial assistance of Rs 3.430 million to 47 scientific societies for publication of journals; Rs 1.775 million to 11 societies and academic universities for holding National Seminars/Symposia/Conferences.
- The Budget Estimates and Revised Estimates of DARE and ICAR (Plan/Non-Plan) for 2002-03 are Rs 14,988.00 million and Rs 14,488.00 million, respectively, and Budget estimates for 2003-04 (Plan and Non-Plan) are Rs 15,109.2 million.
- The *Purchase Manual* is finalized and is in editing stage.

ADMINISTRATION

Recruitment rules: Recruitment rules for the post of Deputy-Director (OL)/UDCs/PAs/Stenographers were framed/revised.

Filling-up of vacant posts: A good number of vacant posts like Deputy Secretaries, Under Secretaries, Senior Administrative Officers, Senior Finance and Accounts Officers, Finance and Accounts Officers/Section Officers/ Private Secretaries/UDCs/PAs and Group D posts were filled-up. One post of Section Officer and 18 posts of Assistants were also filled-up through Limited Departmental Competitive Examination.

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. Section Officers/ PAs/Assistants/UDCs/LDCs and Group D employees.

Meeting of the ICAR Headquarter's Staff Welfare Fund Committee was convened on 9 September 2003. As per the recommendations of the Committee financial assistance of Rs 20,000 each was extended to two employees of the Council on medical grounds.

Total 32 scholarships were awarded to the meritorious wards of the Council's employees under Staff Welfare Fund Scheme.

Probation/Confirmation: Cases of clearance of probation period of eligible Assistants/PAs have been done during the period.

POLICY AND PERSPECTIVE PLANNING

ICAR took a number of initiative constituting 'O and M Task force' under the National Agricultural Technology Project (NATP). The important activities organized under O&M component and outcomes of recommendations include 'Operationalization of the recommendation of the sub-committee on Administrative Matters' (Mehta Committee of the ICAR) which has been finalized. To discuss the implementation/operationalization of recommendation a meeting was held on 9 September 2003 in the presence of Additional Secretary (DARE) and Secretary (ICAR). Almost recommendations were implemented in the ICAR system. All the concerned and Divisional Heads have been requested to take action for implementation of the recommendations.

Report of the ICAR Institute: The report of the Consultant was accepted. The recommendations of the report were sorted out and, with the approval of the Competent Authority sent to the concerned Heads of Subject Matter Division for necessary process and implementation.

Report of the Finance and Audit Budget and Procurement System: A meeting was held on 25 October 2003 in the presence of the Chairperson who is an

Gazetted posts sanctioned/filled/vacant in the ICAR as on 31.12.2003

Posts	Scale of Pay (Rs)	No. of posts sanctioned	Filled	Vacant	No. of SC	No. of ST	No. of OBC
Director(P)	Rs 14300-400-18300	01	01	–	–	–	–
Director(F)	Rs 14300-400-18300	02	02	–	–	–	–
Director(OL)	Rs 12000-375-16500	01	–	01	–	–	–
Dy. Secretary	Rs 12000-375-16500	09	09	–	01	01	–
Dy. Director(F)	Rs 12000-375-16500	02	02	–	–	–	–
Dy. Director(OL)	Rs 12000-375-16500	01	–	01	–	–	–
Under-Secretary	Rs 10000-325-15200	14	13	01	01	01	–
SA to Chairman, ASRB	Rs 10000-325-15200	01	01	–	–	–	–
Senior Finance & Accounts Officer	Rs 10000-325-15200	02	02	–	–	–	–
Legal Advisor	Rs 10000-325-15200	01	01	–	–	–	–
Finance & Accounts Officer	Rs 8000-275-13500	06	06	–	–	–	01
Asst. Legal Advisor	Rs 6500-200-10500	02	01	01	–	–	–
Assistant Director (OL)	Rs 6500-200-10500	02	02	–	–	–	–
Junior Analyst	Rs 6500-200-10500+ Spl. Allowances	02	01	01	–	–	–
Desk Officer	Rs 6500-200-10500	06	05	01	01	–	–
Protocol Officer	Rs 6500-10500	01	01	–	01	–	–
Asst. Finance & Accounts Officer	Rs 6500-10500	06	04	02	–	–	–
Section Officer	Rs 6500-200-10500	78	71	07	11	06	01
Private Secretary	Rs 6500-200-10500	30	30	–	04	–	–

Total number of employees and number of scheduled castes, scheduled tribes and other backward classes at ICAR Headquarters

Posts	Total no. of posts sanctioned	Total no. of employee in position	Total no. of SC among them	Percentage of total employees	Total no. of ST among them	Percentage of total employees	Total no. of OBC among them	Percentage of total employees	Remarks
Assistant	173	139	25	17.98%	10	7.19%	05	3.59%	–
PA (Gr.II)	56	47	06	12.76%	01	2.12%	03	6.38%	–
UDC	188	186	36	19.35%	09	4.83%	–	–	–
Steno Gr. III	53	40	06	15.00%	01	2.5%	–	–	–

On the occasion of World Food Day, Dr Daniel Gustafson, FAO Representative in India, read the message of DG, FAO on 16 October 2003. Others in picture are Shri P. Chaturvedi, representative from an NGO, Shri D. Gangrade, Vice-Chairman, Gandhi Smriti and Darshan Samiti, Shri R.C.A. Jain, Secretary (A&C) and Dr Savita Singh, Director of the Samiti.

The ICAR organized 'Hindi Chetna Mass' and on 25 November 2003 Prize Distribution Function was held in which prizes were awarded to winners of competitions

A 3-day conference of the Directors of the ICAR Institutes/Research Centres/Project Directorates and Chairmen of Research Advisory Committees, held during 29–31 July 2003

Shri Rajnath Singh, Agriculture Minister, presenting the Jagjivan Ram Kisan Puraskar 2002 to Shri Kushal Pal Sirohi, a farmer from Haryana

Total Number of employees at ICAR (HQ) including and number of scheduled castes, scheduled tribes and other backward classes

Posts	Total posts sanctioned	Total employees in position	Total scheduled castes among them	Percentage of total employees	Total scheduled tribes among them	Percentage of total employees	Total OBC	Percentage of total employees
Administrative Posts								
LDC	139	106	23	22%	3	3%	9	8%
Supporting staff								
Group C (non-ministerial) and Group D	198	134	48	36%	10	7%	9	7%
Supporting staff (*Safaiwala*)	15	14	14	100%	–	–	–	–

Budget estimates and revised estimates of DARE and ICAR

(Rs in million)

Items	Budget estimates 2002-03		Revised estimates 2002-03		Budget estimates 2003-04	
	Plan	Non-Plan	Plan	Non-Plan	Plan	Non-Plan
Major Head 3451						
090 Secretariat	–	10.5	–	10.5	–	12.0
Major Head 2415						
80 General						
798 International Co-operation						
(010032) India's membership contribution to Commonwealth	–	1.0	–	1.0	–	1.0
Agricultural Bureau International						
(020032) India's membership	5.0	34.3	5.0	34.3	5.0	35.8
contribution to Consultative	–	0.5	–	0.5	–	0.5
Group on International						
Agricultural Research	–	1.0	–	1.0	–	1.0
(030032) Other Programmes						
(040032(India's contribution to						
Asia Pacific Association of	–	0.5	–	0.5	–	0.5
Agricultural Institution						
(050032) India's contribution to NACA	–	0.1	–	0.1	–	0.1
(060032) India contribution to CGPRT						
(070032) India contribution to Seed	–	0.5	–	0.5	–	0.5
Testing Association						
(080032) ISHS Belgium						

Additional Secretary (DARE) and Secretary (ICAR), and Financial Adviser (DARE) and it was decided that National Institute of Financial Management (NIFM) would further revise the report as discussed and suggested. The issue of *Purchase Manual* has already been finalized and it is under editing stage.

Senior Officers Committee (SOC Meeting): The forum of the SOC has been activated. The SOC meetings were held on the first Tuesday of every month. The feedback on various issues is obtained and decision were taken.

Significant achievements were made in the area of adjustment of outstanding advances, compliance of Audit Paras, Reconciliation of Bank Account and Maintenance of Asset Registers at ICAR Institutes.

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), and 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.

ICAR

The major achievements pertaining to the progressive use of Hindi in the ICAR for 2002-03 are enumerated here.

- During 2002-03 twelve Institutes/Centres of the Council were notified in the Gazette of the Government of India under Rule 10 (4) of the Official Language Rule 1976. Thus now there are 89 offices of the Council which have been notified in the Gazette of the Government of India.
- Joint Official Language Implementation Committee of DARE and ICAR working under the Chairmanship of the Additional Secretary, DARE/Secretary, ICAR met regularly. Similarly, Official Language Implementation Committees constituted at 94 Institutes/Centres etc. of the ICAR held their meetings regularly.
- Proceedings of the Official Language Implementation Committee meetings held by the Institutes etc. as well as the quarterly progress reports regarding the use of Official Language Hindi received from various institutes at the ICAR (Headquarters) were reviewed and remedial steps were suggested to overcome the shortcomings found in the proceedings and the reports.
- Rosters have been maintained for imparting training in Hindi, Hindi typing and Hindi Stenography and officials were accordingly deputed for training during the year. This year, 10 stenographers and 10 typists were nominated for Hindi Stenography and Typing, respectively.
- ICAR (Headquarters) and its institutes celebrated *Hindi Chetna Mass* from 14 September 2003 and organized various programmes and competitions during this month; and winners were awarded during the prize distribution function held on 25 November, 2003. Hon'ble Minister for Agriculture issued a message on the occasion and DG, ICAR also issued an appeal requesting the officers/staff to do their maximum official work in Hindi.
- During 2003, Hindi workshops (3) were organized for officers/staff regularly.
- The cash awards were given to 9 officials at the headquarters for doing their maximum official work in Hindi during 2002-03.
- Under the 'Rajarshi Tandon Rajbhasha Purskar' scheme, launched in 1998-99, Indian Veterinary Research Institute (Izatnagar) received first prize, Central Institute for Fisheries Education (Mumbai) received second prize under the category of large Institutes. Under Category of other Institutes, National Soybean Research Centre (Indore) received the first prize, and the Central Agricultural Research Institute (Port Blair) received the second prize while under the Category of 'C' region Central Research Institute for Dryland Agriculture (Hyderabad) received first prize, and Central Marine Fisheries Research Institute (Cochin) received second prize.
- 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 ICAR (Headquarters) as well as its institutes during 2003, offices were inspected and suggestions were given to improve the shortcoming. Second sub-committee of the Parliamentary Committee on Official Language inspected 7 Institutes/Centres of the Council during this year.
- The *Rajbhasha Alok* (sixth issue) was published which covered the progress made in Hindi at the Council and its institutes. Other institutes of the Council also brought out Hindi publications.
- The ICAR (Headquarters) has bilingual computers and cent per cent work is being done in Hindi on some computers.
- The Council and its institutes organized regular training programmes for farmers in Hindi and in other regional languages and remarkable progress was made at Krishi Vigyan Kendras in the use of Hindi and in the other regional languages in their day-to-day official work.
- Town Official Language Implementation Committee (Nagpur) awarded National Bureau of Soil Survey and Land Use Planning, Nagpur for *Dharti-2001*, its magazine in Hindi, and Central Cotton Research Institute, Nagpur for *Shwet Swarnima* with citation and consolation prize.

  Similarly, Town Official Language Implementation Committee (Jodhpur) was awarded Central Arid Zone Research Institute (Jodhpur) with Rolling Shield as a second winner for doing their maximum work in Hindi during 2001-02.
- Dr Kumudini Nautiyal [Assistant Director (OL)], Central Cotton Research Institute, Nagpur was awarded with 'Munshi Premchand Award' by Maharashtra State Hindi Sahitya Academy for her Hindi book *Rajnigandha Ki Mahak*.

  Similarly, Dr Satish Kaushik, Principal Scientist, Central Arid Zone Research Institute, Jodhpur was awarded with 'Indira Gandhi Official Language Award' to be given by Department of Official Language for his book in Hindi. Central Institute Fisheries Education, Mumbai has included one new course '*Hindi Jalwani*' as a subject for the students of M.FSc. from this year onwards.
- Besides the material pertaining to Parliament, Annual

Plan, Annual 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 prepared bilingual. The hon'ble Minister for Agriculture and other higher officials delivered their speeches in Hindi. The drafts of speeches of Hon'ble Union Agriculture Minister, and other higher officials of the ICAR were prepared originally in Hindi also.

FINANCE AND AUDIT

The Budget Estimate (BE) and Revised Estimate (RE) of DARE and ICAR (Plan, Non-Plan) for 2002-03 are Rs 14,988.0 million, and Rs 14,488.0 million, respectively and BE for 2003-04 (Plan and Non-Plan) is Rs 15,109.2 million. The detailed break-up of these financial figures are given in Table 1.

The detail of Department of Agricultural Research and Education (DARE) in respect of BE and RE for 2002-03 and BE for 2003-04 are given in Table 1. This excludes the payment to the ICAR.

ICAR AWARD CEREMONY, 2003

This year the Council has announced 44 awards in 12 different categories to honour 33 scientists and their 9 associates from our National Agricultural Research System, 4 extension workers, innovative farmers, agricultural journalists, and 3 institutions for their outstanding contribution in agriculture and allied sciences (Appendix 12).

Mahatma Phule Krishi Vidyapeeth, Rahuri has been awarded 'Sardar Patel Outstanding ICAR Institution Award' for region-specific agricultural research, education and extension, and Central Plantation Crops Research Institute, Kasaragod has received the award for its pioneering research in coconut, arecanut and cocoa.

The All-India Co-ordinated Research Project (AICRP) form an important component of our research system based on inter-institutional co-operation. The AICRP on Vegetable Crops, Varanasi has been selected for 'Choudhary Devi Lal Outstanding AICRP Award'. The improved varieties/hybrids and supporting production technologies developed have significantly contributed to make India a leading producer of vegetables at the global level.

The 'Jawaharlal Nehru Award' for outstanding doctoral thesis in agricultural research were given to 11 scientists. One of the 'Panjabrao Deshmukh Women Agricultural Scientist Award' has gone for developing reference standards of many pesticides and preparation of protocols and the other for development and popularization of synthetic twines as fishing gear materials for gill nets that revolutionized deep sea fishing in the country. The 'Vasantrao Naik Award' for Research Applications in Dryland Agriculture has gone for outstanding research and extension contribution in soil and water conservation and rainfed farming in the tribal dominant Eastern Ghats in Orissa.

The 'Lal Bahadur Shastri Young Scientist Awards' for the biennium 2001-02 have been given to five young scientists for their high quality research efforts in frontier areas of agriculture and allied sciences. 'The Hari Om Ashram Trust Awards' for 2001-02 have gone for development of salt-tolerant rice varieties and the low cost crop production technology for sodic soils; development of superfine grain aromatic rice hybrid and basmati rice varieties; developing suitable post-harvest technologies for citrus fruits; on conjunctive use of otherwise unusable highly saline and sodic waters for successful crop production, and development of a power-operated machine for the urea ammonization of crop residues.

The 'Rafi Ahmed Kidwai Awards' for 2001-02 have gone for commendable contributions in molecular characterization and evaluation of plant genetic resources; generation of systematic information on judicious use of mineral fertilizers integrated with organic sources; developing greenhouse enclosures with controlled environments for vegetable cultivation in the tropical conditions of north Indian plains; for development of several varieties and hybrids of vegetables along with screening techniques for disease resistance; developing practical and reliable immunodiagnostics and immuno-prophylactics against important existing and emerging poultry diseases; developing technologies for rapid and precise diagnosis of several dreaded viral infections of livestock; diagnosis and vaccine development for poultry diseases; transgenesis and reconstitution of poultry species; and for pioneering work in fisheries biology, population dynamics, stock assessment and sustainability of several groups of marine fishes.

'Swami Sahajanand Saraswati Extension Scientist/ Workers Awards' for 2001-02 have gone for development of inner potentialities of fruit growers to utilize the recommended practices for sound orchard management for better yield and higher income; innovative extension programme adopting improved methodologies for significant impact of dairying; refining and transferring the intensive aquaculture technology in the northern states and for developing appropriate and sustainable small-scale integrated aquaculture systems mobilizing local resources in Assam.

The 'Jagjivan Ram Kisan Puruskar' was awarded to distinguished farmer from village Chandana, District Kaithal of Haryana for his innovative farming practices that blend traditional and modern technologies to make agriculture a sustainable and higher income providing profession. The 'NG Ranga Farmer Award' for Diversified Agriculture was conferred on an innovative farmer of village Gomchi of district Raipur of Chattisgarh for his outstanding contribution in fruit and vegetable cultivation.

The Council has recognized the important role that the

Press plays between the research institutions and the public at large and farmers in particular and instituted 'Chaudhary Charan Singh Award' for excellence in journalism in agricultural research and development. The recipients of the award this year have made valuable contribution towards information dissemination and transfer of improved technologies and also for writing analytical articles on agriculture and rural development covering policy issues and issues relating to WTO and GATT.

Hon'ble Union Agriculture Minister, Shri Rajnath Singh, gave away the ICAR Awards to the scientists/ research scholars/journalists etc.

TECHNICAL CO-ORDINATION

Financial support to scientific societies: With the approval of the Standing Committee, financial assistance of Rs 3.430 million was provided to 47 scientific societies for publication of journals; Rs 1.775 million to 11 societies and academic universities for holding National Seminars/Symposia/Conferences.

Publication of DARE/ICAR Annual Report 2003-04 and Highlights of Achievements of A.P. Cess Fund Supported Schemes: Manuscripts pertaining to *DARE/ICAR Annual Report 2003-04* and *Highlights of Achievements of A.P. Cess Fund Supported Schemes* were co-ordinated between the corresponding Heads of Subject Matter Divisions, and the Directorate of Information and Publications of Agriculture.

Monthly summary: Compiled monthly summary on major breakthroughs of exports, import, research and other related matters of all the Institutes/Project Directorates and was submitted to Cabinet, Government of India, and other related departments.

Support to DSIR: Evaluated, processed and provided comments on various proposals submitted by the private and public funded organizations related to agriculture for recognition of their Research and Development Units to the Department of Scientific and Industrial Research (DSIR), Government of India.

Best Annual Report Awards: Applications for the 'Best Annual Report Awards' for 2001-02 to the ICAR Institutes were processed.

ICAR's International Training Programme: Material for 'ICAR's International Training Programme 2004' was collected from all the ICAR Institutes and State Agricultural Universities and compiled. Co-ordination is being done with the Directorate of Information and Publications of Agriculture for its publication.

Technical backstopping: Provided technical input like co-ordination and preparation of Memoranda of Understandings and Work Plans, preparation of technical briefs, attending to related querries and monitoring deputation reports.

Parliament questions, VIP references and material for papers/talks/replies and preparation of technical notes: Collected and compiled information for reply of Parliament questions and VIP references, and prepared papers/talks/replies and technical notes on various issues which concerned more than one Subject Matter Division of the ICAR.

Regional committee meeting: To review the status of agricultural research, extension and education in the respective regions and to identify the action points and strategies for the next 2 years, meeting of the Regional Committee No. 2 comprising Assam and West Bengal; Regional Committee No. 5 comprising Orissa, Andhra Pradesh and Chattisgarh; Regional Committee No. 6 comprising Haryana, Rajasthan, Gujarat, Union Territory of Dadar and Nagar Haveli and Daman Diu; Regional Committee No. 7 comprising Maharashtra, Madhya Pradesh and Goa; and Regional Committee No. 8 comprising Kerala, Karnataka, Tamil Nadu and Union Territories of Pondicherry and Lakshadweep were convened.

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6. *Partnership and Linkages*

The 'Partnership and Linkages' is an important wing of the DARE/ICAR in which DARE and ICAR have International collaborations through Memoranda of Understandings/Work Plans, Projects, Training Courses, exchange visit etc.

The Department of Agricultural Research and Education (DARE)/Indian Council of Agricultural Research (ICAR) organized a meeting of the Counsellors-in-Charge of Agriculture and Science and Technology of the Embassies/High Commissions/Honorary Consulates General/Honorary Consulates to exhibit the training facilities available within the National Agricultural Research System (NARS). A field visit of the participants was also organized at IARI/NBPGR, New Delhi and NDRI/DWR/CSSRI/NBAGR/IARI Regional Station, Karnal on 15 March 2004 in two groups.

MoUs/Work Plans

A Work Plan for 2004 was signed between Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India and Ministry of Agriculture and Water Resources, Government of Uzbekistan on 17 December 2003 for co-operation in the field of agricultural research and education. The International Co-operation in ICAR/DARE has been operating through the MoUs/Work Plans signed with various countries/international organizations by ICAR/DARE as the Nodal Department and through participation of ICAR/DARE in the MoUs/Work Plans signed by the Department of Agriculture and Co-operation as 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 in which, DARE participates directly or through the Department of Agriculture and Co-operation.

- An MoU was signed on 17 April 2003 between Indian Council of Agricultural Research, India and Centre de Co-operation International en Recherche Agronomique pour Le Development (CIRAD) and Institute National La Recherche Agronomique (INRA), France for Co-operation in Agricultural Research and Education.
- A Work Plan for 2003-04 was signed between Indian Council of Agricultural Research and Sri Lankan Council of Agricultural Research Policy, Sri Lanka on 5 May, 2003 for scientific and technical co-operation in Agriculture.
- A Work Plan 2004-05 between India and Cuba was signed on 25 November 2003 for co-operation in the field of Agricultural Research and Education.

- Memorandum of Understandings signed between ICAR, India and IVRA and CIRAD, France for co-operation in the field of Agricultural Research and Education.
- ICAR, India signed a Work Plan with Sri Lankan Council of Agricultural Research Policy, Sri Lanka for Scientific and Technical Co-operation in Agriculture.
- ICAR, India also signed a number of projects with UNEP, DFID, CIDA etc. for co-operation in the field of Agricultural Research and Education.
- The 35 cases of deputation/training abroad approved during 2003-04.
- Protocol activities include a number of delegations led by Presidents of Mozambique, Guyana and Prime Minister of Lao People's Democratic Republic etc.
- To strengthen our research programme and intermediate/appropriate technologies several research workers visited foreign countries from different research organizations and ICAR headquarters.
- Foreign scientists of France, Russia, Sri Lanka etc. also came to India to attend research programmes at different research bodies of the ICAR.
- An Indo-French Seminar 'To Identify Priority Areas for Collaborative Research, Germplasm Exchange, Study Visits, Training Programmes' held in New Delhi from 16 to 17 April 2003.

- A Work Plan for biennium 2004-05 between India and Iran was signed on 15 December 2003 for co-operation in the field of Agricultural Research and Education.

International Linkages

- ICAR-UNEP project 'Developing Decision Making Tools for Assessment for Vulnerability to Climate Change in India' was for one year from 20 February 2003 to 19 February 2004 and the total cost of the project is US$ 1,77,000 out of which funds allocated to India are to the tune of US$ 1,37,500. The project is to be implemented at National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi. The project is being funded by UNEP. The main objective of the project is to demonstrate and integrated assessment of vulnerability to food insecurity climate change risk and adaption strategies to manage disaster risk while promoting sustainable development.
- Collaborative project 'Soil Organic Carbon Stocks and Change at National Scale' between University of Reading, UK and NBSS&LUP, Nagpur, India. This project is funded by Global Environmental Fund from 6 June 2003 to 24 September 2005. It is multinational project. The University of Reading is having a contract for research service funded by Global Environment Fund, and NBSS&LUP is participating in the project on sub-contract basis. The cost of the project is US$ 20,02,000 out of which GEF share is US $ 9,78,000 and there is co-financing of US$ 10,24,000 from USA, UK, The Netherlands and Australia. The budget meant for the institute is US$ 76,000 out of which Institute's contribution is US$ 20,000. The project aims to develop and administrate generic tools which quantify the impact of land management and climate scenario on carbon sequestration in soil.
- Joint collaborative research project "Nitrate in tubewell waters of Gurgaon (Haryana), India' is between CCSHAU, Hisar, and University of Rostock, Germany. The project is for 3 years. The cost of the project is Euro 56,500 and is being funded by Volkswagen Foundation, Germany. The share of the CCSHAU, Hisar is Euro 47,800. The aim of the project are to ascertain the source of nitrates in underground waters whether it is due to leaching of nitrates as a result of nitrogenous fertilization or dissolution of some rock material below the surface; to investigate the origin and the spreading of such underground water, and to forecast about the possible chemical development for the future; and how best such water could be utilized without compromising on the yields and soil or environmental health.
- Joint research grant under Asian-Swedish research partnership programme 'Integrated Bio Fuel Cell Technology' is a joint project between CIAE, Bhopal, and Royal Institute of Technology, Stockholm (KTH), Sweden for 3 years w e f August 2003. The funds are being provided by Swedish International Development Co-operation Agency (SIDA) and Swedish Research Council to the Royal Institute of Technology, who will support funding the publication, training/visit of CIAE, which will be to the tune of Rs 1 million. The aim of the project is to increase the scientific and the technological potentials regarding the development of a new range of technologies which permit the use of the biomass, wood and agricultural residues for application in fuel cells.
- Collaborative project 'Consolidation of Food Security in South India' has been launched among UPCD-CIDA, Canada; Tamil Nadu Agricultural University, Coimbatore, University of Agricultural Sciences, Bangalore; and University of Agricultural Sciences, Dharwad, Karnataka, for 5 years. This project is funded by UPCD-CIDA, Canada. The total cost of the project is Canadian $ 7.73 million out of which contribution of Indian partner Institutions is Canadian $ 0.59 million which is in kind. The cost of training, research, supplies etc. for the staff to Indian Institutions will be met out of CIDA's contribution. The project envisages to address India's development priorities in agricultural and food security.
- Indo-Norweigian collaborative project 'Selective Breeding of Rohu (*Labeo rohita*) for Innate Resistance to Aeromoniasis is launched. A model for an alternative approach to disease control in Freshwater Aquaculture' is between Central Institute for Freshwater Aquaculture (CIFA), Bhubaneshwar, and AKVAFORSK for 3 years and is being funded under Indo-Norwegian Programme Institutional Co-operation (INPIC). The cost of the project is Rs 3.518 million as internal cost of CIFA; 0.122 million NOKs as external cost of CIFA; and Rs 1.131 million NOKs for AKVAFIRSK. The project aims at identifying suitable immunological markers of disease resistance against aeromoniasis.
- The project on 'Gender Development under Higher Education Link Programme' is between CCS HAU, Hisar and University of HULL, UK for 3 years from 1 April 2001 to 31 March 2004. The total cost of the project is Rs 1.7 million and is fully funded by British Council. The objective of the project is to design, develop and deliver Post-graduate Diploma courses in Gender Development through collaboration between the 2 universities.
- The 'Environmental Impact Assessment of Community-based Water Resources Management Project in Uttaranchal Pradesh' is between Central Soil and Water Conservation Research and Training Institute, Dehra Dun, Uttaranchal; and McGill University, Canada for 2 years and 5 months w e f 30 July 2003 and is funded by CIDA. The total cost of the project is Canadian $ 104000, out of which Canadian $ 44100 is for Indian partner and Canadian $59,900 for Canadian partner. The sponsoring agency for the project is Shastri Indo-Canadian Institute (SICI) through Shastri Applied

Research Project and is funded by CIDA.

- The DFID funded project 'Integrated Pest Management of Eggplant Fruit and shoot Borer' is being implemented at Indian Institute of Vegetable Research, Varanasi; and Gujarat Agricultural University. The project was approved up to 31 March 2003. This project has been given extension for 2 years from 1 October 2003 to September 2004. The cost of the project for the extended period is £ 0.3 million out of which funds meant for Indian Institute of Vegetable Research and Gujarat Agricultural University are to the tune of £ 90,200 and 28,215, respectively.

TRAINING/DEPUTATION OF INDIAN SCIENTISTS IN FOREIGN COUNTRIES

The 35 cases of deputation/training abroad were approved during 2003-04. Out of these, following visits were of the officers of the rank of Assistant Director-General and above.

- Dr Arvind Kumar (Director, NRCRM, Bharatpur), and Dr N B Singh, [ADG (OP), ICAR, New Delhi] were deputed for attending the 11th International Rapeseed-Mustard Congress held at Cophenhagen (Denmark) as also to UK to review the progress of research on rapeseed and mustard under Indo-UK Collaborative project on 'Oilseed Crops' from 6 to 17 July 2003.
- Dr K S Gajbhiye (Director) and Dr D K Pal (Principal Scientist and Head) and Dr T Bhattacharya (Senior Scientist) of NBSSL&UP, Nagpur were deputed to Nairobi, Kenya for attending the Third Workshop of the Global Funds Project on 'Assessment of Soil Organic Carbon Stocks and Changes at National Scale' from 6 October 2003.
- Dr Nawab Ali (Director, CIAE, Bhopal) was deputed for participating in the APCAEM Regional Seminar on 'Post-Harvest Harvesting Technology' held at China from 3 to 5 November 2003.
- Dr P Chandra, ADG (PE) was deputed for attending 2nd Session of Technical Advisory Committee (TAC) and 2nd Governing Board (GB) Meeting of APCAEM held at Beijing, China from 24 to 27 November 2003.
- Dr Inder Dev (Scientist, IGFRI Regional Station, Palampur) attended ICRA advanced training in Inter-Disciplinary Team Research in Agriculture at Wageningen, The Netherlands from 13 January 2003 to 24 July 2003. The expenditure was incurred by ICRA, Netherlands.
- Dr Khem Chand (Scientist, CAZRI Regional Station, Pali, Rajasthan) attended ICRA advanced training in Inter-Disciplinary Team Research in Agriculture at Wageningen, The Netherlands from 13 January to 24 July 2003. The expenditure was incurred by ICRA, Netherlands.
- Dr S P Dutta, Scientist (Senior Scale, IARI, New Delhi) visited for availing commonwealth scholarship for 2002-03 in UK w e f 1 March 2003 to 1 September 2003. The expenditure was incurred by Commonwealth Scholarship Commission, UK.
- Dr J C Rana (Senior Scientist, NBPGR, Regional Station, Shimla) visited for higher studies in the field of Plant Breeding and Genetics at South Chinese Agriculture University, China under Chinese Government Scholarship w e f 5 February 2003 to 15 July 2003. The expenditure was incurred by Local cost by Government of China and travel cost by M/HRD.
- Dr (Ms) Prameela Krishnan [Scientist (SS), CRRI, Cuttack] visited for availing BOYSCAST Fellowship 2002-03 award at University of Oxford, UK for 10 months w e f 27 March 2003. The expenditure was incurred by Department of Science and Technology, New Delhi.
- Dr Ravi Bhushan Tiwari (Senior Scientist, IIHR, Bangalore) visited for availing United Nations University (KUNU) P.D. Fellowship at the NFRI, Japan for 1 year and 14 days w e f 1 April 2003. The expenditure was incurred by UNU, Japan.
- Dr H S Gupta (Director, VPKAS, Almora) visited for availing Biotechnology Career Fellowship at the Rockefeller Foundation, New York, USA from 1 May 2003 to 15 June 2003. The expenditure was incurred by Rockefeller Foundation, USA.
- Dr S Naresh Kumar (Scientist, CPCRI, Kasaragod) visited for attending a training course on crop weather modeling in Israel from 10 March 2003 to 3 April 2003. The expenditure was incurred by local living cost by Government of Israel and travel cost by applicant.
- Dr (Ms) Anju Manuja (Veterinary Officer, CIRB, Hisar) visited for availing BOYSCAST Fellowship at the Veterinary Diseases Organization, Saskatoon, Canada for 10 months w e f March, 2003. The expenditure was incurred by Department of Science and Technology, New Delhi.
- Dr Sujay Rakshit (Scientist, DMR, IARI, New Delhi) visited for availing the JSPS P.D. Fellowship for Foreigner Research Programme in Japan for 2 years w e f 1 April 2003. The expenditure was incurred by JSPS, Japan.
- Dr (Ms) Shamash Barthakur (Scientist, IARI, New Delhi) visited for availing BOYSCAST Fellowship at the University of Texas, USA for 12 months w e f 22 March 2003. The expenditure was incurred by Department of Science and Technology, New Delhi.
- Shri Ashwani Kumar Sharma (Scientist, CPRS, Kufri, Shimla) visited to attend a training course on 'Potato Production: Storage and Seed' in the Netherlands w e f 28 April 2003 to 4 July 2003. The expenditure was incurred by Government of Netherlands.
- Dr H S Yogeesha (Scientist, IIHR, Bangalore) visited to attend a course on 'Seed Sector Development' in the Nethrlands w e f 28 April 2003 to 4 July 2003. The expenditure was incurred by Government of

Netherlands.

- Smt K Subadra Bai (Technical Officer, SBI, Coimbatore) visited to attend the training course on 'Integrated Pest Management' in the Netherlands w e f 28 April 2003 to 4 July 2003. The expenditure was incurred by Government of Netherlands.
- Shri V G Arude (Scientist, CIRCOT, Nagpur) visited to attend an advance training on 'Scientific Equipment, Rotary Knife Gin' at M/s LMMAS Corporation, Georgia, USA, from 12 to 17 May 2003. The expenditure was incurred by concerned firm.
- Dr (Ms) K Usha (Senior Scientist, IARI, New Delhi) visited to attend a training in her area of specialization in Germany under INSA's Bilateral Exchange of Scientist Programme w e f 1 June to 28 August 2003. The expenditure was incurred by local living cost host Academy in Germany and travel cost shared by INSA/applicant on 50:50 basis.
- Dr (Mrs) Kavita Gupta (Scintist (SS), NBPGR, New Delhi) visited to attend a training course on 'Plant Quarantine (Thermal Treatment for the Disinfestations of Fruit Flies) ' in Japan w e f 27 May 2003 to 11 September 2003. The expenditure was incurred by Government of Japan.
- Dr Goutam Sahana [Scientist (SS), NBAGR, Karnal] visited for availing BOYSCAST Fellowship at Danish Institute of Agricultural Sciences, Denmark for 12 months w e f 15 June 2003. The expenditure was incurred by Department of Science and Technology, New Delhi.
- Dr Vinita Gotmare (Scientist, CICR, Nagpur) visited to attend a training course on 'Development Oriented Biotechnology' in Germany from 25 May 2003 to 28 June 2003. The expenditure was incurred by Government of Germany.
- Dr Y G Prasad (Scientist, CRIDA, Hyderabad) visited to attend short course, viz. (*i*) Plant Biotechnology and Biosafety, (*ii*) Role of Pesticides in Integrated Pest Management in the Netherlands from 9 June 2003 to 4 July 2003. The expenditure was incurred by Local living cost by Government of Netherlands and travel cost by Institute of Public Enterprises, Hyderabad.
- Dr (Ms) Sangeeta Srivastava (Sr. Scientist, IISR, Lucknow) visited to attend a training course on 'Development Oriented Biotechnology' – Refreshment Module for former participant in Germany from 16 to 27 June 2003. The expenditure was incurred by Training Organizer.
- Dr Kaushik Banerjee [Scientist (SS), NRCG, Pune] visited for availing BOYSCAST Fellowship at the University of Dortmund, Germany for 10 months w e f 20 June 2003. The expenditure was incurred by Department of Science and Technology, New Delhi.
- Dr S Nagarajan (Director, IARI, New Delhi) visited to study his area of specialization to Germany under DAAD Fellowship for 2 months w e f 13 June 2003. The expenditure was incurred by DAAD, Germany.
- Dr M S Rao (Senior Scientist, IIHR, Bangalore) visited four weeks training at IACR, Rothamsted, UK under INSA's Bilateral Exchange of Scientists Programme with foreign academy w e f 8 September 2003.
- Dr Sanjeev Kumar (Senior Scientist, CARI, Izatnagar) visited 2 weeks study visit to Germany to Supervise the work of his Ph.D. student – Dr K Ganesh Kumar, Student, IVRI, Izatnagar (Deemed University) w e f 10 to 23 July 2003 under DAAD 'Sandwich Model Scheme'. The expenditure was incurred by DAAD Germany.
- Dr Y S Shivay (Senior Scientist, IARI, New Delhi) visited for availing Norweigian Government Fellowship 2003-04, Norwegian for 10 months w e f 15 August 2003. The expenditure was incurred by local cost by Norway Government and travel cost by applicant.
- Dr G B Shivkumar (Senior Scientist, IARI, New Delhi) visited for availing Norweigian Government Fellowship 2003-04, Norweigian for 10 months w e f 15 August 2003. The expenditure was incurred by local cost by Norway Government and travel cost by applicant.
- Dr S C Das (Senior Scientist, IVRI Eastern Regional Station, Kolkata) visited to attend a training course on 'Infectious Disease Research' at ICDDR, Dhaka, Bangladesh from 8 to 23 September 2003. The expenditure was incurred by Organiser of the Programme.
- Dr (Ms) B Jhansi Rani (Senior Scientist, IIHR, Bangalore) visited to attend SIDA's Advanced Training Programme on 'Sustainable Agriculture in an Environmental Perspective' at Svalov, Sweden from 1 Septermber 2003 to 7 October 2003. The expenditure was incurred by Government of Sweden/SIDA.
- Dr Indra Mani (Senior Scientist, IARI, New Delhi) visited to attend a summer school course on 'Agricultural Engineering' at the Institute of Agricultural Engineering, George August University of Goettingen, Germany from 23 August 2003 to 7 September 2003. The entire expenditure including international travel cost borne by DAAD, Germany.
- Dr R K Bhatt [Senior Scientist, IGFRI, Jhansi (UP)] visited to attend SIDA's advanced training course on 'Sustainable Agriculture in an Environmental Perspective' to be held at Svalov, Sweden from 1 September to 17 October 2003. The expenditure was incurred by Government of Sweden/SIDA jointly.
- Dr D R Biswas [Scientist (SS), IARI, New Delhi] visited to attend an international course on 'Biological Fertilizer Technology' held in China from 1 September 2003 to 15 October 2003. The boarding and lodging etc. borne by Government of China – International air fare cost borne by Dr Biswas himself.
- Ms Edna Antony (Scientist, WTCER, Bhubaneshwar) visited for pursuing higher studies leading to the award of Ph.D. at the University of Newcastle Upon Tyhne, UK under Commonwealth Scholarship Scheme, 2003 for 3

years w e f 16 September 2003. The expenditure was incurred by Commonwealth Commission, UK.

- Dr Jai Gopal (Principal Scientist, CPRI, Shimla) visited to conduct research at the Graduate School of Agriculture, Hokkaido University, Japan. The expenditure was incurred by JSPS, Japan.
- Dr B N Tripathi (Senior Scientist, IVRI, Izatnagar) visited to undertake studies in the field of Molecular Characterization of Microbaterium Avum subspo' at Mordum Research Institute, Edinburg, UK for 4 months w e f 15 September 2003. The expenditure was incurred by WELCOME Trust, UK.
- Dr T Ravisankar [Scientist (SS), CIBA, Chennai] visited to attend a Third Country Training on 'Responsible Aquaculture Development (TCTP-RAD) at SEAFDEC, Tigbauan, Iloilo, Philippines from 14 September 2003 to 13 November 2003. The full deputation cost including international air fare borne by Government of Japan/SEAFDEC.
- Dr K K Krishnani [Scientist (SS), CIBA, Chennai] visited to attend a Third Country Training on 'Responsible Aquaculture Development (TCTP-RAD) at SEAFDEC, Tigbauan, Iloilo, Philippines from 14 September 2003 to 13 November 2003. The full deputation cost including international air fare borne by Government of Japan/SEAFDEC.
- Dr K K Singh (Scientist, IARI, New Delhi) visiting the Yangzhai University, China for higher studies leading to the award of Ph.D. in the field of Plant Breeding and Genetics from 3 October 2003 to 15 July 2007. The boarding, lodging, internal travel, tuition fees etc. will be borne by the Government of China; International air-fare will be borne by M/HRD, Government of India.
- Dr C Ramachandran Nair (Scientist, CMFRI, Cochin) visited to attend a training on 'Alternative Approaches to Fisheries Management' at IAC, Wageningen, The Netherlands from 6 October to 21 November 2003. The deputation cost including both ways international air-fare borne by the Government of The Netherlands under Netherlands Government Fellowship Programme.
- Dr (Ms) P Laxmiletha (Senior Scientist, CMFRI, Cochin) visited to attend a training course on 'Alternative Approaches to Fisheries Management' at IAC Wageningen, The Netherlands from 6 October to 21 November 2003. The full deputation cost including both ways international air-fare borne by the Government of The Netherlands under Netherlands Government Fellowship Programme.
- Dr (Ms) Josileen Jose, (Senior Scientist, CMFRI, Cochin) visited to attend a training course on 'Alternative Approaches to Fisheries Management' at IAC Wageningen, The Netherlands from 6 October to 21 November 2003. The full deputation cost including both ways international air-fare borne by the Government of the Netherlands under Netherlands Government Fellowship Programme.
- Dr (Ms) M K Tripathi [Scientist (SS), SSWRI, Avikanagar, Rajasthan] visited for availing BOYSCAST Fellowship award, 2002-03 at INRA, France for undergoing training in the areas 'Plant Microbe Inter action' under Department of Science and Technology programme for 12 months w e f 20 November 2002 to 19 November 2003. The expenditure was incurred by Department of Science and Technology, Government of India.
- Dr P S Yadav (Senior Scientist, CIRB, Hisar, Haryana) visited for availing Biotechnology Overseas Associateship (long-term) award, 2002-03 at the Institute for Tiezucht and Tierverhaltey, Neustedt, Germany under Department of Biotechnology programme for 12 months w e f 15 November 2003. The expenditure was incurred by Department of Biotechnology, Government of India.
- Dr R P Pant [Technical Officer (T-6), IARI, New Delhi] visited for attending training on operation of 'Electron Microscope' scientific equipment at M/s. JEOl Ltd., Tokyo, Japan from 20 October to 24 October 2003. The entire deputation cost including international travel cost borne by the concerned firm in Japan.
- Dr Jasvir Singh [Technical Officer, IARI, New Delhi] visited for attending training on operation of 'Electron Microscope' scientific equipment at M/s. JEOl Ltd., Tokyo, Japan from 20 October to 24 October 2003. The entire deputation cost including international travel cost borne by the firm concerned in Japan.
- Dr A B Mandal (Senior Scientist, CARI, Port Blair) visited for availing biotechnology Overseas Associateship (short-term) award at the College of Agriculture, University of Kentucky, USA for 3 months from the last week of September, 2003 under Department of Biotechnology programme. The expenditure was incurred by Department of Biotechnology, Government of India.
- Dr (Ms) Renu [Technical Assistant (T-3), IARI, New Delhi] visited for the award of Post-doctoral Degree at NRCGEB, Tehran, Islamic Republic of Iran for taking up research work for 1 year from 15 October 2003. The expenditure was incurred by NRCGEB, Tehran (Iran).
- Dr Neeraj Rana [Scientist (SS), CIRB, Hisar, Haryana] visited for availing JSPS Post-doctoral Fellowship, 2003-2004 at the Obihiro University of Agriculture and Veterinary Medicine, Tokyo, Japan for 24 consequent months from 10 October 2003. The expenditure was incurred by JSPS Fellowship Organizers in Japan.
- Dr Anil Rai (Senior Scientist, IASRI, New Delhi) was deputed to Iowa State University, USA for training in Information Technology-Data.
- A technical team consisting of 4-expert from ICAR, viz. Dr Amerika Singh (Director, NCIPM, New Delhi), Dr Rajinder Kumar (Head, Department of Seed Technology, IARI, New Delhi), Dr S P Singh (Principal Scientist and Head, NBSS&LUP Regional Station, New Delhi)

and Dr Nagendra Sharma (Director, NDRI, Karnal) visited Mozambique to conduct feasibility study of a comprehensive Agricultural Project under ITEC Programme of MEA for 10 days w e f 5 to 14 April 2003.

- Dr K C Bansal, Principal Scientist, visited Tunisia for attending Indo-Tunisian joint Workshop on 'Application of Biotechnology in Agriculture' held on 24 and 25 April 2003 under Indo-Tunisian Programme of Scientific and Technical Co-operation of the Department of Science and Technology.
- A 4-member team consisting of Dr J C Katyal [DDG, (Education)], Shri K N Kumar [Director (DARE)], Dr Gurbachan Singh [ADG (Agronomy)] and Shri B S Dhillon [Director, NBPGR, New Delhi] visited Iran for attending the first meeting of Indo-Iran Joint Working Group on Agriculture from 19 to 21 May 2003.
- A 3-member delegation consisting Dr G Kalloo [DDG, (Crop Science and Horticulture), Dr P D Sharma (ADG, Soils), and Dr A D Diwan (ADG (Marine Fishery)] ICAR Hqrs visited Egypt from 18 to 21 May 2003 for attending the meeting of the Joint Committee on Agriculture.
- Dr K R Solanki [ADG (AF), ICAR Hqrs. New Delhi], Dr K S Gajbhiye, (Director, NBSS&LUP, Nagpur) and Dr R B Rai (Acting Director, CARI, Port Blair) visited Maldives from 23 to 27 June 2003 for development of reclaimed land on Hulhumale including greening of Island.
- Dr S M Paul Khurana (Director, Central Potato Research Institute, Shimla) visited Netherlands to attend a meeting of Indo-Dutch Working Group on Agriculture held at Hague from 30 June to 3 July 2003.
- Dr P S Naik (Principal Scientist), and Dr Sarjeet Singh (Principal Scientist and Head, Division of Seed Technology, Central Potato Research Institute, Shimla) visited Belarus from 7 to 10 July 2003 to study growing of potatoes on non-virus base.
- Dr S K Jalali [Senior Scientist (SG), PDBC, Bangalore] and Dr H R Sardana [Senior Scientist (Entomology, NCIPM, New Delhi] visited All-Russia Research Institute of Plant Protection, St. Petersburg during July 28–6 August 2003 for study in the field of 'Biological and Microbiological control of Pests and Diseases' under ICAR-RAAS Work Plan for 2002-03.
- Dr Vijendra Singh Vihan (Principal Scientist, Central Institute for Research on Goats, Makhdoom Mathura) visited All-Russia Research Institute of Veterinary Virology and Microbiology, Pokrov, Russia during 20–26 September 2003 for study in the field of 'Vaccines against sheep pox, goat pox and IBD and other emerging viral diseases like PPR' under ICAR-RAAS Work Plan for 2002-03.
- Dr Surender Lal Goswami (Principal Scientist and Officer-in-Charge, Animal Biotechnology Centre, National Dairy Research Institute, Karnal) visited All-Russia Research Institute of Veterinary Virology and Microbiology, Pokrov Russia during 20–26 September 2003 for the study of 'Production of Transgenic Animals' under ICAR-RAAS Work Plan for 2002-03.
- A 2-member delegation, viz. Dr V A Parthasarathy (Director, Indian Institute of Spices Research, Calicut), and Dr M Gopalkrishna Bhat (Acting Director, National Research Centre for Cashew, Puttur) visited Vietnam from 3 to 8 November 2003 under Indo-Vietnam Work Plan.
- Dr Prasanta Kumar Dash (Scientist, National Research Centre on Plant Biotechnology, Indian Agricultural Research Institute, New Delhi) visited Keck Graduate Institute of Applied Sciences, California, USA for training in the 'Development of Transgenic Crop Plant Resistant to Insect Pests' from 8 October to 19 January 2004.
- Dr (Ms) Aparna Chaudheri (Senior Scientist, Central Institute of Fisheries Education, Mumbai) visited University of Minnesota, USA for training in 'Development of Transgenic Fish Models to Scale Environmental Toxicity' from 11 October 2003 to 8 January 2004.
- Dr M N Venugopal (Associate Professor, Department of Fishery Microbiology, University of Agricultural Sciences, Bangalore) visited Miyazaki University, Miyazaki, Japan for training in 'Fish Biotechnology' from 12 October 2003 to 8 January 2004.
- Dr (Ms) Archana Sachdev (Senior Scientist, Indian Agricultural Research Institute, New Delhi) visited University of Western Australia, Australia for training in 'Recombinant DNA Technology in Soybean for Oil Quality' from 12 October 2003 to 11 January 2004.
- Dr T K Datta [Senior Scientist, (Biotechnology), National Dairy Research Institute, Karnal] visited Laval University, Quebec, Canada for training in 'Embryonic Stem Culture and Nuclear Transfer' from 16 October 2003 to 13 January 2004.
- Dr Sachinandan De [Scientist (SS) (Biotechnology)], National Dairy Research Institute, Karnal] visited Washington State University, Pullman, USA for training in 'Characterization of New Gene and Promoters' from 22 October 2003 to 19 January 2004.
- Dr Dinesh Kumar [Scientist (SS), National Bureau of Animal Genetic Resources, Karnal] visited Iowa State University, Iowa, USA for training in 'Isolation and Characterization of New Genes' from 16 October 2003 to 15 January 2004.
- Dr Bharat Bhushan (Senior Scientist, Indian Veterinary Research Institute, Izatnagar) visited Washington State University, Pullman, USA for training in 'Genetic Resistance to Diseases' from 29 October 2003 to 27 January 2004.
- Dr P N Jagdev (Assistant Professor, Department of Agricultural Biotechnology, Orissa University of Agriculture and Technology, Bhubaneshwar) and Dr M

N Sheela (Senior Scientist, Central Tuber Crop Research Institue, Thiruvananthapuram) visited Donald Danforth Plant Science Centre, St. Louis, USA for training in 'Molecular Biology of Biotic and Abiotic Stress and 'Development of Transgenic Cassava' respectively from 17 November 2003 to 14 February 2004.

- Dr Sanjeet Kumar, Scientist, Indian Institute of Vegetable Research, Varanasi and Dr S P Das, Scientist, NRC for orchids, Sikkim, visited All-Russia Research Institute of Vegetable Crops, Moscow during December 19-20, 2003 for study in the field of 'Molecular Marker Assisted Breeding in Cabbage and Orchid Hybridization' under ICAR-RAAS Work Plan for 2002-03.

PROTOCOL ACTIVITIES

- H E Mr Carlos Agostinho do Rosario, High Commissioner of Mozambique visited IARI, New Delhi on 28 April 2003.
- H E Mr Joaquim Alberto, President of the Repubic of Mozambique, visited IARI, New Delhi on 13 May 2003.
- H E Mr Arefaine Berhe, Agriculture Minister of Eritrea visited IARI, New Delhi on 8 May 2003.
- Dr William D Dar, Director-General, ICRISAT, Hyderabad visited ICAR (Hq) New Delhi on 9 May 2003.
- H E Mr Bounhang Vorachit, Prime Minister of Lao People's Democratic Republic visited IARI, New Delhi on 17 June 2003.
- A 4-member Jordanian delegation led by Prof. Taineh, Secretary General, Minister of Agriculture, Jordan visited IARI, New Delhi on 7 June 2003.
- A 7-member Parliamentary delegation led by His Excellency Mr Samane Vignaketh, President of the National Assembly of Lao People's Democratic Republic visited IARI, New Delhi on 23 July 2003.
- Right Honourable Pakalitha Bethuel Mosisili, Prime Minister of Lesotho and accompanying delegation visited IARI, New Delhi on 7 August 2003.
- His Excellency Mr Bharrat Jagdev, President of the Republic of Guyana visited IARI, New Delhi on 26 August 2003.
- His Excellency Dr G R Zarifian, Deputy Minister for Science Research and Technology, Government of the Islamic Republic of Iran, Dr S Rahmati, Director-General (Overseas Scholarship students) and Dr Mohammad Kafi, Director (Science and Education), Embassy of the Islamic Repulic of Iran, New Delhi visited IARI, New Delhi on 1 September 2003.
- Chinese delegation led by H E. Mr Zhang Baowen, Vice Minister of Agriculture, China visited National Research Centre on Plant Biotechnology, New Delhi on 29 August 2003.
- His Excellency Mr Yisrael Katz, Agriculture Minister of Israel and accompanying guests visited IARI, New Delhi on 10 September 2003.
- A 7-member high level delegation led by His Excellency Alh. Ahmed Sani (Yeriwah Bakura), Executive Governor of Zamfara State, Nigeria visited National Dairy Research Institute, Karnal on 4 September 2003.
- H E Mr Abdoulaye WADE, President of the Republic of Senegal and accompanied delegation visited IARI, New Delhi on 14 October 2003.
- A 6-member delegation of the Science, Technology and Environment Commission of the National Assembly (Parliament) of Vietnam led by H E Mr Nguyen Van Tri, Vice-Chairman of Committee on Science, Technology and Environment of the National Assembly visited National Dairy Research Institute/National Bureau of Animal Genetic Resources/Central soil Salinity Research Institute, Karnal and Indian Agricultural Research Institute/National Bureau of Plant Genetic Research/National Centre for Planning and Policy Research, New Delhi on the 7 and 9 October 2003 and ICAR Headquarters, New Delhi on 10 October 2003.
- H.E. Mr David Lokian, Agriculture Minister of Armenia visited IARI, New Delhi on 29 October 2003.
- H.E. Mr Lyle Vanclief, Minister of Agriculture and Agri-Food, Canada and accompanied delegation visited IARI, New Delhi on 9 December 2003.

Foreign scientists to India

- A 12-member joint delegation from Instiut National de la Recherche Agronomique (INRA) and Centre de Co-operation Internationale en Recherche Agronomique pour le Development (CIRAD), France led by Dr BertrandHervieu, President, INRA visited India for participation in the Indo-French Seminar on Agriculture held on 16 and 17 April 2003 at New Delhi.
- A 3-member delegation, viz. Mr Dhanasena Hettiarchchi (Secretary), Mr P Periyasamy (Director-General) and Prof. Gunasena (Executive Director, CARP, Sri Lanka) visited India for signing of the Work Plan for 2003-04 between ICAR-CARP, Sri Lanka during 4–11 May 2003.
- Dr Domblides Artour (Head, Department of Diagnostics, All-Russia Research Institute of Selection and Seed Growing of Vegetable Crops, Moscow, Russia visited Indian Agricultural Research Institute, New Delhi; and Indian Institute of Vegetable Research, Varanasi for study in 'Usage of Molecular Markers for Vegetable Crops Breeding' during 16–22 June 2003 under ICAR-RAAS Work Plan 2002-03.
- A 4-member delegation from All-Russia Research Institute of Agricultural Microbiology, St. Petersburg; Central Scientific Research Institute of Agrochemical Service of Agriculture, Russia and Russian Academy of Agricultural Sciences, Moscow, Russia visited Indian Agricultural Research Institute, New Delhi; and Indian Institute of Vegetable Research for study in the field of 'Development on the Production and Usage Technologies for Microbial Fertilizers Based on the Wastes of the Animal and Poultry Production, and

Processing of Organic Fertilizers with Use of Microbiological Preparations during 23 June–2 July 2003 under ICAR-RAAS Work Plan for 2002-03.

- A 4-member delegation from Russian Academy of Agricultural Sciences, Moscow; V S Pustovoit, All-Russia Research Institute for oil Crops, Krasnodar and P P Lukijanenko Agricultural Scientific Research Institute, Krasnodar visited Indian Agricultural Research Institute, New Delhi; Directorate of Oilseed Research, Hyderabad; and Indian Institute of Pulses Research, Kanpur for study in 'Development of New Methods of Genetic Testing Procedures for Wheat, Legumes and Oil Crops Yield Increases' from 22 to 28 July 2003 under ICAR-RAAS Work Plan for 2002-03.
- Two scientists from Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited National Dairy Research Institute, Karnal during 13–19 October 2003 for short-term training in the field of Dairy Farming under ICAR-CARP Work Plan for 2003-04.
- Two officials from Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited National Academy of Agricultural Research and Management, Hyderabad during 27 October to 7 November for short-term training in Administration and Finance under ICAR-CARP Work Plan for 2003-04.
- Three scientists from Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited Central Institute of Freshwater Aquaculture, Bhubaneshwar, for short-term training in Inland Fisheries/Aquaculture from 13 to 18 October 2003 under ICAR-CARP Work Plan for 2003-04.
- Eight Scientists of Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited National Research Centre on Biotechnology, Indian Agricultural Research Institute, New Delhi for short-term training in Biotechnology during 15–21 October 2003 under ICAR-CARP Work Plan 2003-04.
- A 3-member delegation of All-Russia Research Institute of Biological Plant Protection, Krasnodar, Russia visited Project Directorate of Biological Control, Bangalore for study in 'Collaboration in Biological Protection of Plants' during 14–22 October 2003 under ICAR-RAAS Work Plan 2002-03.
- Two officials from Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited National Centre for Agricultural Economics and Policy Research for short-term training in Agricultural Economics from 27 October 2003 to 3 November 2003 under ICAR-CARP Work Plan for 2003-04.
- Two officials of Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited National Dairy Research Institute, Karnal and Indian Veterinary Research Institute, Izatnagar for a short-term training in Animal Science during 1-15 November 2003 (1-7 November, at NDRI, Karnal and 8-15, November, 2003 at IVRI, Izatnagar) under ICAR-CARP Work Plan 2003-04.
- One Scientist from Nepal Agricultural Research Council, Nepal visited Sugarcane Breeding Institute, Coimbatore from 10 to 22 November 2003 for the training in the field of Sugarcane Breeding under the ICAR-NARC Work Plan for 2003-04.
- One official from Nepal Agricultural Research Council, Nepal visited Indian Agricultural Research Institute, New Delhi from 24 November to 6 December 2003 for the training in the field of 'Climate Prediction and Agriculture-Methane NO_2 Emission' under the ICAR-NARC Work Plan for 2003-04.
- Two officials from Nepal Agricultural Research Council, Nepal visited Indian Agricultural Research Institute, New Delhi from 2 to 16 December 2003 for the training in the field of Post Harvest Technology under the ICAR-NARC Work Plan for 2003-04.
- Four officials of Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited Indian Agricultural Research Institute, New Delhi for a short-term training in MIS and Visual Basic during 15-27 December 2003 under ICAR-CARP Work Plan 2003-04.
- Two officials of Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited Central Institute of Agricultural Engineering, Bhopal, New Delhi for a short-term training in Agricultural Engineering during 16-22nd December 2003 under ICAR-CARP Work Plan 2003-04.
- Eleven officials of Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited National Academy of Agricultural Research and Management, Hyderabad for a short-term training in Agricultural Research and Management during 10-22 November 2003 under ICAR-CARP Work Plan 2003-04.
- Six officials of Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited Central Institute of Post Harvest Engineering Technology, Ludhiana for a short-term training in 'Post Harvest Technology' during 17-22 November 2003 under ICAR-CARP Work Plan 2003-04.
- Four officials of Sri Lankan Council of Agricultural Research Policy, Sri Lanka visited Indian Agricultural Research Institute, New Delhi for a short-term training in Agricultural Extension during 4-17 December 2003 under ICAR-CARP Work Plan 2003-04.
- A two-member delegation comprising Dr Ramesh Kanwal, Professor and Department Chair, Department of Agricultural & Biosystems Engg. and Dr David Acker, Assistant Dean, National and Global Programmes and Professor, Department of Agricultural Education and Studies, Iowa State University, USA visited India from 13 to 17 December 2003 to review and discuss the existing Work Plan and future collaboration between ICAR and ISU.
- An eleven member Iranian delegation led by H.E. Mr. Mahmood Hojjati Najagabadi, Minister of Jihad-e-Agriculture, Islamic Republic of Iran visited India from

15 to 19 December 2003. The delegation during their stay in India, visited local institutes, NRC on Rapeseed Mustard, Bharatpur and the ICAR Institutes at Kochi.

Indian scientists to foreign countries

- Dr S K Bandyopadhyay (Project Director, Project Directorate on Food-and-Mouth Disease, IVRI, Mukteswar Campus) visited Rome, Italy for participation in the 35th Session of the 'European Mouth Diseases' from 9 to 11 April 2003.
- Dr (Ms) Malavika Dadlani (Principal Scientist, IARI, New Delhi) visited Rome for participation in the FAO meeting to finalize technical documents on 'Quality Declared Seed' from 5 to 7 May 2003.

Indo-French Seminar

An Indo-French Seminar 'To Identify Priority Areas for Collaborative Research, Germplasm Exchange, Study Visits, Training Programme' was held in New Delhi on 16 and 17 April 2003. Dr Bertrand Hervieu, President, INRA led a 12-member delegation from Institut National de la Recherche Agronomique (INRA) and Centre de Co-operation Internationale en. Recherche Agronomique pour de Development (CIRAD), France for participating in this Seminar.

- Dr A Laxminarayana (Principal Scientist, CMFRI, Kochi) visited Iran for 3 months and 15 days to render technical guidance in Shrimp Breeding and hatchery development programme from 2 to 7 June 2003.
- Dr Y S Ramakrishna [Project Co-ordinator (Agricultural Meteorology), CRIDA, Hyderabad] visited Bonn, Germany to act as an expert on the Committee of Science and Technology of UNCCD Secretariat, Germany and for participation in the Second meeting of the Group of Experts on Science and Technology from 2 to 7 June 2003.
- Dr D C Uprety (Principal Scientist, IARI, New Delhi) visited New York, USA for participation in the expert meeting on the Detection and Attribution of the Effects of Climate Change from 17 to 19 June 2003.
- Dr B S Parmar (Principal Scientist, IARI, New Delhi) visited Vicosa, Brazil to work in the Project Evaluation of activity of neem against soybean cyst nematode heteroderagly cines for 1 year.
- Dr G R Korwar [Principal Scientist (Agronomy), CRIDA, Hyderabad] visited Cotonon, Benin for participation in the Fourth Asia-Africa Forum on 'Combating Desertification' from 24 to 27 June 2003.
- Dr N K Tyagi (Director, CSSRI, Karnal) visited Uzbeckistan (Tashkent) for participation in the FAO Regional workshop 'Management and Rehabilitation of Salt Affected and Fertility Declined Soils for Sustainable Agriculture and Food Security from 7 to 11 July 2003.
- Dr Bhupinder Singh (Scientist, IVRI, Regional Station, Palampur) visited Yezin-Myanmar as on follow-up Expert Mission in the field *in-vitro* food evaluation methodologies, data analysis and interpretation' from 29 September 2003 to 4 October 2003.
- Dr M S Sachedev (Principal Scientist, IARI, New Delhi) visited China for participation in the RC Meeting of IAEA programme on 'Integrated Soil Water and Nutrient Management for Sustainable Rice-Wheat Cropping Systems of Asia from 8 to 12 September 2003.
- Dr V K Taneja [DDG (Animal Sciences), ICAR] visited Lahore to participate in the APHCA meeting as a resource person from 25 to 29 August 2003.
- Dr G V S Saiprasad (Scientsit, IIHR, Bangalore) visted INIBAP, France to work on INISA Programme Structural and functional genomics of BSV sequence integration into Musa genome for 14 months from 7 September 2003 to 6 November 2004.
- Dr (Ms) Pramila Sachdev (Principal Scientist, IARI, New Delhi) visited Greece to attend IAEA programme on 'Classification of Soil System on the Basis of Transfer Factors of Radionuclides from Soil to References Plants' and also for participation in a related workshop on 'Practical Integrated Approach to Agricultural Countermeasures for Enhancing Food Safety and Security' following a nuclear or radiological emergency' from 22 to 29 September 2003.
- Dr R T Patil (Principal Scientist, CIAE, Bhopal) visited Washington State University, USA to work with Dr Juming Tang, Professor and IMPACT Research Fellow on extrusion cooking to produce very special purpose foods from the advanced versions of extrusion.
- Dr S C Gupta (Principal Scientist, NBAGR, Karnal) visited Vienna for attending the International Conference organized by FAO/IAEA on 'Gene-based Technologies for Improving Animal Production and Health in Developing Countries'.
- Dr P Das [DDG (Agricultural Extension), ICAR] and Dr S Senthilkumaran (Associate Director, MS Swaminathan Research Foundation, Chennai) visited SAIC, Dhaka, Bangladesh on deputation for presenting country paper in their respective topic in the areas of ICT in the Regional Workshop from 22 to 23 October 2003.
- Dr Mruthyunjaya (Director, NCAP, New Delhi) visited Dhaka, Bangladesh for participation in the 17th Meeting of the Governing Board of SAIC and Regional Workshop on ICT from 19 to 23 October 2003.
- Dr K V Prabhu (Senior Scientist, IARI, New Delhi) visited Kualalumpur, Malaysia to act as an FAO/TCDC Expert on Post-release Monitoring for 6 weeks which includes 3 weeks assignment at home under the project TCP/MAL/290 w e f 27 September 2003 for 6 weeks.
- Dr V K Taneja [DDG (Animal Sciences), ICAR] and Dr B R Yadav (Principal Scientist and National Fellow, NDRI, Karnal) visited Vienna, Austria for participation in the International Atomic Energy Agency/FAO International Conference on Gene-based Technologies

for Improving Animal Production and Health in Developing Countries from 6 to 10 October 2003.

- Dr M S Sachdev (Nuclear Research Laboratory, IARI, New Delhi) visited Mongolia as an expert assignment of International Atomic Energy Agency to review Agriculture Sector programme for preparation of proposals under the project HRD and NTSOB from 27 to 31 October 2003.
- Dr (Ms) Mathala J Gupta [Scientist, Agriculture Structure and Profess Engineering), IARI, New Delhi] visited Penn State University, USA as visiting scholar position in the area of Seansors for Food Safety and Quality for 12 months.
- Dr S P Tewari [ADG (Seed), ICAR] visited Rome, Italy for participation in the Technical Workshop on Integrating Information Gathering on 'Plant Genetic Resources for Food and Agriculture and also in the Second Session of the Inter-governmental Technical Workshop Group on Plant Genetic Resources from 4 to 7 November 2003.
- Dr Rajendra Kumar (Principal Scientist, IARI, New Delhi) visited Thailand for participation in the Training Workshop on 'Electrophoretic and PCR-based Methods for Varietal Verification and GMO' from 25 to 29 November 2003.
- Dr A K Jain [ADG (ARIS), ICAR] visited Bangkok, Thailand for participation in the Expert Consultation on 'Strengthening Regional Agricultural Information System' Role of ICT in ARD at Asian Institute of Technology from 1 to 3 December 2003.
- Dr R K Pathak (Director, CISH, Lucknow) visited Thailand for participation in the FAO Conference from 3 to 8 November 2003.
- Dr J S Samra [DDG (NRM), ICAR] visited Bangkok, Thailand for participation in the Regional Workshop on 'Agro-Ecological Zoning/Land Resources Information Systems (LRIS) as decision support tool in Agricultural Development and Disaster Management in Asia and Land Degradation Assessment Drylands (LADA) ' from 10 to 14 November 2003.
- Dr A Laxminarayana (Chief Training Organiser, CMFRI, Kochi) visited Mauritius for 1 year as an Adviser in Fisheries.

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7. Agricultural Scientists' Recruitment Board

The analytical information pertaining to the major initiatives and achievements of the Agricultural Scientists' Recruitment Board (ASRB) from 1 April 2002 to 31 March 2003 is given here.

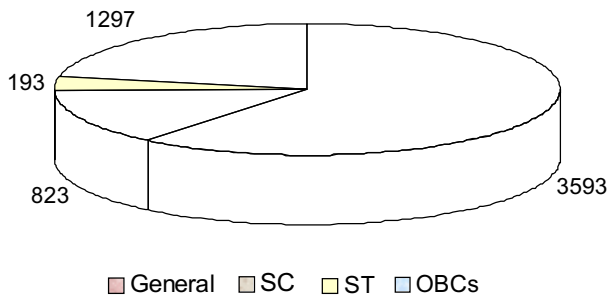
Recruitment by examination

The Limited Departmental Competitive Examination for Section Officers/Assistants at the ICAR Headquarters was held during 8-12 October 2002. The remaining work of the examination will be completed during the year 2003-2004.

The result for appointment of 102 candidates (General 49, SC 20, ST 12 and OBCs 21) as Scientists in the Agricultural Research Service (ARS) on the basis of examination conducted in October 2001 was declared on 1 August 2002 and sent to the Council.

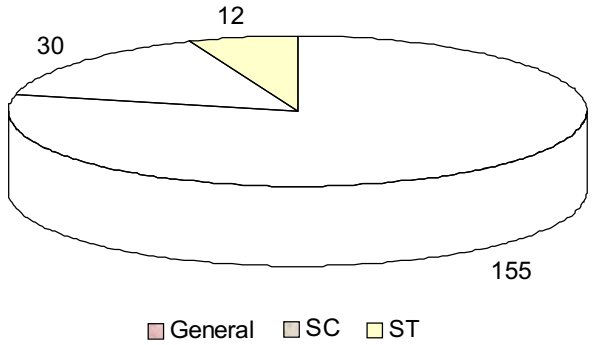
As a result of National Eligibility Test (NET) examination, conducted in October 2001, 5,906 candidates (General 3,593, SC 823, ST 193 and OBCs 1,297) were declared on 6 May 2002 to have qualified provisionally the NET for appointment as Assistant Professor/Lecturer in State Agricultural Universities. List of provisionally qualified candidates has been notified in the *Employment News* and Internet.

Provisionally qualified candidates (Assistant Professor/Lecturer) in SAUs



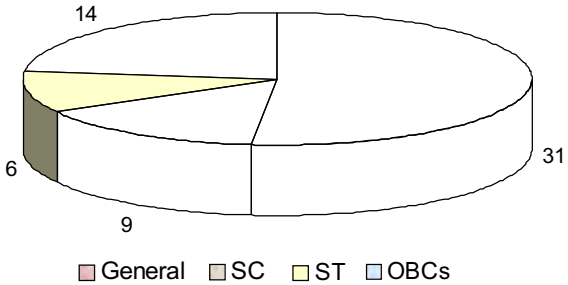
The result of Senior Research Fellow (SRF) examination conducted in October 2001 regarding award of SRF to 197 candidates (General 155, SC 30 and ST 12) was declared on 23 October 2002 and sent to the Education Division of the ICAR.

Award of Senior Research Fellowship to candidates on the basis of SRF examination



The result for appointment of 60 candidates (General 31, SC 9, ST 6 and OBCs 14) as Scientists in the ARS on the basis of examination conducted in December 2001 for NEH Region and Andaman and Nicobar Islands was declared on 5 September 2002 and sent to the Council.

Candidates qualified the ARS examination as Scientists, conducted for NEH Region and A and N Islands



Limited Departmental Examination for Stenographers (Grade-II)

Candidates applied for the examination	41
Candidates appeared in the examination	35
Candidates called for skill test	30
Candidates selected	7 (General 6, SC 1)

The Limited Departmental Competitive Examination for Stenographers (Grade-II) at the ICAR Headquarters was held on 3 October 2001 and the result was declared on 2 July 2002.

Recruitment by interview

Quantum of Work: The Board received requisitions from the ICAR for 38 posts during the year and requisitions for 40 posts were carried-over from the previous year. Against a total number of 78 posts, action to advertise could not be taken for 32 posts due to non-receipt of ICAR's approval. The Board issued 2 advertisements for 46 posts during the year. Besides the advertised 46 posts during the year, earlier year advertised 64 posts were also taken for action during the year. Accordingly out of total 110 (46 + 64), 38 were taken up during the year for recruitment. In 15 cases, the Board recommended re-advertisement due to poor response of eligible candidates, as screened by the expert committees/ Board. The remaining 57 posts could not be taken up during the year due to lack of Council's clearance due to certain reasons, viz. Score Card System and Review of Cadre Strength of Scientists, etc. Subsequently, requisition of 3 posts was withdrawn by the Council. Out of 38 posts for which interviews held during the year, in 3 cases no candidate was found eligible after interview.

Category-wise break-up of these posts is as:

(i)	Deputy Director-General and Directors of National Institutes	Nil
(ii)	Assistant Directors-General, Directors of Institutes, Project Directors and Joint Directors of National Institutes	15
(iii)	Project Co-ordinators and Zonal Co-ordinators/ Joint Directors of Institutes	7
(iv)	Head of Divisions/Regional Stations	23
(v)	Principal Scientists	Nil
(vi)	Senior Scientists	1
	Total	46

Interviews and Selection: For the 113 (excluding 3 posts withdrawn by the Council) posts, for which recruitment process was completed, 565 applications were received, out of which 192 candidates were called for interview.

Recruitment by interview aided by practical test or written test: Tests are resorted to in cases where the proficiency of candidates can be ascertained more purposefully or where this can be advantageously used as a screening method for/in aid of interview. During the year no such test was held for any post.

The Board were unable to find suitable candidates for appointment to 3 posts. For 15 posts no candidate was found eligible to be called for interview.

Category-wise break-up of 113 posts for which recruitment process completed/recommended for re-advertisement etc.

(i)	Deputy Director-General/ Directors of National Institutes	1
(ii)	Assistant Directors-General, Directors of Institutes/Project Directors/Joint Directors of National Institutes	25
(iii)	Project Co-ordinators and Zonal Co-ordinators/Joint Directors of Institutes	9
(iv)	Heads of Divisions/ Regional Stations	3
(v)	Principal Scientist	0
(vi)	Senior Scientists	11
(vii)	Technical	1
(viii)	Posts recommended for re-advertisement	3
(ix)	Posts held up for the sake of Council decision	57
(x)	Posts withdrawn	3
	Total	113

During the year, recruitment action for 3 posts was terminated after advertisement but before interview, on request of the Council.

Reforms

With a view to sharp focus during interview and to gauge the candidates in their areas of strength, the concept of asking Work Plan for next 5 years has been further strengthened and revised, and the candidates are asked to submit:

(i) A brief note (note more than one page) reviewing the work done by the candidate during the last 10 years, highlighting the achievements and accomplishments during the period including technology developed, project completed, contribution to physical and infastructural development, interdisciplinary programme formulation and participation in research activities, mobilization of external funding for projects etc.

(ii) A Work Plan (in not more than three pages) on how the candidate proposes to organize the activities of the post for which he/she is an applicant. The information provided may include new research projects/ thrust areas of work that he/she proposed to introduce, physical and infrastrutural facilities proposed to be developed, linkages with other research units, and development departments proposed, as well as the expected outcome from these changes. The plan should be practical and realistic in nature and should be achievable within a period of 5 years and feasible within the available

Use of Hindi

- Adequate arrangements were made to promote progressive use of Hindi in the office of the Board. To ensure compliance of Official Language Policy of the Central Government/ ICAR, and to fulfil the targets fixed in the annual official language programme, a Hindi Translator is exclusively attending to the related work.
- Majority of Officers and staff working in the Board have acquired working knowledge of Hindi.
- Representative of the Board participates in the quarterly meetings of the Official Language Implementation Committee of the ICAR headquarters where the progress made in the use of Hindi in the official work of the Board is reviewed.
- Hindi version of the examination rules, notice, syllabi, instructions to candidates, admission certificate, test booklets, answer sheets, application forms, attendance sheets and attendance lists, etc. were also printed.
- Hindi version of all the advertisements issued by the Board were prepared and published both in Hindi and English in the leading newspapers of the country including *Rozgar Samachar*.

resources of the institute. In preparing these plans, the past and present achievements, as well as technology developed may be critically reviewed and the critical gaps identified. The annual report, department as well as project reports may be consulted for developing this plan.

To bring total objectivity and transparency in the selection process, a score card system has been developed by appointing a committee of experts and sent for approval of the competent authority.

Recruitment Rules and Services Rules

The cases pertaining to following posts were received for framing amendments in the recruitment rules:

(i) LDC, UDC, Assistant, Stenographer Grade-III and PA

(ii) Press and Editorial Staff.

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8. *Publications and Information*

It is imperative on the part of any research organization to make the results of researches conducted and technological innovations made known to its end-users. This could be possible only through a strong and well-organized communication system.

The Indian Council of Agricultural Research, with a network of research institutes, directorates, research centres and state agricultural universities spread over the country, conducts and coordinates research, education and training activities on agriculture, animal husbandry and fisheries.

With a view to disseminate the agricultural information for the benefit of farmers, scientists, researchers, extension workers, students and the general public, the ICAR, through the Directorate of Publications and Information of Agriculture, brings out a number of periodicals and books both in English and Hindi. These publications match with international standards in both quality and content and have been accepted by the international publishing organizations.

Recently the DIPA added another feather to its cap by adopting Digital Designing Process for all its Publications. It has also developed 5 CDs on on-going projects of ICAR institutes, e-book on Handbook of Agriculture, photographic material of the ICAR, ICAR Vision 2020 and All India Coordinated Research Projects Database.

PUBLICATIONS

English Editorial Unit

During 2003-04, the Indian Council of Agricultural Research brought out 50 publications in English including *Textbook of Textiles and Clothing*, *Textbook of Plant Nematology*, *Makhana*, *Rainfed Agriculture in India* and *Veterinary Helminthology*. Besides DARE (ICAR Annual Report 2002-03), a number of miscellaneous and ad-hoc publications like *Empowerment of Women in Agriculture*, *Validation of Indigenous Technical Knowledge in Agriculture*, *Self-sufficiency in Foodgrain Production* were also brought out.

In addition to books, the DIPA also brings out two monthly scientific periodicals i.e. *the Indian Journal of Animal Sciences*, *The Indian Journal of Agricultural Sciences* and *The Indian Journal of Animal Sciences* which are indexed and abstracted internationally. It also brings out a popular magazine i.e. *Indian Farming* (monthly) and a semi-technical magazine, *Indian Horticulture* (quarterly). In addition, three quarterly newsletters viz. *ICAR News*, *ICAR Reporter* and *ARIS News* are also brought out regularly.

ICAR publications brought out by the Directorate of Information and Publications of Agriculture both in English and Hindi

During the period under report, *Indian Farming* brought out a special number on World Food Day (October 2003), *Indian Horticulture* brought out a special number on Exploring Export Potential of Agriculture (April-June 2003). *ICAR News* is an important newsletter of the Council through which research information pertaining to innovations made, new technologies developed and new crop varieties released both at the institutes and the headquarters is disseminated. The profiles news of institutes gives an insight into their functioning. It has a wide readership both in India and abroad. *ICAR Reporter*, a in-house quarterly newsletter, reports all important activities of the Council including meetings, seminars, conferences, workshops, international linkages, reforms and personnel both at the headquarters and the institutes. The Council also brought out 4 issues of *ARIS News*, which deals with information and communication technology.

Hindi Editorial Unit

During the year under report, Hindi Editorial Unit brought out 10 publications including books, bulletins and reports, in addition to its regular periodicals, viz. *Kheti* (monthly), *Phal-Phool* (quarterly), *Krishi Chayanika* (quarterly) and *ICAR Reporter* (quarterly).

Kheti and *Phal Phool* are popular magazines which cater to the needs of farmers and students. *Kheti* publishes articles relating to agriculture and allied vocations while *Phal Phool* publishes articles pertaining to fruits, vegetables, spices and medicinal plants.

During the period under report, *Kheti* brought out 4 special numbers on *Environment* (June 2003); *World Food Day* (October 2003); *Soil Reclamation* (Feb 2003) and *New Techniques in Potato Production* (September 2003). It also started new columns for the benefit of farmers.

Krishi Chayanika, an informative agriculture digest publishes information on the latest achievements/ researches carried out in India and abroad in its columns. Latest agriculture information available on various websites of international agricultural organization is also included in the regular columns.

In addition to DARE/ICAR Animal Report (2002-03), the Hindi Editorial Unit brought out 7 important books such as *Moti Samvardhan, Krishi Vipran, Greenhouse Prodhyogiki, Jadibootiyonki Kheti, Dhan, Sugandhi Paudhonki Kheti, Chuninda Krishi Prodhyogiki*.

Production Unit

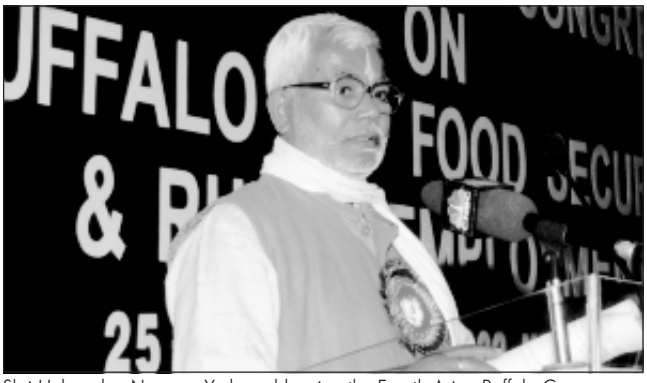
The Production Unit plays a key role in the functioning of the DIPA. It is responsible for management of all the aspects of printing and publishing books and journals, including time bound publications for the headquarters of the Council.

The major activities of production unit:
Administrative planning and management of printing of Council's publications/journals; maintaining close liaison with Editorial Units/Art Unit and Business Unit for speedy publication and distribution of publications.
The unit examines the technical aspects of paper quality and processing it for procurement and responsible for proper consumption of paper and certification of the paper consumption accounts.

All the monthly journals (3 in English and 1 in Hindi) were printed well in time maintaining the desired print quality. The Council's prestigious quarterly newsletters '*ICAR News*', '*ICAR Reporter*' and '*ARIS News*' were printed well in time using the state-of-art print technology to achieve the desired print quality, keeping in view their national and international readership. Besides, 50 publications in English and 10 in Hindi were printed maintaining the high class print standards.

Special care is taken for the printing of annual publications of the Council required for AGM of ICAR Society such as DARE/ICAR Annual Report in English and Hindi. Agenda Notes, Speeches of Agriculture Minister and DG, ICAR, ICAR Budget Book, etc. The time bound publications/certificates/citations/invitation cards meant for ICAR Awards Ceremony were also produced nicely within a short-time during the reported period.

The selected important publications brought out in English were '*Textbook of Textiles & Clothing*', '*Textbook of Plant Nematology*', '*Makhana*', '*Rainfed Agriculture in India*' and '*Veterinary Helminthology*'. Some other miscellaneous publications brought out in English were '*Empowerment of Women in Agriculture*', '*Validation of Indigenous Technical Knowledge in Agriculture*', '*Self-sufficiency in Foodgrain Production*' and *International Training Programme*. Some Hindi publications '*Sugandhiyon Podhon Ki Kheti*', '*Greenhouse Prodhyogiki*', '*Dhan*', '*Jadibootiyonki Kheti*' and '*Prachin Bharat mein Krishi Gyan*', poster for Hindi Week etc. were printed. Assistance was provided to NATP in production of various publications brought out by them during the year. Education Division was also assisted in the production of various curricula and bulletins. For Hindi section of the Council, various certificates and citations were designed and produced in Hindi. The production unit also looks after the electronic production processes of DIPA. The unit is consistantly adopting and implementing the modern printing techniques. In this process, the unit has adopted CtP (Computer to Plate) technology for the printing of multi-coloured high quality publications of ICAR. The staff of Production Unit were trained for enhancing their production capabilities. The unit has provided training to the students of Polytechnic in the area of advanced Production Techniques.



Shri Hukumdeo Narayan Yadav addressing the Fourth Asian Buffalo Congress on Rural Employment and Food Security held in New Delhi from 25–28 February 2003

Art and Photo Unit

The Art Unit of the DIPA plays an important role in designing the illustrations of publications and other publicity material including magazines, newsletters, reports and books etc. It has been striving hard to improve the quality of designs by adopting newer techniques. In addition to digitizing with database all the photographs on web page of the ICAR, the Art Unit also made on-line delivery of photographs to international organizations like FAO.

The Art Unit also made designs for the special numbers brought out on the occasion of national and international conferences which were much appreciated.

The photography unit, which has a good collection of photographs, provides visual support to the publications brought out by the DIPA. It provides colour photographs

and transparencies for various publications of ICAR. It also supplies photographs for exhibitions organized/ anticipated by ICAR. During the period 2003-04, it covered the visits of dignitaries of other countries, press conferences of the Union and State Ministers of Agriculture and the DG, ICAR. Besides, it also covered important MoUs and MoAs signed by the Council with international organizations.

Business Unit

Business Unit looks after the advertisement, distribution and marketing of ICAR publications, both priced and unpriced. This unit generates revenue for ICAR by marketing the publications through its large network among farmers, agricultural scientists, research scholars and students. This unit also distributes the important publications like ICAR/DARE Annual Report, ICAR News, ICAR Reporter, ICAR Budget Book and Telephone Directory etc. to Parliament and other dignitaries regularly.

During the period till December 2003, it earned total revenue of Rs 4.78 million approximately from the sales and advertisements. It is noteworthy that out of Rs 2.5 million received from ICAR Revolving Fund for publication of books, an amount of Rs 1.8 million has already been refunded to ICAR headquarters.

To augment the sale of ICAR publications, vigorous efforts were made by participating in Kisan Melas and organizing Book Exhibitions at a number of places throughout the country. During the year, the Business Unit participated in seven agricultural fairs/exhibitions including India International Trade Fair, New Delhi and National Science Congress, Chandigarh. It has also made tie-up with ICAR institutes and agricultural universities for sale of ICAR publications through Agricultural Technology Information Centre (ATIC).

Agricultural Research Information Centre (ARIC) Unit

Agricultural Research Information Centre (ARIC) is the central source of research information of the Council. During 2003-04, it collected and processed information of A.P. Cess Fund Schemes, Research Projects (AICRPS), National Agricultural Research Database. ARIC as a National Input Centre for AGRIS of FAO submitted ARIS Inputs. Selective Dissemination of Information (SDI) and Document Delivery services were provided to about 150 scientists, research scholars and students. ARIC brought out the biannual publication "Directory of Conferences, Seminars, Symposia, Workshops in Agriculture for the users of ICAR and SAU system. It also brought out ICAR Telephone Directory–2003 and 2004. The major achievements of ARIC unit are:

Development of National Agricultural Research Database - NARD: Agricultural Research Information centre of DIPA is working as Coordinating Unit for the development of National Agricultural Research Database and ICAR institutes are working as the Input Centre. This database covers the bibliographical details of all research information published in India in the fields of agriculture and allied sciences. For this database, minimal editing norms are being followed to provide the information on time. DIPA has procured information on 3000 inputs to the NARD during the reporting period. The information collected under NARD inputs were also submitted to FAO as AGRIS inputs for inclusion in AGRIS database.

A training manual for providing training and data entry guidelines for NARD database to the input centres was prepared by ARIC. This document is provided to the input centres while offering training programmes. This manual will be helpful to the input centres for providing NARD inputs of good quality. The subject categorization scheme manual was also prepared as per the AGRIS categorization standards and was published by DIPA with the prior permission from FAO for supplying this to the input centres of NARD database. This manual is useful for allotting the appropriate subject category to the NARD input.

The Indian Agricultural Sciences Abstracts: The First issue of "The Indian Agricultural Sciences Abstracts" was brought out by DIPA in March, 2003 and released for the use of scientific community.

This publication covers all aspects related to agricultural sciences. Each issue of the abstracting journal contains 500-600 abstracts. Entries are arranged alphabetically as per the FAO Category Scheme. Author and subject indexes are also provided at the end of the publication. The entries have been arranged under different subject headings to facilitate reference by users of varied interests according to their subject preference. Further the keywords and author indexes make searching very specific and more easier. The entries include bibliographical details like author name, affiliation, title, journal name, volume and issue number, page, publication date, keywords and author abstract.

The Indian Animal Sciences Abstracts: The first issue of "The Indian Animal Sciences Abstracts" was brought out by the DIPA in June 2003 and released for the use of scientific community. This publication covers all aspects related to animal sciences. Each issue of the abstracting journal contains 200-300 abstracts. Entries are arranged alphabetically as per the FAO Category Scheme. Author and subject indexes are also provided at the end of the publication. The entries have been arranged under different subject headings to facilitate reference by users of varied interests according to their subject preference. Further the keywords and author indexes make searching very specific and easier. The entries include bibliographical details like author name, affiliation, title, journal name, volume and issue number, page, publication date, keywords, author abstract.

ARIS News: Four half-yearly issues of ARIS News of 2002 and 2003 were brought out by ARIC during the reporting period.

Workshop and Training Organized: A training programme/workshop with the funding support of NATP

was organized under the ICAR-CABI Work Plan from November 17-28 2003. The training was conducted by Mr Robert Taylor, Expert from CAB International and Mr Hans Raj, Information Systems Officer of the Indian Council of Agricultural Research. The review workshop (17-19) November 2003, involving the English and Hindi Editorial Units as well as ARIC, Business, Production Units of DIPA followed by a training course on Building of National Agricultural Research Database for fresher group (20-23, November 2003) and advanced Training Course on Development of National Agricultural Research Database (NARD) from 24-28 November 2003. The participants for this workshop and training course were selected from different units of DIPA, Librarian and Documentation Officer of CTRI, CRIDA, DOR, IARI, IASRI, NCAP, NBAGR, NIRJAF, CRIJAF. The above institutes will serve as input centres and trainers in their respective zones to have a multiplier effect in the organization.

A workshop was also organized at DIPA to enhancing the editorial capability of DIPA staff under the CABI consultant.

Apart from this, 25 persons of different ICAR institutes and professional societies were given training on input process as per AGRIS Methodology for National Agricultural Research Database. These trainings were organized by ARIC at different ICAR institutes and fetched a very good response from the participants. Now these Input Centres have started sending inputs for inclusion in the national database i.e. NARD. All the participants of trainings were given a copy each of the NARD Manual, AGROVOC Thesaurus in CD and Subject Categorization Scheme for use by them while indexing Research Information for NARD.

CD of All-India Coordinated Research Projects Database (AICRP): ARIC developed database on 82 AICRPs covering project title, project code, PC name, centres, objectives, date of start, date of completion, budget, manpower, research achievements, AGROVOC keywords, technologies developed, QRT recommendations, publications, abstract. The AICRP-CD with search facilities was released during the AGB Meeting of the ICAR Society held on 16 July 2003. This CD is useful for monitoring the AICRPs at the Headquarters of the Council and acts as national information source.

CD of DARE/ICAR Annual Report 2002-03: ARIC has developed CD on DARE/ICAR Annual Report 2002-03 for easy navigation of different chapters with PDF links to each chapter.

ICAR Research Projects Information—Research Project Files database (RPFs): Under this activity, ARIC has compiled information on 700 research projects in addition to 2000 projects already compiled. Updating of the information is in progress and second volume of RPF CD will be released soon.

International Cooperation: ARIC as a National Input Centre of AGRIS, indexed bibliographic inputs from Indian Agricultural Periodicals and submitted to FAO for inclusion in AGRIS database.

SAIC: ARIC as a National Focal Point of SAARC Agricultural Research Information Centre (SAIC) compiled information for Directory of Agricultural Institutions and Directory of Agricultural Scientists and Technologists in SAARC countries and submitted the information to SAIC, Dhaka during the reporting period.

Checking Duplication Efforts: ARIC scrutinized about 650 adhoc research project proposals received from different subject-matter disciplines in order to avoid the duplication of research efforts. These proposals were checked from the database of sanctioned adhoc schemes available at this centre.

Web page updation: Web page of DIPA was updated with the free text search facilities for books, journals, adhoc schemes. ICAR telephone directory was made available online. Information of 220 books was updated. Also, the information about title, author and abstract of articles of English Journals of ICAR, including full text of issues of *ICAR News* and *ICAR Reporter* were also included.

DIPA Library Activities: The DIPA Library received about 2200 books Annual Report of ICAR institutes and SAUs. It provided services to the scientists, students and the DIPA staff.

ICAR Library

The ICAR Library has a big collection of publications for reference and information services. It added 577 new technical books to the present 2000 publications during the year under report. About 15,000 readers visited the library for consultation. The library also extended information support for consulting the database of the centre for Agriculture and Biosciences International (formerly Commonwealth Agricultural Bureau International). The document delivery service was extended to individuals and libraries against specific requests for supply of Indian documents from AGRIS database.

The Hindi Library at the headquarters purchased about 300 books and subscribed to a number of Hindi magazines. It also issued 6000 books to its members.

In addition, it has been making payment of newspaper bills to the ICAR officers who get newspapers at their residence.

The ICAR Library has also taken up the job of laminating the identity cards of the retiring and retired staff.

Publicity and Public Relations Unit

The publicity and public relations unit of ICAR plays an important role in dissemination of information on agriculture and allied subjects to the print and electronic media. For effective communication of research findings to the farmers and the general public, the PR unit maintains liaison with the media persons. It also organizes press conferences of the Union Agriculture

Shri Rajnath Singh, Hon'ble Agriculture Minister discussing with Chinese Delegation in New Delhi

Dr Mangala Rai, Director-General, ICAR visiting the Agri-Expo Exhibition held on 10 March 2003 at Pragati Maidan

Minister, Minister of State for Agriculture, DG, ICAR, DDGs and Directors of various institutes.

Liaison with print and electronic media: During the period under report, the unit issued publicity materials to various newspapers, agricultural magazines and electronic media to give a wide publicity to the events at national and international level. This unit also provided relevant newspaper cuttings to the DG, ICAR and other senior officers of the council regularly.

Publicity through print and electronic media: The PR unit issued a number of press releases and articles, organized press conferences and conducted press tours to various ICAR institutes to disseminate information relating to their activities and achievements. The unit also developed video films on the achievements of the ICAR and on important issues of concern to farmers and distributed them to various ICAR institutes, KVKs, Extension Directorates of SAUs for dissemination of information to farmers.

Participation in exhibitions: Organizing exhibitions is also a part of publicity activities of the PR unit. The unit organized exhibitions and displayed items relating to agricultural development to spread awareness of new varieties, technologies etc. During the year 2003-04, the council organized and participated in important exhibitions.

Reception and monitoring of public grievances: The CP & PRO functions as Staff Grievances Officer under the direct supervision of Secretary, ICAR and issues instruction to the officials for speedy disposal of the staff grievances.

Public Information and Facilitation Centre: To bring greater transparency through better access to information, NICNET-based Public Information and Facilitation Centre has been established jointly by the departments of the Ministry of Agriculture-DARE/ICAR, Department of Ministry of Agriculture and Cooperation and Department of Animal Husbandry and Dairying at Krishi Bhavan. It provides information of central and state government agencies. CP&PRO is the nodal officer of the centre.

National Agricultural Science Museum: A National Agricultural Science Museum is being established at the Chaudhary Devi Lal Agricultural Science Centre in IARI, Pusa Campus. After completion of the second phase, this will be opened to farmers, general public and scientists. The work is being carried out in consultation with the PR unit.

❑

Appendices

(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 to 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 at 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 Agri-cultural 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	Scale of pay (in rupees)	Santioned strength
A	Secretary	26,000 (Fixed)	1
A	Additional Secretary (DARE)/Secretary, ICAR	18,400 – 24,400	1
A	Financial Adviser and Additional Secretary	18,400 – 22,400	1
A	Director	14,300 – 18,300	1
A	Senior Principal Private Secretary	12,000 – 16,500	1
A	Under Secretary	10,000 – 15,200	5
A	Principal Private Secretary	10,000 – 15,200	1
B	Assistant Director (Official Language)	7,500 – 12,000	1
B	Private Secretary	6,500 – 10,500	1
B	Section Officer	6,500 – 10,500	3
B	Assistant	5,500 – 9,000	4
B	Personal Assistant	5,500 – 9,000	4
C	Junior Hindi Translator	5,500 – 9,000	1
C	UDC-cum-Cashier	4,000 – 6,000	1
C	UDC	4,000 – 6,000	2
C	Steno Grade 'D'	4,000 – 6,000	5
C	UDC-Hindi Typist	4,000 – 6,000	1
C	Staff Car Driver	4,000 – 6,000	1
C	LDC	3,050 – 4,590	3
D	Daftry	2,550 – 3,540	1
D	Peon	2,440 – 3,200	5
	Total		44

Names of the Important Functionaries

S.No.	Name	Designation
1.	Dr Mangala Rai	Secretary, DARE/DG, ICAR
2.	Ms Shashi Misra	Additional Secretary, DARE/Secretary, ICAR
3.	Mr Gautam Basu	Additional Secretary/Financial Adviser, DARE
4.	Dr K N Kumar	Director, DARE up to 30.9.2003
5.	Mr R S Bhandari	Senior Principal Private Secretary
6.	Mr G Chandra Sekhar	Under-Secretary
7.	Mr Vijay Kumar	Under-Secretary
8.	Ms Vandana Sharma	Under-Secretary
9.	Mr B J Bhattacharya	Under-Secretary
10.	Mr Madan Lal	Under-Secretary
11.	Mr D K Chhatwal	Under-Secretary
12.	Ms Geeta Nair	PPS

APPENDIX III

ACTIVITY PROGRAMME CLASSIFICATION

The Budget Estimates (BE) and Revised Estimates (RE) of DARE and ICAR (Plan, Non-Plan) for 2002–2003 are Rs 1,498.80 crores and Rs 1,448.80 crores respectively and BE for 2003–2004 (Plan and Non-Plan) is Rs 1,510.92 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 2002–2003 and BE for 2003–2004 are given in Table 1. This excludes the payment to the ICAR.

Table 1 Budget estimates and revised estimates of DARE and ICAR

(Rupees in lakhs)

Item	Budget Estimates 2002–2003		Revised Estimates 2002–2003		Budget Estimates 2003–2004	
	Plan	Non-Plan	Plan	Non-Plan	Plan	Non-Plan
Major Head '3451'						
090 Secretariat						
Major Head '2415'	–	105	–	105	–	120
80 -General						
International Co-operation						
(010032) -India's membership contribution to Commonwealth Agricultural Bureau	–	10	–	10	–	10
(020002) -India's membership contribution to Consultative Group on International Agricultural Research	–	343	–	343	–	358
(030032) -Other Programmes	50	–	50	–	50	–
(040032) -India's contribution to Asia Pacific Association of Agricultural Institutions	–	5	–	5	–	5
(050032) -India's contribution to NACA	–	10	–	10	–	12
(060032) -India's contribution to CGPRT	–	5	–	5	–	5
(070032) -India's contribution to Seed Seed Testing Association	–	1.5	–	1.5	–	1.5
(080032) -ISHS Belgium	–	0.50	–	5.0	–	1.5

Table 2 Details of Financial Outlay

Demand No. 2. Department of Agricultural Research and Education

(Rupees in crores)

	Major Head	2002–2003 Budget			2002–2003 Revised			2003–2004 Budget		
		Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total
A.Budget Allocation, net of recoveries										
Revenue		775.00	723.80	1,498.20	725.00	723.80	1,448.80	775.00	735.92	1,510.92
Capital	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total		775.00	723.80	1,498.80	725.00	723.80	1,480.50	775.00	723.92	1,510.92
1. Secretariat - Economic Service Agricultural Research and Education Payments to ICAR	3451	0.00	1.05	1.05	0.00	1.05	1.05	0.00	1.20	1.20
2. Crop Husbandry										
2.1 Payments of net proceeds of cess under Agricultural Produce Cess Act, 1940	2415	0.00	40.00	40.00	0.00	40.00	40.00	0.00	40.00	40.00
2.2 Other Programmes of Crop Husbandry	2415	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.2.01 Crop Sciences	2415	125.50	163.50	289.00	124.10	163.50	287.50	127.00	166.00	293.00
2.2.02 Horticulture	2415	58.30	64.10	122.40	53.00	64.10	117.10	57.00	64.50	121.50
2.2.03 Agricultural Extension	2415	94.30	00.00	94.30	88.00	0.00	88.00	90.90	0.50	91.40
2.2.04 Agricultural Education	2415	72.00	4.00	76.00	65.60	4.00	69.60	71.00	4.10	75.10
2.2.05 Economics, Statistics and Management	2415	3.00	12.15	15.15	2.50	12.15	14.65	2.50	11.50	14.00
2.2.06 Agricultural Engg.	2415	21.20	21.00	42.20	19.20	21.00	40.20	21.00	22.00	43.00
2.2.07 ICAR Hq Admn. including ASRB and DIPA	2415	19.50	185.25	204.75	4.50	185.25	189.75	5.00	175.00	180.00
2.2.08 National Agril. Technology Project	2415	151.05	0.00	151.50	147.50	0.00	147.50	165.60	0.00	165.00
2.2.11 Indo-French Proj. on Seabass Breedings and Culture	2415	0.50	0.00	0.50	0.50	0.00	0.50	1.00	0.00	1.00
Total other Programme of Crop Husbandry		545.80	450.00	995.80	504.80	450.00	954.80	541.00	443.60	984.60
Total Crop Husbandry		545.80	490.00	1,035.80	504.80	490.00	994.80	541.00	483.60	1024.60
3. Soil and Water Conservation										
3.1 Soil and Water Conservation Institutes	2415	3.25	10.50	13.75	3.25	10.50	13.75	3.50	10.50	14.00
3.2 Other NRM Instts. including Agroforestry Research	2415	57.25	57.50	114.75	56.25	57.50	113.75	57.50	74.20	113.70
Total- Soil &Water Conservation		60.50	68.00	128.50	59.50	68.00	127.50	61.00	84.70	145.70
4. Animal Husbandry	2415	65.50	108.50	174.00	61.50	108.50	170.00	67.00	109.50	176.50
5. Dairy Development	2415	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Fisheries	2415	25.20	52.50	77.70	26.20	52.50	78.70	28.00	53.00	81.00
7. Forestry	2415	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8. Lump-sum provision for Projects/ Schemes for the benefit of North-Eastern Region and Sikkim	2552	54.50	0.00	54.50	39.50	0.00	39.50	*77.50	0.00	77.50
Total		54.50	0.00	54.50	39.50	0.00	39.50	*77.50	0.00	77.50
Total-Payments to ICAR		751.50	719.00	1,470.50	691.50	719.00	1,410.50	774.50	730.80	1,505.30
9. Contribution to Commonwealth Agricultural Bureau, Consultative Group on International Agricultural Research and Association of Asia Pacific Agricultural Research Institutes	2415	0.50	3.75	4.25	0.50	3.75	4.25	0.50	3.92	4.42
10. Assistance to Central Agricultural University, Imphal	2415	23.00	0.00	23.00	33.00	0.00	33.00	**0.00	0.00	0.00
Total-Agricultural Research and Education		775.00	722.75	1,497.75	725.00	722.75	1,447.75	775.00	734.72	1,509.72
Grand Total		775.00	723.80	1,498.80	725.80	723.80	1,448.80	775.00	735.92	1,510.92

	Major Head	2002–2003 Budget			2002–2003 Revised			2003–2004 Budget		
		Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total
	Head of Div.	Budget support	IEBR	Total	Budget support	IEBR	Total	Budget support	IEBR	Total
B. Plan Outlay										
1. Agricultural Research Education	12415	775.00	0.00	775.00	725.00	0.00	725.00	775.00	0.00	775.00
C. Major Head-wise Total										
		775.00	723.80	1,498.80	725.00	723.80	1,448.80	775.00	735.92	1,510.92
	2415	720.50	722.75	1,443.25	685.80	722.75	1408.25	697.50	734.72	1,432.22
	3451	0.00	1.05	1.05	0.00	1.05	1.05	0.00	1.20	1.20
	2552	54.50	0.00	54.50	39.50	0.00	39.50	77.50	0.00	77.50

* Including Rs 25 crores for assistance to CAO, Imphal to be reappropriated under 'Major Head 2415' later on with the approval of the competent authority.

**Rs 25 crores to be provided and reappropriated later on with the approval of competent authority from 'Major Head 2552' of Rs 77.50 crores, i.e. 10% allocation from the total provision of Rs 775 crores under Plan in the BE 2003-2004.

APPENDIX 1

INDIAN COUNCIL OF AGRICULTURAL RESEARCH SOCIETY

The Society shall have the following *Ex-Officio* Members:

(i) *Minister-in-charge of the portfolio of Agriculture in the Union Cabinet, President of the Society*

1. Mr Rajnath Singh
   Ministe r of Agriculture
   Government of India, Krishi Bhavan
   New Delhi 110 001

(ii) *Minister of State in the Union Ministry of Agriculture, dealing with the ICAR, Vice-President*

2. Minister of State for AHD&DARE
   Government of India, Krishi Bhavan
   New Delhi 110 001

(iii) *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 Jaswant Singh
   Minister of Finance, Government of India
   New Delhi 110 001
4. Mr Satyabrata Mookerjee
   Minister of State for Planning
   Yojana Bhawan, Government of India
   New Delhi 110 001

5,6 Dr Murli Manohar Joshi
   Minister of Science & Technology, and
   Human Resource Development
   Government of India, Shastri Bhawan
   New Delhi 110 001

7. Mr Arun Jaitley
   Minister of Commerce,Government of India
   Udyog Bhawan, New Delhi 110 001

(iv) *Other Ministers in the Union Ministry of Agriculture*

8. Mr Hukumdeo Narayan Yadav
   Minister of State for Agriculture
   Government of India, Krishi Bhavan,
   New Delhi 110 001

(v) *Ministers in the States/Incharge of Agriculture/Animal Husbandry/Fisheries*

Andhra Pradesh

9. Mr V S Rao
   Minister for Agriculture
   Government of Andhra Pradesh
   Hyderabad (Andhra Pradesh) 500 022
10. Mr N Kishtappa
    Minister of Animal Husbandry
    Government of Andhra Pradesh
    Hyderabad
    (Andhra Pradesh) 500 022
11. Mr N Narsimha Rao
    Minister of Fisheries
    Government of Andhra Pradesh
    Hyderabad 500 022
12. Mr P Narayana Swamy Naidu
    Minister for Horticulture
    Government of Andhra Pradesh
    Hyderabad 500 022

Arunachal Pradesh

13. Mr Tako Dabi
    Minister for Agriculture
    Government of Arunachal Pradesh
    Itanagar (Arunachal Pradesh) 791 111
14. Mr C L Singhpho
    Minister for Animal Husbandry and Dairy Development
    Government of Arunachal Pradesh
    Itanagar (Arunachal Pradesh) 791 111
15. Mr Lichi Legi
    Minister of Fisheries
    Government of Arunachal Pradesh
    Itanagar 791 111
16. Mr Lijum Rohya
    Minister for Horticulture
    Government of Arunachal Pradesh
    Itanagar 791 111

Assam

17. Dr A K Dey
    Minister for Agriculture, Government of Assam
    Janta Bhavan, Guwahati (Assam) 781 006
18. Mr G C Langthasa
    Minister for Veterinary and Animal Husbandry
    Government of Assam, Janta Bhavan
    Guwahati (Assam) 781 006
19. Mr Etuwa Munda
    Minister for Fisheries, WPT&C and Parliamentary Affairs
    Government of Assam, Janta Bhavan
    Guwahati (Assam) 781 006

Bihar

20. Mr Gulam Sarwar
    Minister for Agriculture
    Government of Bihar
    Patna (Bihar) 800 015
21. Dr Mohd. Jawed
    Minister for Animal Husbandry and Fisheries
    Government of Bihar
    Patna (Bihar) 800 015
22. Mr Chedi Paswan
    Minister for Horticulture
    Government of Bihar
    Patna (Bihar) 800 015

Chhatisgarh

23. Minister for Agriculture, Animal Husbandry & Fisheries
    Government of Chhatisgarh
    Raipur (Chhatisgarh)

24. Minister for Horticulture
Government of Chhatisgarh
Raipur (Chhatisgarh)

Delhi

25. Minister for Agriculture Development and Food
Animal Husbandry & Fisheries
National Capital Territory of Delhi, Delhi

Goa

26. Mr Dayanand Rayu Mandrekar
Minister for Agriculture and Horticulture
Government of Goa, Panaji (Goa) 403 001

Gujarat

27. Mr Bhupendrasinh M Chudasama
Minister for Agriculture and Horticulture
Government of Gujarat
Gandhinagar, (Gujarat) 382 010
28. Mr Dalip Thakur
Minister of State for Animal Husbandry and Fisheries
Government of Gujarat,
Gandhinagar, (Gujarat) 382 010

Haryana

29. Mr Jaswinder Singh Sandhu
Minister for Agriculture & Horticulture
Government of Haryana
Chandigarh (Haryana) 160 001
30. Mr Mohammed Ilyas
Minister for Animal Husbandry and Fisheries
Government of Haryana
Chandigarh (Haryana) 160 001

Himachal Pradesh

31. Mr Virbhadra Singh
Chief Minister holding Charge of Horticulture
Government of Himachal Pradesh
Shimla 171 002
32. Mr Raj Krishan Gaur
Minister for Agriculture
Government of Himachal Pradesh
Shimla (Himachal Pradesh) 171 001
33. Mr Harsh Mahajan
Minister of State for Animal Husbandry and Fisheries
Government of Himachal Pradesh
Shimla 171 002

Jammu and Kashmir

34. Mr Abdul Aziz Zargar
Minister for Agriculture, Animal Husbandry,
Horticulture and Cooperation
Government of Jammu and Kashmir
Srinagar (Jammu and Kashmir) 190 001
35. Mr Ghulam Mohi-ud-din
Minister of Fisheries
Government of Jammu & Kashmir
Srinagar (Jammu & Kashmir) 190 005

Jharkhand

36. Mr Arjun Munda
Chief Minister holding charge of Animal Husbandry,
Horticulture and Fisheries
Government of Jharkhand, Ranchi (Jharkhand) 843 001
37. Mr Devidhan Besra
Minister for Agriculture
Government of Jharkhand
Ranchi (Jharkhand) 843 001

Karnataka

38. Mr V S Koujalgi
Minister for Agriculture
Government of Karnataka
Bangalore (Karnataka) 560 001
39. Mr M Mahadeva
Minister for Animal Husbandry
Government of Karnataka
Bangalore (Karnataka) 560 001
40. Mr M Shivanna
Minister for Horticulture
Government of Karnataka
Bangalore (Karnataka) 560 001
41. Mr Vasant V Saliana
Minister of Fisheries
Government of Karnataka
Bangalore (Karnataka) 560 001

Kerala

42. Ms K R Gouri Amma
Minister for Agriculture & Coir including Animal
Husbandry and Horticulture
Government of Kerala
Thriuvananthapuram (Kerala) 695 001
43. Prof K V Thomas
Minister of Fisheries
Government of Kerala
Thiruvananthapuram (Kerala) 695 001

Madhya Pradesh

44. Minister for Agriculture
Government of Madhya Pradesh
Bhopal (Madhya Pradesh) 423 006
45. Minister for Fisheries
Government of Madhya Pradesh
Bhopal (Madhya Pradesh) 423 006
46. Minister for Animal Husbandry
Government of Madhya Pradesh
Bhopal (Madhya Pradesh) 423 006

Maharashtra

47. Mr Govindrao Adik
Minister for Agriculture
Government of Maharashtra
Mumbai (Maharashtra) 400 032
48. Mr Anand Rao Deokate
Minister for Fisheries and Dairy Development
Government of Maharashtra
Mumbai 499 932
49. Dr Dashrath Bhande
Minister for Animal Husbandry
Government of Maharashtra
Mumbai (Maharashtra) 400 032
50. Mr Ajit Pawar
Minister for Horticulture and Irrigation
Government of Maharashtra
Mumbai (Maharashtra) 400 032

Manipur

51. Mr K Ranjit Singh
    Minister of Agriculture
    Government of Manipur
    Imphal (Manipur) 795 001
52. Mr Thangso Baite
    Minister for Animal Husbandry
    Government of Manipur
    Imphal (Manipur) 795 001
53. Dr M D Maniruddin Shaikh
    Minister for Fisheries
    Government of Manipur
    Imphal (Manipur) 795 001
54. Mr R K Thekho
    Minister for Horticulture
    Government of Manipur
    Imphal (Manipur) 795 001

Meghalaya

55. Mr P M Syiem
    Minister for Agriculture and Horticulture
    Government of Meghalaya
    Meghalaya Secretariat
    Shillong (Meghalaya) 793 001
56. Dr D P Iangjuh
    Minister for Animal Husbandry, Veterinary and Soil Conservation
    Government of Meghalaya, Meghalaya Secretariat (C)
    Shillong (Meghalaya) 793 001
57. Mr S Sangma
    Minister for Fisheries
    Meghalaya Secretariat (e)
    Shillong (Meghalaya) 793 001

Mizoram

58. Minister for Agriculture and Horticulture
    Government of Mizoram
    Aizwal (Mizoram) 796 021
59. Minister for Animal Husbandry
    Government of Mizoram
    Aizwal (Mizoram) 796 001
60. Minister for Fisheries
    Government of Mizoram
    Aizwal (Mizoram) 796 001

Nagaland

61. Mr Huska
    Minister for Agriculture
    Government of Nagaland
    Kohima (Nagaland) 797 001
62. Mr Nyeiwang Koryak
    Minister for Animal Husbandry
    Government of Nagaland
    Kohima (Nagaland) 797 001
63. Mr Chenlom Phom
    Minister for Fisheries, Government of Nagaland
    Kohima (Nagaland) 797 002
64. Mr Jongshilemba
    Minister for Horticulture
    Government of Nagaland
    Kohima (Nagaland) 797 001

Orissa

65. Mr Navin Patnaik
    Chief Minister holding the charge of Agriculture and Horticulture
    Government of Orissa
    Bhubaneshwar (Orissa) 751 001
66. Ms Droupadi Murmu
    Minister for Animal Resources Development and Fisheries
    Government of Orissa
    Bhubaneshwar (Orissa) 751 001

Pondicherry

67. Mr A Namassivayam
    Minister for Agriculture, Horticulture, Animal Husbandry and Fisheries
    Government of Pondicherry
    Pondicherry 605 001

Punjab

68. Mr Jagmohan Singh Kang
    Minister of Animal Husbandry, Fisheries and Dairy Development
    Government of Punjab
    Chandigarh (Punjab) 160 001
69. Ms Rajinder Kaur Bhattal
    Minister for Agriculture
    Government of Punjab
    Chandigarh (Punjab) 160 001
70. Dr Mahinder Kumar Rinwa
    Minister for Horticulture
    Government of Punjab
    Chandigarh (Punjab)

Rajasthan

71. Minister of State for Agriculture and Ground Water
    Government of Rajasthan
    Jaipur (Rajasthan) 302 005
72. Minister for Livestock and Dairy Development
    Government of Rajasthan
    Jaipur (Rajasthan) 302 005
73. Minister for Fisheries
    Government of Rajasthan
    Jaipur (Rajasthan) 302 005

Sikkim

74. Mr G M Gurung
    Minister for Agriculture, Horticulture, Irrigation and Flood Control
    Government of Sikkim
    Secretariat, Gangtok (Sikkim) 737 101
75. Mr P S Tamang
    Minister for Animal Husbandry
    Government of Sikkim
    Secretariat, Gangtok (Sikkim) 737 001
76. Mr D T Lepcha
    Minister of Fisheries
    Government of Sikkim
    Gangtok (Sikkim) 737 001

Tamil Nadu

77. Mr R Jeevanathan
    Minister for Agriculture
    Government of Tamil Nadu
    Chennai, (Tamil Nadu) 600 009

78. Mr M Radhakrishnan
Minister for Fisheries
Government of Tamil Nadu
Chennai (Tamil Nadu) 600 009
79. Mr Damodharam
Minister for Animal Husbandry
Government of Tamil Nadu
Chennai (Tamil Nadu) 660 009
80. Minister of Horticulture
Government of Tamil Nadu
Chennai (Tamil Nadu) 600 009

Tripura

81. Mr Tapan Chakravorty
Minister for Agriculture and Horticulture
Civil Secretariat, Government of Tripura
Agartala (Tripura) 799 001
82. Mr Narayan Rupini
Minister for Animal Resources and Development
Government of Tripura
Agartala (Tripura) 799 001
83. Mr Sukumar Barman
Minister for Fisheries and Transport
Government of Tripura
Agartala (Tripura) 799 001

Uttaranchal

84. Mr Mahinder Singh Mahra
Minister for Agriculture
Government of Uttranchal
Dehradun (Uttranchal)
85. Mr Govind Singh Kunjwal
Minister for Horticulture
Government of Uttranchal
Dehradun (Uttranchal)
86. Mantri Prasad Naithani
Minister for Co-operative, Fisheries, Milk,
Animal Husbandry
Government of Uttaranchal
Dehradun (Uttaranchal)

Uttar Pradesh

87. Mr Hukam Singh
Minister for Agriculture
Government of Uttar Pradesh
Lucknow (Uttar Pradesh) 226 001
88. Dr Laxmi Kant Bajpayee
Minister for Animal Husbandry
Government of Uttar Pradesh
Lucknow (Uttar Pradesh) 226 001
89. Mr Raj Kishore Singh
Minister for Horticulture
Government of Uttar Pradesh
Lucknow (Uttar Pradesh) 226 001
90. Mr Shankh Lal Manji
Minister of Fisheries
Government of Uttar Pradesh
Lucknow (Uttar Pradesh) 226 001

West Bengal

91. Mr Kamal Guha
Minister for Agriculture
Government of West Bengal Writers' Building
Calcutta (West Bengal) 700 001
92. Mr Anisur Rahman
Minister for Animal Resources Development
Government of West Bengal
Calcutta, (West Bengal) 700 001
93. Mr Kironmoy Nanda
Minister for Fisheries & Aquatic Resources
and Fishing Harbours
Government of West Bengal
Calcutta (West Bengal) 700 001
94. Mr Sailen Sarkar
Minister for Horticulture and
Food Processing Industries
Government of West Bengal
Writers Building
Calcutta (West Bengal) 700 001

(vi) *Member of Planning Commission, Incharge of Agriculture*

95. Mr Som Pal
Member (Agriculture), Planning Commission
Yojana Bhavan,
New Delhi

(vii) *Six members of Parliament (Four elected by Lok Sabha and two elected by Rajya Sabha)*

96. Mr Oscar Fernandes — 2.4.2004
Member of Parliament (RS)
Doris Rest Haven, Ambalpadi
Post Brahmagiri
Udupi, Karnataka and
C-1/12, Humayun Road
New Delhi 110 001
97. Mr S S Ahluwalia — 2.4.2004
Member of Parliament (RS)
Boring Canal Road
Ward No. 4
P S Shri Krishna Puri
P.O. G.P.O., Patna
Patna (Bihar), and
10, Gurudwara Rakab Ganj Road
New Delhi 110 001
98. Mr Ashok Argal — Till the expiry of Lok Sabha term
Member of Parliament (Lok Sabha)
Duttpara, Murena
Madhya Pradesh 476 001 and
124-126, North Avenue
New Delhi 110 001
99. Mr Padmanava Behera — -do-
Member of Parliament (Lok Sabha)
Bilupader, P O Nuepader
Via Phiringic, Distt. Kondhmal (Orissa) and
23, Feroz Shah Road
New Delhi 110 001
100 Mr Uttamrao Patil — -do-
Member of Parliament (Lok Sabha)
11 Mahabali Layout Wadgon
Yavatmal (Maharashtra), and
No.3, Mahadev Road
New Delhi
101 Tarlochan Singh Tur — -do-
Member of Parliament (Lok Sabha)
Village & P.O. Tur, Teh. Khandoor Sahib
Distt. Amritsar, Punjab and
14-B-Feroze Shah Road, New Delhi 110 001

(viii) *Director-General, ICAR*

102. Dr Mangala Rai
Director-General, ICAR
Krishi Bhavan, New Delhi 110 001

(ix) *All Secretaries in the Ministry of Agriculture*

103. Mr R C A Jain
Secretary (Agriculture and Co-operation)
Ministry of Agriculture, Department of Agriculture,
Krishi Bhavan,New Delhi 110 001

104. Ms Binoo Sen
Secretary (Animal Husbandry and Dairying)
Krishi Bhavan,
New Delhi 110 001

(x) *Secretary, Planning Commission*

105. Mr N K Sinha
Secretary, Planning Commission
Yojana Bhavan, New Delhi 110 001

(xi) *Chairman, University Grants Commission*

106. Dr A S Nigavekar
Chairman, University Grants Commission
Bahadur Shah Zafar Marg, New Delhi

(xii) *Chairman, Atomic Energy Commission (or Director, Bhabha Atomic Research Centre, if nominated by the Chairman, Atomic Energy Commission)*

107. Mr R Chidambaram
Chairman
Atomic Energy Commission and
Secretary to the Government of India
Department of Atomic Energy
Anushakti Bhavan, Chhatrapati Shivaji
Maharaj Marg
Mumbai 400 039

(xiii) *Member, Finance (Secretary/Additional Secretary in the Ministry of Finance), Government of India*

108. Mr D Swarup
Additional Secretary to the Government of India
Ministry of Finance, Department of Expenditure
New Delhi 110 001

(xiv) *Four Vice-Chancellors of the Agricultural Universities nominated by the President*

109. Dr Tej Pratap — 30.4.2005
Vice-Chancellor
Himachal Pradesh Krishi Vishwavidyalaya
Palampur (Himachal Pradesh) 176 062

110. Dr P K Singh — 17.09.2003
Vice-Chancellor
Chandra Shekar Azad University of
Agriculture and Technology
Kanpur (Uttar Pradesh) 208 002

111. Dr K V Peter — 7.07.2005
Vice-Chancellor
Kerala Agricultural University

112. Dr S S Magar — 17.09.2006
Vice-Chancellor
Dr Balasaheb Sawant Konkan
Krishi Vidyapeeth, Distt. Ratnagiri
Dapoli (Maharashtra) 415 712

(xv) *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*

113. Dr C D Mayee — Ex-officio
Agricultural Commissioner
Department of Agriculture and Co-operation
Krishi Bhavan,
New Delhi 110 001

114. Dr H P Singh
Horticultural Commissioner, Department of
Agriculture,
Krishi Bhavan, New Delhi 110 001

115. Ms Nita Choudhary
Joint Secretary and Animal Husbandry
Commissioner
Department of Agriculture, Krishi Bhawan,
New Delhi

116. Mr M K R Nair — Ex-officio
Fisheries Development Commissioner
Department of Agriculture, Krishi Bhavan
New Delhi 110 001

117. 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

(xvi) *Fifteen scientists from within and outside the Council, including one from the Indian Council of Medical Research nominated by the President*

118. Dr Shiv Raj Singh — 25.09.2006
15, Bhagirathi Colony
Sundarpur
Varanasi

119. Dr Y L Nene — 25.09.2006
Ex. DDG, ICRISAT
47, ICRISAT Colony - 1
Brig. Sayeed Road
Secunderabad 500 009

120. Padmashri Dr J S P Yadav — 25.09.2006
Ex-Chairman, ASRB
B-14, Indian Agricultural Research
Institute (IARI)
New Delhi 110 012

121. Dr N Panda — 25.09.2006
Ex. Dean
Department of Soil Science
Orissa University of Agriculture & Technology
Bhubaneshwar 751 003

122. Dr N N Goswami — 25.09.2006
Ex. Vice-Chancellor., CSUAT, Kanpur
Specialization: Social Science
JD-2OD, Pitampura
Delhi 110 034

123. Dr S N Dwivedi — 25.09.2006
Ex. Director, CIFE, Bombay
Specialization: Fisheries & Environment
E-1/106, Arera Colony
Bhopal 462 016
Madhya Pradesh

124. Dr M Y Kamal — 25.09.2006
Ex-Vice-Chancellor
SKUAST
Shahjahan Bagh Society
Block No. 10, Flat No. 102
Dwarka, New Delhi 110 075

125. Dr K Pradhan — 25.09.2006
Ex Vice-Chancellor
RAU, Bikaner
H-101, Somvihar
New Delhi 110 022

126. Dr B S Pathak — 25.09.2006
Director
SPRERI
Vallabh Vidyanagr 388 120

127. Prof M M Mehta — 25.09.2006
Ex Vice-President
M/s Escort Tractors
Consultant, 1179, Sector 15
Faridabad (Haryana)

128. Mr J N L Srivastava — 25.09.2006
Former Secretary (A&C)
25, NRI Colony
Greater Kailash Part IV
New Delhi

129. Mr Sudhir Bhargava — 25.09.2006
Director
Agroman System Pvt. Ltd.
25/2, Tardeo Ac Market
Mumbai 400 034

130. Prof S K Jha — 25.09.2006
Agril. Economics Department
Rajendra Agricultural University
Pusa, Samastipur 848 125

131. Prof N S L Srivastava — 25.09.2006
Ex. ADG, ICAR,
B-6, NASC Complex, DPSM,
New Delhi 110 012

Representatives of the ICMR

132. Dr Rakesh Mittal — 17.9.2006
Deputy Director-General
Division of Reproductive Health & Nutrition
Indian Council of Medical Research
Ansari Nagar, PB4911
New Delhi 110 029

(xvii) *Three representatives of Commerce and Industry, nominated by the President*

133. Vacant
134. Vacant
135. Vacant

(xviii) *One farmer from each region of the country as mentioned in Rule 60 (a) and four representatives of rural interest, nominated by the President*

136. Mr Surya Dev Tyagi — 08.10.2006
Tarni Mohalla
Sardhana, Distt. Meerut (Uttar Pradesh)

137. Dr Yogiraj B Patil — 08.10.2006
'Annapurna'
Akkamahadevi Building
Koppadakeri, Dharward (Karnataka) 580 008

138. Mr Subhash Bhatia — 08.10.2006
R- 65A, Shakti Nagar
Gupteshwar, Jabalpur (Madhya Pradesh)

139. Mr Ajit Singh Kiran — 08.10.2006
Ajay Bagh, Ajhota
Post Laved
Dist. Meerut (Uttar Pradesh)

140. Mr Asha Ram Yadav — 08.10.2006
Ex-M.L.A.
Narghat
Mirzapur (Uttar Pradesh) 231 001 and
B-1/3, Gulab Bagh
Sigra Varanasi 221 002 (Uttar Pradesh)

141. Mr D S Ananth — 08.10.2006
Planter
Sri Satya Sai Estate
Mahadevapet, Madikeri
Distt. Coorg (Karnataka) 571 201 and
3rd Stage, Basavesware Nagar
Bangalore (Karnataka) 560 074

142. Mr Shakuntala Bapusaheb — 08.10.2006
Shirgaonker
At./OO Ankalkhop
Tal. Palus, Distt. Sangli
Maharashtra 416 316

143. Mr Rajendra D Pawar — 23.12.2003
Chairman
Baramati Agro Ltd., Post Pimpli
Tal. Baramati
Distt. Pune (Maharashtra) 413 102

Representatives of Rural Interest

144. Dr S A Khanvilkar — 08.10.2006
Nandashree Apartment
A-Wing, Block No.1
Near Hotel Vrindavan
Tal Dapoli
District Ratnagiri
Dapoli 415 712 (Maharashtra)

145. Mr Gautam Murarka — 08.10.2006
B-104, Gulmohar Park
New Delhi 110 049 and

511 Maker Chambers
221, Nariman Point
Mumbai 400 021

146 Mr Ramesh Dattambhat Vaidya — 08.10.2006
Director
Raichur Distt. Coop. Bank Ltd.
Post Hitnal, PIN 583 234
Tal & Distt. Koppal (Karnataka)

147 . Mr Sant Kumar Chaudhary — 23.12.2003
Ved Kutir
141, Sukhdev Vihar
Mathura Road
New Delhi 110 025 and
President
S K Chaudhary Educational Trust
K V K, Basaitha - Chanpura
Distt. Madhubani (Bihar)

(xix) *Four Directors of the ICAR Research Institutes, nominated by the President*

148. Dr S Nagarajan 07.10.2006
Director
Indian Agricultural Research Institute
New Delhi 110 012

149. Dr S K Dwivedi 07.10.2006
Director
National Research Centre on Equines
Sirsa Road
Hisar (Haryana) 125 001

150. Dr A V Parthasarathy 07.10.2006
Director
Indian Institute of Spices Research
P B No. 1701
Marikunnu P O
Calicut (Kerala) 673 012

151. Dr S Sreenivasan 07.10.2006
Director
Central Institute for Research on Cotton Technoilogy
P No. 16640
Adenwala Road, Matunga
Mumbai (Maharashtra) 400 019

(xx) *Secretary, Indian Council of Agricultural Research*

152. Ms Shashi Misra
Member-Secretary
Indian Council of Agricultural Research
Krishi Bhawan,
New Delhi 110 001

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. Mr D Swarup
   Additional Secretary to the Government of India
   Ministry of Finance, Department of Expenditure
   New Delhi 110 001

Secretary, Planning Commission

3. Mr N K Sinha
   Secretary
   Planning Commission
   Yojna Bhavan, New Delhi 110 001

Secretary, Agriculture

4. Mr R C A Jain
   Secretary (Agriculture and Co. op),
   Government of India
   Ministry of Agriculture, Department of
   Agriculture, Krishi Bhavan, New Delhi 110 001

Chairman, University Grants Commission

5. Dr A Nigavekar
   Chairman
   University Grants Commission
   Bahadur Shah Zafar Marg, New Delhi

Chairman, Atomic Energy Commssion or Director, BARC, if nominated by Chairman (AEC)

6. Mr R Chidambaram
   Chairman, Atomic Energy Commission and Secretary,
   Government of India, Department of Atomic Energy
   Anusakti Bhawan Chatrapatishivaji Marg, Trombay,
   Mumbai 400 039

Members

Four scientists (including one Management Expert) who are not employees of the ICAR and are nominated by the President

Management Expert — *Up to*

7. Mr J N L Srivastava — 25.09.2006
   Former Secretary (A&C)
   25, NRI Colony
   Greater Kailash Part IV
   New Delhi

Scientists

8. Dr Y L Nene — 25.09.2006
   Ex. DDG, ICRISAT
   47, ICRISAT Colony - I
   Brig. Sayeed Road
   Secunderabad 500 009
9. Dr Shiv Raj Singh — 25.09.2006
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10. Shri Sudhir Bhargava — 25.09.2006
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22. Dr V A Parthasarthy — 07.10.2006
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APPENDIX 3

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Secretary, **Agriculture**	3. Mr R C A Jain Secretary (Agriculture & Coop.) Govt. of India Ministry of Agriculture Department of Agriculture Krishi Bhawan, New Delhi	Ex-officio
Seven members of the Governing Body of the ICAR Society (viz. one Management Expert, two Scientists, one Vice-Chancellor, one Director, one Farmer & one Member of Parliament elected by the Governing Body in its 188th Meeting (18th Dec, 2001) on the Standing Finance Committee for a fresh period of one year from 18.12.2001 to 17.12.2002.	*SCIENTISTS* 4. Vacant 5. Vacant *DIRECTOR* 6. Vacant *FARMER* 7. Vacant *MEMBER OF PARLIAMENT* 8. Mr Uttamrao Patil 11, Mahabali Nagar Wadgon, Yavatmal, Maharashtra and 3, Mahadev Road, New Delhi 110 001 *MANAGEMENT EXPERT* 9. Vacant *VICE-CHANCELLOR* 10. Prof K V Peter Vice-Chancellor Kerala Agricultural University Vellanikkara P.O. Thrissur 680 656, Kerala *SPECIAL INVITEES* 11. Mr Gautam Basu Financial Adviser (ICAR & DARE) Krishi Bhavan, New Delhi 110 001 12. Ms Shafali Shah Director, EP (Agri) Room No. 222 Dept. of Commerce Ministry of Commerce & Industry Udyog Bhavan, New Delhi 110 001 13. Dr R C Maheshwari Asstt. Director-General (TC) ICAR, Krishi Bhavan, New Delhi 110 001 *MEMBER - SECRETARY* 14. Ms Shashi Misra Additional Secretary (DARE) & Secretary Indian Council of Agricultural Research Krishi Bhavan, New Delhi 110 001	14.07.2004 13.03.2004

APPENDIX 4

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   Department of Agricultural Research and Education
2. **Ms Shashi Misra**
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   Additional Secretary to Government of India
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2. Dr P D Sharma (Soils)
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2. Dr Lal Krishna (Animal Health)
3. Dr (Ms) P P Bhat (Animal Genetics)

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2. Dr Tej Verma (Home Science)
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4. B S Bisth (HRD I)

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2. Dr B S Hansra (Extension)

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2. Dr J P Mishra (ESM)
3. Dr K S Khokhar (PIM)

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1. Dr A K Sharma (Food Crops)
2. Dr C P Singh (Seeds)
3. Dr S Maurya (Commercial Crops)
4. Dr (Ms) P Kaur (Plant Protection)
5. Dr S Kochar (Intellectual Property Rights)

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1. Dr K C Garg
2. Dr U C Srivastava

Natural Resource Management

1. Dr D K Paul (Engineering)
2. Dr O P Sharma (Agronomy)

Education

1. Dr G D Diwakar (Accreditation)

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1. Dr Anil Aggarwal (Marine Fisheries)
2. V S Chitranchi (Fisheries)

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1. Dr A K Jain

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4. Dr D P Singh, Principal Scientist
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E-mail: rajkhuwa_c@rediffmail.com
28. Dr K M Bajarbarauah
National Research Cesntre for Pigs
Parijabari Road, 6th Mile
Guwahati (Assam) 785 037
29. Dr Mohan Bhattacharya
National Research Centre on Yak
West Kemeng, Dirang (Arunachal Pradesh) 790 101
E-mail: yak.director@mailcity.com

General

30. Dr Mruthyunjaya
National Centre for Agricultural Economics and Policy Research,
IASRI Campus, New Delhi 110 012
E-mail: dir_ncap@iasri.delhi.nic.in
31. Dr (Ms) Hema Pandey
National Research Centre for Women in Agriculture
1199, Jagamara
Bhubaneshwar (Orissa) 751 030
E-mail: nrewa@ori.nic.in
32. Mr K N Kumar
National Centre for Values and Ethics
Krishi Bhawan, New Delhi 110 001

APPENDIX 9

ALL-INDIA CO-ORDINATED RESEARCH PROJECTS

Crop Sciences

1. Dr B Mallik
Project Co-ordinator (Acarology)
University of Agricultural Sciences, GKVK
Bangalore (Karnataka) 560 065
2. Dr V Vasudeva Rao
Project Co-ordinator (Agricultural Ornithology)
ANGRAU Veterinary College Campus
Rajendranagar, Hyderabad (Andhra Pradesh) 500 030
3. Dr D Kumar
Nodal Scientist (Arid Legumes) CAZRI,
Beehwal, Jodhpur (Rajasthan) 342 003
4. Dr Jag Shoran
Project Co-ordinator (Wheat and Barley), PDWR,
Karnal 132 001
5. Dr D M Hegde
Project Co-ordinator (Castor), Directorate of Oilseed Research Rajendranagar,
Hyderabad (Andhra Pradesh) 500 030
6. Dr S P Mishra, Project Co-ordinator (Chickpea)
Indian Institute of Pulses Research
Kalyanpur, Kanpur (Uttar Pradesh) 208 024
7. Dr T P Rajendran
Project Co-ordinator (Cotton), Regional Research Station (CICR), PO Lawley Road, Coimbatore
(Tamil Nadu) 641 003
8. Dr N P Melkania
Project Co-ordinator (Forage Crops)
Indian Grassland and Fodder Research Institute
PO Pahuj Dam, Jhansi-Gwalior Road
Jhansi (Uttar Pradesh) 284 003
9. Dr M S Basu
Project Co-ordinator (Groundnut)
C/o NRC on Groundnut
Ivanagar Road, PB 5
Junagadh (Gujarat) 386 001
10. Dr S N Maiti
Project Coordinator (Jute and Allied fibres)
CRIJAF
Barracpore 700 120
11. Dr G S Gatoria
Project Co-ordinator (Honeybees)
Division of Zoology
(Entomology), CCS Haryana Agricultural University
Hisar (Haryana) 125 004
12. Dr S A Kherkhi
I/c Project Co-ordinator (Linseed)
CSA University of Agriculture and Technology
Kanpur, (Uttar Pradesh) 208 002
13. Dr N N Singh
Project Co-ordinator (Maize)
Directorate of Maize Research
IARI Campus, Pusa
New Delhi 110012
14. Dr K T Krishne Gowda
Project Co-ordinator (Small Millets)
University of Agricultural Sciences
GKVK Campus, Bangalore (Karnataka) 560 065
15. Dr D P Tripathi
Project Co-ordinator (MULLaRP)
Indian Institute of Pulses Research
Kalyanpur, Kanpur (Uttar Pradesh) 208 024
16. Dr S D Mishra
Project Co-ordinator (Nematodes)
Division of Nematology
Indian Agricultural Research Institute
New Delhi 110 012
17. Dr R K Chowdhury
Project Co-ordinator (NSP)
Division of Seed Science and Technology
IARI, Pusa, New Delhi 110 012

18. Dr J S Khairwal
Project Co-ordinator (Pearl Millet)
Agricultural Research Station, RAU Mandore
Jodhpur (Rajasthan) 342 304
19. Dr D B Saxena
Project Co-ordinator (Pesticide Residues)
Division of Agricultural Chemicals, LBS Building
Indian Agricultural Research Institute, Pusa
New Delhi 110 012
20. Dr N D Majumdar
Project Co-ordinator (Pigeonpea)
Indian Institute of Pulses Research
Kalyanpur, Kanpur (Uttar Pradesh) 208 024
21. Dr Arvind Kumar
Project Co-ordinator (Rapeseed and Mustard)
Sewar Farm, Distt Bharatpur (Rajasthan) 321 303
22. Dr R S Tripathi
Project Co-ordinator (Rodent Control)
Central Arid Zone Research Institute
Jodhpur (Rajasthan) 342 003
23. Dr D M Hegde
Project Co-ordinator (Safflower)
Directorate of Oilseeds Research, Rajendranagar
Hyderabad (Andhra Pradesh) 500 030
24. Dr S S Duhoon
Project Co-ordinator (Sesame and Niger)
JNKVV, Jabalpur (Madhya Pradesh) 482 004
25. Dr N Seetharama
Project Co-ordinator (Sorghum),NRC for Sorghum
Rajendranagar, Hyderabad (Andhra Pradesh) 500 030
26. Dr O P Joshi
Project Co-ordinator (Soybean)
National Research Centre for Soybean
Khandwa Road, Indore (Madhya Pradesh) 452 017
27. Dr O K Sinha
Project Co-ordinator (Sugarcane)
Indian Institute of Sugarcane Research
Lucknow (Uttar Pradesh) 226 002
28. Dr D M Hegde
Project Co-ordinator (Sunflower)
Directorate of Oilseeds Research
Rajendranagar, Hyderabad (Andhra Pradesh) 500 030
29. Dr B S Dhillon
Nodal officer (Under-utilized and Under-exploited Crops),
NBPGR, Pusa, New Delhi 110 012
30. Dr K D Singh
Project Co-ordinator (Tobacco)
CTRI, Rajahmundry (Andhra Pradesh) 533 105
31 Dr B Mishra
Project Co-ordinator (Rice)
DRR, Rajendranagar
Hyderabad (Andhra Ptradesh) 500 030
32. Dr R B L Gupta
Project Co-ordinator (Whitegrubs)
Agricultural Experimental Station
Rajasthan Agriculture University
Durgapura, Jaipur (Rajasthan) 302 018

Horticulture

33. Dr D G Dhandar
Project Co-ordinator (Arid Fruits)
CIAH, Bikaner 334 006
34. Dr S Maiti
Project Co-ordinator (Betelvine)
NRC for Medicinal and Aromatic Plants
Boriavi (Gujarat) 387 310
35. Dr M Gopalakrishna Bhat
Project Co-ordinator (Cashew)
National Research Centre for Cashew
Puttur (Karnataka) 574 202
36. Dr A P Singh
Project Co-ordinator (Floriculture)
Division of Floriculture and Landscaping
Indian Agricultural Research Institute, Pusa
New Delhi 110 012
37. Dr R P Tewari
Project Co-ordinator(Mushrooms)
National Centre for Mushroom Research and Training
Chambaghat, Solan (Himachal Pradesh) 173 213
38. Dr S Arulraj
Project Co-ordinator (Palms),Central Plantation Crops
Research Institute, Kasaragod (Kerala) 671 124
39. Dr D S Khurdiya
Project Co-ordinator (Post-Harvest Technology),
Division of Fruits and Horticultural Technology
Indian Agricultural Research Institute,
New Delhi 110 012
40. Dr S M Paul Khurana
Project Co-ordinator (Potato),Central Potato Research Institute,
Shimla (Himachal Pradesh) 171 001
41. Dr R K Pathak
Project Co-ordinator (Subtropical Fruits)
Central Institute for Subtropical Horticulture
Rahmankhera, Lucknow (Uttar Pradesh) 227 107
42. Project Co-ordinator (Spices)
Indian Institute of Spices Research
PB 170, Marikunnu, Calicut (Kerala) 673 012
43. Dr Om Prakash
Project Co-ordinator (Fruits)
CISTH, Lucknow 226 016
44. Dr B M C Reddy
Project Co-ordinator (Tropical Fruits)
IIHR, Hessarghatta Lake Post
Bangalore (Karnataka) 560 089
45. Dr P G Rajendran
Project Co-ordinator (Tuber Crops), Regional Station
of the Central Tuber Crops Research Institute
Thiruvananthapuram (Kerala) 695 017
46. Dr Mathura Rai
Project Co-ordinator (Vegetable)
Project Directorate of Vegetable Research
11VR, Varanasi (Uttar Pradesh) 221 005

Natural Resource Management

47. Dr P Rai
Project Co-ordinator (Agroforestry)
NRC on Agroforestry, Jhansi (Uttar Pradesh) 284 003
48. Dr D L N Rao
Project Co-ordinator (Biological Nitrogen Fixation)
Indian Institute of Soil Science
Bhopal (Madhya Pradesh) 462 038
49 Dr S K Sharma
Project Co-ordinator (Cropping Systems)
PDCSR, Medipuram
Meerut (Uttar Pradesh) 250 110

50. Dr Biplab Saha
Project Co-ordinator (Diara Lands)
Directorate of Water Management Research
WALMI Complex, Phulwari Sharif P.O.
Patna (Bihar) 801 505
51. Dr K P R Vittal
Project Co-ordinator (Dryland Agriculture)
CRIDA Campus, Santoshnagar
Hyderabad (Andhra Pradesh) 500 059
52. Dr M V Singh
Project Co-ordinator (Long-term Fertilizer Experiment)
Indian Institute of Soil Science
Bhopal (Madhya Pradesh) 462 038
53. Dr Mohan Singh
Project Co-ordinator (Microbiological Decomposition)
Indian Institute of Soil Science
Bhopal (Madhya Pradesh) 462 038
54. Dr M V Singh
Project Co-ordinator (Micronutrients and Secondary Nutrients and Pollutant Elements)
Indian Institute of Soil Science
Bhopal (Madhya Pradesh) 462 038
55. Dr A Subba Rao
Project Co-ordinator (Soil Test and Crop Response)
Indian Institute of Soil Science, Nabi Bagh
Bhopal (Madhya Pradesh) 462 038
56. Dr D K Painuli
Project Co-ordinator (Soil Physical Constraints)
Indian Institute of Soil Science
Bhopal (Madhya Pradesh) 462 038
57. Dr P S Minhas
Project Co-ordinator (Management of Salt-affected Soils and Saline Water in Agriculture)
Central Soil Salinity Research Institute
Karnal (Haryana) 132 001
58. Dr H N Verma
Project Co-ordinator (Water Management)
Khurda, Bhubaneswar (Orissa) 751 023
59. Dr N T Yaduraju
Project Co-ordinator (Weed Control)
National Research Centre for Weed Science
PB 13, M.P. Housing Board Colony, Maharajpur
Adhartal, Jabalpur (Madhya Pradesh) 482 004
60. Dr H N Verma
Project Co-ordinator (Ground Water)
Khurda, Bhubaneswar (Orissa) 751 023
61. Dr Y S Ramakrishna
Project Co-ordinator (Agricultural Meteorology)
CRIDA Campus, Santoshnagar
Hyderabad (Andhra Pradesh) 500 059

Engineering and Technology

62. Dr A K Bhattacharya
Project Co-ordinator (Agricultural Drainage)
Water Technology Centre, Indian Agricultural Research Institute, New Delhi 110 012
63. Dr Dipankar De
Project Co-ordinator (Energy Requirements in Agricultural Sector),Central Institute of Agricultural Engineering, Nabi Bagh, Berasia Road
Bhopal, (Madhya Pradesh) 462 038
64. Dr M M Pandey
Project Co-ordinator (Farm Implements and Machinery)
Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road, Bhopal, (Madhya Pradesh) 462 038
65. Dr L P Gite
Project Co-ordinator (Human Engineering and Safety-Studies in Agriculture)
Central Institute of Agricultural Engineering
Bhopal (Madhya Pradesh) 462 038
66. Dr Mohan Singh
Project Co-ordinator (Organic Farming)
CIAE, Bhopal (Madhya Pradesh) 462 038
67. Dr Ashwani Kumar
Project Co-ordinator (Application of Plastics in Agriculture)
Central Institute of Post-Harvest Engineering and Technology
Ludhiana (Punjab) 141 004
68. Dr S M Ilyas
Project Co-ordinator (Post-Harvest Technology)
Central Institute of Post-Harvest Technology
Ludhiana (Punjab) 141 004
69. Dr R K Verma
Project Co-ordinator (Power Tillers)
Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road, Bhopal
(Madhya Pradesh) 462 038
70. Dr Jaswant Singh
Project Co-ordinator (Processing, Handling and Storage of Jaggery and Khandsari)
Indian Institute of Sugarcane Research
Lucknow (Uttar Pradesh) 226 002
71. Dr M Shyam
Project Co-ordinator (Renewable Energy Sources)
Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road
Bhopal (Madhya Pradesh) 462 038
72. Dr G C Yadav
Project Co-ordinator (Utilization of Animal Energy)
Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road, Bhopal
(Madhya Pradesh) 462 038
73. Dr S K Sharma
Project Co-ordinator (Network Programme for Development of Technology Package for Organic Farming PDCSR
Modipuram, Meerut (Uttar Pradesh) 250 110

Animal Sciences and Fisheries

74. Dr S P S Ahlawat
Project Co-ordinator (Animal Genetic Resources)
National Bureau of Animal Genetic Resources
PB 129, Karnal, (Haryana) 132 001
75. Dr R K Sethi
Project Co-ordinator (Buffalo Breeding)
Central Institute for Research on Buffaloes
Hisar (Haryana) 125 001
76. Dr R P Misra
Project Co-ordinator
(Crop Based Animal Production Systems)
Central Institute for Research on Goat
Mathura, Makhdoom, (Uttar Pradesh) 281 122

77. Dr Arun Varma
Project Co-ordinator (Embryo Transfer)
Indian Council of Agricultural Research
Krishi Bhavan, New Delhi 110 001
78. Dr R P Mishra
Project Co-ordinator (Goats)
CIRG, Mathura, Makhdoom (Uttar Pradesh) 281 122
79. Dr A K Chhabra
Project Co-ordinator (Pigs)
Indian Veterinary Research Institute
Izatnagar (Uttar Pradesh) 243 122
80. Dr A L Arora
Project Co-ordinator (Sheep Improvement)
Central Sheep and Wool Research Institute
Aviknagar 304 501
81. S K Bandyopadhyay
Project Co-ordinator (Foot-and-Mouth Disease)
Division of Epidemiology
Indian Veterinary Research Institute
Mukteshwar Campus (Uttar Pradesh) 263 138
82. Dr Nem Singh
Project Co-ordinator
(Network on Haemorrhagic Septicaemia)
IVRI, Izatnagar (Uttar pradesh) 243 122
83. Dr Sushil Kumar
Project Co-ordinator (Agril. Byproducts as Animal Feed)
Indian Council of Agricultural Research
Krishi Bhavan, New Delhi 110 001
84. Dr M Rajshekhar
Project Director (Animal Diseases Monitoring
and Surveilance)
Institute of Animal Health and Veterinary Biology
Hebbal, Bangalore (Karnataka) 560 004
85. Dr Nem Singh
Project Coordinator
(Network on Haemorrhagic Septicaemia)
IVRI, Izatnagar, Uttar Pradesh 243 122
86. Dr Nem Singh
Project Co-ordinator
(Network on Gastro-intestinal Parasitism)
IVRI, Izatnagar
(Uttar Pradesh) 243 122
87. Dr Nem Singh
Project Co-ordinator
(Network on Bluetongue)
IVRI, Izatnagar
(Uttar Pradesh) 243 122
88. Dr Sushil Kumar
Project Co-ordinator
Network Programme on Micronutrients in Animal
Nutrition and Production
Krishi Bhawan
New Delhi 110 001
89. Dr G R Patil
Project Co-ordinator (Process Upgradation of
Indigenous Milk Products)
Network Project on R & D Support for Process
Upgradation of Indigenous Milk Products for
Industrial Application,
NDRI, Karnal, (Haryana) 132 001
90. Dr R K Sethi
Project Co-ordinator (Network on Buffalo)
CIRB, Hisar (Haryana) 125 001
92. Dr Sushil Kumar
Project Co-ordinator (Network on Agricultural
Byproducts as Animal feed)
ICAR, Krishi Bhawan
New Delhi 110 0011

Education

93. Dr (Ms) Tej Verma
Project Co-ordinator (Home Science)
ICAR, Krishi Anusandhan Bhavan II
Pusa, New Delhi 110 012

APPENDIX 10

AGRICULTURAL UNIVERSITIES AND THEIR VICE-CHANCELLORS

1. Dr S P Singh
   Acharya N G Ranga Agricultural University
   Rajendranagar, Hyderabad (Andhra Pradesh) 500 030
   E-mail: root@apau.ren.nic.in
2. Dr G L Kaul
   Assam Agricultural University, Jorhat
   (Assam) 785 003
   E-mail: glkaul@aau..ac.in
3. Prof Debabrata Das Gupta
   Bidhan Chandra Krishi Vishwa Vidyalaya
   PO Krishi Vishwa Vidyalaya
   Mohanpur, Nadia (West Bengal) 741 252
   E-mail: vcbck@vsnl.net
4. Dr S N Pandey
   Birsa Agricultural University
   Ranchi (Jharkhand) 834 006
   E-mail: vc_bau@rediffmail.com
5. Dr P K Singh
   Chandra Shekhar Azad University of Agriculture
   and Technology,
   Kanpur (Uttar Pradesh) 208 002
   E-mail: pks_csau@hotmail.com
6. Dr M K Miglani
   Chaudhary Charan Singh Haryana Agricultural
   University, Hisar (Haryana) 125 004
   E-mail: vc@hau.nic.in
7. Dr S A Nimbalkar
   Dr Punjabrao Deshmukh Krishi Vidyapeeth
   Akola (Maharashtra) 444 104
   E-mail: vc@mah.nic.in
8. Dr S S Negi
   Dr Yashwant Singh Parmar University of
   Horticulture and Forestry
   Nauni, Distt Solan, (Himachal Pradesh) 173 230
   E-mail: vcuhf@yahoo.com
9. Dr P L Gautam
   Govind Ballabh Pant University of Agriculture
   and Technology
   Pantnagar (Uttaranchal) 263 145
   E-mail: vc@gbpuat.ernet.in
10. Dr R P S Ahalawat
    Gujarat Agricultural University
    Sardar Krushinagar, Distt Banaskantha
    (Gujarat) 385 506
    E-mail: vc@gauskn.guj.nic.in
11. Dr Tej Pratap
    Ch Shravan Kumar
    Krishi Vishvavidyalaya
    Palampur (Himachal Pradesh) 176 062
    E-mail: vc@hillagric.org
12. Dr C R Hazra
    Indira Gandhi Krishi Vishwavidyalaya
    Raipur (Chhatisgarh) 492 012
    E-mail: crhazra@yahoo.co.in
13. Dr D P Singh
    Jawaharlal Nehru Krishi Vishwa Vidyalaya
    Jabalpur (Madhya Pradesh) 482 004
    E-mail: dpsingh_inkw@yahoo.co.in
14. Dr K V Peter
    Kerala Agricultural University
    Vellanikara, Distt Trichur (Kerala) 680 656
    E-mail: vckau@vsnl.com
15. Dr S S Magar
    Dr Balaesahib Sawant Konkan Krishi Vidyapeeth
    Dapoli (Maharashtra) 415 712
    E-mail: ssmagar@hotmail.com
16. Dr S N Puri
    Mahatma Phule Krishi Vidyapeeth
    Rahuri (Maharashtra) 413 722
    E-mail: snpuri@mail.com
17. Dr V M Pawar
    Marathwada Agricultural University
    Parbhani (Maharashtra) 431 402
    E-mail: vemau@rediffmail.com
18. Dr R P Singh
    Maharana Pratap University of Agriculture and
    Technology
    Udaipur (Rajasthan) 313 001
    E-mail: vc@oudt.om.nic.in
19. Dr B B Singh
    Narendra Deva University of Agriculture
    and Technology,
    Faizabad (Uttar Pradesh) 224 229
    E-mail: nduat@up.nic.in
20. Mr Sahadeva Sahoo
    Orissa University of Agriculture and Technology
    Bhubaneshwar (Orissa) 141 004
    E-mail: vc@oudt.ori.nic.in
21. Dr K S Aulakh
    Punjab Agricultural University
    Ludhiana (Punjab) 141 004
    E-mail: vcpau@glide.net.in
22. Prof Parmatma Singh
    Rajasthan Agricultural University
    Bikaner (Rajasthan) 334 006
    E-mail: vc@raub.raj.nic.in
23. Dr S R Singh
    Rajendra Agricultural University
    Samastipur, Pusa (Bihar) 848 125
    E-mail: rau@bih.nic.in
24. Dr Anwal Alam
    Sher-E-Kashmir University of Agricultural Sciences
    and Technology
    Srinagar (Jammu and Kashmir) 191 001
25. Mr H U Khan
    Sher-e-Kashmir University of Agricultural
    Sciences and Technology
    45-B, Gandhinagar, PB 37
    Jammu (Jammu and Kashmir) 180 012
    E-mail: hu_khan@rediffmail.com
26. Dr C Ramasamy
    Tamil Nadu Agricultural University
    Coimbatore (Tamil Nadu) 641 003
    E-mail: vc@tnau.ac.in

27. Dr R Kadirvel
    Tamil Nadu Veterinary and Animal Sciences
    University, Chennai (Tamil Nadu) 600 051
    E-mail: tanuvas@vsnl.com
28. Dr A M Krishnappa
    University of Agricultural Sciences
    Bangalore (Karnataka) 560 065
    E-mail:amkrishnappa@yahoo.com
29. Dr S A Patil
    University of Agricultural Sciences
    Dharwad (Karnataka) 580 005
    E-mail:sapatil_uas@redifffmail.com
30. Dr A K Bhattacharya
    West Bengal University of Animal and
    Fishery Sciences, 38KB Sarani
    Kolkata (West Bengal)
    E-mail : wbuaatsherikar@hotmail.com
31. Dr A T Sherikar
    Maharashtra Animal and Fishery Sciences University
    Nagpur (Maharashtra) 440 006
    E-mail: atsherikar@hotmail.com
32. Dr M Zaka-ur-Rab
    Director
    Faculty of Agriculture
    Aligarh Muslim University
    Aligarh (Uttar Pradesh) 202 002
33. Dr Ramachandra Rao
    Banaras Hindu University
    Varanasi (Uttar Pradesh) 221 005
34. Dr S K Basu
    Viswa Bharati, Santiniketan
    (West Bengal)
35. Dr P P Singh
    Sardar Vallabh Bhai Patel University of Agriculture and
    Technology, Modipuram
    Meerut (Uttar Pradesh) 250 110
36. Dr S K Garg
    U P Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan
    Vishwa Vidyalaya Evam Go Anusandhan Sansthan
    Mathura (Uttar Pradesh) 281 001
37. Dr S K Brahmachari
    Uttar Banga Krishi Vishwavidyalaya
    Pundibari
    Cooch Bihar
    (West Bengal) 736 165

Central University

1. Dr S S Baghel
   Central Agricultural University
   Imphal (Manipur) 795 004

Deemed-to-be Universities

1. Dr S Nagarajan
   Indian Agricultural Research Institute
   Pusa,
   New Delhi 110 012
2. Dr M P Yadav
   Indian Veterinary Research Institute
   Izatnagar (Uttar Pradesh) 243 122
3. Dr Nagendra Sharma
   National Dairy Research Institute
   Karnal (Haryana) 132 001
4. Dr S C Mukherjee
   Central Institute of Fisheries Education
   Jaiprakash Road,
   Seven Bungalows, Versova
   Mumbai (Maharashtra) 400 061
5. Prof R B Lal
   Allahabad Agricultural University
   Allahabad (Uttar Pradesh) 211 007

APPENDIX 11

Total number of employees in the ICAR and its research institutes and Number of Scheduled Castes, Scheduled Tribes and other backward classes*

Sl.no.	Posts	Total posts sanctioned	Total employees in position	Total scheduled castes among them	Percentage to total employees	Total scheduled tribes among them	Percentage to total employees	Total OBC among them	Percentage total employees
1.	**Scientific Post**								
	Scientist	3,881	3,126	297	9.50	46	1.46	207	6.62
	Senior Scientist	1,651	1,232	92	7.46	13	1.05	62	5.03
	Prinicipal Scientist	749	528	34	6.44	2	0.38	13	2.46
	RMP Scientist	147	140	2	1.43	1	0.71	6	4.29
	Total	**6,428**	**5,026**	**425**	**8.45**	**62**	**1.23**	**288**	**5.73**
2.	**Technical Posts**								
	Category I	4,456	4,083	830	-	305	-	341	-
	Category II	3,075	2,648	507	-	182	-	198	-
	Category III	731	702	103	-	44	-	46	-
	Total	**8,262**	**7,433**	**1,440**	**-**	**531**	**-**	**585**	**-**
3.	**Administration Posts**								
	(a) Directors/Dy.Secretaries Under Secretaries/ Sr. Admn. Officer/ Sr. Accounts Officer/ Admn. Officer/ F&AO/Legal, PS etc.	301	211	40	-	12	-	9	-
	(b) Asstt. Fin. & Accounts Officer/Accounts Officer Section Officer/Hindi Officer/Desk Officer/	724	551	81	-	37	-	34	-
	(c) Assistants	1,364	1,010	166	-	65	-	44	-
	(d) Stenographers	691	599	87	-	11	-	5	-
	(e) UDC/Senior Clerk	1,358	1,160	238	-	71	-	52	-
	(f) LDC/Junior Clerk	936	919	158	-	45	-	96	-
	Total	**5,374**	**4,450**	**770**	-	**241**	-	**240**	-
4.	**Supporting Staff**								
	Grade I	4,572	3,654	1,004	-	223	-	525	-
	Grade II	3,365	3,400	961	-	212	-	150	-
	Grade III	1,936	1,915	515	-	126	-	59	-
	Grade IV	928	912	284	-	103	-	54	-
	Total	**10,801**	**9,881**	**2,764**	-	**664**	-	**788**	**-**
5.	**Supporting Staff** (*Safaiwala*)	**381**	**311**	**230**	-	**13**	-	**14**	-
	Auxillary posts (dying cadre)	**53**	**88**	**19**	-	**1**	-	**5**	**-**

APPENDIX 12

AWARDS

AWARD	AWARDEES
Sardar Patel Outstanding Institution Award (2002)	*State Agricultural University* Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra *ICAR Institutes* (i) Central Plantation Crops Research Institute, Kasaagod, Kerala
Jawaharlal Nehru Awards for Outstanding Post-graduate Agricultural Research (2002)	*Crop Improvement* (i) Dr Vinay Kumar Sharma, RAU, Pusa, Bihar (ii) Dr (Ms) Ranjana Bhattacharjee, ICRISAT Patancheru (AP) *Biotechnology* (i) Dr Perumal Azhaguvel,National Institute of Agricultural Sciences, Ibaraki, Japan(TNAU, Coimbatore) *Plant Protection* (i) Dr (Ms) Thirumala Devi, University of Wisconsin, Madison, USA, Osmania University, Hyderabad (ii) Dr Avijit Roy, University of Florida, Gainsville, USA, IARI, New Delhi *Natural Resource Management* (i) Dr P Shaji James, KAU, Tavanur (ii) Dr Vinay Kumar Sehgal, ISRO, Ahmedabad *Horticulture* (i) Dr (Ms) Ganga Mathian, TNAU, Coimbatore *Engineering Technology* (i) Dr Atmaram Mishra, WTC for Eastern Region, Bhubaneshwar *Animal Sciences* (i) Dr Sreekumar Chirukandoth, USDA, Maryland, USA, IVRI, Izatnagar *Social Sciences* (i) Dr V Venkatesa Palanichamy, TNAU, Coimbatore
Jagjivan Ram Kisan Puruskar (2002)	(i) Mr Kushal Pal Sirohi, Sirohi Agril. Farm, Chandna, Haryana
N.G. Ranga Farmer Award for Diversified Agriculture (2002)	(i) Mr Vimal Chawda, VNR Farm, Gomchi, Raipur Agartala, Tripura
Panjabrao Deshmukh Women Scientist Award (2002)	(i) Dr Irani Mukherjee, IARI, New Delhi (ii) Dr (Ms) B Meena Kumari, CIFT, Cochin
Vasantrao Naik Award for Research Applications in Agriculture (2002)	(i) Dr U S Patnaik and Associates, CSWCRSTI, Sunabada, Orissa
Chaudhary Devi Lal outstanding AICRP Project Award (2002)	(i) AICRP on Vegetable Crops, IVRI, Varanasi
Chaudhary Charan Singh Award for Ex cellence in Journalism in Agricultural Research & Development (2002)	(i) Mr Sunil Gangrade, Editor, Krishak Jagat, Bhopal New Delhi (ii) Mr Harvir Singh, Spl. Correspondent, Hindustan, New Delhi
Lal Bahadur Shastri Young Scientist Awards for the Biennium (2001-2002)	*Crop Sciences (Crop Improvement and Protection)* (i) Dr A J Rajkumar, Cardamom Research Station, Pampadumpara, Kerala (ii) Dr Bhupinder Singh, IARI, New Delhi

AWARD	AWARDEES
	Soil Science, Agronomy and Agroforestry (i) Dr T Raghavareddy Rupa, IISS, Bhopal, M.P. *Horticulture* (i) Dr Sankar Prasad Das, NRC for Orchids, Pakyong, East Sikkim *Animal Science* (i) Dr D Nagalakshmi, College of Veterinary, Science, ANGRAU, Rajendranagar, Hyderabad, A.P.
Hari Om Ashram Trust Awards for the Biennium (2001–2002)	*Crop Sciences* (i) Dr B Mishra & Associates, Directorate of Rice Research, Hyderabad *Horticulture* (i) Dr M S Ladaniya & Associates, NRCC, Rohtak *Resource Management* (i) Dr I S Dahiya and Associates, KVK, Rohtak *Animal Sciences* (i) Dr Usha R Mehra & Associates, IVRI, Izatnagar
Rafi Ahmed Kidwai Awards for the Biennium (2001-2002)	*Crop Improvement and Crop Protection* (i) Dr J L Karihaloo, NBPGR, New Delhi *Horticulture* (i) Dr G Kalloo, ICAR, New Delhi *Natural Resource Management* (i) Dr M S Aulakh, PAU, Ludhiana *Engineering and Technology* (i) Dr Pitam Chandra, IARI, New Delhi *Animal Sciences* (i) Dr J M Kataria, IVRI, Izatnagar and Dr S K Bandyopadhyay, IVRI, Mukteswar (*Jointly*) (ii) Dr B P Singh, CARI, Izatnagar and Dr Parimal Roy, TNVASU, Chennai *(Jointly)* *Fisheries and Aquatic Sciences* (i) Dr V S Murty, CMFRI, Cochin
Swami Sahajanand Saraswati Extension Scientist /Worker Awards for the Biennium (2001-2002)	*Crop production* (i) Dr R N Padaria, IARI, New Delhi *Livestock Production* (i) Dr (Mrs) Jancy Gupta, NDRI, Karnal *Resource Management* (i) Dr Hardial Singh, Regional Research Centre for CIFA, PAU, Campus, Ludhiana (ii) Dr Sanjay Kumar Das, College of Fisheries, AAU, Assam.

APPENDIX 13 Audit Paras

MINISTRY OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION

Unfruitful expenditure on prematurely closed projects: Southern Regional station of the National Dairy Research Institute, Bangalore undertook two in-house projects entitled "Strategies for augmenting fertility in buffaloes" in January 1996 and "Integrated Approach for Optimum Performance of Cattle in Farmers' Herds" in April 1996 at an estimated cost of Rs54.35 Lakh and Rs.60 Lakh respectively. Both the Projects were foreclosed without achieving their objectives. This resulted in unfruitful expenditure of Rs55.97 lakh being incurred on these projects.

(Para 6.1 of Report No.5 of 2003)
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Failure of Revolving Fund Scheme: ICAR sanctioned a loan of Rs30.53 lakh to the Sugarcane breedingt Institue (SBI), one of its constituent units, in September 1997 for a project, "Mass Production of Bio-fertilisers for Sugarcan" to be repaid in five annual instalments. However, before sanctioning the loan, it did not ensure the SBI had conducted a formal feasibility study and market survey. Since the Institute could not earn the projected revenue, the first instalment amount to Rs.6.11 lakh was made only in July 2000 and further instalments were yet to be paid. The future of the project is still uncertian and it is unlikely that the Institute would be in a position of repay the balance amount of Rs.24.42 lakh to ICAR.

(Para 6.2 of Report No.5 of 2003)
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