

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 spgazzinii* 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-pastoral 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



An *arboreum* cotton (left) showing superior performance to hybrid (right), with considerably low cost of cultivation

will result in increased adoption of and better price for *arboreum* cotton.

- 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 slopes 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



Breeding multi-cut sorghum hybrids and varieties with enhanced nutritional quality

other green fodders are not available for the livestock.

- 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.



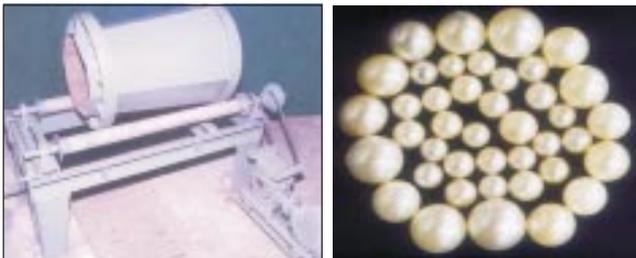
Permanent bed planting in rice-wheat production system – a new concept in crop production

- 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 antihelmintic 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 statewide. 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), enterotoxemia (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

- 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, α -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.

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.

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

- 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 has started paying dividends in frontier areas of research

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 characterization 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 tospovirus 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/cm²) has been developed and modified after field evaluation.



Low-energy water application device



- Storage life of Baneshan mango was extended under controlled atmosphere (CA) storage conditions of 5% O₂+2.5% CO₂ 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% O₂, 5 or 10% CO₂ 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 borivillianum*) 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*, Trichover, 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 Hesaraghatta 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 *sal* 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 GA₃ (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.

INNOVATIONS IN TECHNOLOGY DISSEMINATION—ICAR COMPONENT

The ITD-ICAR Component has made significant contribution in empowerment of farmers and stakeholders in terms of information, knowledge and material.

Zonal Agricultural Research Stations Remanded 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-scientist interaction meetings with the farmers.
- Information has been disseminated 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 stakeholders.

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 revenue of Rs 34.8 million.



Cardamom dryer

- 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.