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Indian Council of Agricultural Research
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भाकृअनुप
ICAR

Indian Council of Agricultural Research

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Foreword

A perfect agricultural scenario in India in 2030 – adequate foodgrains production, assured good quality seeds, optimized water management, flourishing livestock and poultry farming to supplement farmers' income, remunerative horticultural and plantation crops, thriving fisheries sector, appropriate food processing infrastructure, sensitive extension system and effective marketing facilities – is the target of research of the Indian Council of Agricultural Research. The ICAR is in the forefront and taking revolutionary steps to mark a qualitative change in agricultural technology, education and frontline extension. Agriculture in India is not only an employment but also a means of livelihood for rural masses, and steps have to be taken to make their livelihood secure.

During the year, 150 varieties and hybrids of different crops including horticultural crops were released/identified for cultivation in different parts of the country. Insecticide-resistance management strategies were formulated for sustainable pest management. Signature markers were identified for the first time in castor to establish hybrid purity. National Test Guidelines for Distinctness, Uniformity and Stability for 35 economically important crops were developed. Voracious feeding of isabelline chat bird on *Helicoverpa armigera* on pigeonpea crop has been recorded for the first time. Tommy Atkins mango was found as a potential donor for red peel and precocity characters, and release of predator of mealy bug reduced 80% bunch damage in grapes. Transgenic tomato cultivars with combined resistance to viruses, and organic farming protocols for vegetable-based cropping systems were developed. A high-yielding, single spore selection SSI 4035 of mushroom, *Agaricus bisporus,* was recommended for commercial release. In potato, post-transcriptional gene silencing (PTGS) transgenic lines of Kufri Badshah were developed that have resistance to bacterial wilt and late blight, and transgenic lines tolerant to cold-induced sweetening were identified. Eco-friendly and sustainable land-use models were identified for 16 watersheds. Salt-affected soil database of Rajasthan, Madhya Pradesh, Gujarat and Andhra Pradesh were digitized. A model OPTALL was developed for canal-water management.

Crop diversification options proved beneficial in mitigating drought in rainfed uplands of eastern India. Zero tillage practices significantly reduced population and dry matter of weed in rice-wheat system.

Genetic resource database was prepared for livestock and poultry, which also provides raw data for further analysis. Phenotypic characterization of several indigenous breeds of cattle, buffaloes, sheep, goats, poultry, camels and horses was completed in their home tract. Under field progeny testing programme, a decreasing trend was observed in calving age of Frieswal daughters born from first to fourth set of bulls. Sensitive diagnostic techniques and effective vaccines for several prevailing diseases were developed. District-wise compilation of information on feed resources was complied for use in livestock development

activities. Several techniques were developed for commercial production of different milk products and improvement in their shelf-life.

In marine fisheries, the first phase of the National Marine Fisheries Census, 2005, was completed in all the coastal states excepting Tamil Nadu. Endangered yellow catfish was successfully bred under captive conditions. In coldwater fisheries, a computerized database of upland fishes of India was developed. A nested RT-PCR diagnostic kit for *Macrobrachium rosenbergii* nodavirus was released. In Andaman and Nicobar Islands, fibre glass reinforced plastic boats were introduced to help fishermen facing losses due to tsunami. Pedal-operated peeler was developed for rural level production of potato chips. Gender-friendly motor-operated lac grader and winnower were developed for village level processing. Memorandum of Understanding (MoU) with the IGNOU for co-operation in agricultural education in distance mode, and co-operation with the ISRO, IGNOU and MHRD for utilization of EDUSAT by the ICAR and SAUs for agricultural education are new initiatives. A core germplasm collection set was established for the first time in fingermillet at the National Active Germplasm site at Bangalore, which represents 98% of the variability present in the entire world collection. Agricultural markets in India need to attract big business to invest and operate in bulk buying and selling, which would give better deal to consumers as well as producers.

At present, 503 Krishi Vigyan Kendras (KVKs) are working, where technologies are being taken up for on-farm testing. Involvement in the activities of self-help groups gave confidence and decision-making ability to women. Due attention was paid on agricultural research planned specially for tribal and hilly regions to meet needs of farmers of these regions. Besides, impact of tsunami tidal waves was assessed on agricultural lands and suitable technologies were suggested for rehabilitation of the affected farmers. MoUs/ Agreements were signed between the ICAR and Brazilian Agricultural Research Corporation, the Government of India and Government of the Republic of Afganistan, and Government of India and United States Department of Agriculture. A magnum opus publication *Handbook of Agriculture* was brought out after complete revision and updating.

Surveys have revealed that adoption of technologies by farmers reduced the cost of production of crops leading to improved benefits, which are further improved by better market facilities. Information technology is going to play a vital role at every stage of food production process. The whole web of national agricultural research system having scientists at one-end and information seeker — the farmer — on the other end, will change the face of rural India.

It is a matter of satisfaction to see the effective dovetailing between national priorities in the agriculture sector and ICAR's programmes, particularly in the current concerns regarding conservation and optimization of resources, commercialization of technologies and biotechnology. It is hoped that this report would be useful for policy-makers, planners and development agencies.

(SHARAD PAWAR)
President
ICAR Society

Contents

The Mandate of the Indian Council of Agricultural Research

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

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

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

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

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

Overview

The Indian Council of Agricultural Research (ICAR), in pursuance of its mandate, remains actively engaged in generation of farmworthy technologies to achieve science-based growth and development of the agriculture and also to develop competent human resources through its institutions of higher agricultural education. An overview of the important activities, research achievements and new initiatives taken during the year is presented here.

The year witnessed late arrival of south-western monsoon over the peninsular and eastern India but early in north-western parts of India. The season ended with an all India area weighted rainfall at 99% of the long period average (LPA). Out of 36 meteorological sub-divisions, monsoon rainfall was normal in 25, excess in 8 and deficient in 3 sub-divisions. The output of foodgrains is expected to be 209.3 million tonnes, which is about 5 million tonnes more than in the previous year and the overall agricultural growth is about 2.3%. The Agriculture at present contributes about 22% to India's GDP and the agri-exports valued at Rs 39,863 crore constitute nearly 11.2% of the total national exports.

In agriculture, quality seed and planting material are essential to realize optimum production potential of other inputs. Nearly 7,500 tonnes of breeder seed of different crops including potato were produced and distributed as per the state indents so that farmers could get the quality seed at the appropriate time. A new programme on seed production in crops and fisheries has been approved by the Government for a total amount of approximately Rs 200 crore.

The ICAR organized for the first time a national conference of the Krishi Vigyan Kendras (KVKs) to improve their relevance and effectiveness in the process of technology assessment, refinement and dissemination. The Hon'ble Prime Minister of India inaugurated the event and also released on this occasion a set 44 CDs and 28 technical bulletins on agricultural technologies. The Council has sanctioned 62 new Krishi Vigyan Kendras (KVKs) during the year. The total number of KVKs now stands at 503 in fulfillment of the target of establishing KVKs in each of the rural districts.

A National Research Centre on Pomegranate at Sholapur was established to provide necessary boost to the process of diversification of agriculture towards enhancing farm production, income and nutritional security.

A new National Agricultural Innovation Project (NAIP) with the support of World Bank has been planned, and is likely to be launched from July 2006. The main features of the project include research on production to consumption system (market), sustainable livelihood security in disadvantaged areas (poverty) and basic and strategic researches at the frontiers of science (productivity).

India and the USA have signed an agreement to launch an India-US Knowledge Initiative on Agricultural Education, Research, Service and Commercial linkages. The Knowledge Initiative Board from the Indian side visited the USA in December 2005, and a reciprocal visit of the US Board took place in February 2006.

Efforts were made to provide fresh thrust to organizational and systemic reforms of ICAR through rationalization of manpower strength, commercialization, public-private linkages, delegation of powers etc. Further, the Score Card System has been introduced for objective and quality assessment of scientists on direct recruitment and on career advancement. An empowered committee to operationalize the National Fund for Strategic Agricultural Research has been set up under the chairmanship of Dr C N R Rao with eminent scientists as members of the board.

Crop improvement: Germplasm being basic and essential for crop improvement, 5,846 accessions of crops and their wild relatives were collected through 85 explorations in different parts of the country. And 22,964 accessions were added to the National Genebank. More than 785 varieties/landraces of 12 crops have been fingerprinted.

During the year, 11 varieties of rice, 16 varieties of wheat, four varieties of barley, 11 cultivars of maize, one variety each of fingermillet and foxtail millet, one variety of grain-amaranth and two varieties of buckwheat have been released for cultivation in different parts of the country. In forage crops, three varieties of oats and one variety each of cowpea, *anjan* grass and berseem have been released for cultivation.

In oilseeds, one variety of sesame has been recommended for cultivation in rainy season. A protocol has been standardized for anther culture in groundnut. And identified signature markers for the first time in castor to establish hybrid purity, besides establishing transformed pigeonpea plantlets by rooting and micro-grafting. In pulses, one variety each of mothbean, horsegram and cowpea have been released and notified for commercial cultivation. Among commercial crops, two varieties of jute and one variety each of mesta and sunnhemp have been released and notified for cultivation. Two *arboreum* varieties of cotton and one hybrid each of intra-*arboreum* and intra-*hirsutum* cotton have been notified for commercial cultivation.

During the year, 4,341 tonnes of breeder seeds of main crops were produced. National Test Guidelines for Distinctness, Uniformity and Stability for economically important crops were developed raising their number to 35. To promote biocontrol of crop pests, *Crytolaemus montrouzieri* could be mass reared successfully on *Sitotroga cerealella* eggs and *Puccinia spegazzinii,* a fungal biocontrol agent, is ready for release in Kerala and Assam.

The production of major horticultural crops during 2005–06 is estimated to be 178 million tonnes with a share of nearly 57 million tonnes of fruits and 99 million tonnes of vegetables. The spices, plantation crops and flowers comprise a little over 20 million tonnes. Our country has emerged as the second largest producer of fresh fruits and vegetables in the world, besides being the largest exporter of spices and cashew.

Udhayam (ABB) variety of banana has been released that yields 40% more than Kapuravalli. Fruit production in arid zone is important to improve nutritional security, promote agricultural diversification and supplement farmers' income. The research efforts have led to development of eight cultivars of ber with tolerance to frost, and storage of aonla for 30 days at 6–7°C with negligible loss of total phenols and flavonoids. In temperate fruits and nuts, apple cultivars Oregon Spur, Golden Spur and Prima gave good yields in rainfed areas at Mukteshwar (Uttaranchal). Walnut landrace LG 5 has potential for commercial exploitation.

In vegetables, 26 varieties (five each in tomato, okra and pea, two each in cowpea and radish and one each in brinjal, chilli, Frenchbean, cauliflower, muskmelon, ash-gourd and pumpkin) have been identified for release. Besides, a tomato hybrid Arka Ananya, a brinjal hybrid Arka Anand and two chilli hybrids Arka Meghana and Arka Sweta have been identified for release. A high-yielding, single spore selection SSI 4035 of *Agaricus bisporus* has been recommended for commercial release. High-yielding *Pleurotus flabellatus* hybrids have been developed. Cultivation technologies of *Lentinula edodes* and *Flammulina velutipes* and techniques for modified atmosphere packaging to improve shelf-life of *Agaricus bisporus* have been standardized.

Potato hybrids Kufri Himalini and Kufri Chipsona 3 have been recommended for release. Six varieties of tuber crops (Goutam, Sourin and Kishan of sweet potato; Panisaru 1 and Panisaru 2 of colocasia, and Orissa Elite of greater yam) have been recommended for release for general cultivation in Orissa. Perfection of cold water miscible starch technology from cassava and release of its product as 'Texcool', preparation of instant gulab-jamun mix from sweet-potato and its release as 'Nutrigulab jamun mix', and characterization of musilages from taro, tannia and yams having pharmaceutical effects, are other important findings.

Floriculture is an upcoming sector with export potential. The research efforts led to development of an interspecific hybrid of carnation CS1, between *Dianthus caryophyllus* and *D. chinensis* for field cultivation. In jasmine, four pruning treatments prolonged flowering and staggered pruning at monthly intervals resulted in continuous flowering during lean period. DAS ELISA method has been standardized for detection of CMV infection in vanilla plants. Six new varieties of coriander, cumin, fennel and fenugreek; six varieties of black pepper and turmeric and five entries of nigella, dill and *ajowan* have been identified and recommended for state release.

Natural resource management: The management of natural resource is essential for sustainable food and nutritional security. Safeguarding environment implies overall well-being of the people. Soil-resource survey and mapping of 12 districts of nine states was done for land-use planning, and a detailed soil survey of 15 watersheds/farms has been completed for their land-use planning. Eco-friendly and sustainable land-use models have been identified for 16 watersheds, covering 5,258 hectares from dry semi-arid to sub-humid. Salt-affected soil databases of Rajasthan, Madhya Pradesh, Gujarat and Andhra Pradesh have been digitized, which would help in planning salinity management.

The resource conservation technologies are now spread to over 2 million

hectares of the Indo-Gangetic plains. Direct-seeded rice and sesbania co-culture (brown manuring), followed by zero-till wheat and other upland crops (chickpea/lentil/mustard) have exhibited tremendous scope for their acceptability in rice-wheat production system. Continuous contour trenches with *Stylosanthes scabra* + *Gliricidia maculata* as vegetative barriers proved most effective in minimizing run-off and soil loss in coastal Goa. An indigenous cost-effective technique has been evolved for preparing broad-bed and furrow (BBF) that has replaced costly BBF maker.

Research in integrated water management resulted in development of OPTALL model for canal-water management, improvement in quality and yield of banana with drip irrigation coupled with fertilizers, better fruit yield and quality of kinnow with supplemental irrigation and *sal*-leaf mulching, and economically viable participatory water management in foot-hills of western Himalayan region.

A new PGPR strain *Bacillus megaterium* isolated from rhizosphere of apple seedlings could fix atmospheric N, solubilize P and inhibit white rot of apple caused by *Dematophora necatrix*.

Under cropping or farming system, groundnut gave about 160% higher yield than check in Goa and showed promise for hilly terrains or as an intercrop in cashew plantation. Khedbrahm accession of henna has been found high yielding with 1.87% lawsone content. More than 500 cuttings of *guggal* (*Commiphora wightii*), a gum-resin yielding shrub, after dipping for a few seconds in 5,000 ppm IBA solution, have been transplanted successfully in field. Zero tillage significantly reduced population and dry matter of weed in rice-wheat system. Integration of 2, 4-D (1.5-2.0 kg/ha) or glyphosate (2.0–2.5 kg/ha) with bioagent (*Neochetina* sp.) controlled two waves of water hyacinth and significantly reduced herbicide load in aquatic environment.

Animal sciences: India continues to enjoy the position of world leader in milk production with 90.7 million tonnes in 2004–05, and with a production of 45 billion eggs, India ranks among the top six egg-producing nations. Poultry today is one of the fastest growing agricultural segments. Under the livestock and poultry improvement and management, genetic resource database was prepared, and this system also provides raw data for further analysis. Phenotypic characterization of several indigenous breeds of cattle, buffaloes, sheep, goats, poultry, camels and horses was completed in their home tract. DNA polymorphism revealed high genetic variability in Marwari equine population which may be exploited by equine breeders.

Genetic selection and breeding showed superior juvenile body weight of Naked Neck to normal birds. Embryo culture system was studied to make hatching observations, as its understanding has relevance to both medical and poultry sciences. The HSRBC and HCMI lines of poultry showed higher Newcastle disease vaccine response among different divergent immune-response lines.

In Frieswal cattle, farm, season of calving and year of birth were the main factors affecting age at first calving, highest milk yield 300 days, peak yield etc. Under field progeny testing programme, a decreasing trend was observed in calving age of Frieswal daughters born from first to fourth set of bulls. Nili Ravi

buffalo showed an improvement over the years in wet average, herd average and 300-day-milk yield. A survey was conducted to document the status of pigs in eight states of North-east including Sikkim. Duroc breed was used to produce pigs having lean meat with 60–70% less fat than Large White Yorkshire breed.

The field situation demands a need to change vaccine strains in case of FMD type A. Complete nucleotide sequence of several Asia 1 field isolates of FMD was determined. Immune response was assessed in sheep for early diagnosis of haemonchosis. Other achievements in animal health are: development of *Babesia equi* specific ELISA, reliability of abortus bang ring test for detecting brucellosis in mithun, sequencing of matrix gene of Indian isolate of avian influenza virus (H9N2), and development of sensitive diagnostic techniques and effective vaccines for several prevailing diseases.

The work carried out under animal nutrition led to transfer of technology for detoxification of castor-cake for commercialization, increase in cattle-milk yield on feeding of encapsulated choline-chloride, reduction in methane production on addition of brono-chloromethane capsule in diet of rams, and improvement in micronutrients and mineral-dependent enzymes in sheep on inclusion of Cu and Zn in appropriate amounts in diet.

Fisheries: India is the third largest producer of fish and second largest producer of inland fish in the world and provides livelihood to 11 million people in the country. In marine fisheries, the first phase of the National Marine Fisheries Census, 2005, was successfully completed in all the coastal states except Tamil Nadu. In inland sector, a river and reservoir database management module system was developed.

In area of culture fisheries, a portable fiberglass reinforced plastics (FRP) hatchery for carp production was developed that could be easily operated by small fish-farmers. Success has been achieved in breeding of an endangered yellow catfish *Horabagrus brachysoma* and of spiny eel *Mastacembelus aculeatus* under captive conditions. Breeding and culture technology of an endangered catfish pabda (*Ompak pabda*) has been developed. A highly nutritious starter-M, a weaning feed was developed for baby magur.

In coldwater fisheries, a computerized database of upland fishes of India was developed for proper management and conservation of native fish germplasm. Development of broodstock of rainbow trout *Onchorynchus mykiss* and formulation of feed for golden mahseer (*Tor putitora*) are significant achievements in upland aquaculture. The research carried out under brackishwater aquaculture led to improvement in traditional culture of tiger shrimp, molecular characterization and diagnosis of Indian strain of white muscle disease virus of giant freshwater prawn, and release of a nested RT-PCR diagnostic kit for *Macrobrachium rosenbergii* nodavirus.

Development of a low-cost mussel seeder for seeding mussels and a mussel harvester to strip mussels from culture ropes, preparation of a national mussel seed calendar, formulation of a cost-effective, bio-enriched feed for ornamental fish, and development of an economically viable, eco-friendly, easy-to-transport pellet feed for mud crab fattening are expected to give further boost to mariculture.

In fish harvest and processing technology, a corrosion-resistant, light weight LOA aluminium boat for reservoirs and rivers and a fish tunnel dryer using solar energy were developed. The process parameters for curing jelly fish were standardized. The activities undertaken in R&D programme in North-Eastern region include survey of fish fauna in river and lakes in Arunachal Pradesh, demonstration of cage culture in NEH states, training to rural artisans of NEH region on harvest and post-harvest technology. In Island development programmes, technical details were given to the Directorate of Fisheries, Andaman and Nicobar Islands in introducing FRP boats to help fishermen in the wake of the destruction caused by tsunami.

Agricultural engineering: In agricultural engineering a number of implements such as check-row planter, semi-automatic three-row plug-type vegetable transplanter, turmeric digger, rotary field shredder for sugarcane, and two-row pit digger for ring planting of sugarcane for high cane productivity, multi-purpose implement for sugarcane and banana stem-shredder have been developed as tractor-operated machinery. Under power tiller-operated machinery, PAU light-weight power tiller, earthing-cum-fertilizer applicators, manure spreader and shredder-cum-*in-situ* incorporator have been fabricated. In case of self-propelled machinery, PAU light-weight boom sprayer, tree climber and a prototype of simple manually-operated machine for making bamboo sticks have been developed.

Paddy sowing in hills with six-row manual type rice transplanter saved 68% in cost of transplanting including nursery raising. Recovery of high quality low fat degermed maize on pearling, evolvement of a technology for processing of wild pomegranate for quality *anardana*, fabrication of integrated paddy dryer for fast drying, development of pedal-operated peeler for rural level production of potato chips, standardization of process and recipe for soy-fingermillet-based biscuit, preparation of tofu-based vegetarian *kabab*, development of copra dryer, and commercialization of arecanut dehusker are significant achievements in post-harvest engineering technology.

An operator-friendly improved double roller gin has been developed which consumes 30% less energy than conventional machine for cotton. Stick machine and saw band cleaner could effectively improve cotton-lint grade without any deleterious effect on fibre attributes. Particle boards have been prepared from date-palm leaves—a viable substitute of wood or plywood products—for multiple uses. A portable sunflower threshing device has been developed that saves 25% in time and reduces drudgery of women-worker. Gas-fuelled automatic control dryer was designed and developed and found most suitable for maintaining natural colour and quality of products of aonla, curry leaf, drumstick leaves, medicinal and dye-yielding plants like senna and henna.

An electronic weighing machine for animals having capacity of 1,500 kg that can be transported easily on a jeep trailer is ready for commercial use. Dewatering machine for digested slurry from biogas plants and pilot plant for anaerobic digestion of rice straw have been developed.

In irrigation and drainage engineering, a low-cost equipment for nutrient management through micro-irrigation system has been developed, besides

fabrication of screen filter for micro-irrigation system in greenhouse. Technical feasibility and economic viability of mole drainage technology for enhancing productivity of soybean in Vertisols was assessed.

Agricultural education: Under agricultural human resource development, Memorandum of Understanding (MoU) with the IGNOU for co-operation in agricultural education in distance mode and co-operation with the ISRO, IGNOU and MHRD for utilization of the EDUSAT by the ICAR and SAUs for agricultural education are new initiatives which have immense potential for enriching agricultural education as well as to reach the unreached. The ICAR has provided financial support to the State Agricultural Universities (SAUs) for development of under-graduate (UG) and post-graduate (PG) programmes to expand and improve quality and utility in agricultural education and training. During the year, 151 students from 25 foreign countries were admitted to various degree programmes in ICAR-Deemed-to-be Universities (DUs) and SAUs. In diverse disciplines of agriculture and allied sciences, 3,305 scientists or faculty members were trained in Centres of Advanced Studies and Summer/Winter Schools/Short Courses. Best Teacher Award was given to 27 faculty members of SAUs and ICAR-DUs.

On the basis of the merit, National Talent Scholarship (NTS), Senior Research Fellowship, Junior Research Fellowship were awarded to 1,204, 202 and 475 candidates. For the first-time 2% of the total seats were reserved for candidates from 11 underprevileged states, not having any agricultural university, and the NTS of Rs 800 enhanced to Rs 1,000/month was awarded to all candidates who joined universities outside their state of domicile.

Under *Social Sciences and Policies*, present situation of agricultural markets in India has indicated a need to attract big business to invest and operate in bulk buying and selling, which would give better deal to consumers as well as producers. WTO agriculture negotiations vis-à-vis South Asia countries were studied and it was suggested that measures like export credit guarantee and insurance should be allowed only to developing countries. Stagnation in public investment in agriculture is affecting agriculture growth. Determinants of capital formation and agriculture growth were discussed and it was found that GDP agriculture is affected by both capital formation and subsidies, besides terms of trade.

Agricultural extension: For assessment and refinement of technology through the demonstration of technologies/products, the Council has established a network of 503 Krishi Vigyan Kendras (KVKs) in SAUs, ICAR institutes, NGOs, state governments and other institutions. At KVKs, 1,318 technologies were taken up for on-farm testing. A large number of demonstrations of production technologies on various aspects of crop production in oilseeds, pulses, cotton, other crops and dairy, sheep, goats, poultry, piggery etc. were organized. The KVKs also organized 37,963 training programmes, benefiting 680,000 farmers and farmwomen, 163,000 rural youth and 84,925 in-service personnel. And to accelerate the process of dissemination of technologies, extension activities such as field-days, *kisan melas* and discussion fora, film shows and diagnostic services

etc. were also organized, covering 2.43 million farmers. Advisory services were also provided to 127,594 farmers and other users. At KVKs, 5,322.5 tonnes of seed of major crops; 5.225 million saplings/seedlings of fruits, plantation crops and forest species; and 23,321,176 livestock strains were produced for availability to farmers.

Organizing self-help groups, followed by skill development trainings helped farmwomen to set up different enterprises in agriculture. Nearly 212,000 farmwomen and 64,394 rural girls were given training on crop production, horticulture, home science, livestock production/management etc, besides 27,076 farmwomen and rural girls trained through sponsored training programmes. Ten nutritious recipes based on cereals, pulses and nuts were developed and evaluated for their acceptability.

Hill and tribal areas: Due attention was paid on agricultural research planned specially for tribal and hilly regions to meet needs of farmers of these regions. Two hybrids and one composite in maize were released from the Vivekananda Parvatiya Krishi Anusandhan Shala, Almora. Besides, four varieties in rice, two varieties in tomato and one variety each in maize, fingermillet, fieldpea, lentil, soybean, horsegram, toria and vegetable pea were identified for release. Popularization of polyhouses for year-round cultivation of high-value vegetables, identification of different crop varieties suitable for organic-farming conditions, development of light-weight, rust-proof, pedal-operated paddy-thresher-cum pearler, and identification of new bacterium *Paenibacillus koreensis* possessing vast potential for white-grubs management in hill region are other findings worth-mentioning.

At the ICAR Research Complex for NEH Region, Umiam, a protocol was developed for *in-vitro* conservation and cryopreservation of wild rice. Soft-wood grafting was standardized in Khasi mandarin with a success rate of more than 90%. The other achievements are establishment of hatcheries in three stations to popularize Vanaraja birds in NEH region, development of DOT-ELISA-based diagnostic kit for identification of specific gastro-intestinal parasitic infection in goat and cattle and preparation of cost-effective package of practices for commercial production of exotic ornamental fishes.

The research efforts made at the Central Agricultural Research Institute, Port Blair, led to the development of putative transgenics in rice, allocation of indigenous collection numbers to 26 species of underutilized fruits, 15 orchids and 10 ferns and ornamental plants, and standardization of technology of composting coir pith and dried leaves using *Pleurotus* and urea. Fabrication of coconut dehusker for Nicobari tribals and solar dryer to trap solar energy and to improve quality of copra, achievement of captive breeding in *A. ocellaris* fish in laboratory are some of the other significant findings. Besides, impact of tsunami tidal waves was assessed on agricultural lands and suitable technologies were suggested for rehabilitation of affected farmers.

To improve working environment and to make research effective, efficient and relevant, the Council has taken several initiatives under the organization and management. The ICAR has decided to delegate powers to Directors of the

ICAR institutes to file patent applications under the Intellectual Property Rights. Forty new patent applications have been filed with Patent Office, New Delhi.

The Budget Estimates (BE) and Revised Estimates (RE) of the DARE and ICAR (Plan and Non-Plan) for 2004-2005 were Rs 17,533.10 million and Rs 16,750 million respectively. The BE for 2005–2006 (Plan and Non-Plan) is Rs 19,420 million. The Council announced 53 awards in 12 categories to honour 46 scientists, four farmers, one journalist and one co-ordinated research project. Financial assistance was given to 65 scientific societies and 12 academic universities/institutions for publication of journals and for conducting seminars/ symposia/conferences.

The DARE and ICAR have been operating partnership and linkages at the national and international level in agricultural research and education through the Memoranda of Understanding (MoUs), Agreements, Work Plans, Projects, Training Courses, Exchange Visits etc. Three MoUs/Agreements were signed between the ICAR and Brazilian Agricultural Research Corporation, the Government of India and Government of the Republic of Afghanistan, and Government of India and United States Department of Agriculture.

Under the international linkages, 18 projects have been approved/initiated. Delegations led by Vice Minister of Education of Ethiopia; President of the Walloon Parliament at Nimur, Belgium; Deputy Minister of Agriculture, Planning and Finance, Government of Islamic Republic of Iran; Deputy Minister of Agriculture, Chile; Deputy Minister of Food and Agriculture, Ghana; Minister for Rural Rehabilitation and Development, Afghanistan; Minister of Agriculture, Water and Forestry, Namibia; Director-General, IRRI, Manila; Director-General, FAO, Rome, besides others visited India. Indian scientists visited foreign countries for participating in international conferences/trainings to understand recent developments in agriculture and allied subjects.

The Directorate of Information and Publications of Agriculture (DIPA) brought out 40 publications in English and 15 Hindi. Two research journals, viz. *The Indian Journal of Agricultural Sciences* and *The Indian Journal of Animal Sciences*, and semi-technical magazines/newsletters, viz. *Indian Farming, Indian Horticulture, ICAR News, ICAR Reporter, ARIS News, Kheti, Phal-Phool* and *Krishi Chayanika,* were also brought out. A new expanded edition of *Handbook of Agriculture* with several new topics has been published. The two quarterly periodicals, *Indian Horticulture* (English) and *Phal-Phool* (Hindi), have been made bimonthly, w.e.f. January 2006. On the occasion of 75th anniversary of the two research journals (which are indexed in AGRIS, *Science Citation Index*, *Current Contents* etc.), research review articles were included in each issue. The *Indian Farming* and *Kheti* brought out special issues on World Food Day. Keeping the mandate of the Directorate for dissemination of information on the latest developments in agriculture, the semi-technical magazines also published accent numbers/dedicated issues on themes such as subtropical fruits, vegetable cultivation, flowers. The DIPA earned more than Rs 5 million through sale of its publications, advertisements etc., and also participated in various exhibitions.

The DIPA has developed CDs containing full text of articles of 60 issues of *Indian Farming* and 40 issues of *Indian Horticulture*. Two abstract journals, viz. *Abstracts of Indian Journal of Agricultural Sciences* and *Abstracts of Indian Journal of Animal Sciences,* were also published. *Directory of Conferences, Seminars, Symposia; Workshops in Agriculture and Allied Sciences*, *ICAR Telephone Directory 2006*, etc. are available on ICAR website.

Increased productivity, greater value-addition and cost and quality competitiveness will definitely provide to our farm exports. In addition, it is also necessary to give priority to strengthening the input delivery system, scientific water management, expansion of irrigation facilities, improving agronomic practices etc. The country can sustain growth rate with equity only when rural incomes rise, as 60% of the population earns their livelihood from farm and related activities. Substantial and innovative production system research on farmers' fields has made a greater impact on productivity enhancement, cost effectiveness, profitability and employment and income generation.

A detailed account of the DARE/ICAR activities, carried out during the year are given in this report. It is sincerely hoped that the information provided in this publication would find use with the stakeholders in the national endeavour of strengthening agriculture in the country and making it an instrument of economic transformation particularly in rural areas.

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