20. National Agricultural Innovation Project

The overall objective of the National Agricultural Innovation Project (NAIP) is to facilitate and accelerate sustainable transformation of Indian agriculture in support of poverty alleviation and income generation by collaborative development and application of agricultural innovations by the public research organizations in partnership with private sector, the civil society organizations and other stakeholders. The Project having 188 approved sub-projects is being operated under following four components:

Strengthening ICAR as the catalyzing agent for the management of change in the Indian NARS

The project aims at bringing in the operational changes in the National Agricultural Research System (NARS) so that it becomes capable of responding to the present as well as future needs of agricultural research and development. In all 40 sub-projects have been approved and are at various stages of implementation. Some of the salient achievements are:

More than 7,000 Ph D theses have been digitized and hosted on the internet and password access given to all the libraries of the NARS. Consortium for e-Resources in Agriculture (CeRA) is providing free online access to more than 2,900 international journals and 124 libraries of the NARS. Over 1.20 million articles have so far been downloaded from CeRA subscribed publishers.

E- publication of research papers has been introduced and is in operation through integrated online communication system and automation of complete life cycle of research journal publication and their access at global level. The dissemination of knowledge at grass-root level has been strengthened by mobilizing mass media support through Television channels and regional and national dailies. Besides, over 55 scientists have been exposed to the latest communication startegies at IIM, Lucknow and IIMC, Delhi.

Ten Business Planning and Development (BPD) units—five each in ICAR and SAU system—have been established for commercialization of technologies. Each BPD has identified 5–10 technologies, and are at various levels of commercialization. Business incubation facilities have been created in all BPDUs, and so far 15 incubatees are housed, 31 technologies were commercialized and 155 entrepreneurs developed.

Extensive market sensitization was carried out through advertisements, e-mails, websites, direct contact, participation in exhibitions/shows etc, distribution of brochures/fliers, etc. More than 500 scientists including many senior managers representing 97 institutes were sensitized about intellectual property assets, their protection and management including commercialization. A Network of Indian Agri-Business Incubators (NIABI) was launched and the first issue of the six-monthly newsletter was brought out. Over 250 scientists of the NARS have so far availed international training in 23 cutting edge areas of science such as allele mining, marker-assisted selection, apomixes etc. Further, 127 scientists have obtained international training under approved consortia.

Eleven market intelligence centres were established and 120 commodity price forecasts including 72 during the *kharif* 2010 were made. Through case studies, it was demonstrated that the adoption of these forecasts has resulted in additional income to farmers.

Research on production to consumption systems

Rural income augmentation and employment generation through post-harvest processing and value-addition, building of rural agro-industries, export promotion and import substitution and exploiting the market are the areas of thrust. Under this component, 51 value chains have been approved and are operational. Salient achievements are:

Multi-grain *rotis*: Multi-grain *rotis* (made with a mix of sorghum, wheat and soybean flour; some *rotis* are also made by adding *bajra* and ragi or maize and barley flour) are being adopted and sold over the past 10 months. Meanwhile, a city-based bakery unit came forward to procure these *rotis* made at a processing unit to sell through its four outlets. It is now selling over 400 packets a day. Each packet is priced at ₹ 12.

Production technology for *jowar* flakes for nutritional improvement: Efforts were made to retrofit rice flaking machinery to process *jowar* or sorghum flakes. The advent technology, edge runner (flaking machine) along with roaster has made possible to produce flakes from sorghum. Sorghum flakes are tasty and white as rice flakes. These flakes are pure form of consumption of *jowar* but offer a choice of convenience and ready-to-eat or cook products. Recipes such as *pongal*, upma or *poha,* porridge, *chidwa*, fried and seasoned mixtures etc. can be made from flakes. These flakes can be stored for 75–90 days at ambient temperature.

Sorghum flakes are suitable for all age groups, especially people ailing from diabetes and obese conditions, owing to content of slowly digestible starch in it. These flakes have more protein, fat, riboflavin, calcium, copper, but less carbohydrates, magnesium and iron than rice flakes. Pyridoxine, folic acid and zinc are absent in rice but present in sorghum flakes. The price of sorghum-based flakes is 11% lesser than rice-based flakes available in the market.

Standardization of process for development of complementary composite dairy food: The

formulation and process for development of whey-pearl millet-barley extract and skim milk-based complementary foods was standardized. The product is available in the form of dried mix, having a shelf-life of more than six months in laminated pouches. The dried mix has moisture, fat, protein, ash and crude fibre for tray dried and spray dried products 2.64, 2.57, 1.24, 0.96, 12.82, 12.83, 2.02, 2.09, 0.86, 0.84% respectively. The dried complementary food had 2.58, 38.56 and 1.40 mg/100 g of iron, calcium and zinc respectively. The product is meeting the standard requirements of complementary foods meant for weaning purpose.

Production technology for whey protein and iron-enriched biscuits: A technology was developed for pearl millet flour-based whey protein-enriched biscuits. The developed biscuits can provide 15% calorie, 20% protein, 7.6% iron and 9% calcium requirement of RDA per 100 g for children. The product can be promoted as better substitute for mid-day meal that is presently provided to children. The large-scale consumer survey of these biscuits revealed that more than 90% respondents (100 sample size) rated the biscuit as "like very much".

Protein-enriched extruded snacks: A technology was developed for the manufacture of extruded snack (*kurkure*-like product). The extruded snack contained pearl millet flour, maize flour and whey protein concentrate. The extruded snack contained 13% protein and 2% fat, compared to commercially available similar products possessing about 6% protein and 32% fat.

Value chain on ginger-based products: Three new products have been developed for commercialization.

Natural remedies ginger: It is a standardized water-soluble extract of ginger intended for the management of hyperlipidemia. *In vivo* preclinical study on NR-Ginger supports it to be an effective agent in the management of hyperlipidemia by showing significant cholesterol-lowering activity in albino wistar rats. In animal studies, LD_{50} of NR-Ginger was greater than 5,000 mg/kg body weight in rats. Ginger has a strong traditional backing from safety point of view.

Gingerols (less than 30%): The extract (free-flowing powder) is recommended for incorporation in nutraceutical formulations.

Gingerols (less than 20%) water-soluble grade: It is a completely water-soluble standardized extract (free-flowing powder), offering dietary supplement, food and beverage manufacturers an ingredient with tremendous formulation versatility. Excellent choice for applications such as dry drink mixes, ready-to-drink products, nutritional bars and other beverages.

Research on sustainable rural livelihood security

The major objective of this component is to improve livelihood security of the rural people living in selected disadvantaged regions through technology-led innovation systems. Under this component, 33 sub-projects have been approved covering 91 backward districts out of 150 backwards districts, and three sub-projects, covering 11 districts are also approved under Global Enviornment Facility (GEF) funding. The sub-projects continued to work in Integrated Farming System mode. Last year, though it was drought period, mitigation measures taken by the project personnel have developed a sense of confidence among the target community.

During this period, a major effort has been on identification of interventions with high pay off that may be upscaled. Such interventions are seed of improved variety/hybrid, diversification to high-value crops, introduction of improved breed of buck for enhancing goat production particularly for landless families, pig production particularly in North-East through supply of improved breed males, backyard poultry, water harvesting, improving water-use efficiency and promoting efficient use of natural resources. Besides these, some specific income-generating activities were also identified and are being implemented.

A very substantive effort was made to introduce improved crop varieties. As much as 88,238 ha area was brought under improved variety. This significantly improved the yield, income and also nutritional security to the farmers. Seed production has been taken up in 4,712 ha. Some of the significant results are:

- Hybrid seeds revolutionized the productivity of maize in the tribal belts of Rajasthan. Looking at the success, the Government of Rajasthan launched a Golden Rays programme in the state.
- System of Rice Intensification (SRI) was demonstrated in Nawada and Purnea , Bihar where

Natural dye

Two women of Muchintal village in Ranga Reddy district of Andhra Pradesh were trained in making natural dyed banana handicrafts. These women trained 20 other women in making different types of handicrafts. Out of those, 15 women started a unit in Muchintal which is running successfully in the village. GMR Marketing group (International Airport) has given their support in marketing these products in their outlets. *Rakhi* prepared with natural dyed banana fibre were sold by GMR. Besides, silk textile products were developed and displayed in Hyderabad and Chirala markets. This provided an opportunity to rural women to learn the technique of extraction of natural dyes and printing on fabric. More than 1,200 shades on cotton yarn, banana fibre, and fabrics of cotton, chiffon, georgette and silk dye shades were developed from 10 natural sources. The techno-economic feasibility of these colours showed that besides being eco-friendly, these colours were found to be seven times cheaper than the synthetic colours (concentrated).

Eco-powders with nine different shades were developed incorporating the essential colours as required and rated as excellent by the consumers. Demand for these colours increased after a news item appeared in popular newspapers. It is expected to replace at least 5% of the synthetic dye usage in *holi* colours by next year.

it has been widely accepted. It has also found wide acceptance in target districts under different sub-projects in Uttar Pradesh, Bihar, West Bengal and Maharashtra.

- Banana cultivation with supplemental organic compost was introduced to 40 farmers in Raebareli and Barabanki, Uttar Pradesh for a period of one and half year. The average income of the farmers, who adopted this technology, is about ₹ 134,444 from an area of half an acre.
- A low-cost technology for reclamation and crop production in sodic saline soil was developed and implemented. The average total annual income of the beneficiary at the end of first year was ₹ 86,200, whereas their baseline income was ₹ 21,500.
- A total of 29,450 multi-purpose trees were planted in an area of about 61 ha to check soil erosion in North-eastern hills region.
- The improved production technology for conservation and strengthening of local high-value poultry race Kadaknath was implemented in Jhabua district. An individual beneficiary is getting the net income of ₹ 80,000 to 105,000/ beneficiary/year. This success created interest among other tribals.
- Integrated fish-*makhana* and chestnut system has been tried in an area of 50 ha with 96 beneficiaries in Darbhanga. An average income of ₹ 25,626/ ha was reported.

Farmer showing *makhana*

- A model for collection of farm produce by Vegetable and Fruit Promotion Council, Keralam, has started 13 fruit and vegetable collection places in Wayanad district, Kerala, which is managed by farmers in a self-help mode.
- Organic Farming Certification programme was implemented with 506 farmers/beneficiaries of Wayanad district. The farmers are practising organic farming in 910.8 acres.
- Under sustainability fund, ₹ 297.9 lakh were generated by 21 consortia, and three more consortia have initiated the process of fund generation.

Basic and strategic research in the frontier areas of agricultural sciences

Component 4 aims to enhance capacity and help the extended NARS attain excellence in basic and strategic research in the frontier areas of agricultural sciences through innovations and collaboration. The sub-projects sanctioned under this component are from the diverse fields in advanced areas of sciences for plants, fisheries, animals, engineering, physical science and so on. There are 61 consortia, of which 26 are application-oriented and 35 are focused on basic and exploratory research with the total approved budget of ₹ 3,060.8 million. There are 254 partner institutions. Some of salient findings are:

- Identified differentially expressed genes for four stages (0–2, 5, 10, 15 days post-anthesis) using lint and lintless cotton mutant by proteomic and transcriptomic approach. Three additional genes associated with fibre development (Expansin, RD 22 like protein, E6 protein) were isolated and cloned into transformation vectors for over-expression. Four promoters for the genes expressing highly in the boll tissue of cotton (starting from square stage to boll-opening stage) were cloned and validated in transgenic plants. These promoters are highly valuable in expressing *Bt* genes in bolls only. A patent application for these promoters is in process.
- For field evaluation, two rubber dams developed under the NAIP, have been installed successfully and tested in the last monsoon at Badapokharia and Baghamari of Khurda district near Bhubaneshwar. Hydraulic inflation-deflation mechanism of rubber dams in watersheds was designed and developed. The Government of Odisha has shown interest in these dams.
- Complete genome sequence of an Indian strain of Potato Virus X has been generated for the first time. PUSA-ELISA kit for Groundnut Bud Necrosis Virus (GBNV) detection was commercialized. The sensitivity limit of the kit is about 25 ng. Hybridoma-secreting monoclonal antibody specific to GBNV was developed, which will make development of highly specific detection of virus possible.
- A flow injection analysis-enzyme thermistor (FIA-ET) bio-sensing system for monitoring of urea in adulterated milk was developed. The response time of the sensor was 2 min. The immobilized urease column exhibited a good operational stability up to 180 days when used continuously at room temperature. It fulfils the need of dairy processing plant for monitoring of urea in milk.
- A protocol for the isolation of bacterial outer membrane protein (OMP) was standardized for the sheep foot rot disease bacterium *Dichelobacter nodosus* as a first step towards the development of broad-spectrum vaccine. Three known OMP genes of *D. nodosus* were amplified and cloned for their expression. A whole cell group B specific

National Fund for Basic Strategic and Frontier Application Research in Agriculture (NFBSFARA)

During the year 2010–11 a renewed thrust was given to the activities of NFBSFARA as a new Empowered Committee (EC) was formed and a separate unit established as the Secretariat of NFBSFARA.The EC identified eight strategic areas, namely abiotic stress, water quality and productivity, micronutrient use efficiency, RNAi based gene silencing technology, development of resistance to pod borers of pulses, alternate sources of energy, post-harvest technology, and improvement of fibre quality in fibre crops. A special thrust is being given under NFBSFARA to develop research capabilities and facilities for Plant Phenomics, which will boost the research efforts in development of plants with abiotic and biotic stress resistance and other desirable characteristics.

Salient achievements of certain projects operating under NFBSFARA are presented here.

Plant disease management: Crown gall is an important disease of stone fruits especially of the nursery. Four agrocin-producing *Agrobacterium radiobacter* isolates enhanced the growth of pea plants and also reduced the crown gall incidence by 40–67% in stone fruit nurseries.

Rice gall midge is an important pest of rice causing an average annual yield loss of ₹ 30 crores in India. *Gm1* and *Gm11* genes with distinct molecular mechanisms for resistance to gall midge were identified. Linked markers for these two genes are available which will help in breeding for putting these together in rice in a relatively rapid manner.

Soil-borne fungal pathogen *Sclerotium rolfsii* causes disease in a large number of crops. The species specific PCR technique based on fungal gene (rDNA-ITS region) is highly specific to the species *Sclerotium rolfsii.* A technique for *S. rolfsii* detection from culture using nucleic acid spot hybridization technique (NASH) was developed, which is useful in testing large number of soil samples or planting materials.

Animal reproduction: Quantitative gene expression showed that in buffalo embryos the zygotic genome gets activated from 8–16 cells onwards and most of the developmentally important genes were of the maternal origin as they were expressed before zygotic genomic expression. Glucose transporter-5 was absent during the transition phase from maternal to zygotic transition, confirming that the early stages of embryos are pyruvate dependent.

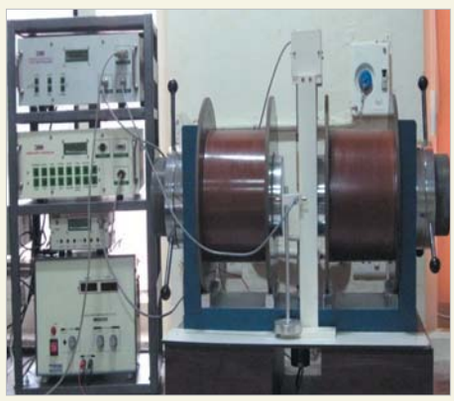
Buffalo endometrial stromal and luteal primary cell culture was established for the first time. It will be useful as an alternate model for working on development of strategies for enhancing embryonic survival and thus conception.

Vaccine for animal disease: Biosysnthetic virus, made up of only a small portion of foot-and-mouth disease virus of animal, was developed and tested in cell cultures. Vaccine produced by using this biosysnthetic virus was highly effective in guinea pigs. This approach of producing biosynthetic synthetic virus will help in rapid vaccine production against new strains of virus.

Alternate source of energy: A system to produce H_2 production from wood gas obtained from biomass gasifiers was devloped. Wood gasifier with burning rate of 1 kg/h has been set up. The gasifier has been operated for a number of days and it works satisfactorily.

Seed health: Two machines—pulsed magnetic field generator and a high power radiofrequency applicator, were designed and developed. The pulsed magnetic field drastically improved the viability of old seeds and germinabilty and seedling growth in garden pea, cucumber, sunflower, maize, chickpea and papaya. Storage pests of rice, groundnut and soybean when subjected to different frequencies and power levels of radio frequency energy were effectively controlled.

High power radiofrequency applicator



Pulsed magnetic field generator

vaccine was formulated for the first time in India and is currently under field trials in sheep. It is showing good therapeutic effect as well as humoral immunal response. All vaccinated animals recovered after the booster dose. Protective level of agglutination titre remained up to four months post-vaccination. ❑