The National Agricultural Innovation Project (NAIP), effective since September 2006, is the initiative of the Indian Council of Agricultural Research (ICAR), funded jointly by the Government of India and the World Bank to broadly identify and promote technology-led innovations in agriculture sector. The project continues to enhance multi-dimensional competence of the National Agricultural Research System (NARS) for steering-up agriculture R&D. The 13th Institutional Support Mission of the World Bank (ISM 13; 12-20 August 2013) has re-confirmed that the competitive consortia based funding through the NAIP has introduced a pragmatic pluralism in the NARS. A total of 91 public-private partnerships have been established in 203 sub-projects, approved with the NAIP financing, including 3 sub-projects with the additional financing from the Global Environment Facility (GEF).

Promising results emerging from the NAIP research and development activities as determined by select key performance indicators include, 72 patent/intellectual property protection applications filed; 319 research papers published in the high impact peer reviewed journals; 82 technologies/products commercialized based on the NAIP research; 51 new rural industries piloted, and over 3,800 hectares of farmers’ agricultural land brought under sustainable land-management practices.

The first Agri Tech Investors meet (18-19 July 2013) conducted by the NAIP on the recommendations of the ISM 12 came out successfully in catalyzing and managing change in the Indian NARS with a formal transfer of 58 technologies, including 30 technologies developed under the NAIP, to private entrepreneurs generating licence fees of ` 3.2 crore, besides deals worth another ` 1.50 crore in the pipeline.

The other components of the NAIP have focused on the three high-priority research themes—market-oriented collaborative research alliances; rural livelihood research alliances; and basic and strategic research alliances.

ICAR as a catalyzing agent

In terms of harnessing the knowledge flow through information, communication and dissemination system, potential of information and communication technology (ICT) for enhancing quality of education has been augmented by developing e-courses for 7 bachelor degree-level programmes in agriculture, horticulture, veterinary science, home science, fishery science, dairy technology and agricultural engineering; deploying them on-line, and also making them available as off-line copies. Further, operation of an online e-publishing system for the ICAR research journals has increased their readership by 4-5 folds, and reduced article processing time from 2 years with conventional publishing to 2-4 months. And the Consortium for e-Resources in Agriculture (CeRA) has provided an online access of around 3,000 journals to 142 CeRA member-NARS institutions throughout India. The sustainability of such an access is being secured by the concerned institutes through XII-plan funding.

A knowledge management platform – Agropedia – for aggregation and dissemination of information; a rice knowledge management portal – RKMP – for a complete information package on rice; a group catalog “AgriCat” (http://www.agricat.worldcat.org) of 12 major libraries for online access by researchers and students; a new platform vKVK (http://www.vkvk.in) as a knowledge network for the Krishi Vigyan Kendras (Farm Science Centres); and a strengthened statistical computing platform in the NARS (http://www.iasri.res.in/sscnars) are some other achievements, which have been strengthened during the period. And e-Granth provides digital access to library resources of 39 partner institutes; 27 new partners have been included.

Over 85 lakh pages have been scanned and are being uploaded to the repository, Krishikosh, at four digitization centres. Over 4,900 post-graduate theses from 36 agricultural universities have been processed and uploaded. Improved library services have been provided in 12 KOHA-LMS partner institutions. A
total of 473,756 records have been added to the Agricat (Union Catalogue).

Establishment of a National Agricultural Bio-informatics Grid would provide scientists’ access to high performance computing facilities for biotechnology-related research and of an online examination system would be for recruitment of agricultural scientists’ across the country.

Advance price forecasts of 20 agriculture commodities provided by the network of 10 market-intelligence cells before the sowing of crops have been used by farmers in pre-sowing decision-making. More than 700 scientists have received international training in cutting-edge areas of agricultural sciences, and 82 national trainings, many involving international experts, have also been completed.

Research on production-to-consumption systems

Research aimed at harnessing innovations involving production, processing, value-addition, marketing, resource use, pilot-scale testing of developed technologies, income generation and employment is addressed by the NAIP under 51 value-chains on food and agricultural commodities, including processed foods and agro-industrial commodities. Broadly, six models of value-chains have been supported: Model-1: Producer technology \(\Rightarrow\) Farming \(\Rightarrow\) Post-harvest \(\Rightarrow\) Marketing, Export; Model-2: Pre-harvest technology \(\Rightarrow\) Post-harvest \(\Rightarrow\) Open market; Model-3: Farming \(\Rightarrow\) Post-harvest \(\Rightarrow\) Entrepreneurs/Self-Help Groups; Model-4: Post-harvest \(\Rightarrow\) Products/Processes \(\Rightarrow\) Enterprises; Model-5: Products/Processes \(\Rightarrow\) Organized Industry; Model-6: On-shelf technology \(\Rightarrow\) Post-harvest processes \(\Rightarrow\) Community marketing (Social mobilization/Community participation/ Sharing resources)

More than 29,100 farmers have been benefited by market linkage under different interventions like export of flowers and fruits, afforestation, meat production, fish production, development of value-added products. Fifty-one new rural industries were piloted by the consortia funded under the NAIP, including 43 consortia in public-private partnership mode. Salient achievements include establishment of a pilot plant for extraction of bioactive components of Melia and Eupatorium using green-extraction technology; the estimated cost \(\bigcirc\) 1.3 lakh/litre) and returns \(\bigcirc\) 1.7 lakh/litre) of the formulation produced indicate this to be an economically viable enterprise.

Biopesticides-based good agricultural practices modules were successfully demonstrated and tested for production of clean cabbage, cauliflower and peas in 18 on-farm trials/demonstrations in Kangra, Kullu and Mandi districts of Himachal Pradesh. These practices have increased overall average returns of growers by Rs 5,903/ha. Field-level demonstrations in Vadaparud area of Gujarat on intercropping of cotton with ragi and radish resulted in its adoption by 148 farmers; including 48 farmers not supported under the sub-project. Adoption of clean-cotton picking practices reduced trash content, and with 2-3 protective irrigations, farmers received benefit of \(\bigcirc\) 24,700/ha.

A value-chain on industrial agroforestry in Tamil Nadu addressed constraints in paper and matchwood industrial raw material generation by designing model bi-partite, tri-partite and quad-partite contract farming systems involving farmers, research institutes, wood-based industries and financial institution as stakeholders. New industrial wood species for pulp, plywood and bioenergy were demonstrated; 7,500 hectares were brought under these species involving 2,378 farmers covering 30 districts of Tamil Nadu incorporating high-yielding pulpable clones of Casuarina, Eucalyptus and Melia.

In agro-processing value-chains, two rural feed-processing units were established at Mahabubnagar, Nellore, which produced complete feed, 50 tonnes/day, by utilizing locally available crop residues like sorghum-straw, maize-straw, groundnut-haulms and blackgram-straw. Scientifically managed pig farm and feed mill unit with a milling capacity of 8 q/hour has been developed. Regular disposal of slaughterhouse waste in aerobic-waste disposal pond maintained environmental safeguards in farm premises.

More than 200 millet-foods processing clusters were promoted across the country with technologies developed and adopted over the past two years; EATRITE branded products were commercialized through retail stores in Hyderabad, and their horizontal expansion has been initiated in Mumbai, Delhi and Pune. Sorghum-based products, including sorghum-fibre biscuits, 4 types of trans-free biscuits, sorghum crispies, and other value-added by-products like roasted flakes pedha, bran pedha, and bran soup have been developed and standardized. Sorghum-processing technologies were showcased through International Trade Fair, New Delhi, National Conference of KVK, Ludhiana, Industrial Exhibition, Hyderabad, and 48
A notable achievement is the restoration/revival of endangered Kadaknath poultry. The poultry birds are now commercially viable in Dhar and Jhabua districts of Madhya Pradesh.

Initiating with just 10 Kadaknath poultry sheds under the project, a total of 133 poultry sheds are at present functioning in the area. Kadaknath growers are getting a profit of Rs 0.95 to 1.00 lakh/year/shed. Thus, an annual income of around Rs 107.10 lakh is being generated by Kadaknath farming in Jhabua. The additional income generated is promoting tribal-farmers for better education of children, renovation of old houses, creation of transportation facilities, and for better management of their social functions.

Ten technical support centres have been created in Dungarpur district, Rajasthan, to provide advisory services to farmers. The consortium demonstrated potential of hybrid maize in 6,187.4 hectares, covering 21,006 beneficiaries. Average yield obtained showed 97.6% increase in hybrids (3.42 tonnes/ha) as against an average yield of 1.73 tonnes/ha from traditional varieties; there was an additional economic benefit of 8.8 crore. Observing the success of the hybrid maize demonstration in Udaipur, Banswara, Dungarpur and Sirohi districts, the Rajasthan Government has launched a Golden Rays Programme, and provided hybrid-maize seeds to 8 lakh farmers.

Creation of agribusiness producer companies in Rajasthan, West Bengal and Madhya Pradesh has been encouraging; more such initiatives on market linkages were reported, which altogether benefitted over 8,100 farmers.

Significant adoption and diffusion has been reported of interventions involving low-cost bio-enhancer for higher productivity; innovative drip irrigation technique for vegetable cultivation; modified system of trench farming in cucurbits; maize variety “Pragati” - a boon to farmers in Sonbhadra; mustard horizontal spread in Sahibganj and Pakur; ornamental fish farming in Keonjhar; and organic farming in Waynad.

Sustainable land and environment management (SLEM)

The GEF-financed SLEM project is another component of PIU-NAIP, consisting of three sub-projects. It was scheduled to close on 31 August 2013 but has been extended up to 30 June 2014 making it co-terminus with the NAIP. Among the successful practices supported, three activities are making visible impacts in their respective areas/states—(i) Land
shaping activities in West Bengal coastal zone, which
reclaims land parcels in saline-affected areas, (ii)
Activities in the livestock sector, including
characterization of local breeds of goat, sheep, and
their genetic upgradation, nutrition and control of
common diseases in Adilabad and Udaipur districts,
and (iii) Activities undertaken on Potential Fishing
Zone (PFZ) forecasting and promoting M-Krishi®
through mobile network in Maharashtra and Odisha.
Successful restoration of red rice landraces from the
long term (~20°C) storage vaults of the National Gene
Bank to farmers’ fields in Chamba district of Himachal
Pradesh has been another milestone achieved under
this component.

Basic and strategic research in the frontier areas of
agricultural science

A total of 52 patent applications have been filed in
India, including 15 published applications; also filed
an international PCT application, and an Australian
short patent has been granted; 246 research papers
have been published. 149 in high impact journals with
a NAAS rating of >6/10. More than 5.5 lakh molecular
resources have been reported and documented at the
GenBanks.

Twenty-four bench-scale technologies developed by
the researchers have been commercialized in the recent
Agri Tech Investors’ Meet 2013. Scientific outputs
and important developments include the following.

Conspicuous discoveries in molecular domain for
abiotic stress tolerance in maize involve ‘binding’ and
‘oxidation-reduction’ related linkage (mapping) of genes
induced under stress conditions in a waterlogging-
tolerant genotype, and ‘chloroplast’, ‘plastid’ and
‘transferase’ gene-sets in a susceptible genotype. In
rice, stunted expression in homozygous transgenic lines
expressing abiotic stress responsive *OsFBK1* gene was
reported to be tagged with *myc* gene; this expression
could be reversed by silencing *OsFBK1* gene using
RNAi approach. Ten differentially expressed proteins
that may impart tolerance to salinity stress have been
identified from *Bacillus pumilus* SB-49 cultured on
20% saline medium. Inheritance factor for Endosulfan
tolerance in *Trichogramma chilonis* strains was reported
to be ‘recessive’ to ‘semi-dominant’ whereas tolerance for
*α*-cyhalothrin was found ‘dominant’ one.

Allelic variants of dominant blast resistance rice
Gene *Pi54* have been searched from 92 Indian landraces
and cultivars using diagnostic blast fungal isolate Mo-
awi-37’1. Allele-specific markers have been developed
for marker-assisted blast resistance breeding
Programme; 120 homoyzogous advanced backcross
derived lines carrying genes *Pi54, Pi1, Pita, Pi9, Pi5, Pih,
Piz5* and simultaneously having basmati- grain
phenotype have been field evaluated in replicated trials.

A controller-based five-row seed-cum-fertilizer drill
has been developed. With this, required quantity of
seeds and fertilizers can be dropped by matching with the
speed of the tractor, which is sensed by a proximity
sensor, mounted on the front wheel of the tractor.
Field validation of the drill along with software
developed has been successfully done on soybean farms.

Micronutrient efficient and inefficient cultivars of
rice, wheat, maize, pigeonpea and chickpea have been
identified. The efficient cultivars can be grown in
deficient soils without affecting yields. Micronutrient
localization studies have showed deposition of Fe and
Zn in epidermis of chickpea, and apical cortical regions
of pigeonpea stems. In wheat, Zn concentration was
more in aleurone layer and seed embryo. Mn application
influences vessel size of vascular bundle, and thus
enhances translocation to grains.

An integrated ICT model, involving toll-free
Interactive Voice Response System (IVRS), Smart
Phone Application and Web-based agri-advisory system,
has been developed to address farmers’ information
needs on important aspects in a location-specific
manner. The model is under field validation in Andhra
Pradesh through Krishi Vigyan Kendras ANGRAU.

In-silico modeling of the leucine-rich repeat domain
(LRR) of the TLR of farm animals and their docking
with different ligands indicate potential of structural
variations contributing to differences in the downstream
cytokine levels across species and different breeds. A
simple PCR- based DNA test has been developed for
differentiating cattle and buffalo meat and milk.

Two herbal acaricides products developed for control of
tick infestations in animals have been found 50-
75% effective against resistant-tick lines; and 60-80%
against lice, dog tick (*R. sanguineous* and *Hyalomma
anatolicum*). They were safe with no adverse reaction
on animals (OECD guideline-410 followed), and were
stable in storage for more than a year at room
temperature.