Stakeholder Engagement to Achieve the Prime Minister's Clarion Call of Doubling Farmers' Income

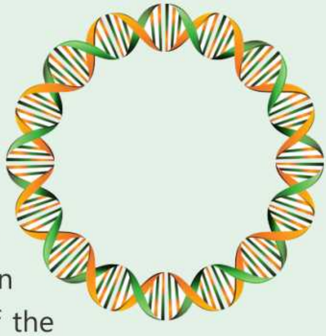
Role of Public Private Partnership in Agricultural Research, Technology & Innovation

SOUTH ASIA
BIOTECHNOLOGY CENTRE®

ICRISAT
INTERNATIONAL CROPS RESEARCH
INSTITUTE FOR THE SEMI-ARID TROPICS

Farmers' profitability and agricultural sustainability are the twin goals of the modern agricultural production systems. Achieving these twin goals requires collaboration between public and private partners-ranging from companies to communities to improve input efficiency & crop productivity, with an overall aim of improving the income of farmers in India. The public- private partnerships, presently at a nascent stage, are the important mechanisms to harness scientific expertise, skills, resources and technological innovations in the cropping system. Increasing yield, improving small farmers' asset productivity and enhancing environmental sustainability amidst depleting natural resources, and climate change need a paradigm shift and a transformative approach in collaboration and

Unique Opportunity



India has 1.3 billion people or approx. 17.84% of global population which lives on the 2.4% land and 5% water resources of the world. Despite being highly populous nation in the world, India has made remarkable strides in crop production since independence. From being food deficit nation in 1950s and 60s, it has become self-sufficient in food production. **In 2017, India produced a record of 277.5 million tons of foodgrains, 29.88 million tons of oilseeds, 23.95 million tons of pulses, 33.92 million bales of cotton, and 47.16 million tons of sugarcane.** Similarly, we have also production partnership–united we stand, divided we fall. In nutshell, the public private partnerships can revolutionize agricultural production systems driven by collaborative research and technological innovations, making agriculture more efficient, sustainable and profitable for increasing Indian farmers.

Photo : IARI, ICAR

of horticultural crops outstripping that of foodgrains for the sixth year in row, levelling at 305.4 million tons from only 25 million hectares in 2017. The high agricultural and horticultural produce has led to its export, with India's contribution of about 2.2% in the world market. Almost half of India's population led by 118 million farmers involved in agricultural production systems throughout the year, Kharif, Rabi, Spring and Summer seasons – growing almost all crops with increasing cropping intensity offer a tremendous opportunity to become a global hub for food, feed and fibre production.

Despite these achievements in crop production, agrarian crisis persists for most of 118 million farmers as about 70% own less than 1 hectare. About 60% of crop area is rain-fed, with its unpredictability forcing most to subsistence farming. With the rising input costs, farmers do not often get remunerative prices for their produce forcing them in to indebtedness. Farm produce being perishable often leads to glut in market forcing them to sell their produce below cost of production. The market interventions in the form of minimum support prices are limited thereby depriving them a subsistence living.

Big Challenge

The Government on its part has often resorted to alleviate the farmers' suffering by writing off loans, providing fresh credits with low interest rates, providing minimum support prices, market intervention in the form of bridging gap between MSP and prevailing market prices (price deficiency payment system), irrigation projects (Pradhan Mantri Krishi Sinchayee Yojana), soil health card scheme, eNAM (electronic National Agricultural Market), various kinds of subsidies and infrastructure supports including crop insurance (Pradhan Mantri Fasal Bima Yojana).

The farm distress is far and wide, with deceleration in the rate of productivity growth likely to offset the gains made in the past. The technology fatigue appears to have set in; as our funds on agricultural research and development are merely ₽ 6250 crores, less than 0.4% of total GDP from agriculture and allied sectors. This is in contrast to other developing and developed economies that spend more on R&D like Brazil (1.8%), Mexico (1.05%), Malaysia (1.0), China (0.62%) and many developed high income countries at 3.0%. In view of the above, it is proposed that for doubling the farmers' income by

2022; the Government needs to create an enabling public policy (PP) environment for public & private sector institutions to follow the IPPP mantra to tap innovation for prosperity (Innovate, Patent, Produce and Prosper) and to increase its expenditure on agricultural R&D to 1% of agricultural GDP.

Photo : South Asia Biotechnology Centre

Agricultural Research has time and again come to the rescue of the farmers increasing their productivity and consequently their income. For instance, farmers growing basmati rice Pusa 1121 have increased their income substantially and the country exporting it to the extent of about ₽ 15000 crores annually. Similarly, innovation and technologies in cotton has transformed India from a net importer to the world largest producer and exporter of cotton & significantly increased farmers' income over a period of time. India has been traditionally a major exporter of spices and condiments. India is the largest exporter of guar gum with earning in the range of ₽ 15,000-20,000 crores. We need to develop value-addition to our agricultural exports. Therefore, we need to develop technologies for climate resilient agriculture, and so for crop protection, post-harvest farm produce and crop residues.

Photo : South Asia Biotechnology Centre

CASE STUDIES

There are some successful examples of public private partnerships to drive research, technology and innovation in Indian agriculture production system. Though, PPPs focused mainly on agricultural infrastructure projects such as irrigation & agricultural supply chain, their involvement particularly in large research, technology and innovation projects remain mostly absent. However, in the recent year, there has been a now growing interest in the public private partnerships, from both public and private institutions to create short, medium and long term R&D & technological projects to bring transformational change in the agricultural production system for achieving the clarion call of Hon'ble Prime Minister to achieve doubling of farmers' income. The round table meeting will discuss successful case studies of PPPs among Indian public sector institutions, CGIAR institutions, NGOs and private sector companies, particularly various crops-based interventions tried in public private partnerships for enhancing productivity and sustainability of agriculture production system.

The Way Forward – The Role of Public Private Partnership

The progress and promise of public private sector partnerships (PPP) is striking in the recent past in India. Many public and private sector institutions, both nationally and internationally have established projects to facilitate the transfer of technological applications from both the private and public sector for the benefit of farmers and consumers. A preliminary review of the initiatives involved in technology transfer projects from both the public and private sector, suggests that the PPP projects have been relatively successful and offer advantages that increases the probability of delivering an approved product at the farmer level, within a reasonable time frame. Following PPP case studies have been selected to review and illustrate the diversity in characteristics of the model projects.

Hybrid Rice-A successful case of public private partnership

Hybrid vigour is exploited in many crops like sorghum, maize, cotton as the hybrids give more yields than parents. Similar attempts were initiated in rice too with the availability of male sterile lines. The hybrid rice was first developed in mid-1970s in China, with the efforts of Yuan Longping,

Photo : IARI, ICAR

known as "father of hybrid rice". More than 50% of rice area in China is planted every year with hybrid rice, which has increased production and contributed to the food security significantly. Currently, China has reportedly developed super hybrid rice yielding about 15-17 tons per hectares.

In India, hybrid rice development started in 1980s first in public institutions like State Agricultural Universities, ICAR institutions, and later in private seed companies. These efforts culminated in commercializing first rice hybrids in mid-1990s initially on small scale, and later area expanding over about 1 million ha in 2006. Presently, hybrid rice occupies about 3 million ha which constitute nearly 7% total rice area in the country. As many as 93 hybrids have been released so far. The first public private partnership for ICAR as public institution and the then Barwale Foundation as private NGO, evolved with the contribution of ₽ 1 Crore by the latter for developing rice hybrids in early 1990s. It acted as catalyst for hybrid rice development and set an example for similar collaborations.

Pusa Rice Hybrid 10, the World's first Basmati hybrid, was released in 2001 with duration of only 120-125 days and yield up to 7 tons per ha as against Pusa Basmati 1 yielding only 4-4.5 tons/ha. Indian Agricultural Research Institute, New Delhi made available technology for its seed multiplication to many companies in partnership with several private partners thus expanding its reach to large number of farmers.

Over the years, partnership between private and public institutions have helped in building vibrant seed sector in the country and helping in achieving high seed replacement in many crops.

Golden Rice-A case of public private partnership in agriculture research, yet long way to go

More than 200 million children suffer from Vitamin A deficiency (VAD) and a large number of them (2.5-3 million) die due to compromise of immune system to various infectious diseases arising out of VAD. This deficiency can be met by eating green vegetables, carrots, milk, butter and other dietary sources. However, VAD continues to plague the children and adults too mostly in South East Asia including India where rice is a staple food and the ignorance of need for balanced diet high.

Professors Ingo Portrykus and Peter Beyer envisaged an approach to counter VAD through expressing carotenoid pathway in rice grains in 1999, which is naturally available in the leaves only. The developing transgenic rice expressing ß-carotene, a precursor of Vitamin A however was not an easy task given the fact that it involved huge funding for food and environmental safety trials for regulatory approval. Portrykus and Beyer sought help of the agrochemical giant, Syngenta, a deal that created public private partnership. This partnership resolved issues around intellectual property rights (IPR), helped in getting access to technologies held by multiple partners in 2001. As a result, the first regulatory event expressing 1.6 µg/gm of ß-carotene was produced in 2002, followed by first field trials in open of golden rice at Crowley in Louisiana in 2004. The new experimental lines (GR2) of Asiatic/Japonica rice expressed as much as 36-37 µg/gm of ß-carotene in rice grains. Golden rice turned out to be an efficient way of utilizing and conversion of ß-carotene to Vitamin A, and a bowl of 100-150 gm of cooked golden rice enough to meet 60-70% Vitamin A needs in children.

Photo : IRRI

Next generation Golden Rice event GR2-E is being developed by the International Rice Research Institute (IRRI) with the support of the Gates Foundation. The International Rice Research Institute (IRRI) reports that as of March 2014, the research, analysis and testing of ß carotene-enriched Golden Rice continues, in partnership with collaborating national research agencies in the Philippines, Indonesia, and Bangladesh. The Golden Rice event GR2-E was introgressed into selected mega varieties by ICAR IIRR, IARI and TANU, closely monitored by the Department of Biotechnology (DBT) to adapt them to the local conditions, yield as much as other do, and suit the local taste. Recently, EPA (USA), Health Canada and Food

Standards Australia and New Zealand have given approval of its being safe and nutritious food from the commercial rice varieties in May 2018

High Iron Pearl Millet

Pearl millet biofortification research at ICRISAT is carried out in partnership with HarvestPlus, the ICAR-All India Coordinated Pearl Millet Improvement Project, state agricultural universities and seed companies. To ensure long-term sustainability, HarvestPlus engages seed companies in GxE testing of hybrids and inbred lines developed at ICRISAT, and encourages them to develop their own high iron hybrids for commercialization. Until date, seed companies have commercialized two cultivars and four hybrids have been officially released by state agricultural universities. Nutrition research has shown that biofortified pearl millet with iron can provide young children with 100% of their daily iron needs.

Photo : HarvestPlus

IR Brinjal: An illustration of co-development by public and private sector

The Insect Resistant (IR) brinjal was developed by Mahyco in collaboration with public sector research institutions and state agricultural universities in India from 2000-2009. The IR brinjal project was supported by the Agricultural Biotechnology Support Project (ABSP) funded by USAID. It had undergone a rigorous science-based regulatory approval process in India during this period. Over the last 9 years, Mahyco, the co-developer of technology along with public sector institutes and state agricultural universities had undertaken various studies and field trials including laboratory experiments, greenhouse and confined field trials, biosafety and food safety studies, multi-location and large scale field trials for agronomic evaluation, socio-economic and environmental impact assessment.

In this period, 8 IR brinjal hybrids

Photo : South Asia Biotechnology Centre

were developed by Mahyco whereas 10 open pollinated varieties developed by public sector universities including 4 IR brinjal varieties by the Tamil Nadu Agricultural University (TNAU), Coimbatore; & 6 IR brinjal varieties by the University of Agricultural Sciences (UAS), Dharwad. All of these 10 varieties & 8 hybrids had undergone biosafety evaluation for commercial release in 2009. In addition, there were 6 open pollinated IR brinjal varieties developed by the Indian Institute of Vegetable Research (IIVR), Varanasi which were evaluated under large scale field trials throughout India. On 14th October 2009, India's Genetic Engineering Approval Committee (GEAC), the country's biotech regulator recommended the commercial release of IR Brinjal Event EE-1 developed indigenously Mahyco in collaboration with the University of Agricultural Sciences (UAS), Dharwad, the Tamil Nadu Agricultural University (TNAU), Coimbatore and the Indian Institute of Vegetable Research (IIVR), Varanasi. However, on the 9th Feb 2010, the Ministry of Environment and Forest (MoEF) decided to temporarily halt the commercial release of IR brinjal till such time independent scientific studies establish to the satisfaction of both the public and professionals, the safety of the product from the point of view of its long-term impact on human health and environment, including the rich genetic wealth existing in brinjal in India. Meanwhile, our neighbour Bangladesh approved IR brinjal in 2013, and has been successfully cultivating for last 4 years without any report of environmental or human hazards.

High Zinc Wheat

The high-zinc wheat lines developed in partnership with CIMMYT are provided to NARS and agricultural universities for testing and further local adaptive breeding. HarvestPlus collaborates with ICAR- All India Wheat Improvement Program, public organization, seed companies and five NGO's. Two zinc wheat varieties have been officially released and seed companies have commercialized four zinc wheat varieties.

Nutrition research has shown that 100 grams of biofortified zinc wheat a day meets 40% of the daily zinc requirement of the school age children. By the end of 2017, more than 90,000 farmers have grown iron pearl millet in India.

In addition, Harvest Plus engages stakeholders from private and public sector for participatory rural appraisal and multi-environment testing, on-farm and on station, in collaboration with public and private sector partners, including Agricultural State Universities (ASU), NGO's and seed companies. With these collaborative partnerships, the most promising germplasms are evaluated in the national testing trials and verify that varieties proposed for test marketing and commercialization comply with consumer preferred end-use quality attributes and are widely adapted and stable nutrition contents across sites and generations. By the end of 2017, more than 200,000 farmers have planted and benefited from high zinc wheat varieties in India.


Photo : HarvestPlus

CIMBAA: Insect Resistant Cabbage and Cauliflower

An unique Public-Private Partnership named "Collaboration on Insect Management for Brassicas in Asia and Africa" (CIMBAA) was formed in mid-2000s led by AVRDC-the World Vegetable Center, Taiwan. It comprised of the partners viz., The World Vegetable Center, Centre of Environmental Stress and Adaption Research (CESAR) of the University of Melbourne (Australia), Cornell University's Departments of Entomology and International Programs (USA), Natural Resources Institute of Greenwich University (UK) and the private partner, Nunhems Seeds of Bayer Crop Science. This partnership later included many other institutions like IARI and TERI in India.

Brassicas suffer high losses due to insect pests. It is reported that cabbage and cauliflower incurs loss of about US$ 1 billion every year worldwide due to the diamondback moth alone. In

India, cabbage and cauliflower loss of production was assessed at US$16 million every year due to insect pests alone. This unique public private partnership envisaged development of the IR cabbage and IR cauliflower with the help of Bayer Crop Science in collaboration with public partners. The USAID Program for Biosafety Systems funded the first project (2005-2008) involving US, Australia, India and Indonesia with an aim to provide national regulatory bodies with an enhanced capacity to make informed decisions on stacked IR gene brassica crops proposed for commercialization in India and Indonesia. Under this program, CIMBAA tested efficacy of IR toxins against several pests of cabbage and cauliflower. These studies helped us to shortlist effective Cry toxins, Cry1B and Cry1C. Later, funding under Indo-Australian Strategic Research Fund "Grand Challenge" was obtained to continue studies on various aspects of integration of IR toxins with insect management tactics and collaborate with IR transgenic cabbage and cauliflower development carried out by Bayer Crop Science. Several events of IR cabbage and IR cauliflower were extensively tested under controlled conditions during 2006-10 and some promising lines were shortlisted. Most of these IR cabbage and cauliflower lines were found to be highly effective against key insect pests. However, CIMBAA collaboration came to an end in 2011 with shift in interests of various partners. This partnership was thus successful in developing IR transgenic cabbage and cauliflower.

In view of progress carried out in the above project, another grand challenge project (2012-2016) with India-Australia funding was envisaged for developing GM cabbage and Cauliflower for India and GM canola for Australia to control both lepidopterans as well as hemipterans, with IR cry genes for lepidopteran and RNAi approach for hemipteran control. This project made considerable progress in developing two-toxin IR cabbage and cauliflower and identifying RNAi constructs for aphid control.

Food Chain Partnership: Working together for sustainable agriculture

The Food Chain Partnership is an ambitious public private sector

Photo : Bayer Crop Sciences

Griffith food; the Vegetable Projects in collaboration with Metro & Reliance Fresh to improve yield and quality of fruits and vegetables by imparting trainings to farmers on sustainable practices to get higher returns through regular farm

initiative by Bayer Crop Sciences with two-fold objectives: proactive approach to serve needs of food industry with sustainable crop solutions and facilitate mutually beneficial business relationships by generating added value for all involved stakeholders from farmers to consumers. As of 2017, around 524 food chain initiatives involving public and private sector were undertaken across 76 different crops in 40 countries worldwide. In India alone, the food chain partnership runs 39 food chain initiatives across category of retail chains, processors & exporters. Major programs under the food chain partnership include Chilli project in Karnataka to develop and implement effective solutions that improve the yield, quality of Chilli and manage the level of residues while reaching to more farmers in partnership with Synthite, ITC, Omnikan and

visits, program monitoring & passports, establish farmer linkage to market and arrange linkages with Agri-clinics; the Gherkin project is to develop and implement effective solutions that improve the yield and quality of Gherkin and manage the level of residues by training farmers about the customized spray schedule (IPM) & export norms, new molecule testing & initiations for label extension and services on certification, measuring improvements, pesticide storage & safe use. Ultimately, the objectives of the the food chain partnership is to educate, train and skill farmers and create an integrated supply chain for the benefits of farmers, benefits of processors, benefits of exporters/importers, benefits of retailers and benefits of consumers. More information about the food chain partnership can be accessed at https://www.foodchainpartnership.cropscience.bayer.com/

Objectives/Deliverables

- Recognize public private partnership in the form of a policy instrument by the Government of India as the most effective mechanism for research, technological innovations and transfer of technology from the lab to the land.
- Gazette the model of a progressive public private partnership with well-defined scope of activities, roles and responsibilities and a time bound executions
- Develop guidelines for entering into collaboration and partnerships for jointly carrying out research and technological innovations to generate both exclusive and public goods for the benefits of Indian agriculture
- Set up of a common platform as part of Kharif and Rabi season meetings to exchange information, new cropping practices and technologies between public and private sector institutions
- Devise BIRAC type program at MOA/ICAR/SAUs to develop collaborative research programs between public and private sector institutions
- Foster an attractive environment for technology development & technology acquisition funds and venture capital funds focusing on agriculture research and technological innovations to ensure higher farmers income and sustainable agriculture development
- Harness collaborative agricultural extension efforts to disseminate knowledge about new technologies and techniques and to demonstrate viability of cutting edge extension technologies
- Streamline regulation for export-import of seeds and planting materials, access of bioresources and time bound regulatory clearances to reduce lag times for promising agricultural technologies
- Create public private partnerships with an aim to leverage investment, enhance private sector involvement in agriculture research and commercialization of technologies developed by public sector institutions
- Develop an institutional mechanism to field tests the safety, efficacy and performance of new products developed by private sector

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