



Strengthening the agricultural technology dissemination through Institutional partnership-based extension model

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ABSTRACT

Partnership among institutions have been globally recognised as useful tool for effective extension for development of agriculture and rural dwellers. This have been proved through a national level public-private partnership-based technology dissemination extension model that was executed across 15 states of India categorized into six regions for the period from 2009-10 to 2015-16. There were 13 public institutions (9 SAUs and 4 ICAR institutes) and 41 voluntary organizations involved in this project with ICAR-IARI, New Delhi as the nucleus institution from where the multi-disciplinary integrated technology and packages were disseminated. The programme was monitored and evaluated through a well-structured inbuilt mechanism of annual review workshop, project area visits; monthly, six monthly and annual progress reporting and contingency field level workshop. During the period of six years, 21211 on-farm technology demonstrations were conducted which covered 6565 ha of area. About 30000 farmers across 15 selected states were directly and indirectly benefitted from different interventions of the project. The farmer level feedback helped to evolve two new varieties of paddy and participatory on-farm seed production ensured self-sufficiency by way of generating the quality seed pool for paddy (4526 q), wheat (7965 q) and vegetables (15 q). Based on the experiences, expected potential of the outcome have been implicated.

Key words: Agricultural technology, Institutional partnership, SAUs, Voluntary organizations

More than half a decade ago, there was consensus that the world has entered a new millennium but crippled with poverty, food insecurity and environmental depletion (Shah and Strong 1999). The challenge of sustainably feeding the nine billion people by 2050 is definitely the herculean task and therefore, the agricultural sector needs to undergo major transformation. Achieving this transformation will require evolving the new approach and extensive coordination among all stakeholders in the agricultural system. Market-based approaches will be the *sine-quo-nin* to the change driver and shall offer efficacy, scalability and market based incentives to gear-up the large-scale effort.

Understanding the effectiveness of institutional partnership is also essential in order to have correct understanding of the potential benefits and challenges of partnership. Hartwich *et al.* (2007), eleven years ago systematically analyzed 70 partnership cases gathered from 15 developing countries and identified four common project types, viz. partnerships that may aim to develop agricultural

value chains, for joint agricultural research, innovation and technology transfer; for building and upgrading market infrastructure; and for the delivery of business development services to farmers and small and medium enterprises. Experiences, however, have also reflected that partnerships may become useful way of increasing extension effectiveness. (Singh *et al.* 2016).

The Indian context is still challenging. In India, the number of cultivators and agricultural labourers constitute the 22% of the population, i.e. 1.2 billion (Hindustan Times 2014). Further, it is also on record that about 40% of the field level extension worker posts are still vacant (Chandragowda 2011). Using the data, farmer: extension workers' ratio works out to be 2879: 1. Therefore, an alternative and supplementary approach of extension that is in the form of participation of private agencies together with public institution has come into picture.

Since the extension activity jurisdiction of ICAR-Indian Agricultural Research Institute (IARI), New Delhi is limited to National Capital Region (NCR) only and it was often felt that taking the technologies to far off areas, intending for increased production and productivity of crops across the country was a difficult task. Keeping this in view, an innovative partnership based alternate extension model was

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conceptualized on the principle of 'sharing of strength' for technology dissemination through 'partnership' by involving the public funded institutions; ICAR institutes and State Agricultural Universities (SAUs) as well as Voluntary Organizations (VOs).

MATERIALS AND METHODS

The project was implemented by multidisciplinary team of scientists at the institute in partnership with selected ICAR Institutes, SAUs and Voluntary Organizations in different parts of the country (15 states) in 7 zones for the period of six years (2009-10 to 2015-16). The works were executed as per the following procedure with the specific task assigned to respective team members.

Situation and farming system appraisal: The analysis of the existing farming system was carried out through joint workshops with partner Institutions. In this exercise, multi-disciplinary scientists were involved besides the members of the selected institutions. The joint workshop and appraisal resulted in understanding the farming situations characteristics, limitations, farmers' priorities, problems and potential interventions. This exercise evolved the systematic plan document and roadmap for execution of best technological options through suitable approaches like demonstrations, training, etc. There were 54 organizations (SAUs, ICAR institutes and VOs) representing northern hill zone (9 organizations), northern plain zone and NCR (11 organizations), north eastern plain zone (10 organizations), north-eastern region (5 organizations), eastern region (8 organizations), western region (13 organizations) and Maharashtra, Gujarat and southern region (9 organizations) who did the situation analysis of their respective areas and did prioritization of farmers' felt needs. Considering very large number of organizations involved (54) across the country, it was not practically possible to mention the geographical locations like longitude, latitude and height from mean sea level of each site and therefore, these figures for the country itself were taken (8°4' north to 37°6' north latitude and 68°7' east to 97°25' east longitude).

Execution of the interventions: Suitable crop production, plant protection and natural resource management technologies and farm-enterprises were identified based on participatory analysis and joint consultations for profitable farming system. Technology backstopping was provided by Production Unit of the Institute. The Production Unit members are the scientists identified from different disciplines, to play the advisory role to the project. There is strong linkage between the project associates and the nodal officer of different collaborative Institutes for smooth implementation of the programme. The identified interventions were executed in all three seasons namely *kharif* (rainy), *rabi* (winter) and *zaid* (summer). Apart from that, employment generating activities and social institutions building exercises were carried out simultaneously. Field crop based, fruit crop based, vegetable crop based related interventions were assessed and demonstrated in closed partnership with

different identified institutions/organizations spread across the country. In all the interventions and at all locations we used the standard indication for check plot/farmer's plot (T1) and intervention (T2).

Monitoring and feedback: The output of the interventions was gathered throughout the crop stages and at the terminal stage. Farmers' feedback was recorded at every stage of data collection. Half yearly and annual workshops were organized to monitor the progress of the project and sharing the feedback among the researchers and partner institutes. These workshops were also utilized for doing mid-term corrections of any deviation in programme execution. During the cropping season regular joint field visits were also made. All the members of the project were involved at this stage with greater responsibility to the social scientists.

Output and outcome: The output of the experiment was documented in terms of physical achievements and coverage. The technical output was captured on the parameters of yield advantage, profitability, disease incidence, etc. Outcome was ascertained in terms of farmers' level of acceptability of the technologies, their feedback and horizontal spread.

RESULTS AND DISCUSSION

Physical output of the project

A large area of crops and varieties were assessed and transferred in addition to other technologies and capacity development interventions. A summary table of the total demonstrations is given below. During the reported period, 21211 on-farm technology demonstrations were conducted which covered 6565 ha of area. About 16500 farmers across 19 states were directly and indirectly benefitted from different interventions of the project. This implied that on an average, the nucleus institute conducted above 3000 demonstrations every year with average coverage of area and farmers of above 900 ha 2345 farmers annually under one single project because of the fact of multi-institutional partnership which otherwise may be confined to fewer number and lesser area coverage.

Identification of appropriate technologies effective across the country

Case of wheat (HD 2733): It was interesting to observe that the centrally recommended crop varieties performed well even in zones where it was not recommended. In case of wheat variety HD 2733 (T2) as evident from Fig 1 that out of 10 recommended zones, it performed well (50-55 q/ha) in only three zones namely Deoria, Chhapra and Varanasi, where as in seven zones, the yield ranged from 35-48 q/ha. Further, in the 10 new niches, this variety showed the performance 50-63 q/ha. This is the stable yield observed consequently for three growing seasons. Such experiences not only establish the new variety in its matching farming system, the prevailing micro-location trials for crop variety development demands to revisit its approach and protocol.

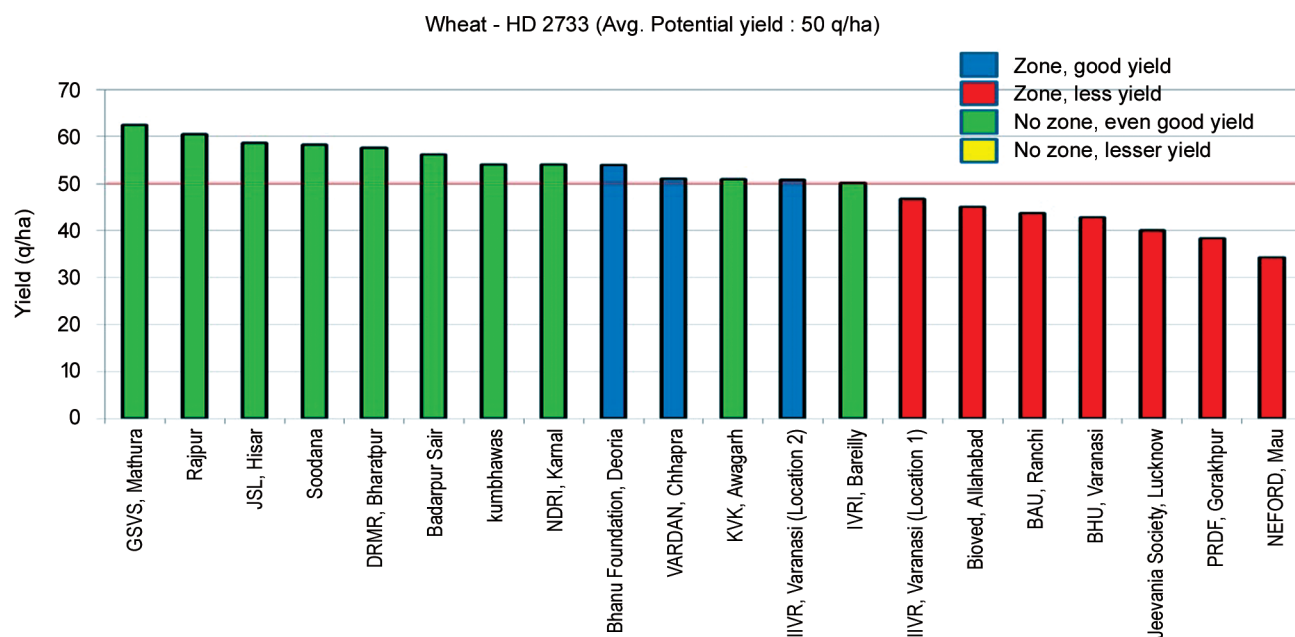


Fig 1 Appropriateness of the wheat variety (HD 2733).

Case of paddy (P 2511): The short duration aromatic and high yielding paddy variety Pusa Sugandh (P2511) when tested across the country showed very interesting trends. As indicated in Fig 2, the yield ranged from 30-63

q/ha across 25 zones with highest yield in Kushinagar (UP) and lowest at Dahod (Gujarat). The net return, however, showed another type of spatial variation. It was highest (₹ 160 th./ha) at Ghaziabad and lowest (₹ 18.0 th./ha) at

All : Kharif 2013

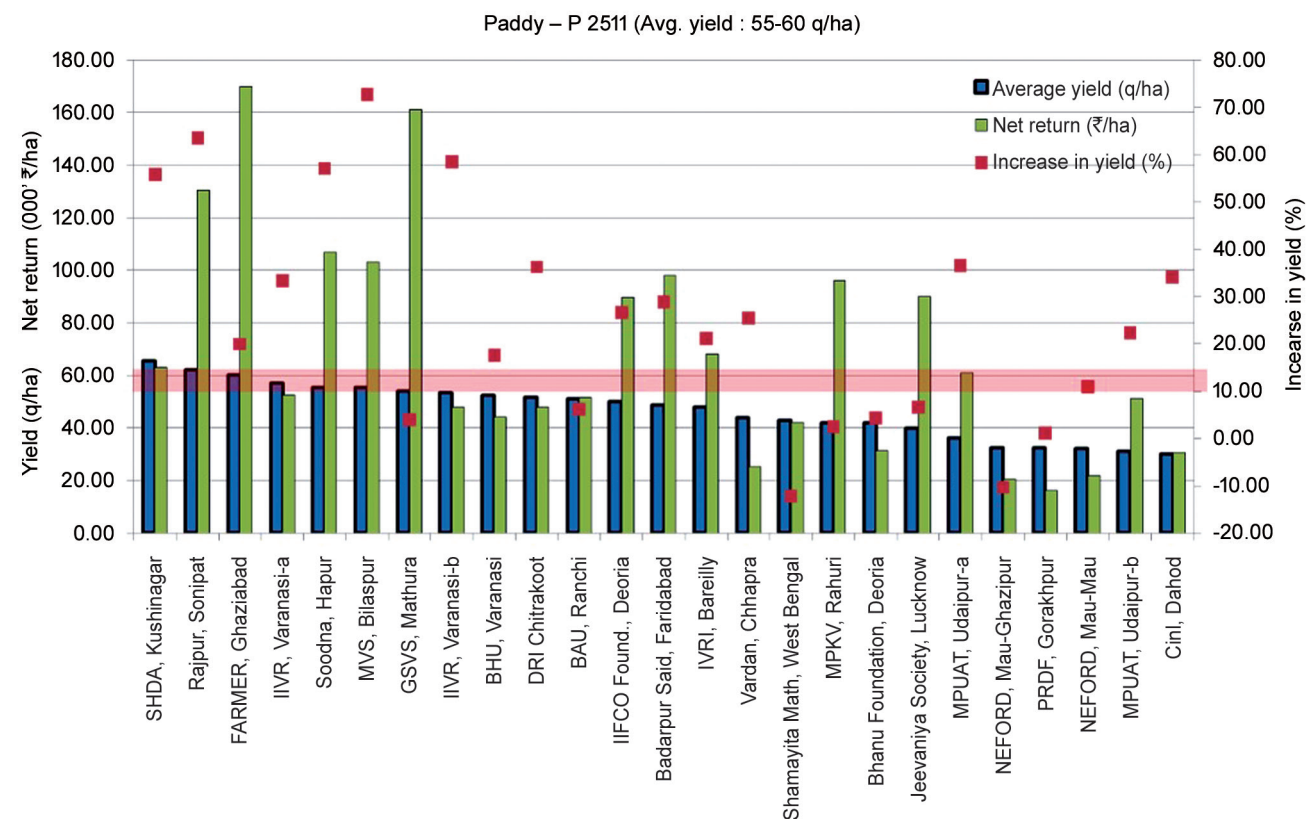


Fig 2 Appropriateness of paddy variety (P 2511).

Gorakhpur. Out of 25 zones, the yield was observed more stable at 10 zones (40%) and in the remaining 60% areas, there was substantial variation (8-42%) in the yield (5-25 q/ha) in treatment plots (T2).

Addressing the productivity problems of disadvantaged areas/areas bypassed in Green Revolution

Water scarcity areas: In Madhya Pradesh, Gujarat and Rajasthan, the chickpea and pigeon pea varieties were assessed, demonstrated and popularized. For instance, Pigeon Pea variety Pusa 2001 was found more profitable short duration variety as wheat crop could be taken after early maturing pigeon pea and it was also sold as Green pod in Gujarat fetching higher return. The Maize variety, Pusa Composite 3, was found suitable for intercropping in cotton and Pigeon pea and was reported as tastier and sweet compared to local variety at Dahod, Gujarat. Paddy variety JD 3 was found suitable for rainfed area of Gujarat and P 44 resulted in higher yield (52 q/ha), bold grain as compared to GR-11 (Gujarat Rice-1146 q/ha).

Jharkhand area: In Ranchi the short duration mustard variety, Pusa Jaikisan was liked by the farmers due to high yield (T2:19 q/ha) and more oil content (39%) and Pusa Bold was preferred by the farmers due to its high yield (20 q/ha), bold seeded variety with about 40% oil content. Wheat variety HI-1539 was most preferred variety among the farmers due to higher yield (T2:37 q/ha) and shorter plant height. Pigeonpea variety P-2001 was also preferred due to its medium plant height and early maturity (160 days) compared to existing variety Bahar (270 days) and other traditional varieties.

Flood prone areas: In Gorakhpur area the potential of paddy P 44 (T2:59 q/ha) and PNR 381 (T2:44 q/ha) could be realized by the farmers. P 44 was rated as high yielding, medium grain size. This variety can replace the Sarju -52 (T1:52 q/ha) because of its good taste and yield in eastern UP. PNR 381 has demonstrated good production and adoption for vegetable growers in short duration regime. Jaldi Dhan 13 was preferred for *rabi/winter* paddy cultivation under less water requirement in Shamayita Math, West Bengal. The potential of improved paddy and maize varieties in Meghalaya was also demonstrated. Paddy varieties VL Dhan 65 and VL Dhan 85 recorded 51% and 42%, respectively increase in yield over the local check (T1:31 q/ha). Farmers preferred these improved paddy varieties as the duration was found 20 – 30 days less. In Nagaland, improved maize variety Vivek QPM 9 was rated high by the farmers for its less duration (advantage of 25 days) and higher yield (53%).

Hill agro-ecosystem: The varieties developed by regional station of IARI at Shimla (HP) were disseminated in the analogous regions like Jammu, Uttarakhand and other parts of Himachal Pradesh (HP). In this project with collaboration of organisations at Uttarakhand and other parts of HP, the wheat varieties were assessed. As a result, Wheat (HS 420) was found resistant to yellow rust at the farmers' fields, while local varieties were badly affected

at Jammu location. PNR 519 gave 17% more yield, high B:C ratio (2.24) and less duration (20-30 days less) in West Bengal. As an impact of our project, farmer started growing vegetables. The seasonal vegetables like okra, capsicum and early cauliflower were found remunerative by the farmers and thus the earnings improved their livelihood (MVS, Bilaspur, HP).

New/non-conventional areas: It is a known fact that varieties in each crop are released for a specific zone after testing in respective crop improvement programme. However, in this model of extension, flexibility was provided to test these varieties outside the zone of their recommendation. This led to generating very interesting information about some crops and varieties being successful and remunerative in non-conventional areas. Through interventions of the project following newly introduced crops have become popular in non-conventional areas. Some of the results are described below:

- Palak (spinach) variety Pusa Bharti was well accepted in Karnataka because of its good market price, broader leaves, rapid growth and four times more harvest as compared to local varieties.
- Pusa 44, a popular paddy variety in Punjab was demonstrated in Jharkhand, where farmers liked it for its very high yield (T2:51 q/ha) and coarse grains, unlike the local varieties (T1:38 q/ha).
- Moong variety Pusa Vishal was found suitable in Hazaribagh district of Jharkhand for better return as 80% pod mature at same time. As a result, farmers could take early vegetables in the same field, thus maximizing their income.
- Pigeonpea varieties P 2002 and P 992 were preferred by farmers for higher yield (9 q/ha and 10.5 q/ha respectively) and good taste in Uttarakhand hills.
- In Bilaspur, Himachal Pradesh, farmers started growing seasonal vegetables like okra, capsicum and early cauliflower which were found remunerative and thus the earnings improved their livelihood.

Feedback to research system

Generating the field level and farmers' experienced feedback to the research system was also the major purpose of this project. As evident from Table 1, feedback for cereals (paddy and wheat), oilseeds (mustard) and vegetable crops (radish and okra) were gathered and communicated to the research system ICAR-IARI. During the project period itself, the institute took the feedback in right perspective and for two paddy varieties namely P 2511 and PB 1121, the respective new varieties namely P 1612 and PB 1509 were evolved incorporating the bacterial blight resistance and *bakane* resistance respectively. The feedback inputs are being processed by the institute for the remaining oilseed and vegetable crops.

Participatory seed production

Enabling farmers for on-farm quality seed production of crop varieties which were actually preferred by them

Table 1 Feedback of various crop varieties given to the research system and new varieties evolved

Crop	Variety	Trait	Desirable improvement suggested	New variety (ies) evolved
Paddy	PB-1121	Disease	Need for Bakane resistance	PB 1509
		Shattering	Shattering resistance	
		Lodging	Lodging resistance	
		Insect infestation	Resistance to BPH, Stem borer	
	P 2511	Disease	Resistance to Bacterial blight.	P 1612
	PB-1401	Maturity	Synchronization in maturity	
		Yield	Improvement in yield	
Wheat	Pusa-44	Growing period	To be reduced by 10-15 days so as to compete with the Sarju-52 in Eastern UP.	Suggestions incorporated in the breeding programme
	HD 2985	Tillering	Number of tillers to be increased	
		Lodging	Lodging resistance	
	HD 2687	Grain size	To be improved for market price.	
	HD 2851	Tillering	Number of tillers to be increased	
Mustard	P. Jagannath	Plant height	Plant height to be reduced to avoid lodging as experienced in the Eastern India.	Many varieties are in pipeline with such attribute
Radish	Pusa Chetki	Shape of root	Lower part should be tapering instead of club shape.	The vegetable variety improvement programme has been made more focused and sharp
		Foliage	Should be lesser	
		Plant population	Due to variation in root shape, size, there is requirement of maintenance breeding.	
Okra	Pusa A-4	Fruit colour	To be more green	
		YMV infestation	Requirement of resistance breeding for successful crop in <i>kharif</i> season	
		Plant population	Due to variation in plant phenotype, there is a need for maintenance breeding	
Bottle gourd	Pusa Naveen	Fruit setting	Fruit setting in high temperature (More than 40°C and low temperature (below 15°C)	

was the another thrust area of the project. Partner farmers were capacitated for various dimensions of quality seed production of the suitably designed training interventions. Wheat, Paddy, mustard, okra, bottle gourd were the major crops for which the seed production was initiated. Thus, 7951 q of wheat seed and 4526 q of rice seeds were produced on-farm which have the potential to replace about 8000 ha (wheat) and 36200 ha (paddy) of the respective crops with quality seeds (in one season) leading to proportionate yield advantages.

Impact of the programme

Increase in Share of IARI varieties

Wheat varieties: Performance of wheat varieties was evaluated using primary survey data for the year 2014-15 and found that yield gap prevails on farmers' field and that observed in demonstration plots. Nearly 90 percent of the farmers adopted HD 2967 variety in Punjab with a mean yield of 5.5 t/ha. The variety HD 2967 has been adopted by almost all the sample farmers of Ludhiana district of Punjab.

The impact analysis of wheat crop showed that the adoption of HD 2967 variety has enhanced the profitability of farmers recording ₹ 14000/ ha higher incremental returns

over the existing variety. The secondary data analysis was used to understand the relationship between yield and fertilizer use shows continuous increase in fertilizer use during the period 2000-2012. However, in the recent years there was a decrease in fertilizer use though yield increase sustained.

The share IARI varieties in total supply of certified seeds in Punjab and Haryana were found to be 71 per cent and 42 per cent in the year 2014 which increased from 17% and 5% in the year 2011 respectively. The analysis of diversity of IARI wheat varieties in four major states reveals predominance of single variety HD 2967 in Punjab, in Haryana and UP a good mix of the IARI varieties and in Madhya Pradesh prevalence of two IARI varieties, HI 1544 and HI 8498. The spatio-temporal increase in the share of IARI wheat varieties were also captured (Table 2).

Success story of area expansion in wheat under HD-2967 in Jammu

This is primarily on account of varietal introduction especially of IARI variety HD 2967. In the beginning during 2011-12, the wheat variety HD 2967 was introduced through demonstration in 6 ha area which expanded up to 1500 ha in two years (2013-14).

Table 2 Temporal increase in share of IARI wheat varieties

Year	Total area (ha)	Name of IARI varieties demonstrated	Share of IARI varieties (%)
2012-13	44804	HD-2967	02.15
2013-14	44719	HD-2967	04.40
2014-15	44584	HD-2967	30.00
2015-16	45890	HD-2967, HS-507	40.64
2016-17	44590	HD-2967, HD-3086, HS-507, HS-542	47.30

Carrot Pusa Rudhira triggered profitability and entrepreneurship

At village Soodna, Hapur, UP *Pusa Rudhira* spread in about 60% area (90 acres) under carrot cultivation in the village within a year of its introduction. Enthused with the profits from *Pusa Rudhira* carrot farmers adopted mechanized cleaning of carrots by procuring three cleaning machines on community sharing basis, which facilitated faster washing and minimizing damage to carrots. Higher productivity of *Pusa Rudhira* coupled with premium price in the next season provided farmers with an impressive net income of ₹ 222690.00/ ha. Regular advisories were provided to optimize use of farm inputs in the crop. The farmer could harvest a bumper crop of *Pusa Rudhira* yielding 393.75 q/ha, which is about 10 q/ha higher than the prevailing variety. It provided a net return of ₹ 264286.00/ha, which was 37% higher than that of local variety. Superior quality traits of the newly introduced variety led to 18% higher price in the local market. *Pusa Rudhira* fetched higher price of ₹ 928.00/q which was ₹ 140.00/q higher than prevalent variety, due to its attractive long and deep red roots, red coloured core, uniformity in shape and size and more sweetness having TSS value of 9.5°Brix.

Potential implications

Technologies demonstrated through this programme have shown the potential of boosting the production and productivity in the target areas and also for employment generation and enhancing farmers' income.

Crop varieties of various food crops have shown the potential to enhance the yields substantially. Especially in

low productivity areas, the percent increase in the yield has been ranging from 25 to 60% in different crops and varieties.

Technological interventions were demonstrated which can help in sustainable as well as low-cost agricultural production systems. This include demonstration of disease resistant varieties and use of *Trichoderma* to save on the cost of pesticides, short duration varieties to save on the irrigation water and use of biofertilizer to save on the cost of chemical fertilizers. In addition, some technologies, like Biogas plants have been demonstrated which can help developing organic production system and also saving of the fuel energy. The model in this case was basically adopted with the aims of combining the strength of institutions having them as an active partner in solving local problems in different agro-climatic zones, providing backstopping of technologies to the partners in multiple fields with the aim to overcome the problems of a conventional frontline extension programme, reducing the cost of dissemination of technologies in a very large area and fostering inter-institutional complementarity in public sector and also capitalizing the public-private partnership.

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