

# Evidence of Encouraging Adoption through Frontline Demonstrations (FLDs): Indian Hybrid Rice Program

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## Abstract

*Frontline demonstrations are considered to be an effective and useful extension activity to demonstrate the latest technologies developed at research stations to the ultimate clientele, that is, farmers, in their own fields. However, extension organizations end up only in conducting the FLDs for the benefit of the farming community, but not on analyzing the results of such demonstrations to develop an extension action plan. In this paper an attempt is made to empirically establish the usefulness of FLDs on hybrid rice, linking FLDs with other development programs and macro analysis of FLDs for developing an effective commodity extension strategy. It is expected that future extension research on FLDs (demonstrations of any kind) will adopt similar methodologies for analyzing, documenting and advocating commodity based extension strategies.*

## Introduction

The principle of “seeing is believing” is operational in demonstrations, as the farmers become easily convinced when they see the performance of new technologies in the fields of their neighboring farmers. The program on Frontline Demonstrations (FLDs) is formulated by the Indian Council of Agricultural Research (ICAR) and funded by the Ministry of Agriculture, Government of India. Since the technology generators (scientists) are directly demonstrating and disseminating the research technologies in farmers’ fields, these are called “front-line” demonstrations.

A comprehensive package consisting of new seed (variety/hybrid) and recommended cultivation and plant protection practices, etc., is demonstrated to farmers. Financial assistance is provided for critical inputs such as seed, fertilizer, weedicide, pesticide, etc. The unique feature of these demonstrations is the active involvement of concerned scientists for providing technical guidance from time to time and the active participation of farmers in implementing the recommended technologies. The organization of field days at an appropriate stage of the crop at

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strategic locations for a cluster of 20–30 demonstrations is an integral part of these demonstrations, which adds significantly to their effectiveness. These field days provide an on-the-spot opportunity for a large number of interested farmers to acquaint themselves with the advantages of the new technologies, to have their doubts clarified with subject matter specialists during question-and-answer sessions, and to meet the scientists and extension officials who are aware of the latest developments in agriculture. Overall, this approach has proved to be a very effective tool for the transfer of new technologies. The operational workflow for conducting these FLDs may be seen in Figure 1.

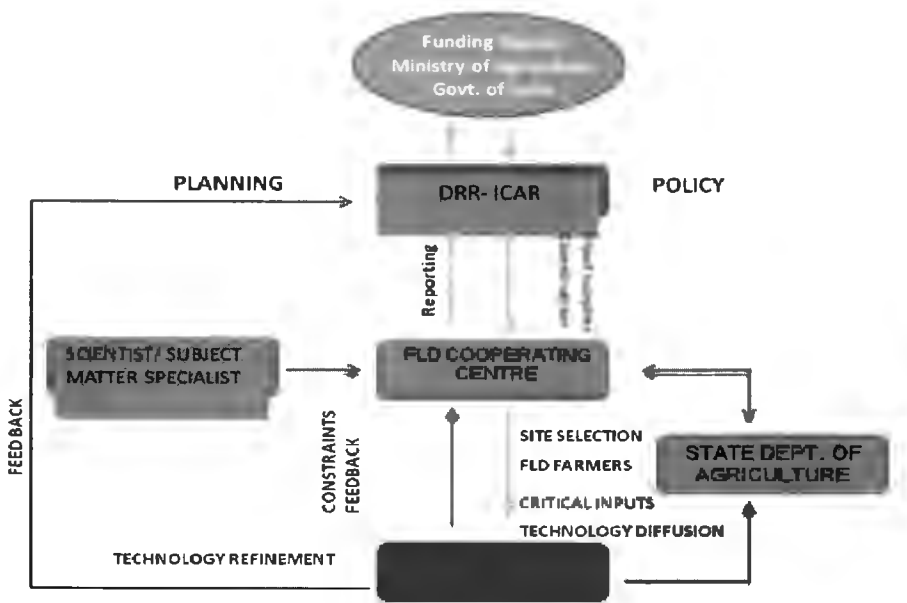


Fig. 1. Conceptual framework of the FLD program

**FLDs on hybrid rice: the beginning**

Hybrid rice is an innovative technology that was introduced to Indian agriculture in 1994. Hybrids are expected to give 1.0 to 1.5 tons extra yield per hectare compared with high-yielding inbred varieties. Despite the distinct yield advantage, the large-scale adoption of hybrid rice in India was found to be slower than expected in the initial years. There were many reasons for this but perhaps one of the major reasons was inadequate extension efforts to create awareness about the potential benefits of this innovative technology among rice farmers. The Directorate of Rice Research (DRR), Hyderabad, took the lead in initiating a national program on hybrid rice, coordinating and implementing the national program and developing the hybrids and seed production and cultivation packages, and had to take the lead again in

popularizing this innovative technology. Despite the lack of a specific mandate in this respect, and lack of personnel and facilities, pioneering efforts have nevertheless been made by DRR to popularize this technology in the country. To begin with, a large number of compact block frontline demonstrations of released hybrids as well as demonstrations on seed production technology were organized in various states under the second phase of the United Nations Development Programme (UNDP) project during 1998-2002.

A large number of training programs on both hybrid rice seed production technology and hybrid rice cultivation were also organized for various clients for 1 to 7 days' duration by DRR as well as the research network centers. Special training programs were organized for farm women. Interstate exposure visits were organized for hybrid rice farmers and hybrid rice seed producers. Sensitization workshops were organized for senior research managers and policymakers.

After conclusion of the UNDP project, the frontline demonstrations on hybrids were continued under the National Agricultural Technology Project (NATP) of ICAR and, for the past 7 years, FLDs on hybrid rice have been organized under the macro-management scheme of the Ministry of Agriculture, Government of India.

### **Specific objectives:**

Frontline demonstrations are considered to be the most effective and useful extension activity to demonstrate the latest technologies developed at research stations to the farmers, in their own fields. Most of the times success of these activities are documented in the annual reports and do not go through a rigorous analysis for developing critical insights. In this backdrop, the present paper is written with the following specific objectives:

1. To discuss the technology outreach details of FLDs
2. To understand the yield gap analysis in the perspective of FLDs
3. To develop insights for an effective FLD strategy

### **Technology outreach using FLDs: achievement in number**

The FLD program on hybrid rice has two distinct phases. The first one comprised compact block demonstrations conducted as a part of the UNDP and NATP projects in which first-generation hybrids were demonstrated. The focus of these demonstrations was mainly on southern Indian states along with a few northern Indian states such as Uttar Pradesh, Uttarakhand, Haryana, and Punjab. The second phase of FLDs has witnessed a large number of second-generation hybrids making their way to new states such as Chhattisgarh, Bihar, Jharkhand, and Odisha.

Between 1998 and 2012 (14 years), a total of 12,001 FLDs of 1 hectare each were conducted covering all the major rice-growing states of the country. It is estimated that about 28,000 farmers directly benefited from these demonstrations along with thousands of farmers who became aware of hybrid rice technology. The trickle-down effects of the FLD program are many. State-wise hybrids demonstrated, the total area covered, and the yield advantages recorded may be seen in Table 1.

**Table 1. Overview of FLDs conducted on hybrid rice (1998-2012)**

State	Hybrids demonstrated	No. of FLDs (1 ha each)	Yield advantage (kg/ha)
Uttar Pradesh	NSD-2, PSD-1, PSD-3, PA 6444, PHB-71, KRH-2	2,876	850-2,215
Karnataka	KRH-2, DRRH-3	1,903	700-1,650
Maharashtra	Sahyadri, KRH-2, PHB-71, PA 6444	1,485	1,450-2,610
Andhra Pradesh	PHB-71, PA 6444, DRRH-1	600	650-1,170
Tamil Nadu	CORH-2, CORH-3, ADTRH-1, PHB-71, DRRH-3	1,069	715-1,210
West Bengal	PA 6444, PHB-71, KRH-2, CNRH-3	710	1,020-1,670
Odisha	PA 6444, PHB-71, KRH-2	858	810-1,050
Uttaranchal	PSD-1, PSD-3, PHB-71	640	780-1,158
Goa	KRH-2, Sahyadri	680	780-1,155
Bihar Chhattisgarh	KRH-2, PHB-71, PA 6444, Sahyadri,	1180	950-1,870
Jharkhand	DRRH-1, PSD-3		
Punjab			
Haryana Gujarat,			
Tripura			
	<b>Total</b>	<b>12,001</b>	

In Uttar Pradesh, 2,876 demonstrations were conducted focusing on hybrids such as NSD-2, PSD-1, PSD-3, PA 6444, PHB-71, and KRH-2. Compared with the most popular high-yielding varieties (HYVs) in the state; these hybrids recorded yield advantages in the range of 850-2,215 kg/ha. Karnataka conducted about 1,900 FLDs, whereas Maharashtra conducted 1,485 FLDs. Other states that have conducted FLDs on hybrids were Andhra Pradesh, Tamil Nadu, West Bengal, Odisha, Uttarakhand, Goa, Bihar, and Chhattisgarh. In most of the demonstrations, the yield advantages of hybrids were conspicuous and were in the range of 1 to 1.5 t/ha.

The skewed distribution in terms of the number of FLDs conducted in Uttar Pradesh, Tamil Nadu, Maharashtra, Karnataka, and Andhra Pradesh is due to the release of first-generation hybrids in these states and more emphasis given during the UNDP project period. The number of FLDs sponsored during that period was more than in the later period.

Figure 2 indicates clustering in terms of the cafeteria of hybrids demonstrated. Farmers always need a cafeteria of hybrids that are suitable to their area. "One size fits all" may not work all the time. Within a state, there may be differential perceptions as far as the selection of hybrids is concerned. In such cases, it is better to plan demonstrations across the state with more hybrids. It can be noted here that more



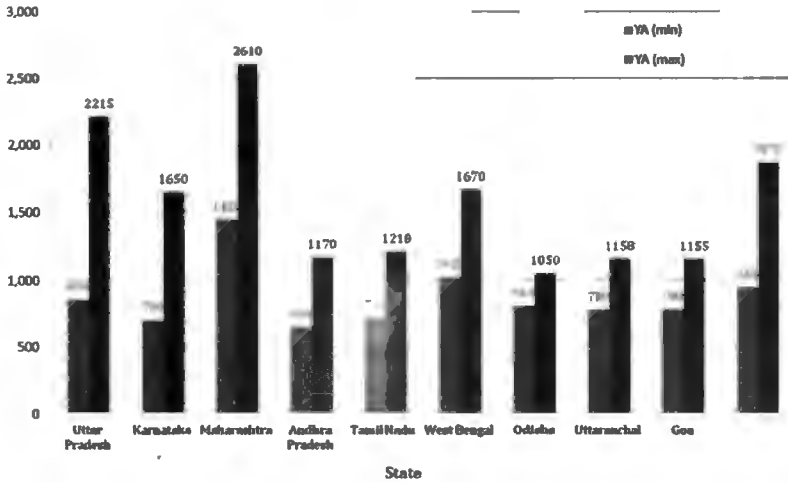


Fig. 3. Yield advantage range for hybrid rice

Based on the yield advantages and perceptions of farmers and extension workers, over the years, some hybrids were found to be promising. The same was communicated to the Department of Agriculture (the public-sector extension department in India) for scaling up activities. State-wise promising hybrids identified over the years appear in Table 2. For Uttar Pradesh and Jharkhand, several hybrids were identified as promising. A recently released hybrid (DRRH-3) that has better grain quality (on par with that of Samba Mahsuri, the most preferred variety in southern India) has received good feedback in southern Indian states. States such as Chhattisgarh have established that a single hybrid (Indira Sona) can also be the most promising.

Table 2. Promising hybrids identified from FLDs by state

State	2007	2008	2009	2010	2011
Uttar Pradesh	Indira Sona				Indira Sona
Jharkhand	PA 6444 KRH-2	PA 6444 PHB 71		PA 6444 PA 6444 (SRI Method)	PA 6444
Karnataka	KRH-2	PUSA RH 10 KRH-2			DRRH 3
Tamil Nadu	CORH-3	CORH 3		CORH 3	CORH 3 DRRH 1
Uttar Pradesh	NDRH-2 PHB-71	PHB 71 PA 6444	PA 6444	PHB 71	PA 6444 PHB 71 DRRH 3
Chhattisgarh			Indira Sona		Indira Sona PA 6201
Madhya Pradesh					
Maharashtra	Sahyadri-4				
Uttarakhand	Pusa RH-10				
Pondicherry	ICORH-3				

## Year-wise and state-wise details of FLDs

To further explore the specific performance of a hybrid in a particular state, year-wise details are provided in Tables 3, 4, 5, 6, and 7. It can be observed from the data that the absolute yield of a hybrid may vary from state to state and year to year. However, it is important to see the comparative yields of hybrids in relation to the most popular HYVs in farmers' fields. Keeping in view the benchmark yields, hybrids were found to be higher yielding than HYVs.

**Table 3. FLDs on hybrid rice 2011-12**

State	Hybrid	Area (ha)	Local check	Mean FLD yield (t/ha)	Mean check yield (t/ha)	% Mean yield advantage
Chhattisgarh	Indira Sona	17	HYV 1010, Mahamaya	4.31	3.52	22.1
Gujarat	DRRH-3	1	Local GR-11, Gurjari	5.16	4.30	20.2
Jharkhand	PA 6444	20	Local	6.27	3.33	88.2
Karnataka	DRRH-3	1	BPT-5204	6.80	6.69	1.6
	DRRH3	1	KRH 2	5.95	-7.30	
Uttar Pradesh	PA 6444	1	NDR 359	6.10	4.80	27.1
	PHB 71	4	NDR 359	6.00	4.80	25.0
	DRRH-3	1	NDR 359	4.90	4.20	16.6

**Table 4. FLDs on hybrid rice 2010-11**

State	Hybrid	Area (ha)	Local check	Mean FLD yield (t/ha)	Mean check yield (t/ha)	% Mean yield advantage
Jharkhand	DRRH-2	6	Swarna	3.18	2.18	45.9
	PA 6444	14	IR64	6.01	3.55	69.3
	PA 6444	6	Swarna	7.02	5.45	28.8
	SRI Method		Normal Method			
Tamil Nadu	COR H 3	2	Local check	8.28	6.68	24.0
Uttar Pradesh	PHB 71	15	Local Check	5.90	3.50	68.6

**Table 5. FLDs on hybrid rice 2009-10**

State	Hybrid	Area (ha)	Local check	Mean FLD yield (t/ha)	Mean check yield (t/ha)	% Mean yield advantage
Chhattisgarh	Indira Sona	10	HYV	6.75	3.25	51.5
Jharkhand	PA 6444	20	HYV			
Tamil Nadu	COR H 3	16	HYV	6.96	5.06	27.5
Uttar Pradesh	PHB 71	18	Sarjoo	6.15	4.00	53.8

**Table 6. FLDs on hybrid rice 2008-09**

State	Hybrid	Area (ha)	Local check	Mean FLD yield (t/ha)	Mean check yield (t/ha)	% Mean yield advantage
Jharkhand	PA-6444, PHB-71, Pusa RH-10	125	HYV	5.45	3.6	51.4
Tamil Nadu	CO R H 3	40	HYVs	7.30	5.6	30.4
			Local Check	6.75	4.0	68.8

**Table 7. FLDs on hybrid rice 2007-08**

State	Hybrid	Area (ha)	Mean FLD yield (t/ha)	Mean check yield (t/ha)	% Mean yield advantage
Chhattisgarh	Indira Sona	10	3.92	3.44	13.9
Jharkhand	PA-6444,	163	6.10	3.67	66.2
	KRH-2	137	4.78	3.67	30.2
Karnataka	KRH-2	50	7.90	6.90	14.5
Puducherry	CORH 3	5	5.09	3.96	28.5
Uttar Pradesh	PHB 71	10	7.80	5.87	32.9
	NDRH-2	12.8	6.33	4.77	32.7

Hybrid rice seed sold in tons ('000 kilograms)

The FLD program can generate awareness among millions of rice farmers, but it is not possible to cover all rice farmers through this program alone. This should be supported by various other activities such as growth in the seed industry. The success of hybrid rice technology primarily depends on genetic purity, timely availability, and the affordability of hybrid seed to farmers. The production of pure hybrid seed at an affordable price in rice—a self-pollinated crop—is a highly skill-oriented activity. A good hybrid may not reach a large number of farmers unless it is feasible to commercially produce the seed on a large scale economically. Hybrid seed production technology is quite different from the technology for varietal seed production. Fresh hybrid seed is essentially purchased/procured by farmers every year/season. The hybrid seed should have purity of about 99%.

The state-wise market share with number of FLDs conducted also revealed that quality seed production and spread of hybrid rice through seed market is positively correlated. For eg. during 2008, a total of 17,355,000 tons of quality seed was made available which resulted in spread of hybrid rice in Haryana, Punjab, Uttar Pradesh, Chattisgarh (Singh et al 2010).

### Yield gap analysis in the perspective of FLDs

Figures 4 and 5 give glimpses of yield gap analysis for 2011 and 2007, respectively. Two types of yield gaps are calculated: Yield Gap 1 and Yield Gap 2. Yield Gap 1 is the difference in yield obtained on the research station’s farm and the potential or possible yield obtainable in farmers’ fields. This yield gap is due to non-transferable technologies, the environmental difference between the research station farm and farmers’ fields, etc. Yield Gap 2 is the difference in potential obtainable yield in farmers’ fields and the actual yield obtained by farmers. This yield gap is bridgeable. In fact, through frontline demonstrations implementing the entire package developed in a holistic way, the potential obtainable yield in farmers’ fields can be demonstrated to neighbouring farmers. The actual causes for Yield Gap 2 may be many, which can be broadly classified as biological constraints and socio-economic constraints.

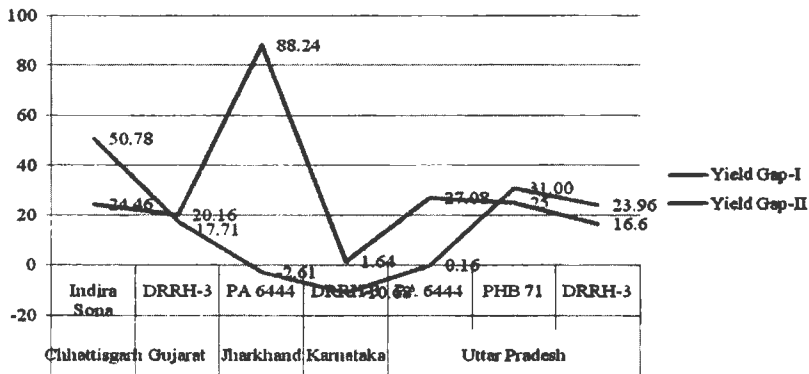


Fig. 4. Yield gap analysis, 2011 (Units are %)

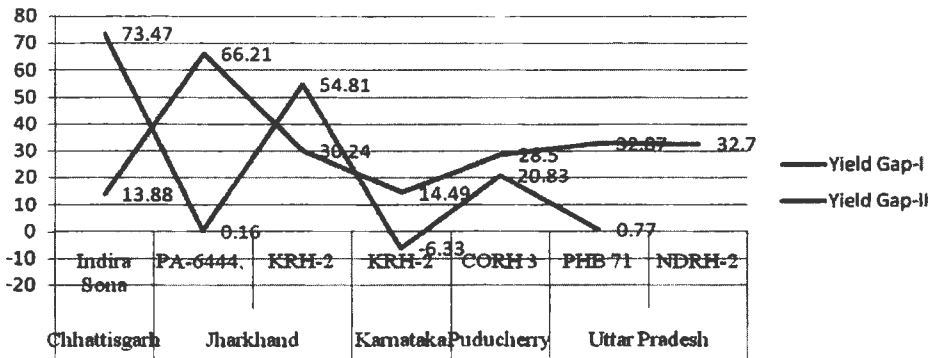


Fig. 5. Yield gap analysis, 2007 (Units are %)

In the present context, yield gap analysis gives an excellent opportunity for scaling up strategies. For example, Yield Gap 2 in Chhattisgarh was 24.5%, which means there is a potential for increasing production to this tune, if Indira Sona is adopted by farmers across the state. This gap is due to the difference in yields obtained between Indira Sona and locally adopted HYVs. Similarly, Yield Gap 1 in the same state was 50%. This was obtained by calculating the difference between the yield obtained from Indira Sona at the research station and in FLD fields. Large-scale adoption of Indira Sona may lead to bridging the yield gap to the range represented in Figure 4.

### **Moving beyond yield advantages: earlier experiences of FLDs**

Various studies have documented hybrid rice adoption by farmers for the past decade. Some of them concentrated on the socio-economic dimensions of hybrid rice adoption and some focused on a comparative analysis of the profitability of hybrid rice adoption with that of high-yielding varieties. Very few studies have focused on the institutional efforts required for large-scale adoption of hybrid rice in India. Here, we attempt to analyze farmers' experiences with hybrid rice in general and FLDs for hybrids in particular.

Most of the FLD farmers believed that the amount of fertilizer required and weed incidence were the same in the case of hybrids compared with inbreds. Although some FLD farmers believed that crop management skills varied, a majority felt that it was more or less the same. About two-thirds of the hybrid rice farmers expressed marketing problems as the most prominent constraint to large-scale adoption. In the case of hybrid seed production, average yield was around 2 t/ha, which many farmers perceived as satisfactory. Hybrid seed was procured by the agencies with whom farmers had contracts. In Andhra Pradesh, the price paid for procurement of seed ranged between Rs.22 and Rs.26 per kg. On average, the net returns from seed production over variable cost were Rs.35,185 per ha during 2002. Farmers opined that seed production required considerably more laborers, especially for rope pulling, roguing, leaf clipping, etc., which led to increased demand for labor. Seed production in Mandya and Mysore districts of Karnataka yielded high net returns of around Rs.70,000 per ha. For Uttar Pradesh and Uttarakhand, more than 85% of the farmers stated that they were satisfied with hybrid rice cultivation for its yield and profitability. A large number of farmers believed that the hybrids could be grown in both upland irrigated and shallow lowland conditions irrespective of the size of holdings. The net profit received from hybrids was Rs.14,894 per ha compared with Rs.11,131 per ha obtained by cultivating inbreds. The cost of cultivation for hybrids was estimated to be Rs.16,409 per ha.

## **Perceptions of farmers and extension workers**

Around 70% to 80% of the farmers and extension workers were convinced of the hybrid rice yield advantage over inbred rice. They were in agreement that the pace of area expansion of hybrid rice may be restricted to some extent because of the need for seed replacement every year. A majority of the respondents did not agree about the notion of poor grain filling of hybrid rice and also higher chaffiness. Around 72% to 83% of the respondents considered hybrid rice more profitable than inbred rice. A majority of the hybrid rice growers did not agree with the higher grain breakage of hybrid rice. However, in their opinion, hybrid PA-6201 has some breakage if shelling is done without parboiling of the seed.

## **Perceptions of millers**

The perceptions of millers toward hybrid rice are given here for a comprehensive understanding of hybrid rice adoption in northern Indian states. More than 53% of the millers stated that the hulling percentage of hybrid rice is lower than that of inbred rice. Millers with larger plants and the Department of Civil Supplies did not offer a lower price for hybrid rice. However, owners of hullers and small rice mills purchasing small quantities have artificially created the opinion of higher breakage and they were offering a low price for hybrid rice.

## **Future prospects of FLDs on hybrid rice**

Efforts should be made to increase the multiplier effect of Frontline Demonstrations. Once FLDs are conducted, follow-up activities should take place so that the large-scale adoption of demonstrated varieties/hybrids/technologies is realized. To have a visible impact, it should be assured that a complete package of practices is adopted in demonstration plots. In the absence of a complete package, the potential yield of demonstrated technology will not be perceived by farmers. Wherever possible, farmers' innovations can be included along with the demonstrated package of practices. There is a need for a paradigm shift in the FLD program. The funding-centric approach needs to be replaced by a need-centric approach. The yield advantage perspective should be replaced by "problem-solving" capability of new technologies. There should be continuous demonstration fora (which result in regular dialogue between FLD farmers and neighboring farmers) in place of a single field day. This will also promote continuous learning opportunities among farmers.

Process documentation is one area that needs to be carried out immediately for the scaling up of successful technologies. Along with success stories, cases of failure should be reported. Impact assessment methodologies for the FLD program should be

redefined. This should focus not only on yield advantages but should also focus on the number of farmers adopting a demonstrated technology after a few seasons. There is a need to integrate the concept of yield gaps into the FLD program. For this, existing yield gaps at the local/district level should be determined and FLDs should address those yield gaps. Time-series data of FLD technologies should be made available. Integrating an ICT approach in FLDs will help maximize the impact of technologies markedly. Integration should be in the form of documenting the various activities undertaken in demonstration plots such as method demonstrations, field days, etc.

### **Insights for developing effective FLD Strategy**

To further enhance the effectiveness of FLDs on hybrid rice, there is a need to develop a sound strategy beyond the traditional way of conducting demonstrations. Such a strategy should answer the following six broad questions.

#### **1. Will mere yield advantages lead to large-scale adoption?**

FLDs traditionally focus more on the yield advantages of hybrids over existing HYVs. Mere yield advantages will not lead to acceptance and adoption among rice farmers. Examining the issue of profitability should be the aim of FLDs rather than simple yield advantages. Profitability at the farmer level may be due to higher yields, higher market price, reduced cost of cultivation, etc. The relative advantages of hybrids in terms of simplicity of package of practices, compatible practices, and predictable and consistent yields over seasons may be good indicators for success.

Similarly, these micro-level productivity issues should be reflected in macro-level production strategies and policy guidelines. In the absence of this, critical services will not be available to those farmers who have interest in adopting hybrid rice.

*An institutional mechanism.* The positive consequences that emerge out of hybrid rice adoption need to be harnessed for further popularizing hybrid rice. The need for hybrid rice adoption should be seen in the light of alternate scenarios of food security in the absence of hybrids. "What would be the level of food insecurity in the future in the absence of hybrid rice adoption?" should be assessed through scenario projections. Institutional readiness to make certain structural and functional adjustments to derive benefits out of hybrids needs to be carried out. Further, adoption of hybrid rice on a large scale would lead to crop diversification in some areas. That's a kind of indirect advantage in rice-based farming systems. The intensive labor requirement (30% more, or 300 person-days per hectare) would lead

to the creation of rural employment to a limited extent. As in the case of the Hybrid Rice Commercialization Program (HRCP) of the Philippines and other countries, notable policy interventions such as a seed growers' subsidy, seed distribution, seed pricing and procurement, and hybrid rice pricing and procurement could be taken up by public institutes.

## **2. Will single-plot demonstrations lead to conviction?**

Single-plot demonstrations may not lead to farmers' conviction about hybrid rice. A cluster approach seems to be more appropriate. FLDs can be planned for a cluster of 10 hectares involving several farmers' fields. This enables farmers to become convinced about the advantages of adopting hybrid rice. These clusters can be identified based on need at the village, block, and district levels in each state. The cluster approach should be linked to demonstrations of the private sector in that area.

As was mentioned earlier, there is no point in demonstrating a single hybrid in farmers' fields in a given area. A cafeteria of hybrids suitable to an area can be demonstrated, so that farmers can choose among the available hybrids.

## **3. Are scaling-up options adequate?**

Once demonstrations are conducted, there are no adequate follow-up activities. The strategy should involve a large number of stakeholders who would be responsible for scaling-up activities. The strategy of FLDs accordingly should have pre-scaling-up activities, impact indicators, and capacity building. For a scaling-up strategy, the first step is to identify the ecosystems. Irrigation was considered as a crucial input for hybrid rice cultivation. But, in many countries, including India, hybrids gave better results in unfavorable soil and climatic conditions than in favorable irrigated rice ecosystems. Hence, a proper analysis needs to be made in the country. Second, is whether the purpose of rice farming is commercial or subsistence?

## **4. Hold prescriptive or participatory demonstrations?**

The futuristic aim has to be on increasing the impact of appropriate high-potential hybrid rice interventions, and promoting their adoption through the development and application of improved dissemination strategies. Public and private sector partnerships along with active involvement of farmers may adapt the resource-test-demonstrate-adopt model for the large-scale adoption of hybrids. When there are appropriate roles and decision-making processes, this may be the most effective, broad-based, and sustainable solution. Partnerships among NGOs and private and public organizations are likely to be the agents of change for the future, although the most appropriate combination for a given situation will vary depending on the

existing circumstances and technology. It is expected that in the near future a network of partnerships with participatory hybrid selection will enable hybrid rice pull by farmers.

### **5. How do you make learning effective using ICT?**

Nationally, there is a need to develop an online platform for providing a complete database of frontline demonstrations. This platform should facilitate real-time (online also) data sharing. The success stories of FLD technologies should be placed online for use by State Departments of Agriculture. Integrating the Information and Communication Technology (ICT) approach in FLDs will help in maximizing the impact of technologies markedly. Integration should be in the form of documenting the various activities undertaken in the demonstration plots such as field days, etc.

### **6. Is strategic planning effective?**

A strategic planning document exclusively for popularizing hybrid rice through FLDs could be developed. For example, the Government of India is planning to launch a program called "Farmers First" involving a large number of demonstrations. Such demonstrations can be integrated with hybrid rice popularizing activities. A target of expanding hybrid rice area to 5 million hectares could be possible in 5 years' time with 10,000 FLDs each year (50,000 FLDs in 5 years) and with substantial supporting services.

### **Conclusion**

Hybrid rice development, large-scale seed production, extension efforts, and institutional support should go hand in hand in order to achieve the coordination required to popularize hybrid rice in India. Front-line demonstrations have tremendous potential to generate awareness and interest among farmers, thereby stimulating the large-scale adoption of hybrid rice across the country. Regular evaluation studies and feedback emanating from FLDs should continue to help hybrid researchers to evolve better hybrids that are location-specific, thereby creating a demand-driven environment. The continued efforts on the part of hybrid generators, technology transfer specialists, and social scientists will bring about a paradigm shift in the near future, whereby the "hybrid rice pull" by rice farmers will dominate the "hybrid rice push" by development practitioners. Increased rice productivity and production contributed by the large-scale adoption of hybrid rice will undoubtedly form a major component of national food security in the decades ahead.

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