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Yield Gap Analysis of Rice through Front Line Demonstrations in Tropical Andaman Islands

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The present study aimed to know the gaps for yield performance between potential and actual yield of rice through 137 Front Line Demonstrations (FLD) conducted across 3 years in the Andaman Islands. Improved rice varieties with recommended package of practices could give on an average yield of 4.72 t ha^{-1} to 5.78 t ha^{-1} as compared to local varieties yielding 3.21 t ha^{-1} to3.69 t ha^{-1} under rainfed conditions of Andaman and Nicobar Islands. The extension gap ranged between 1.22 to 1.70 t ha^{-1} in improved varieties as compared to 1.55 to 2.70 t ha^{-1} under hybrid varieties. The trend of technology gap ranged from 0.15 to0.30 t ha^{-1} in hybrid varieties compared to 0.18– 0.35 t ha^{-1} in case of pure line varieties. The technology index showed the feasibility of realising the performance of evolved technology at the farmer's fields. The value technology index showed wide range of 3.60 to 15.80 for HYVs and 2.50 to 5.00 in hybrid varieties. The benefit cost ratio was slightly high in hybrids than pure line varieties. The yield of rice could be increased from 36% to 54% by high yielding varieties and from 37% to 86 % by rice hybrids complimented by improved seed and appropriate crop management technologies. Availability of improved seed of high yielding rice varieties and required inputs along with timely extension interventions can greatly narrow the gap between potential yield and actual yield to reap high rice productivity in Andaman and Nicobar Islands.

(Key words: *Rice, FLD, Technological gap, Extension gap, Technological index)*

National food security bill envisages availability of food for all. In this respect, productivity potential especially of disadvantaged and less explored areas has to be assessed and accordingly production strategies to be followed. Rice is the main cereal crop cultivated in Andaman and Nicobar Islands. The climatic conditions including more than 3180 mm rainfall annual also favours rice cultivation. Rice crop is annually grown on about 8,100 hectares of cultivated land producing over 23976 tons of paddy, with productivity of about 2.96 t ha^{-1} (Anonymous 2012) against the annual rice demand of 60,000 tons for the islands. The substantial gap between annual demand and production is bridged by shipment of rice from mainland, India and thus causing transport price rise and subsidy costs to the government exchequre.

The main reason for large gaps between production and demand is low productivity of rice varieties (photosensitive, tall, very late, low yielding and susceptible to biotic and abiotic stresses) which grown on about 50 percent of paddy area. Other major reasons for low productivity which are include imbalanced and inadequate use of fertilizer, non-availability of improved seed of HYVs, heavy and prolonged rain up to December month, constant warm temperature and high humidity favouring pest and disease incidence. About 3000 ha area of rice is also affected by costal salinity especially in the aftermath of *tsunami* of 2004.

In view of high demand of rice and existing climatic conditions of Bay Islands the rice varieties should preferably possess long duration, high yield ability, fertilizer responsiveness, semi-tall stature, good grain and straw quality, resistance/tolerance to biotic and abiotic stresses especially salinity and submergence. Productivity can be increased to about 4.5 to 5.0 t ha^{-1} through appropriate varieties and other crop management and protection technologies (Gautam *et al.*, 2013). The available agricultural technology does not serve the very purpose until it uniformly reaches and adopted by its ultimate users the farmers. Technology transfer refers to the spread of new ideas from originating sources to ultimate users (Prasad *et al.*, 1987). It is also important to ensure uniform adoption of recommended package of practice through understanding the extent of gaps between actual and potential yield for introducing the urgency and extent of technology interventions. Conducting of

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Front Line Demonstrations (FLDs) on farmer's fields helps to identify the constraints and potential of the rice in specific area as well as it helps in improving the economic and social status of the farmer's. The aim of the FLDs is to convince the farmers through "seeing is believing" approach. Farmers use recommended package and practices then the yield of this crop can be easily increased existing levels. Several biotic, abiotic and socio-economic constraints inhibit realization of the yield potential and these needs to be alleviated. North and middle Andaman district has the maximum area under rice cultivation but the productivity level is very low. The reasons for low productivity include poor knowledge about newly released crop varieties and recommended production and protection technologies. Keeping the above points in view, the FLDs, comprising of high yielding rice varieties and improved production technologies were conducted for 3 years to know yield gaps and extant of intervention required.

MATERIALS AND METHODS

The present study was carried out by Central Island Agricultural Research Institute, Port Blair during *Kharif* season from 2010 to 2012 (three years) at farmers field in 16 villages of rice dominant district of North and Middle Andaman through NABARD funded Out Reach Centre (ORC) in Diglipur, North Andaman. Under these Front Line Demonstrations (FLDs) a total of 39.13 ha area was covered. Farmers were selected through group meetings and training programmes on different aspects of rice cultivation were imparted for knowledge skill development (Choudhary, 1999 and Venkattakumar *et al.*, 2010). The details of the technical practices for FLDs and farmers' practices have been given in Table 1. A total of 137 FLDs were conducted during 3 years. Recommended cultivation practices were adopted under FLDs including improved rice varieties (CARI Dhan 3, CARI Dhan 4, CARI Dhan 5, CSR 23, CSR 36, Varsha, Ranjeet and Savitri) and hybrids (VNR 2355, US 312 and US 316). Crop was planted in rows and recommended dose of fertilizer (90:60:40 NPK kg ha^{-1}) was applied. The pests and diseases were controlled through need based application of pesticides at economic threshold level. In case of local check plots, existing practices being used by farmers were followed. Soils of the area were mostly sandy loam and crop totally depended on rains. In demonstration plots, quality seeds of improved varieties, line sowing and timely weeding, need based application of pesticides, use of balanced fertilizer were implemented as per technical recommendations. Recommended package of practices for the Andaman and Nicobar was followed and comparison made with the existing practices. Visits of farmers and the extension functionaries were organized at demonstration plots to disseminate the technical know how at large scale. The farmers under demonstration were facilitated in performing field operations like sowing, spraying, weeding, harvesting etc. during the course of

Table 1. *Details of improved varieties and recommended practices vis a vis farmer's practice under FLDs on rice in Andaman Islands.*

Particulars	Demonstrated varieties with package of practices		Farmers varieties with own package of practices
	Improved varieties	Hybrid varieties	Farmers varieties
Farming situation Variety	Rain fed lowland CARI Dhan 3, CARI Dhan 4, CARI Dhan 5, CSR 23, CSR 36, Gayatri, Varsha and Ranjeet	Rain fed lowland VNR 2355, US 312 and US 316	Rain fed lowland Lal Sanno, BPT, Jaya,
Time of sowing	First week of June	First week of June	First week of June
Method of sowing	Line transplanting	Line transplanting	Un even planting (Random)
Seed rate (kg ha^{-1})	25	25	35
Fertilizer dose(NPK kg ha^{-1})	90:60:40	90:60:40	20-30 kg N or Nil
Plant protection	Need based use of pesticides	Need based use of pesticides	Nil
Weed management	Two hand weedings i.e., on 25th & 45th day	Two hand weedings i.e., on 25th & 45th day	One hand weeding at 40th day

trainings and field visits. The selection of sites and farmers and layout of demonstration were followed as suggested by Choudhary (1999). The traditional practices followed by farmers were maintained in case of local checks.

The data outputs were collected from both FLD plots as well as control plots (farmer's practices) and finally the extension gap, technology gap, technology index and benefit cost ratio were worked out as per Samui *et al.*, (2000) as given below:

Technology gap = Potential yield – Demonstration yield

Extension gap = Demonstration yield – Farmers yield

$$\text{Technology index} = \frac{\text{(Potential yield – Demonstration yield)}}{\text{Potential yield}} \times 100$$

RESULTS AND DISCUSSION

The results of FLDs of HYVs and promising hybrids conducted during 3 years (2010, 2011 and 20112) in North Andaman are presented in Table 2 and Table 3 respectively. FLDs on HYVs (4.72 t ha^{-1}) showed on an average 47.55% more yield of rice as compared to local varieties (3.21 t ha^{-1}) as shown in Table 2. Similarly hybrids gave an average yield of 5.78 t ha^{-1} which is 58.83% more compared to local varieties 3.69 t ha^{-1} (Table 3). The data of Tables 2 and 3 revealed that the yield of rice varied from 4.65 to 4.82 t ha^{-1} in pure line varieties whereas from 5.70 to 5.85 t ha^{-1} in case of hybrids across three years. It is also pertinent to mention that the yield of farmers varieties varied from 3.08 to 3.43 t ha^{-1} and 3.15 to 4.15 t ha^{-1} in case of FLDs on HYVs and hybrids, respectively.

The percentage increase in yield over the local varieties ranged from 36% to 55% and 37% to 86% across years in HYVs and hybrids respectively. Tiwari *et al.*, (2014) have also performed yield gap analysis in chickpea through FLDs. The results indicated that the Front Line Demonstrations have given a good impact on the farming community of this district as they were motivated by the improved rice varieties and agricultural technologies used in the Front Line Demonstrations. The results clearly indicated the positive effects of improved rice varieties over the existing rice varieties towards doubling the rice productivity in Diglipur area, North Andaman.

Benefit-Cost ratio was also recorded higher under demonstration plots against control plots in all the years of study. The findings revealed that a gap exists between the actual farmer's yield and realizable yield potential of the varieties. Use of improved varieties has the potential to enhance the present level of rice productivity which is not percolating down at desired pace due to communication gap and lack of confidence among the farmers. Hence, to exploit the potential of improved rice varieties coupled with production and

Table 2. *Productivity, technology gaps, extension gaps, technology index and cost benefit ratio of high yielding varieties under FLD's of rice in North Andaman district*

Years	Area (ha)	Grain yield (t ha^{-1})			% increase over control	Technology gap (t ha^{-1})	Extension gap (t ha^{-1})	Technology index (%)	B : C ratio	
		Potential	FLD's	Control					FLD's	Control
2010	13.30	5.00	4.70	3.08	53	0.30	1.62	6.00	2.97	1.95
2011	2.25	5.00	4.65	3.43	36	0.35	1.22	7.00	2.94	2.17
2012	14.69	5.00	4.82	3.12	54	0.18	1.70	3.60	3.04	1.97
Average	10.08	5.00	4.72	3.21	48	0.28	1.51	5.53	2.98	2.03

Table 3. *Productivity, technology gaps, extension gaps, technology index and cost benefit ratio of promising rice hybrids under FLD's in North Andaman district.*

Years	Area (ha)	Grain yield (t ha^{-1})			% increase over control	Technology gap (t ha^{-1})	Extension gap (t ha^{-1})	Technology index (%)	B : C ratio	
		Potential	FLD's	Control					FLD's	Control
2010	6.30	6.00	5.80	3.78	53	0.20	2.02	3.33	3.31	2.39
2011	2.60	6.00	5.85	3.15	86	0.15	2.70	2.50	3.34	1.99
2012	1.60	6.00	5.7	4.15	37	0.30	1.55	5.00	3.26	2.62
Average	3.5	6.00	5.78	3.69	59	0.22	2.09	3.61	3.30	2.33

protection technologies, efforts through FLDs have to be increased among the farmers. The extension gap was found to range from 1.22 to 1.70 t ha^{-1} in HYVs and from 1.55 to 2.70 t ha^{-1} in case of hybrids during the study period. This highlights the need to educate the farmers through various means for adoption of improved varieties and agricultural production technologies to achieve higher rice productivity in the islands.

The technology gap ranged from 0.18 to 0.35 t ha^{-1} and from 0.15 to 0.30 t ha^{-1} in HYVs and hybrid FLDs respectively. This reflects farmer's cooperation in carrying out such demonstrations with encouraging results in subsequent years. The varying technology gaps might have arisen due to the dissimilarity in soil fertility status and weather conditions. Mukharjee (2003) stated that depending on identification and use of farming situation, specific interventions may have greater implications in enhancing system productivity. Similar findings were also recorded by Mitra and Sanajdar (2010) and Katare *et al.*, 2011. The magnitudes of technology index showed the technical feasibility of the evolved technology at the farmer's fields. The lower the value of technology index, the more is the feasibility of technology implementation. Over here the technology index ranged from 3.60 to 7.00% in improved varieties and from 2.50 to 5.00% in hybrids during the study period. This implies that the technology (rice varieties recommended) in field conditions is very much accepted by the farmers and varietal approach is practically feasible and implementable. The lateral spread of the variety technology is found to be remarkably acceptable which is evidenced by the large scale cultivation of CIARI recommended varieties especially in the North and Middle Andaman district. The component of benefit cost ratio of front line demonstrations has clearly showed higher BC ratio of FLDs than control plots *i.e.* farmers practice in all the years of study. The benefit cost ratio of improved varieties FLDs in demonstrated *vis a vis* control plots were 2.97 and 1.95, 2.94 and 2.17, 3.04 and 1.97 and in case of hybrid varieties, benefit cost ratios were 3.31 and 2.39, 3.43 and 1.99, 3.26 and 2.62 during 2010, 2011 and 2012 respectively. Hence, technology index and favourable benefit cost ratios proved the technical and economic viability respectively of the interventions and convinced the farmers on the utility of these simple, economical and ecologically safe interventions. Similar findings were also reported by Sharma *et al.*, (2003) in moth bean, Gurumukhi *et al.*, (2003) and Mishra *et al.*, (2003) in sorghum and Mitra and Samajdar (2010) in rapeseed mustard.

CONCLUSION

The results of rice front line demonstrations convincingly brought out that the yield of rice could be increased by 36% to 54% by improved varieties and 37 - 86 % by adaptation of hybrids in conjunction with their improved seed with balanced fertilizer application and disease management in the Andaman and Nicobar Islands. From the above findings, it can also be concluded that use of scientific methods of rice cultivation can reduce the technology gap to a considerable extent thus leading to increase in rice productivity in these Islands. Moreover, extension agencies in the Islands need to provide proper and timely technical support to the farmers through different educational and extension methods to reduce the extension gap for achieving higher rice production and productivity. Favourable benefit cost ratio of these interventions indicates economic viability and convinced the farmers for adoption of interventions towards high productivity and better livelihood of the Islands farmers.

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