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Impact of Farmers' Participatory Rice (*Oryza sativa* L.) Demonstration Programme on Crop Yield and Economics Under Temperate Hill Ecology

Tasneem Mubarak[1*], Ab. Shakoor Khanday[2] and Haseeb-ur-Rehman[2]

[1]Mountain Research Center for Field Crops, SKUAST-Kashmir

[2]Krishi Vigyan Kendra Kulgam, Sher-e-Kashmir University of Agriculture Science and Technology of Kashmir (J&K) India-192233

*Corresponding author Email: drtasneem.mubarak@skuastkashmir.ac.in

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Abstract

There exists a gap between the potential yield and the yield realized in farmers' field in India. Situation is no different in the Union Territory of Jammu and Kashmir. With an aim to narrow down the yield gaps Farm Science Center Kulgam-SKUAST, Kashmir conducted 63 frontline demonstrations on Shalimar Rice-4, a high yielding disease tolerant variety in the lower plains of Kashmir valley from year 2019-2021. Results of these demonstrations revealed a significant improvement in yield and higher monetary returns with the introduction of new varietyy. Average crop yield (73.8 q ha^{-1}) was 15.5% higher in improved practice compared to farmers' practice (63.9 q ha^{-1}). An extension gap of 9.9 q ha^{-1} and a technology gap of 6.2 q ha^{-1} were observed in the study. Net returns were Rs. 129243 ha^{-1} in farmers practice against Rs.146815 ha^{-1} in technology demonstrated, indicating an additional income of Rs. 17572 ha^{-1} and effective gain of Rs. 14812 ha^{-1} in the latter. Higher benefit: cost ratio (2.9) was registered in improved practice compared to farmers practice (2.7).

Key Words: Rice, Front line Demonstration, hills, yield, economics

Introduction

Rice is staple food and also a source of employment and livelihood for majority of the populaion in India and also for the farmers associated with its cultivation in Kashmir valley situated in the North western Himalayas. Its cultivation in the valley extends from the plains having altitude 1570 meters to high hills 2180 meters above mean sea level. Like other parts of the country, rice farming has seen dramatic changes from 1960s in the Union Territory of Jammu and Kashmir. The contribution made by the State Agriculture University SKUAST-Kashmir through Mountain Research Center for Filed Crops (MRCFC), in terms of development of rice technologies is enormous. Before the availability of varieties developed and promoted by the center the productivity of tradition land races cultivated by farmers of the valley hovered between 1 to 1.5t/ha. Despite these developments, there still exists a gap between what is produced and what can be produced in the farmers' field (Mubarak and Shakoor, 2019). Use of traditional rice cultivars by farmers is one of the major cause of low productivity in farmers field in the valley (Mubarak and Sheikh, 2014). The reason farmers stick to the traditional varieties like China-1039, Jhelum and some mixtures may either be their unawareness about new ones or lack of desirable traits like early maturity, disease resistance, higher yields and good cooking quality in the varieties. In order to bridge the yield gap, it is therefore, essential that new varieties with higher yield potential and desirable traits are developed and popularized among

farmers. Shalimar Rice-4 possesses resistance to major diseases and a yield potential of 10 t ha^{-1}. This variety has been the farmers best choice during the Participatory Varietal Selection (PVS) programme conducted by the center at farmers field (Najeeb *et al.,* 2018) as it possesses farmers' acceptable traits and can be cultivated without any fungicide or insecticide spray. In this back drop, it was required to popularize the variety in farmers participatory mode and with this aim a technology dissemination programme through frontline demonstrations in farmers' participatory mode were conducted at multi-location from 2019 to 2021.

Materials and Methods

The study area, which included 13 villages (**Table 1**) adopted for the demonstrations, is located in the lap of Peer Panchal Himalayan Ranges between 33.62 to 33.70^{0}N latitude and 74.8 to 75.02^{0}E longitude. Soils in the demonstration plots were silty clay loam to clay loam in texture and the area possesses facility of assured irrigation round the year. Shalimar Rice-4 variety released in year 2017 was selected for the demonstrations in the farmers fields in the adopted villages against the Jhelum variety popular in the area. The variety is recommended for irrigated low lands (up to the altitude of 1700 m amsl) of the Kashmir valley due to high yielding potential in this ecology. The variety exhibits tolerant reaction to blast disease and moderately resistant reaction against major diseases under national screening trials. Farm Science Center Kulgam working under the aegis of Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir in collaboration with Mountain Research Center for Field Crops (MRCFC) and the Department of Agriculture Govt. of Jammu & Kashmir, conducted 64 frontline demonstration programmes sponsored by ICAR-Agricultural Technology Application Research Institute Zone-1, over an area of 38.8 ha. from 2019 to 2021. Thirteen villages scattered across the southern part of valley were selected for the programme after consultation with the officers of Department of Agriculture and Scientists from Mountain Research Center for Field Crop (MRCFC)-Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir. Each demonstration occupied 1-acre area (0.5 acre under demonstrated variety and 0.5 acre under old variety). A recommended dose of fertilizer (120: 60: 30 kg N, P and K ha^{-1}) was utilized in both the varieties. After transplanting of one month old seedlings at a spacing of 15 cm x 15 cm, water was impound (5 cm) until complete draining out of water at active-tillering stage (for 1st top dose of nitrogen after hand weeding) and panicle initiation stage (for 2nd top dose of nitrogen). From flowering to milk stage, a thin layer of water was maintained in the field. Alternate wetting and drying was carried out from dough stage to physiological maturity. No irrigation was given after physiological maturity. Crop was harvested in the last week of September and the grain and straw yield were recorded from each demonstration. For economics, values of both grain and paddy straw were taken into consideration, as paddy straw has economic value in the valley particularly for cattle feeding and apple packing. Additional gains, effective gains, extension gap, technology gap and technology Index were calculated by using formulae given below;

- Additional gains (₹ ha^{-1}) = Net returns (₹ ha^{-1}) from Improved practice - Net returns (₹ ha^{-1}) from farmers' practice
- Effective gains (₹ ha^{-1}) = Additional returns (₹ ha^{-1}) - additional costs (₹ ha^{-1})
- Extension gap (q ha^{-1}) = Improved practice yield (q ha^{-1}) -farmers' practice yield (q ha^{-1}).
- Technology gap (q ha^{-1}) = Yield in demonstrated technology (q ha^{-1}) - Potential yield (q ha^{-1}).
- Technology Index (%) =

$$\frac{\text{Potential yield} - \text{Demo yield}}{\text{Potential yield}} \times 100$$

Table 1: List of villages covered under demonstrations

S. No	Name of Village	S. No	Name of Village
1	Tarigam	8	Kanipora
2	Sonogam	9	Kujar
3	Yaripora	10	Brazloo
4	Home shali bough	11	Kaladrangh
5	Frisal	12	Chimegam, Chanpora
6	T N Pora	13	Gnosargam
7	Shurat	-	

The data recorded on crop yield were subjected to statistical analysis through student's t -Test using excel data analysis tool and means compared at $p \leq 0.05$.

Results and discussion

Crop yield

Shalimar Rice-4 variety recorded an average yield of 74.5 q ha^{-1} in the farmers' participatory trials conducted across Kashmir valley, which was the highest observed so far (Najeeb *et al.,* 2018). The results necessitated the promotion of this variety as fast as possible given to its yield potential and farmers acceptance. Farm science center, Kulgam took a lead and conducted Frontline Demonstration programmes on the variety along with related package of practice. Data pertaining to the yields obtained under frontline demonstrations are presented in **(Table 2)**. Improved practice registered significantly higher grain yield compared to the existing farmers practice during all the three years of study **(Tables 2 and Figures 1 to 3)**. Yield ranged between 73.2 to 74.5 q ha^{-1} and 62.0 to 65.2 q ha^{-1} in improved practice and farmers' practice, respectively. Improved practice gave an additional yield of 9.9 q ha^{-1} on an average basis. Average crop yield (73.8 q ha^{-1}) was 15.5% higher in improved practice compared to farmers' practice (63.9 q ha^{-1}). Additional yield was highest (11.2 q ha^{-1}) in year 2021 probably due to weather conditions suitable for the new variety. This may be attributed to the resilience of this variety to biotic and abiotic stresses and better response to farm inputs (Parray *et al.,* 2020). Similar findings were also reported by Patil *et al.,* (2018) and Mubarak and Shakoor (2019). Sharma *et al.,* (2022) also concluded that new variety has significant yield advantage over tradition one. The change in per cent increase in yield over the years indicates varying response to the environment prevailing during the respective years of study. These findings are in line with those of Singh *et al.,* (2015) and Asif *et al.,* (2017).

Table 2: Yield of rice varieties under Frontline Demonstration programme at farmers' field

Year	Name of Varieties	Ecology	No. of demons.	Area under demonstration (ha)	Average yield in Improved Practice (q ha^{-1})	Average yield in Farmers practice (q ha^{-1})	Additional yield in the improved practice	% age yield increase
2019	• Jhelum (FP)* • Shalimar Rice -4(IP)**	Irrigated valley planes	25	10	73.9	65.2	8.7	13.3
2020	• Jhelum (FP) • Shalimar Rice-4(IP)	Irrigated valley planes	14	5.6	74.5	64.7	9.8	15.1
2021	• Jhelum (FP) • Shalimar Rice-4 (IP)	Irrigated valley planes	25	23.2	73.2	62.0	11.2	18.0
Total (Demos & Area) / Mean yield & % increase in yield			64	38.8	73.8	63.9	9.9	15.5

*FP: Farmers' Practice **IP: Improved Practice

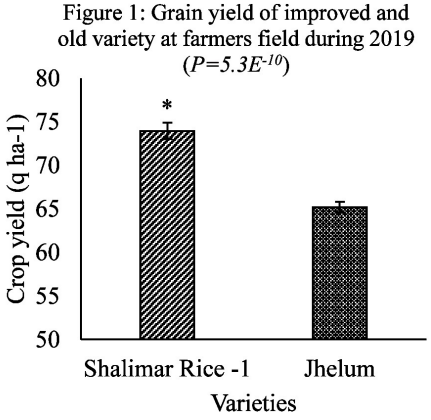

Figure 1: Grain yield of improved and old variety at farmers field during 2019 ($P=5.3E^{-10}$)

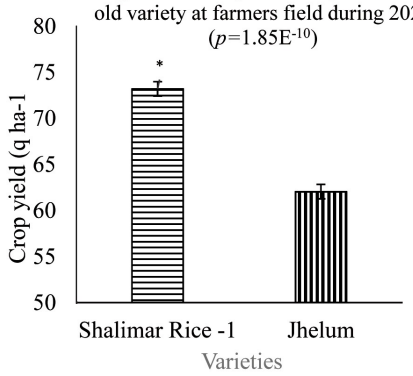

Figure 2: Grain yield of improved and old variety at farmers field during 2020 (p=1.85E^{-10})

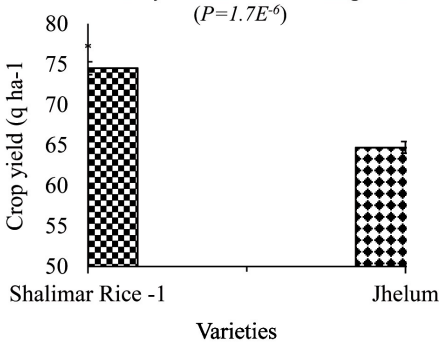

Figure 3: Grain yield of improved and old variety at farmers field during 2021 ($P=1.7E^{-6}$)

Gap analysis

The yield gap analysis in the present study revealed an extension gap ranging between to 8.7 to 11.2 q ha^{-1} (**Table 3**). On an average the extension gap was 9.9 q ha^{-1}. The Technology gap varied between 5.5 to 6.8 with an average value of 6.2 pooled over the years. These results indicate that there is further scope to enhance the rice production in the valley by popularizing the latest high yielding varieties like Shalimar Rice-4. This can be achieved through collaborative efforts of extension functionaries involving farm science Centers and the department of agriculture existing in each district of the valley. Earlier Mubarak *et al.* (2013) and Sheikh *et al.* (2014) also reported similar results during their studies on demonstration of rice technologies under Kashmir conditions.

Table 3: Gap analysis and technology Index in Frontline Demonstration on rice at farmers' field

Year	Name of Varieties	Ecology	Extension gap	Technology Gap	Technology Index
2019	• Jhelum (FP) • Shalimar Rice (SR)-4	Irrigated plains of valley	8.7	6.1	7.625
2020	• Jhelum (FP) • Shalimar Rice (SR)-4	Irrigated plains of valley	9.8	5.5	6.875
2021	• Jhelum (FP) • Shalimar Rice (SR)-4	Irrigated plains of valley	11.2	6.8	8.5
Total			**9.9**	**6.2**	7.75

Similarly, variations in Technology Index were also recorded between 6.8 to 8.5% with an average value of 6.2%. Technology index is an indicator of the feasibility of the evolved technology at the farmers' fields. The lower the value of technology index more is the feasibility of the technology. Technology index ranging between 6.8 to 8.5% indicates that there is scope for further improvement in productivity of rice in Valley. These findings are in line with those of Mitra *et al.* (2014) and Singh *et al.* (2015).

Economic impact

Economics in terms of costs of cultivation, gross and net returns, additional returns, effective gain and B:C ratio varied during different years of study both in the improved technology and farmers practice (**Table 4**). The cost of cultivation varied from ₹ 47280 ha^{-1} in year 2019 in farmers' practice to Rs.53068 ha^{-1} in the improved practice in year 2020. This was due to variation in cost of inputs in different years and comparatively higher input requirement in the improved practice. On an average the cost

of inputs was Rs.47647 ha^{-1} and Rs.50407 ha^{-1} for farmers practice and improved practice, respectively. Improved practice involved an additional cost of inputs to the tune of Rs.2760 ha^{-1}. Gross and net returns fluctuated during the years of study with maximum values recorded for improved practice (**Table 4**). Gross returns of Rs.176890 ha^{-1} and Rs. 197222 ha^{-1} were registered under farmers practice and improved practice, respectively. Net returns pooled over the years were Rs. 129243 ha^{-1} in farmers practice against Rs.146815 ha^{-1} in technology demonstrated, indicating an additional income of Rs. 17572 ha^{-1} and effective gain of Rs. 14812 ha^{-1} in the latter. Higher benefit: cost ratio (2.9) was registered in improved practice compared to farmers practice (2.7). The additional returns, effective gain and higher net returns obtained under improved practices could be due to its high yield potential under existing ecology and environmental conditions. Verma *et al.,* (2017) also concluded their study with similar results.

Table 4: Economic Analysis of frontline demonstration programme on rice at farmers' field

Year	Input cost (₹ ha^{-1})		Additional cost in IP	Gross returns* (₹ ha^{-1})		Net returns (₹ ha^{-1})		Additional returns from IP (₹ ha^{-1})	Effective Gain from IP (₹)	B:C ratio	
	Farmers Practice (FP)	Improved Practice (IP)		FP	IP	FP	IP			FP	IP
2019	47280	49242	1962	176536	195694	129256	146452	17196	15234	2.7	3.0
2020	48229	53068	4839	180899	200300	132670	147232	14562	9723	2.8	2.8
2021	47432	48912	1480	173234	195672	125802	146760	20958	19478	2.6	3.0
Average	47647.0	50407.3	2760.3	176890	197222	129243	146815	17572	14812	2.7	2.9

**It also includes the returns from paddy straw owing to its demand in the valley for apple packing and as cattle fodder for lean winter season.*

Conclusion

Rice being the staple food for the people of Kashmir Valley, will remain a top priority of agriculture research and extension. The area is shrinking day by day due to diversification into other sectors especially horticulture and non-agriculture activities, indicating that we need to get more from less land. To meet the demand, the present productivity must not only increase but sustain growth in future. So demonstration of proven technology capsules pertaining to different rice ecologies in farmers' participatory mode is vital to achieve this goal. The present study also indicates that use of new variety Shalimar Rice-4 is crucial in bridging the yield gaps and improving returns in the valley.

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