



Impact of Front Line Demonstrations on Productivity and Economics of Rainfed Pearl Millet [*Pennisetum glaucum* (L.) R. Br.] in Western Rajasthan

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Abstract: Front line demonstrations were carried out in ICAR-Farmer FIRST Project in different villages of Jodhpur (Rajasthan) from Kharif 2017 to 2020 to demonstrate the potential of improved crop production technologies of pearl millet for enhancing the crop productivity and farmers' income. The 'improved technologies' (IP) consisted of two pearl millet hybrids (MPMH-17 and HHB-67(I)) with or without the recommended dose of fertilizers (60 kg N + 30 kg P₂O₅ ha⁻¹) and were evaluated against farmers' practice (FP). The grain yield under IP ranged from 1.36 to 1.64 t ha⁻¹ whereas under FP it ranged from 1.07 to 1.34 t ha⁻¹. The per cent increase in grain yield with IP over FP was 17.8 to 26.7% whereas the per cent increase in stover yield was 31.1 to 36.0%. An extension gap ranged from 0.21 to 0.31 t ha⁻¹ during the different years. Both the technology gap (1.56-1.84 t ha⁻¹) and the technology index (48.8-57.5) were higher for hybrid MPMH-17 irrespective of fertilizer application than for HHB-67(I). The highest increase in net returns and added net returns was recorded for MPMH-17 supplemented with fertilizers followed by improved hybrid HHB-67(I). However, the incremental cost-benefit ratio was slightly lower for HHB-67(I) than for MPMH-17 (average of three years). The improved hybrids MPMH-17 and HHB-67(I) performed better over the farmer's practice indicating that for realizing higher yield and income from pearl millet, farmers should adopt the improved cultivars and should apply recommended dose of fertilizers also.

Keywords: Arid region, extension gap, farmer income, technology index, technology gap.

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is one of the most important millet or coarse grain cereal crops. It is cultivated as rainfed crop and provides staple food to the people living mostly in arid and semi-arid regions. Pearl millet is a hardy crop, that has good adaptation to a wide range of environments especially heat, drought, and marginal & degraded soils (Jain, 2018). Nutritionally, pearl millet is superior to wheat, rice, maize and sorghum in terms of essential minerals, dietary fiber and essential amino acids. It is rightly termed as "nutria-

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cereal" as it is a good source of energy (361 Kcal 100 g⁻¹), carbohydrate (67.5%), protein (9.2–11.6%), fat (5 mg 100 g⁻¹), dietary fiber (1.2%), minerals (2.3 mg 100 g⁻¹) and B-vitamins. It is rich in unsaturated fatty acids (75%) with higher content of nutritionally important n-3 fatty acids than other cereal grains (Satyavathi *et al.*, 2017). Besides grains, pearl millet stover is also important as dry fodder and green forage. These adaptive and nutritional features combined with yield potential make pearl millet an important nutria-cereal crop to address the emerging challenges of climate change, food-related health issues, and decreasing farm profitability.

Rajasthan has maximum area (4.23 mha) and with average productivity is 886 kg ha⁻¹ produces maximum pearl millet in India. In Jodhpur district it covers an area of 0.42 mha with average productivity of 995 kg ha⁻¹ (Anonymous, 2018). Although, the productivity level of the crop in the Jodhpur district is higher compared to the State average however, it is still far below the average productivity of other districts and the potential productivity of improved cultivars with the improved package of practices.

Farmers of western Rajasthan cultivating pearl millet continue to face uncertain and low economic returns sometimes due to low production and often due to low prices. Thus the area under pearl millet cultivation is shrinking especially in arid regions because of lower yield and returns. In addition, under rainfed conditions crop often experiences moisture stress at various growth stages resulting in low yield. Therefore, a wide gap exists between the potential productivity of pearl millet cultivars and the actual productivity realized by the farmers. Therefore, making pearl millet a remunerative crop needs investment in crop management for productivity enhancement. There is tremendous scope for increasing the productivity of crop by adopting improved adaptable varieties/hybrids. Similar studies on crop yield increase through the adoption of improved crop management practices were reported by Jat and Gupta (2015), Jain (2018), and Kumar *et al.* (2010) in pearl millet.

Adopting advised scientific and sustainable management production practises would boost pearl millet productivity because

varieties and INM have an impact on it. Front line demonstration (FLD), aims to boost productivity by offering necessary inputs as well as enhanced production and good agricultural techniques that have been tested by the researchers of ICAR Institutes and State Agricultural Universities (SAUs). The promotion of the cultivation of better varieties, gathering feedback from farmers regarding obstacles to the adoption of suggested enhanced technologies for additional study, and maximizing the process of technological diffusion among farmers are other important components of this program (Nagarajan *et al.*, 2001). Therefore, Front line demonstrations were carried out in ICAR-Farmer FIRST Project in four villages of Jodhpur (Rajasthan) from *Kharif* 2017 to 2020 to demonstrate the potential of improved crop production technologies of pearl millet for enhancing the crop productivity and farmers' income.

Materials and Methods

The present study was conducted in the farmers' fields in a front line demonstration (FLD) mode for four consecutive years from *kharif* 2017 to 2020 under the ICAR-Farmer FIRST Project. The study was carried out in four villages *viz.*, Popawas, Rajwa, Sirodi, and Ghantiala of Popawas Panchayat of Mandor block of Jodhpur. The FLDs were conducted to demonstrate the potential benefits of the improved package of practices in comparison to the existing farmers' practice and to evaluate the extension gap and technology index of the improved package. Each demonstration was conducted in an area of 0.4 ha and with an adjacent area of 0.4 ha selected for farmer's practice. A total of 194 demonstrations covering an area of 77.6 ha having a similar number of farmers' practice as local checks were carried out in rainfed conditions. Soils of the study area are sandy to sandy loam and medium in fertility status. The details of the interventions followed in the improved practices (IP) and farmer's practice (FP) are given in Table 1. The pearl millet crop was sown between mid-June to mid-July and harvested in mid-September across the years. At the time of harvest, data on grain and stover yields were collected by harvesting a crop of 1 m² randomly from 3 to 4 places each from IP and FP plots and converted in t ha⁻¹. Based on the cost of inputs and the market price of the product, gross and

Table 1. Details of improved practice vis-a-vis farmer's practice for pearl millet FLDs.

Particular	2017		2018		2019		2020	
	FP	IP	FP	IP	FP	IP	FP	IP
Demonstrations (Nos.)	55		36		63		40	
Improved hybrid	Farm-own seed, private sector hybrids	*MPMH-17	Farm-own seed, non-descript private sector hybrids	MPMH-17	Farm-own seed, non-descript private sector hybrids	MPMH-17	Farm-own seed, non-descript private sector hybrids	**HHB-67(I)
Fertilizer	-	N - 60 kg ha ⁻¹ P ₂ O ₅ - 30 kg ha ⁻¹	-	-	-	N - 60 kg ha ⁻¹ P ₂ O ₅ - 30 kg ha ⁻¹	-	-

*Potential grain and stover yield of MPMH-17 is 3.20 and 8.41 t ha⁻¹, respectively;

**Potential grain and stover yield of HHB-67(I) is 2.26 and 5.58 t ha⁻¹, respectively

net returns were worked out. The following analytical tools were used for assessing the performance of the FLDs:

Technology gap (t ha ⁻¹)	=	Potential yield - Demonstration yield
Extension gap (t ha ⁻¹)	=	Demonstration yield - Farmers yield
Technology index (%)	=	(Technology gap/potential yield) × 100
Additional cost (Rs. ha ⁻¹)	=	Demonstration cost - Farmers' practice cost
Additional return (Rs. ha ⁻¹)	=	Demonstration return - Farmers' practice return
Incremental B:C ratio (ICBR)	=	Additional return/Additional cost

Results and Discussion

Yields

The mean yield data of different years revealed that the use of high-yielding varieties alone or in combination with a balanced fertilizer produced higher grain and stover yield of pearl millet (Table 2). The average grain yield of pearl millet under FP varied from 1.07 to 1.34 t ha⁻¹ during the four years

of study whereas under the IP it varied from 1.36 to 1.64 t ha⁻¹. Similar trend was observed for stover yield also. Increase in the yield under IP over the FP ranged from 17.8-26.7% for grain and 31.3-36.0% for stover in different years suggesting that yields under FLDs were better than those under FP. Similar findings have also been reported by Narolia *et al.*, (2015). During 2017 and 2019 when MPMH-17 was grown in combination of recommended dose of fertilizer, average grain yield was 26.7 and 25.0% higher over farmers practice, respectively but in 2018 when it was grown without fertilizers the yield increase was 22.9%. During 2020, HHB-67(I) gave a 17.8% advantage in grain yield over FP. These results indicated that the newly developed hybrid MPMH-17 has added advantage over existing improved cultivar HHB-67(I) and that MPMH-17 even without fertilizers would yield more than FP.

Yield gap analysis

The extension gap is a parameter used to elicit the yield differences between IP and FP. An extension gap ranging from 0.21-0.31 t ha⁻¹ was found between IP and FP during the different years (Table 2). It was minimum

Table 2. Production performance of pearl millet under improved practice vis-a-vis farmer's practice.

Year	Improved Hybrids	Yield (t ha ⁻¹)				Increase yield over FP (%)		Extension gap (grain yield t ha ⁻¹)	Technology gap (grain yield t ha ⁻¹)	Technology index
		IP		FP						
		Grain	Stover	Grain	Stover	Grain	Stover			
2017	MPMH-17	1.36	3.13	1.07	2.36	26.7	32.6	0.29	1.84	57.5
2018		1.64	3.56	1.34	2.64	22.9	34.8	0.31	1.56	48.8
2019		1.42	3.05	1.14	2.24	25.0	36.0	0.29	1.78	55.6
2020	HHB- 67(I)	1.36	3.12	1.15	2.38	17.8	31.1	0.21	0.90	39.8

IP- improved practice; FP- farmer's practice

Table 3. Comparative economics of pearl millet under improved practice vis-a-vis farmer's practice.

Year	Total cost of cultivation (Rs. ha ⁻¹)		*Gross returns (Rs. ha ⁻¹)		Net returns (Rs. ha ⁻¹)		Additional cost (Rs. ha ⁻¹)	Additional net returns (Rs. ha ⁻¹)	ICBR
	FP	IP	FP	IP	FP	IP			
2017	14800	18500	38933	50737	24133	32237	3700	8104	2.19
2018	15540	19240	44690	58338	29150	39098	3700	9948	2.69
2019	16628	20328	58512	75680	41884	55352	3700	13468	3.64
2020	18124	21824	53457	66766	35333	44942	3700	9609	2.60

*MSP of pearl millet during 2017, 2018, 2019 and 2020 were Rs. 1425, 1950, 2000 and 2150 q⁻¹, respectively. The sale price of fodder was assumed to be Rs. 1000 q⁻¹ for 2017 and 2018; and Rs. 1200 q⁻¹ for 2019 and 2020.

(0.21 t ha⁻¹) in 2020 with improved hybrid HHB-67(I) and was maximum (0.31 t ha⁻¹) in the year 2018 with improved hybrid MPMH-17. Interestingly, the extension gap with MPMH-17 combined with fertilizer during both 2017 and 2019 was 0.29 t ha⁻¹ that was lower than 0.31 t ha⁻¹ recorded in 2018. This consistent yield gap over the years clearly suggested that the adoption of IP wholly or even partially can increase yield over FP.

Besides this, the technology gap illustrates the difference between potential yield and yield obtained in IP. The technology gap is of larger importance as it specifies the constraints in implementation and problems in IP. The technology gap during 2017-2019 (1.56-1.84 t ha⁻¹) with hybrid MPMH-17 with or without fertilizers and lowest (0.9 t ha⁻¹) during 2020 with hybrid HHB-67(I). The difference in technology gap during different years could be due to the differential performance of improved hybrids and their respective potential yield. In specific case of HHB-67(I) and MPMH-17, it might be attributed to the lower potential grain yield of former (Table 1). This could also be attributed to the variations in soil fertility, rainfall and inherent genetic potential etc. Therefore, location-specific recommendations are required to bridge this gap. Similar results were also recorded by Meena *et al.* (2012) and Katare *et al.* (2011).

The values of technology index for all the FLDs during different years followed the trends of technology gap. The technology index shows the feasibility of the IP on the farmer's fields. Lower values of the technology index indicate higher feasibility of the technology. The technology index was higher in the range of 48.8-57.5 during 2017-2019 with improved hybrid MPMH-17, whereas it was comparatively lower with improved hybrid HHB-67(I) (39.8) in 2020. These findings are also supported by

reports of Meena *et al.* (2012) and Katare *et al.* (2011).

Economic analysis

Economic returns as the determinant of the yield, cost of cultivation, and sale prices of products varied from year to year due to the variations in the amount and cost of inputs and prices of outputs (Table 3). Additional investment of Rs. 3700 ha⁻¹ was incurred for improved seed and fertilizer under FLDs. This extra cost is affordable even for small and marginal farmers. Thus, the cost may not deter the farmers from adopting the latest technologies. Gross return is a function of yield and market prices of grain and stover, which vary over the years. Gross returns were maximum in the year 2019 with improved hybrid MPMH-17 supplemented with fertilizers followed by improved hybrid HHB-67(I) in the year 2020. Net returns and added net returns also follow the same trend and indicate that the adoption of improved technologies can increase the farm income in arid regions. The higher additional returns could be attributed to higher yields due to improved technology in terms of seed, fertilizer, or both. The IBCR fluctuated between 1.94 (2020) and 3.13 (2019) over the years but are sufficiently high to motivate the farmers under rainfed conditions to invest in improved crop production technology. The results are in conformity of the findings of Dayanand *et al.* (2012), Meena *et al.* (2012) and Ramniwas *et al.* (2022).

Conclusions

Higher grain and stover yield in the demonstrations over farmers' practice indicated that MPMH-17 and HHB-67 (I) can further enhance yield under the prevailing agro-climatic conditions. High values of extension and technology gaps indicated the need for farmers' awareness through extension machinery. Total

net returns and added returns indicated that economics of demonstrated technology is favorable for realizing higher profit by farmers of the region.

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