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An Appraisal of Cluster Frontline Demonstrations on Mustard Crop in Sawaimadhopur District of Rajasthan

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ABSTRACT

The study attempted to analyse the overall effectiveness of the Cluster frontline demonstrations (CFLDs) conducted by the Krishi Vigyan Kendra, Sawaimadhopur, from 2018–19 to 2021–22 using Integrated Crop Management technologies on mustard. A combination of experimental and before-after research designs was used, and 492 beneficiaries were selected for conducting the CFLDs. The obtained results from both the demonstrated and local check plots were compared, and the average yield of the improved mustard variety Giriraj from the demonstrated plots was significantly higher than that from the local check plots during these years. On average, extension and technology gaps were recorded as 4.82 q/ha and 5.99 q/ha, respectively. The average technology index was 21.79 per cent, and the lowest was noticed in the last season of the demonstrations, indicating the increased adaptability and efficiency of recommended technologies in field conditions. The average net returns and benefit-cost ratio from the demonstrated plots outperformed the local check plots in all four seasons. Overall, the CFLDs positively impacted the mustard growers of that particular area and motivated them to adopt the recommended practises for higher yield and profitability.

INTRODUCTION

India is bestowed with diverse agro-climatic and soil conditions which enable the cultivation of different kinds of oilseed crops. In terms of acreage, production, and value, the oilseeds are the next to food grains in the Indian agricultural economy (Sangwan et al. 2021). In India, oil seed production is given significant importance due to the enormous disparity between supply and demand, which led to the purchase of vegetable oil worth millions of rupees yearly (Layek et al., 2021). Among the various oilseeds grown in India, mustard is considered the third most important crop after groundnut and soybean (Kumar et al., 2020). In India, Mustard covers 6.69 million hectares of area with a productivity of 1511 kg ha^{-1}. Among the various mustard-producing states of India, Rajasthan ranks first in terms of total acreage, covering 2.72 million hectares with a production of 4.51 million tonnes in 2020-21. (Directorate of Economics & Statistics, 2021).

Integrated crop management (ICM) incorporates suitable crop production practices for yield and productivity enhancement, comprising of tillage, integrated nutrient management, integrated weed management, integrated nutrient management, and integrated pest management practices. ICM is mainly beneficial from the perspective of small and marginal farmers as it is a sustainable long-term approach, aiming to utilize the on-farm resources judicially in a suitable and collective manner. Cluster frontline demonstration (CFLD) is a popular extension activity for demonstrating the potential of newly released technologies in the farmer's fields at different localities in a given farming system by organizing farming and extension activities for the farmers.

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Sawaimadhopur district is a prominent mustard-growing region in Rajasthan. Though in 2021, the area under mustard for this particular district increased to 190487 ha from 149696 ha in 2020 but the productivity exhibited a downward trend, i.e. 1871 kg/ha in 2020 to 1784 kg/ha in 2021 (Commissionerate of Agriculture, Rajasthan, 2021). Such an alarming decline in mustard productivity could severely impact the overall mustard production for the state. All though the agricultural research institutes have made much progress in improving the production technologies of the mustard crop, the farming community is yet to harness the benefits of these developments. Therefore, Krishi Vigyan Kendra, Sawaimadhopur, took an initiative to introduce the Integrated Crop Management practices of mustard cultivation through Cluster frontline demonstrations to increase the productivity and reduce the cost of cultivation for attaining high economies of scale by the mustard growers. The present study aims to evaluate the effectiveness of the KVK-conducted CFLDs on mustard from 2018-19 to 2021-22.

METHODOLOGY

The CFLDs were conducted in 5 blocks (Sawaimadhopur, Chauthka Barware, Gangapur City, Bauli, and Khandar) of the Sawaimadhopur district of Rajasthan during the 4 consecutive *rabi* seasons from 2018-19 to 2021-22 as mustard is the major rabi season crop in these blocks. A combination of experimental (control-treatment) and before-after research designs was used for the present study. Before conducting the CFLDs, a baseline survey was done in the selected blocks to identify the existing cultivation practises followed by the mustard growers. A total of 492 mustard growers with a cumulated land holding of 293 ha. were identified for conducting the CFLDs as per their interest and participation during the baseline survey, interactive meetings, and awareness campaigns. The farmer's existing mustard cultivation practises were considered as the local check plot. In selected plots for CFLDs, the recommended ICM practises were adopted as per the recommended Package of Practices for Zone V and Zone III-B of Rajasthan for mustard crop. Each and every one of the selected beneficiaries was trained to adopt the recommended ICM technologies for mustard cultivation, and the demonstrations were laid out in an area adjacent to the plots, where the mustard was being grown with the prevailing cultivation practises / variety by the beneficiaries. The details of the recommended ICM technologies are presented in Table 2. The data regarding the crop yields were immediately collected from the check plots as well as the demonstration plots to identify the yield gaps. The economic parameters were worked out by considering the inputs' prevailing market prices and the mustard's minimum support price for the particular year. The effectiveness of the conducted CFLDs was assessed by using the formulas suggested by Samui et al., (2000).

The information from the beneficiary farmers regarding the adoption of recommended technologies, varietal replacement, and horizontal spread of recommended variety was collected with a structured and pre-tested interview schedule at the end of the four consecutive CFLDs. A two-way ANOVA was used to determine whether the mean results obtained from the demonstrated plots for different parameters (grain yield, cost of cultivation, and net returns) of mustard cultivation, significantly differed from local check plots or not.

RESULTS AND DISCUSSION

Yield performance and gap analysis

Cluster Frontline Demonstrations of recommended technologies covered 30 ha, 50 ha, 193 ha, and 20 ha areas in 2018–19, 2019–20, 2020–21, and 2021–22 years, respectively. The average yield of Demonstrated plots was 21.50 q ha^{-1}, 21.27 q ha^{-1}, 21.17 q ha^{-1}, and 22.08 q ha^{-1} for the four consecutive cropping seasons, which was significantly higher than farmers' practice by 31.98 per cent, 26.44 per cent, 26.39 per cent and 30.96 per cent respectively, during this entire period. The average yield of demonstrated plots was higher due to the adaptation of recommended ICM practices like line sowing, seed treatment, weed management, and disease management practices. The average yield of the mustard crop in demonstrated plots also outperformed the district yield by 34.03 per cent, 32.61 per cent, 13.14 per cent and 18.01 per cent (Table 1). In the adopted villages, such a positive impact on the yield performance of mustard was observed due to the proper adoption of integrated crop management technologies and suitable mustard variety Giriraj. Jha et al., (2021) also reported similar yield enhancement of mustard crops under CFLDs. The study also revealed a wide gap between the potential yield and the yield obtained from the local check plots for the mustard crop. Such yield disparity of mustard in this region was due to a lack of awareness regarding the suitable mustard variety and a lack of knowledge about improved agronomic practices and fertilizer scheduling by the farmers.

An extension gap of 5.21 q ha^{-1}, 4.45 q ha^{-1}, 4.42 q ha^{-1} and 4.24 q ha^{-1} was observed in the respective years from 2018-19 to 2021-22 (Table 1). Sensitizing the farmers to adopt improved mustard production technologies using extension activities like training, field days, *Kisan goshthis, Kisan melas*, awareness programmes, result demonstration initiatives, etc., can reduce the galloping trend of the extension gap in mustard production. The resulting technology gap depicted the disparity between the potential yield and the yield obtained from the demonstrated plots of mustard. Table 1 shows that the technology gap was highest in 2020-21, at 6.33 q ha^{-1}, and lowest in 2021-22, at 5.42 q ha^{-1}. The observed technology gap may be attributed to various factors related to dissimilarity in crop management practices, soil fertility, and climatic factors. In the last year of the demonstration, the technology gap was the least due to the better performance of the improved mustard variety and the adoption of recommended ICM technologies with different interventions.

The technology index in Table 1 depicts the feasibility of the adopted ICM technologies in the farmer's field. A higher technology index value indicates the inadequate transfer of proven technology among farmers, and a lower technology index value signifies the greater feasibility of any technology in the farmers' field. In this study, the technology index value ranged from 19.20 to 23.01 per cent. Further, on average, the technology index during these four study years was found to be 21.79 per cent, which shows the efficacy of ICM interventions and the adoption of demonstrated

Table 1. Yield performance and gap analysis of mustard crop grown under CFLDs and prevailing farmers' practices**.**

Year	Crop Yield (q ha^{-1})			% increase over local check plots	Extension gap (q ha^{-1})	Technological gap (q ha^{-1})	Technology index (%)
	Potential yield (q ha^{-1})	CFLD plots (q ha^{-1})	Local check plots (q ha^{-1})				
2018-19	27.5	21.50	16.29	31.98	5.21	6.00	21.81
2019-20	27.5	21.27	16.82	26.44	4.45	6.23	22.64
2020-21	27.5	21.17	16.75	26.39	4.42	6.33	23.01
2021-22	27.5	22.08	16.86	30.96	5.22	5.42	19.70
Average	-	21.0	16.68	25.89	4.82	5.99	21.79
Total	-	-	-	-	-	-	-

(CFLD= Cluster Frontline Demonstration)

technologies to increase the yield performance in farmers' fields. Singh et al., (2020) also reported the similar trend of technology index in case of pigeon pea cultivation under CFLDs in Gorakhpur.

Impact of cluster frontline demonstrations on adoption of ICM mustard technologies

It was clear that once the yield potential of the recommended mustard variety Giriraj was realized, all 492 beneficiaries switched from previously adopted hybrid varieties realised by private sector companies and local mustard seed companies to this variety (Table 2). An upward trend was observed in the number of adopters of seed rate (190.47%), sowing method (251.92%) and spacing (446.26%) of the mustard crop. Out of 492 farmers, a total of 366 farmers adopted the recommended practices regarding the seed rate, sowing method, and spacing after the CFLDs as they started using seed-cum fertilizer drill for simultaneous seeding and fertilization process while maintaining proper spacing. The remaining beneficiary farmers could not afford the machine due to their low income and low utility perspective of such modern equipment in their small/marginal lands, and they were dependent upon normal seed drills and broadcasting methods for the sowing of mustard. Regarding the recommended seed treatment practice before sowing, adopters increased by 169.76 per cent as it prevents the attacks of painted bugs at the seedling stage of mustard plants. A similar trend was observed in the adoption of recommended time of sowing, with an increase of 54.23 per cent in the total number of adopters. All of the beneficiary farmers started following the proper time of sowing, which is from September 15th to September 30th, as beyond this period, the temperature starts decreasing, which hampers the germination of mustard seeds. The soil moisture remains highest during the period, which is more conducive for sowing operations in rain-fed areas. In the case of weed management, only 153 farmers adopted the pre-emergence spraying of pendimethalin as per the recommended dose, while the major chunk of the beneficiary farmers could not adopt the practice due to the unavailability of water for effective spraying of the chemical. Due to the highly positive impact of nutrient management interventions suggested in CFLDs, there was a 532.20 per cent hike in the number of adopters of the recommended fertilizer application practices. Before conducting the demonstrations, the majority of the beneficiaries were ignorant of the benefits of the micronutrients, and they used to apply phosphoric fertilizer (DAP) at the time of sowing and nitrogenous fertilizer (urea) after irrigation at a single dose, which used to induce more vegetative growth as compared to the desired reproductive growth of the plants. Regarding irrigation management interventions, there was only a 22.62 per cent change in the number of adopters. The scarcity of irrigation water was the major reason behind such a low adoption rate. Those who had adequate irrigation facilities irrigated the crop at two stages, i.e., one at the time of flowering and the second one at the time of pod formation, and those who had limited water resources irrigated the crop 65–70 days after sowing. Overall, the adoption rate was satisfactory for all of the recommended ICM practices after the demonstration period, which was indicative of the beneficiary farmers' positive utility perception and satisfaction level.

Table 2. Impact of CFLDs in adoption of recommended mustard cultivation technologies

Particulars	Recommended ICM technologies	Change in No. of adopters	Impact (% change)
Variety	Improved variety - Giriraj (DRMR IJ 31)	492	**
Seed Rate	5 kg/ha	240	190.47
Seed Treatment	Seed Treatment with Mencozeb @ 2 g/kg seed & Imidacloprid 48% FS 6 ml kg^{-1} seed	292	169.76
Time of Sowing	15th to 30th September	173	54.23
Spacing	30 cm X 10 cm	299	446.26
Method of Sowing	Use of seed cum fertilizer drill	262	251.92
Weed Management	Pre-emergence spray of pendimethalin (30 EC) @ 3.3 lt. ha^{-1}	153	**
Fertilizer management	Application of nitrogen, phosphorus, zinc and sulphur @ 80 kg, 40 kg, 5 kg and 40 kg/ha basic and application of nitrogenous fertilizer in two split doses	314	532.20
Irrigation Management	One at the time of flowering, another one at the time of pod formation, i.e. 65-70 days after sowing	50	22.62

(******As the initial number of the beneficiary was 0, the impact was calculated from the absolute change in the number of the beneficiaries rather than percentage change)

Economic analysis

From the economic analysis of mustard production (Table 3) it can be concluded that due to additional use of herbicide, seed treatment, application of micronutrients, and incorporation of insecticide, the cost of mustard cultivation was higher in demonstrated plots compared to local check plots in all four cropping seasons. The average gross and net returns were significantly higher in demonstrated plots compared to local check plots due to higher grain yield, indicating the importance and economic feasibility of the recommended production technologies. An additional return of Rs. 17139 ha^{-1} in 2018-19, Rs. 17827 ha^{-1} in 2019-20, Rs. 17661 ha^{-1} in 2020-21, and Rs. 22316 ha^{-1} in 2021-22 were recorded from the demonstrated plots. The pattern of benefit-cost ratios of mustard production under CFLDs was recorded as 4.01, 4.25, 4.22, and 4.64 for the consecutive cropping seasons, which were higher in comparison to the local check plots under farmers' practice, i.e., 3.43, 3.67, 3.66, and 3.89, respectively. The higher benefit-cost ratio of the demonstrated plots proved the economic viability of the recommended ICM technological interventions with additional return on each rupee invested for the production purpose, and the farmers were highly convinced regarding the utility of the recommended package of practices for mustard production. The findings were confirmatory with the study of Meena et al., (2020) as under the variety Giriraj, higher additional returns and effective gain was obtained from the demonstrated plots as compared to the plots under farmer practice with local mustard variety.

Impact of CFLDs on horizontal spread of high yielding mustard variety- Giriraj

The current study aims to assess the impact of CFLDs on the horizontal spread of the improved mustard variety, Giriraj, among the adopted blocks. Table 4 shows that the CFLDs helped to significantly increase the area under the Giriraj variety from 30 ha to 31879 ha. Giriraj (DRMR IJ 31) was introduced in these villages as it is a bold-seeded variety with an average yield of 22–27 q ha^{-1} and is suitable for irrigated conditions. The oil content of the variety is 39–42 per cent, the test weight is 5.6 g, and the maturity duration is 137–153 days. The possible reasons might be the suitable agronomical attributes of the particular variety, like higher oil content and yield, etc. By incorporating proper crop management practices with such an improved high-yielding variety, farmers could generate higher returns, and hence there was a gradual increment in the total area under cultivation. The replacement of local mustard variety due to the adoption of ICM technologies was also reported by Kumar et al., (2021) & Vishal et al., (2022).

Table 4. Impact of CFLDs on horizontal spread high yield variety-Giriraj

Year	Average yield (q ha^{-1})	Change in area (ha)	Impact (% change)
2018-19	21.50	30	-
2019-20	21.27	1905	6350
2020-21	21.17	13570	701.29
2021-22	22.08	16374	105.60

Effect of ICM technologies on selected Economic parameters

The statistical analysis (Two-way ANOVA) was carried out to compare the dependent variables (yield, cost of cultivation, and net returns) separately year-wise as well as treatment-wise (local check plots and demonstrated plots) for their interaction effect. From Table 5, it was established that in the case of yield and net returns, there was a significant difference across the different years of study. In the case of treatment effect and interaction effect between year and treatment for all the dependent variables, the results from demonstration plots were significantly higher at the 1% level of confidence. Such findings lead to the conclusion that the treatments (ICM technologies) not only differed significantly from the local mustard production practices, but they were also behaving somewhat differently in different environments prevailing throughout the years.

Further clarification of interaction effect can be visualized in Figure 1, from which we can conclude the mean of the yield parameter was higher in the demonstrated plots over the controlled plots for all four years, and in the control plot it slightly increased in 2019-20 from the previous year and almost remained the same for the next consecutive years. In case of cost of cultivation, the mean values for the demonstrated plots were on the higher side as compared to the control plots. The cost of cultivation did not differ significantly in the control as well as in the demonstration plots until 2020-21, but in 2021-22, the cost of cultivation increased significantly in the demonstration plots while it decreased significantly in the control plots. The average net return was always higher in demonstrated plots as compared to controlled plots, and it had a significant growth trend during the study years. Despite a significant increase in the mean cost of cultivation for the demonstrated plots, the mean net return was also significantly hiked for 2021–2022. Hence, we can conclude that the recommended ICM technologies in the demonstrated plots had a significantly positive impact on several parameters of mustard production over the farmers' existing practices of mustard production in the control plots.

Table 3. Economic analysis of mustard production technologies under CFLDs

Year	Average cost of cultivation (Rs ha^{-1})		Average gross return (Rs ha^{-1})		Average net return (Rs ha^{-1})		Additional return (Rs ha^{-1})	Benefit-cost (B:C) ratio	
	DP	LCP	DP	LCP	DP	LCP		DP	LCP
2018-19	22096	20307	88648	69720	66551	49412	17139	4.01	3.43
2019-20	22102	20246	94128	74446	72026	54199	17827	4.25	3.67
2020-21	22114	20229	93692	74146	71578	53917	17661	4.22	3.66
2021-22	22111	20154	102672	78399	80561	58245	22316	4.64	3.89

(DP= Demonstrated plots, LCP= Local Check Plots)

Table 5. Two-way ANOVA analysis for comparing the means of dependent variables across the year and plots (Tests of Between-Subjects Effects)

Tests of Between-Subjects Effects						
Dependent Variable: Yield						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Year	125.636	3	41.879	18.726	.000	.057
Plot	2345.010	1	2345.010	1048.595	.000	.531
year * Plot	39.766	3	13.255	5.927	.001	.019
Dependent Variable: Cost of Cultivation						
year	1070350.022	3	356783.341	2.950	.032	.009
Plot	573841654.148	1	573841654.148	4745.138	.000	.837
year * Plot	19513802.068	3	6504600.689	53.787	.000	.148
Dependent Variable: Net returns						
year	18319187554.447	3	6106395851.482	137.795	.000	.309
Plot	38871709521.541	1	38871709521.541	877.168	.000	.486
year * Plot	1238324841.293	3	412774947.098	9.315	.000	.029

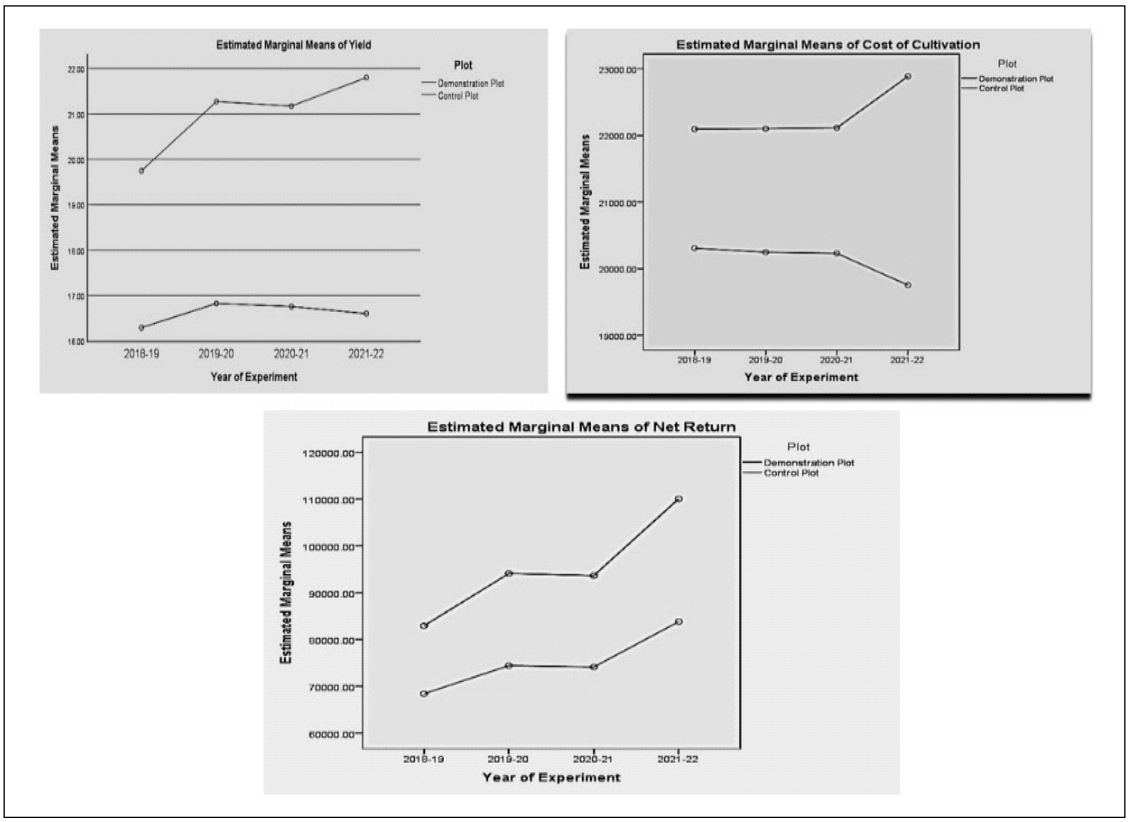

Figure 1. Estimated marginal means of yield, cost of cultivation and net returns

CONCLUSION

Based on the assessment of the conducted CFLDs, it can be concluded that the crop yield and economic return were significantly higher in the demonstrated plots than in the local check plots. The resulting technological gap was attributed to dissimilarity in climatic and soil fertility factors, and the lowest technology index at the end of the last cropping season of the CFLD denoted the efficacy of technological interventions in increasing the mustard yield in demonstration plots. Such superior yield performance motivated the beneficiary farmers to adopt the improved mustard variety (Giriraj) and the recommended ICM technologies by replacing the existing cultivation practices. The extension agencies engaged in transferring various agricultural technologies to farmers' fields must prioritize cluster frontline demonstrations on a large-scale basis for disseminating flagship production technologies of the National Agricultural Research System (NARS).

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