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Swati Thakur Mirjha
Subject Matter Specialist
(Agronomy), Krishi Vigyan
Kendra, Bhatapara,
Chhattisgarh, India

Dr. Angad Singh Rajput
Professor (Agronomy) & Senior
Scientist and Head, Krishi
Vigyan Kendra, Bhatapara,
Chhattisgarh, India

Deepmala Lakra
Subject Matter Specialist
(Plant Pathology), Krishi
Vigyan Kendra, Bhatapara,
Chhattisgarh, India

Dr. Panch Ram Mirjha
Assistant Professor
(Agronomy), D.K.S. College of
Agriculture & Research
Station, Bhatapara,
Chhattisgarh, India

Corresponding Author:
Swati Thakur Mirjha
Subject Matter Specialist
(Agronomy), Krishi Vigyan
Kendra, Bhatapara,
Chhattisgarh, India

Impact of cluster frontline demonstrations on yield enhancement and productivity of mustard (*Brassica juncea* L.) in the Chhattisgarh plains agro-climatic zone

Swati Thakur Mirjha, Angad Singh Rajput, Deepmala Lakra and Panch Ram Mirjha

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Abstract

A study was conducted by Krishi Vigyan Kendra, Bhatapara, in Baloda Bazar-Bhatapara district of Chhattisgarh, India, to assess yield gaps and economics of mustard (*Brassica juncea*) under Cluster Frontline Demonstrations (CFLDs) in comparison with farmers' practices (FP) under irrigated conditions. The demonstrations were conducted during six consecutive *rabi* seasons (2017-18 to 2022-23) under the National Mission on Oilseeds and Oil Palm, covering 145 ha with 363 farmers. The mean grain yield under CFLDs (808 kg ha⁻¹) was higher than FP (515 kg ha⁻¹), with yield increase ranging from 24.8 to 89.8%. The extension gap ranged from 162 to 440 kg ha⁻¹, while the mean technology gap was 620 kg ha⁻¹. The technology index varied between 34.9 and 55.9%. The cost of cultivation was higher under CFLDs (₹14,998 ha⁻¹) than FP (₹11,916 ha⁻¹). However, CFLDs recorded higher gross returns (₹33,585 ha⁻¹) and net returns (₹18,588 ha⁻¹) compared to FP (₹21,743 and ₹9,827 ha⁻¹, respectively), with benefit-cost ratio of 2.20 under CFLDs and 1.80 under FP.

Keywords: Chhattisgarh, cluster frontline demonstrations (CFLDs), farmers' practices, mustard (*Brassica juncea*), yield

Introduction

Rapeseed-mustard (*Brassica* spp.) is the third most important edible oilseed crop in the world, after soybean and oil palm. Among the nine oilseeds cultivated in India, rapeseed-mustard contributes 29.47% to the total oilseed production. In India, rapeseed and mustard occupy an area of 8.66 million ha, with a production of 12.67 million tonnes and a productivity of 1463 kg ha⁻¹, of which 84.19% of the area is under irrigation (Anonymous, 2025) [1]. In the Baloda Bazar-Bhatapara district, the area, production, and productivity are 1910 ha, 550 tonnes, and 288 kg ha⁻¹, respectively. The productivity of rapeseed-mustard at the farmers' level in this district remains low, mainly due to the non-adoption of improved production technologies. A wide gap exists between recommended scientific practices and farmers' practices, resulting in lower yields and reduced economic returns. This gap highlights the need for effective field-level validation and dissemination of improved technologies.

Farmers generally follow traditional methods such as the use of local varieties, higher seed rate, absence of seed treatment, broadcasting method of sowing, imbalanced fertilizer application, and inadequate weed and pest management. In contrast, recommended practices emphasize the use of improved varieties, optimum seed rate, seed treatment, line sowing, balanced nutrient management, and proper crop protection measures. Deviation from these scientific practices leads to poor crop establishment, higher weed competition, nutrient imbalance, and increased incidence of pests and diseases, ultimately reducing crop productivity and profitability.

In *Brassica*, breeding programmes play a crucial role in improving seed quality. The development and dissemination of high-yielding varieties, along with improved agronomic practices, are essential to meet the increasing demand for edible oil driven by population growth, rising per capita consumption, and the slow growth in domestic oilseed production

(Parashar *et al.*, 2021) [8]. Therefore, bridging the yield gap through effective technology transfer and adoption of scientific crop management practices is of paramount importance.

The cluster frontline demonstration programme under the National Mission on Oilseeds and Oil Palm, Government of India, aims to disseminate improved technologies and recommended packages of practices among farmers to enhance crop productivity. In this context, CFLDs play a vital role by providing a direct comparison between improved practices and farmers' practices under real farming conditions, thereby demonstrating their advantages in terms of yield, resource-use efficiency, and economic returns. Hence, the present investigation was undertaken to assess the impact of cluster frontline demonstrations on yield enhancement of mustard under irrigated conditions in the Baloda Bazar-Bhatapara district of Chhattisgarh, with the objective of increasing productivity, reducing the time lag in technology adoption, and ensuring rapid dissemination of improved practices among farmers.

Materials and Methods

The study was carried out in farmers' fields at Baloda Bazar-Bhatapara district during the *rabi* season from 2017-18 to 2022-23 using two varieties of Indian mustard (*Brassica juncea*), viz. 'Chhattisgarh Sarson-1' and 'NRCHB-101'. The variety 'Chhattisgarh Sarson-1' is suitable for sowing after paddy harvest. Its maturity period is 99-128 days with 35.8 to 40.10% oil content. 'NRCHB-101' is a long-duration (130-150 days) variety with 34.6 to 42.1% oil content. The area under each demonstration was 0.40 ha. Beneficiaries were identified through their participation and feedback received during surveys, awareness programmes, and training. Farmers were trained to follow the package of practices of mustard cultivation, and critical inputs like improved seed, fungicides, and biofertilizers were distributed to the farmers.

Basic information was recorded from the demonstration and control plots and analysed for comparative performance of CFLDs and farmers' practices. Yield data were collected by the random crop cutting method and analysed using statistical tools. The technology gap and technology index (Yadav *et al.*, 2004) [12], along with benefit-cost ratio (Samui *et al.*, 2000) [9], were calculated using the following formulae:

$$\text{Technology gap (kg ha}^{-1}\text{)} = \text{Potential yield (kg ha}^{-1}\text{)} - \text{Demonstration yield (kg ha}^{-1}\text{)}$$

$$\text{Extension gap (kg ha}^{-1}\text{)} = \text{Demonstration yield (kg ha}^{-1}\text{)} - \text{Farmers' yield (kg ha}^{-1}\text{)}$$

$$\text{Technology index (\%)} = \frac{\text{Technology gap (kg ha}^{-1}\text{)}}{\text{Potential yield (kg ha}^{-1}\text{)}} \times 100$$

$$\text{Percentage increase in yield (\%)} = \frac{\text{Extension gap (kg ha}^{-1}\text{)}}{\text{Farmers' yield (kg ha}^{-1}\text{)}} \times 100$$

$$\text{Benefit: cost ratio} = \frac{\text{Gross returns (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

Results and Discussion

Technological interventions

Integrated crop management, coupled with technological interventions, plays a crucial role in enhancing the

productivity and profitability of oilseed crops. The detailed package of practices adopted under recommended technologies is presented in Table 1. The technological interventions implemented under CFLDs exhibited marked differences compared to farmers' practices. The demonstration plots involved the adoption of improved varieties ('Chhattisgarh Sarson-1' and 'NRCHB-101'), optimum seed rate (5 kg ha⁻¹), seed treatment with fungicides and biofertilizers, and line sowing using a seed drill. In contrast, farmers' practices were characterized by the use of local variety (Vaibhav), higher seed rate (10-12 kg ha⁻¹), absence of seed treatment, and the broadcasting method of sowing.

Furthermore, the demonstration plots followed balanced nutrient management based on soil test recommendations (60, 40, 20, 20 kg N, P₂O₅, K₂O and S ha⁻¹), irrigation at critical growth stages, and effective weed and pest management practices, whereas farmers' practices involved imbalanced fertilization, water stress during critical stages, and inadequate weed and pest control measures. Sulphur, being an essential nutrient for oilseed crops, was supplied through single super phosphate, which fulfils the requirement of both phosphorus and sulphur in mustard. These variations in crop management practices clearly indicate the superiority and potential of improved technologies over existing farmers' practices in enhancing crop performance and productivity.

Yield performance and yield gap analysis

The grain yield of demonstration plots and farmers' practices is presented in Table 2. The results indicated that the average grain yield was consistently higher under demonstration plots compared to farmers' practices across all tehsils of the Baloda Bazar-Bhatapara district. The average grain yield under demonstration plots ranged from 630 to 930 kg ha⁻¹, whereas under farmers' practices it ranged from 410 to 654 kg ha⁻¹. On a pooled basis, the mean yield recorded under demonstration plots (808 kg ha⁻¹) was substantially higher than that under farmers' practices (515 kg ha⁻¹), reflecting the positive impact of improved technologies.

The percent increase in yield under CFLDs over farmers' practices varied from 24.8% to 89.8%. The maximum yield (930 kg ha⁻¹) and highest yield advantage (89.8%) were recorded during 2019-20, which may be attributed to favourable agro-climatic conditions and better adoption of recommended practices. The higher productivity under demonstration plots can be ascribed to the combined effect of improved varieties, optimum seed rate, balanced nutrient management, timely irrigation, and efficient weed and pest control measures. Similar results have been reported by Kumar *et al.* (2021) [4] and Singh *et al.* (2020) [10], who also observed significant yield enhancement under CFLDs.

The extension gap, which reflects the difference between demonstration yield and farmers' yield, ranged from 162 to 440 kg ha⁻¹, with an average of 283 kg ha⁻¹. The highest extension gap (440 kg ha⁻¹) was observed during 2019-20, indicating considerable scope for increasing mustard productivity through the adoption of improved technologies at the farmers' level. The presence of a substantial extension gap emphasizes the need for strengthening extension services and technology dissemination. The technology gap, defined as the difference between potential yield and demonstration yield, varied from 498 to 798 kg ha⁻¹, with a

mean value of 620 kg ha⁻¹. The variation in technology gap across years might be attributed to differences in soil fertility, weather conditions, and partial adoption of recommended practices. These findings are in agreement with Kumar *et al.* (2022) [5], who also reported variability in technology gap under frontline demonstrations.

The technology index, which indicates the feasibility of the demonstrated technology under farmers' conditions, ranged from 34.9% to 55.9%, with an average value of 43.4%. The lower value of technology index during 2019-20 (34.9%) indicates better performance and adaptability of the demonstrated technologies, whereas higher values in other years suggest the need for location-specific refinement of technologies. CFLDs were effective in enhancing mustard productivity, reducing yield gaps, and promoting the adoption of improved crop management practices under farmers' field conditions. Similar findings have been reported by Parashar *et al.* (2021) [8] and Meshram *et al.* (2022) [6], who emphasized the role of frontline demonstrations in improving productivity and bridging yield gaps.

Economics

The economic analysis presented in Table 3 revealed that the cost of cultivation, gross returns, net returns, and benefit-cost ratio (B:C) were consistently higher under CFLDs as compared to farmers' practices. The cost of cultivation under demonstration plots ranged from ₹11980 to ₹19852 ha⁻¹, whereas it ranged from ₹9998 to ₹14033 ha⁻¹ under farmers' practices. The slightly higher cost under demonstration plots might be attributed to the use of quality inputs and improved crop management practices. Despite the higher cost, the gross returns under demonstration plots were markedly higher, ranging from ₹23375 to ₹53980 ha⁻¹, as compared to ₹16329 to ₹37250 ha⁻¹ under farmers'

practices. On a pooled basis, the average gross return under demonstration plots (₹33585 ha⁻¹) was higher than that under farmers' practices (₹21743 ha⁻¹), registering an increase of about 54.45%, indicating the economic superiority of improved technologies.

Similarly, the net returns under demonstration plots (₹11395 to ₹34128 ha⁻¹) were substantially higher than those under farmers' practices (₹5350 to ₹23276 ha⁻¹). The average net return under demonstration plots (₹18588 ha⁻¹) was nearly 89.16% higher than that under farmers' practices (₹9827 ha⁻¹), clearly demonstrating the profitability of CFLDs. The benefit-cost ratio also followed a similar trend, with higher values recorded under demonstration plots (1.90 to 2.71) compared to farmers' practices (1.43 to 2.66). The average B:C ratio was 2.20 under demonstration plots, as against 1.80 under farmers' practices, indicating better economic efficiency and higher returns per unit investment. The higher benefit-cost ratio observed under CFLDs might be attributed to increased yield levels and efficient utilization of inputs. The adoption of improved technologies through CFLDs significantly enhanced the economic returns of mustard cultivation despite a slight increase in the cost of cultivation. Similar findings have been reported by Ojha and Bisht (2020) [7], Meshram *et al.* (2022) [6], Bairwa *et al.* (2013) [2], Vedna *et al.* (2007) [11], and Jamwal *et al.* (2020) [3], who also observed higher gross returns, net returns, and benefit-cost ratio under frontline demonstrations compared to farmers' practices.

This study indicated that the incorporation of scientific crop management practices, along with the active participation of farmers, had a positive effect on enhancing the yield and economic returns of mustard in the Baloda Bazar-Bhatapara district. The economic viability of the demonstrated technologies for increasing mustard productivity motivated farmers to adopt the improved practices at the field level.

Table 1: Technological interventions under CFLDs and farmers' practices in mustard

S. No.	Intervention	Demonstrated Intervention (CFLDs)	Farmers Practices
1.	Variety	Chhattisgarh Sarson-1 and NRCHB-101	Vaibhav
2.	Seed rate	5 kg ha ⁻¹	10-12 kg ha ⁻¹
3.	Seed treatment	Carbendazim 12% + Mancozeb 63% WP @ 2.5 g kg ⁻¹ seed; PSB, Azotobacter and Trichoderma @ 5 g kg ⁻¹ seed	No seed treatment
4.	Sowing method	Line sowing by seed drill	Broadcasting
5.	Sowing time	October-November	November-December
6.	Nutrient management	Balanced fertilizer dose as per soil test report (60, 40, 20, 20 kg N, P ₂ O ₅ , K ₂ O and S ha ⁻¹)	Imbalanced fertilizer use
7.	Water management	Irrigation at critical stages (branching, flowering and siliqua formation)	Water stress at critical stages
8.	Weed management	Pendimethalin @ 2.5-3.5 L ha ⁻¹	No herbicide application
9.	Insect pest Management	Dimethoate 30 EC @ 650 mL ha ⁻¹ ; neem oil spray	No insecticide application

Table 2: Year-wise productivity, yield gap, technology gap, extension gap, and technology index of mustard under CFLDs and farmers' practices

Year	Variety	Total area	No. of demonstration	Average yield (kg ha ⁻¹)		% increasing over Farmer's Practice	Technology gap (kg ha ⁻¹)	Extension gap (kg ha ⁻¹)	Technology index (%)
				CFLDs	Farmer's Practice				
2017-18	Chhattisgarh Sarson-1	40	100	816	654	24.8	612	162	42.9
2018-19	Chhattisgarh Sarson-1	20	50	819	530	54.5	609	289	42.7
2019-20	Chhattisgarh Sarson-1	10	25	930	490	89.8	498	440	34.9
2020-21	NRCHB 101	20	50	728	427	70.5	700	301	49.0
2021-22	Chhattisgarh Sarson-1	35	88	926	639	44.9	502	287	35.2
2022-23	Chhattisgarh Sarson-1	20	50	630	410	53.7	798	220	55.9
Total		145	363	808	515		620	283	43.4

Table 3: Economics of mustard under CFLDs and farmers' practices

Year	Cost of cultivation (₹ ha ⁻¹)		Gross returns (₹ ha ⁻¹)		Net returns (₹ ha ⁻¹)		B:C ratio	
	CFLDs	Farmer's Practice	CFLDs	Farmer's Practice	CFLDs	Farmer's Practice	CFLDs	Farmer's Practice
2017-18	11980	10091	23375	18735	11395	8644	1.95	1.85
2018-19	11954	9998	25233	16329	13279	6331	2.11	1.63
2019-20	14900	12200	33309	17550	18409	5350	2.23	1.43
2020-21	14100	11200	32764	19218	18664	8018	2.32	1.71
2021-22	19852	13974	53980	37250	34128	23276	2.71	2.66
2022-23	17200	14033	32850	21379	15650	7346	1.90	1.52
Total	14998	11916	33585	21743	18588	9827	2.20	1.80

Conclusion

The study demonstrated that Cluster Frontline Demonstrations (CFLDs) significantly improved mustard productivity and profitability over farmers' practices in the Baloda Bazar-Bhatapara district. Yield enhancement was primarily driven by the adoption of improved varieties and integrated crop management practices. The considerable extension gap indicates substantial scope for increasing productivity through wider dissemination of recommended technologies, while the observed technology gap suggests the need for location-specific refinement. Despite slightly higher cultivation costs, CFLDs resulted in higher net returns and benefit-cost ratio, confirming their economic viability. Overall, CFLDs proved to be an effective approach for bridging yield gaps and promoting the adoption of improved technologies.

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