



Assessment of mustard productivity through Cluster Frontline Demonstration (CFLD) in Banda district of Uttar Pradesh

Diksha Patel¹, Shyam Singh¹, Shalini², Arjun Prasad Verma^{3*} and Vister Joshi⁴

¹KVK, Banda, BUAT, Banda 210 001, Uttar Pradesh, India

²KVK, Hamirpur, BUAT, Banda-210 001, Uttar Pradesh, India

³Department of Agriculture Extension, BUAT, Banda 210 001, Uttar Pradesh, India

⁴KVK, Jalaun, BUAT, Banda 210 001, Uttar Pradesh, India

*Corresponding author: arjunverma45753@gmail.com

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Abstract

The study was conducted by Krishi Vigyan Kendra, Banda, from 2021-22 to 2024-25, encompassing 150 hectares of land with 359 demonstrations across 19 villages in Banda district of Uttar Pradesh. The objective was to assess the impact and yield discrepancies between enhanced practices under Cluster Frontline Demonstration (CFLD) and the existing practices used by farmers for mustard crops. Yield characteristics of both the demonstrations and the farmers' practices were documented, and their yield gap, technology gap, extension gap, and technology index were analyzed. The improved practices involved high-yielding varieties and integrated crop management strategies (sulphur @ 25 kg ha⁻¹ + line sowing + thinning + seed treatment with Thiram 75% WP @ 2 g kg⁻¹ seed + application of neem oil @ 2-4 ml L⁻¹ of water). The findings indicated that the average yield of 15.55 q ha⁻¹ was achieved in the demonstration plots, which was 25.4 percent greater than the yield from farmers' practices (12.40 q ha⁻¹). Additionally, the technology gap, extension gap, and technology index were measured at 9.89 ha⁻¹, 3.15 q ha⁻¹, and 38.83 percent, respectively. The average gross return in the demonstration plot was Rs 78319 ha⁻¹ compared to Rs 62467 ha⁻¹ in the farmers' practices. Similarly, the average net return in the demonstration plot was Rs 55319 ha⁻¹, while it was Rs 41300 ha⁻¹ in the farmers' plots. The benefit-cost ratio was calculated to be 3.41 in the demonstration plot, which is higher than the 2.96 observed under farmers' practices. This clearly demonstrates the production and economic efficiency of the demonstrated mustard technology in the study area. Overall, Giriraj (DRMRIJ31) exhibited greater vegetative vigor, reproductive efficiency, superior seed quality, and increased oil content. The technology gap and extension gap were attributed to the lack of adoption of high-yielding varieties, timely sowing, appropriate seed rates, seed treatments, fertilizer management, and plant protection strategies. The study highlighted that the CFLD significantly contributed to the dissemination of technologies to farmers' fields, thereby increasing crop yields and farmer incomes in the area.

Keywords: CFLD, Demonstration plot, extension gap, ICM, technology gap, technology index

Introduction

In India's agricultural economy, oilseeds are the second most significant crop in terms of area and production, after food grains (Dastagiri *et al.*, 2022). Approximately 39.67 million tonnes of oilseeds with an average yield of 13.14 q ha⁻¹ were produced during 2023-2024 on 30.19 m ha of land, most of which was rainfed. Over 92% of the nation's total oilseed production comes from three primary oilseed crops *i.e.* groundnuts (27%), rapeseed and mustard (31%), and soybeans (34%). However, mustard, groundnuts, and soybeans account for 31.49%, 19.81%, and 17.99% of the output of vegetable oil, respectively (Annual Report, 2024-25). The domestic output growth is not keeping up with rising demand and population expansion in the country. The only significant commodity

in the agro-based product basket for which India had a trade deficit of 56.25% imports in 2023-2024 is edible oil; in contrast, India had a trade surplus in the majority of other agro-based products (Dastagiri *et al.*, 2022). After soybean, mustard is second most popular source of vegetable oil worldwide (Ghintala *et al.*, 2018). From 91.24 lakh tonnes in 2019-20 to 132.59 lakh tonnes in 2023-2024, mustard production increased by 45.32%. From 68.56 lakh ha in 2019-20 to 91.83 lakh ha in 2023-2024, the area planted to mustard and rapeseed grew by 34%. Rajasthan (43%), Madhya Pradesh (15%), Uttar Pradesh (14%), Haryana (10%), and West Bengal (6%) are the states that cultivate the most mustard (Annual Report, 2024-25). Brassicas are among the first crop plants that humans have tamed. It may have been farmed as early as 5000 BC and is

recorded in a number of ancient texts. Since rapeseed-mustard is the primary oilseed crop that can aid in resolving India's edible oil supply and demand mismatch, its significance and potential are widely recognized. Every single component of the plant is essential to human survival. Since ancient times, it has also been used for flavouring, medicine, and preservation. In India, rapeseed and mustard crops are cultivated in a variety of agroclimatic situations, including saline soils, irrigated/rainfed, timely/late planted, and mixed cropping, from the northeast to the northwest hills and down south. In Uttar Pradesh and Banda district, the cultivated area, production, and productivity of rapeseed-mustard were 17.76 lakh ha and 11562 ha; 17.88 lakh tonnes and 14395 q; 11.51 q/ha and 12.45 q/ha, respectively, in 2023-2024 (GoUP, 2024). Adopting improved mustard cultivars has become essential for increasing its output due to the growing need for edible oils as well as the difficulties presented by pests, diseases, and climate change (Sarkar *et al.*, 2025). Realizing the value of oilseed, the Indian government launched a number of initiatives, including the Technology Mission on Oilseeds (TMO) from 1986 to 2004, the Integrated Scheme on Oilseeds, Pulses, Oil Palm, and Maize (ISOPOM) from 2004 to 2024, the National Mission on Oilseeds and Oil Palm (NMOOP) from 2014 to 2018) the NFSM for Oilseed and Oil Palm (2021 to the present) and the National Mission on Edible Oilseed and Oilpalm, NMEO-OP from 2021. Under the National Mission on Oilseeds and Oil Palm (NMOOP), the Ministry of Agriculture and Farmer's Welfare, Government of India, New Delhi, launched the Cluster Front Line Demonstration (CFLD) program in 2014-15. Later, starting in 2018-19 the National Food Security Mission (NFSM) and the National Mission on Oilseed and Oil Palm program were combined and implemented as NFSM (OS&OP). The National Mission on Edible Oilseed and Oil Palm (NMEO-OP) will thereafter, introduce CFLD oilseed starting in 2024-2025 with the primary goal of showcasing the production potential of recently released varieties and location-specific technology. The Indian Council of Agricultural Research, New Delhi, launched a national-level CFLD program on oilseeds. The program also sought to reduce the adoption gap while implementing the newest technology throughout the farming community and boost oilseed yield across the nation. The mission's primary goal is to increase the use of enhanced technologies, such as seed, micro-nutrients, soil amendments, weed control, integrated pest management, farm equipment and tools, micro-irrigation devices, and cluster-mode farmer capacity training. In order to boost mustard's productivity in the Banda area

of Uttar Pradesh, efforts have been made through Cluster Front Line Demonstrations (CFLDs) to promote an innovative package of techniques.

Materials and Methods

The present study was conducted in the Banda District of Uttar Pradesh during the rabi season for the last 4 years from 2021-22 to 2024-25 at the farmers' field in different villages. Krishi Vigyan Kendra, Banda, Uttar Pradesh, conducted Cluster Frontline Demonstration on Mustard crop during 2021-22 to 2024-25 on farmers' fields of 359 farmers by covering 150 ha of land. The demonstrations were laid out in 06 blocks and 21 villages of the Banda District of Uttar Pradesh. The demonstration made use of the entire set of enhanced technologies, including the needed seed rate, line sowing, nutrition management, and seed treatment. KVK gathered the farmers' baseline data before implementing the CFLD program. Data was gathered using both sample surveys and PRA (participatory Rural Appraisal) techniques. Both farmers' plots and demonstration plots provided the data. The outcome is analysed using the descriptive approach. The following formulas were used to calculate the yield, extension gap, technology gap, and technology index with the benefit-cost ratio after CFLD programs were carried out in the farmer's field in accordance with the recommended package of practices of Banda University of Agriculture and Technology, Banda (Samui *et al.*, 2000).

Technology Gap (qha^{-1}) = Potential Yield - Demonstration Yield
 Extension Gap (qha^{-1}) = Demonstration Yield - Farmers' Yield (Check Yield)

Technology Index (%) = Technology Gap / Potential Yield X 100
 Benefit cost ratio = Gross return (Rs/ha) / Gross cost (Rs/ha).

The paired t-testis used to find a statistical difference between the means of two independent groups of small size (<30), and the z-testis used to provide a hypothesis test of the difference between population means of larger samples (30) for a pair of random samples whose differences are approximately normally distributed. These tests were used to assess the significance between the check and demo yield of particular farmers.

Results and Discussion

Table 1 provides comprehensive details regarding the package of practices used in mustard plots that have been demonstrated, as well as farmer practices. The improved varieties of mustard, such as RH-749, RH-406, and Giriraj, were sown by demonstrating farmers by adhering to the recommended package of practices, which included the following: optimal sowing time (last week of October to first fortnight of November), proper seed rate

Table 1: Technologies demonstrated and farmers' practices under Cluster Frontline Demonstration

Interventions	Demonstration plot	Farmer's plot	Gap
Land situation	Rainfed	Rainfed	No gap
Variety	HYV like Giriraj/RH-409/RH-749	Local- Urvashi	Full gap
Sowing time	Last week of October to 1 st fortnight of November	First week of October to second week of December	Partial gap
Seed rate	5 kg ha ⁻¹	8-10 kg ha ⁻¹	Full gap
Seed treatment	Thiram @ 2 g kg ⁻¹ seed	No scheduled	Full gap
Sowing method	Line sowing	Broadcasting	Full gap
Spacing	30 cm x 10 cm	-	Full gap
Thinning	At 15-20 DAS to maintain 10-15 cm plant to plant spacing	No scheduled	Full gap
Nutrient Management	120:60:50:25 (NPKS kg ha ⁻¹)	20:20:0:0	Full gap
Irrigation	One irrigation at 50% flowering stage	No schedule	Full gap
Weed management	Two hand weeding @ 25 and 45 DAS	As per need	Partial gap
Plant Protection measures	Application of neem oil @ 2-4 ml L ⁻¹ of water for controlling of aphid	As per need	Partial gap

(5 kg/ha), proper sowing method (line sowing), spacing (30x10cm), nutrient management (120:60:50:25 (NPKS kg/ha), irrigation management, timely weed control and recommended plant protection measures to achieve potential yield.

A total of 359 cluster frontline demonstrations were carried out over an area of 150 ha in farmers' fields in 19 chosen villages of the Banda district throughout the last four research years, from 2021-2022 to 2024-2025, according to the results shown in Table 2. In contrast to the average mustard production under farmers' practice, which was 12.75, 12.85, 11.60, and 12.43 q/ha in 2021-2022, 2022-2023, 2023-2024, and 2024-2025, the average mustard output in the demonstration plot was 16.15, 16.05, 14.46, and 16.68 q/ha. During the study years 2021-2022, 2022-2023, 2023-2024, and 2024-2025, it was observed that the demonstrated plots produced yields that were 26.67, 24.9, 24.66, and 34.19 percent higher than the farmer's practice.

Similar findings were verified by Gupta et al. (2020), who discovered that the enhanced mustard variety NRCHB 101 had a greater yield when compared to farmer methods in the U.P. district of Banda. A number of problems, including the adoption of local or unknown varieties, delayed sowing, high seed rate, lack of thinning, poor nutrition and irrigation management, and insufficient plant protection measures, may contribute to lower yields under farmers' practices. These findings are consistent with those of Kashyap and Singh (2021) in CFLDs regarding the effect of Cluster Frontline Demonstrations on Gobhi Sarson (Canola) yield and net returns in the Punjabi area of Sangrur.

Table 2 displays the information on the technology gap, extension gap, and technology index. The discrepancy between potential and demonstration yield is known as the "technology gap." CFLD Mustard had an average technology gap of 9.49 q/ha. It shows that there is a gap

Table 2: Grain yield performance of the Cluster Frontline demonstration on Mustard

Year	Variety	Area (ha)	FLDs (no.)	Cluster (no.)	Yield (q ha ⁻¹)			% increase over check	z/ t value	Technology gap (q ha ⁻¹)	Extension Gap (q ha ⁻¹)	Technology index (%)
					Potential	Demo	Check					
2021-22	RH-406	10	25	02	yield	yield	yield					
2022-23	Giriraj (DRMRIJ31)	20	50	03	25.6	16.15	12.75	26.67	19.48**	9.45	3.4	36.91
2023-24	RH-749	20	50	02	24.96	16.05	12.85	24.9	15.71**	8.91	3.2	35.70
2024-25	Giriraj (DRMRIJ31)	100	234	12	25.76	14.46	11.6	24.66	15.1**	11.3	2.86	43.87
Total/Average		150	359	19	24.96	16.68	12.43	34.19	45.30**	8.28	4.25	33.17
					25.32	15.84	12.41	27.61		9.49	3.43	37.41

(**Significant at 0.01 per cent level of significance)

Table 3: Economics of cluster frontline demonstration on Mustard

Year	Cost of cultivation (Rs ha ⁻¹)		Gross return (Rs ha ⁻¹)		Net return (Rs ha ⁻¹)		Additional return (Rs ha ⁻¹)	Net return increase over check (%)	B:C ratio		MSP of mustard
	Demo	Check	Demo	Check	Demo	Check			Demo	Check	
2021-22	22500	19500	75098	59288	52598	39788	12810	32.20	3.34	3.04	4650
2022-23	22400	21500	81053	64893	58653	43393	15260	35.17	3.62	3.02	5050
2023-24	24100	22500	78807	63220	54707	40720	13987	34.35	3.27	2.81	5450
2024-25	24000	22000	99246	73958	75246	51958	23288	44.82	4.16	3.36	5950
Average	23250	21375	83551	65339.75	60301	43964.75	16336.25	36.64	3.60	3.06	-

in technology demonstrations, which prevents farmers from realizing the potential yield of the presented variety. Differences in the district's climate, the fertility of the soil, and poor management during crucial growth stages could all contribute to the bigger technological disparity. The term "extension gap" refers to the discrepancy between the yield of the demonstration plot and agricultural practices. A variety of extension techniques, including awareness campaigns, kisan ghosthies, and trainings, should be used to close the 3.43 q/ha average extension gap in CFLD Mustard. Extension staff should encourage farmers to adopt better practices and close the extension gap by promptly disseminating information via print, electronic, social media, etc. (Singh et al., 2020). The viability of the advanced technology in the farmer's field is displayed by the technology index. A lower technological index shows that the technology is operating efficiently. In CFLD Mustard, the average technological index was 37.41 percent. Similar results were found in Rapeseed & Mustard by Mitra and Samajdar (2012), Mustard by Chaudhury *et al.* (2018), Toria by Bora *et al.* (2020), and Mustard by Sarkar *et al.* (2025). The findings of Gupta *et al.* (2021) corroborate with the present study.

Economics *viz.*, cost of cultivation, gross return, net return, benefit cost ratio and additional net return of

mustard under farmers' practice and demonstrated technologies have been calculated and presented in Table 4. Returns were calculated from the Minimum Support Price of Mustard as shown in Table 4. The Cluster front line demonstrations recorded higher average gross returns (Rs.83551/ha), average cost of cultivation (Rs. 23250/ha) and net return (Rs. 60301/ ha) with B:C ratio (3.6) compared to farmers practice where average gross returns, average cost of cultivation, average net return and B:C ratio was reported to be Rs. 65339.75/ha, Rs. 21375/ha, Rs. 43964.75/ha and 3.06 respectively. All these findings indicate the better potential and higher profitability of high-yielding mustard varieties demonstrated by KVK, Banda. Therefore, the farmers should adopt the new, improved, recommended mustard varieties based on their cropping pattern and land type for better production and productivity.

The evaluation of growth and yield parameters across mustard varieties revealed that Giriraj (DRMRIJ31) demonstrated superior agronomic performance. It recorded the tallest plant height of 201 cm, which was 14.8% greater than the check variety Urvashi (175 cm), indicating enhanced vertical growth and potential for improved light interception and biomass accumulation. The number of siliquae per plant in Giriraj (111) exceeded that of RH-406 (98) by 13.3% and Urvashi (91) by 22%,

Table 4: Growth and yield attributes of mustard varieties under CFLD and control plot

Year	Variety	Plant height (cm)	Siliqua /plant (no.)	Primary branches (no.)	Oil content (%)	Seed /silique (no.)	Test weight (g)	Days to Maturity (days)
2021-22	RH-406	185	98	5.5	39.8	13.5	4.85	137
2022-23	Giriraj (DRMRIJ31)	198	105	5.6	41.7	14.4	5.3	126
2023-24	RH-749	184	102	5.3	40	13.1	4.82	145
2024-25	Giriraj (DRMRIJ31)	201	111	5.8	41.2	15	5.38	132
Check variety	Urvashi	175	91	4.6	39.10	12.3	4.70	125

Table 5: Impact of CFLD on technology adoption in mustard (n= 359)

Technology/practices	Before CFLD	After CFLD	Change in no. of adopters	% change in adoption
Use of HYV of mustard	71 (19.78)	307 (85.52)	236	65.73
Selection of suitable land	52 (14.48)	325 (90.53)	273	76.04
Moisture conservation (Deep ploughing)	155 (43.18)	243 (67.69)	88	24.51
Seed rate (5Kg/ha)	51 (14.21)	342 (95.26)	291	81.06
Seed treatment (Chemical)	14 (3.90)	247 (68.80)	233	64.90
Sowing time (Optimum)	162 (45.13)	338 (94.15)	176	49.03
Sowing method (Line Sowing)	22 (6.13)	307 (85.52)	285	79.39
Maintaining crop Geometry (45 x 15 cm)	2 (0.56)	209 (58.22)	207	57.66
Nutrient management (NPKS)	3 (0.84)	159 (44.29)	156	43.45
Disease and insect management (IPM/IDM)	36 (10.03)	244 (67.97)	208	57.94
Thinning (Within 15-20 DAS)	12 (3.34)	135 (37.60)	123	34.26
Irrigation management (1/2)	32 (8.91)	209 (58.22)	177	49.30
Weed management (Chemical)	77 (21.45)	163 (45.40)	86	23.96
Time of Harvesting (Optimum)	196 (54.60)	318 (88.58)	122	33.98
Overall impact				52.94

(*Figures in parentheses indicate percentage (%))

reflecting a higher reproductive sink capacity. Giriraj also produced the highest number of primary branches (5.8), signifying robust canopy architecture conducive to increased photosynthetic area and yield potential. In terms of seed quality traits, Giriraj achieved the highest oil content (41.7%), which was 4.8% higher than RH-406 (39.8%) and 6.6% higher than Urvashi (39.1%). The average number of seeds per siliqua in Giriraj (15) was 14.5% higher than RH-749 (13.1) and 21.9% higher than Urvashi (12.3), suggesting superior seed setting efficiency. Test weight in Giriraj (5.38 g) was 12.6% heavier than RH-749 (4.82 g) and 14.5% more than Urvashi (4.70 g), denoting better seed development and market acceptability. Regarding phenological traits, RH-749 exhibited the longest maturity duration (145 days), whereas Urvashi, with a maturity period of 125 days, was identified as an early-duration variety. However, this earliness was associated with comparatively lower values in yield-contributing traits. Overall, Giriraj (DRMRIJ31) was found with higher vegetative vigor, reproductive efficiency, superior seed quality, and elevated oil content.

The findings on the adoption of different mustard growing technologies and practices revealed a significant increase in the adoption of recommended technologies after CFLD in the adopted villages. It is found that earlier, only 71 farmers adopted HYV of mustard in the region, which increased to 307 farmers with an increase of 65.74 per cent. The number of adopters for the selection of improved varieties like Giriraj, RH-749, and RH-406 increased significantly from 19.78% to 85.92% after

demonstrations. Similarly, 67.97%, 44.29% and 37.60% of farmers adopted disease and insect management technology, nutrient management, and thinning practices after CFLD. The CFLD intervention made a highly positive impact on the adoption of seed treatment technologies like seed treatment with Thiram and Carbendazim, increasing from 3.90% to 68.80% in the study area. After CFLD intervention, seed rate and proper time of sowing, sowing method, and crop geometry were also maintained by 95.26%, 94.15%, 85.52% and 58.22% farmers, respectively. The overall adoption level of Mustard production technology was 52.94% due to CFLD programme organized by Krishi Vigyan Kendra, Banda. These results are in close conformity with the findings recorded in the case of Toria by Deka *et al.* (2021) and Kumar *et al.* (2025) in the case of the adoption of the wheat crop.

Conclusion

The findings showed that the Banda district farming community was positively and significantly impacted by the Cluster front-line demonstration because they were inspired by the innovative agricultural technologies used in the demos. The technologies that were exhibited were better than current methods in every way. Mustard productivity has grown by 27.61% thanks to the CFLD initiative, increasing net income by 36.64%. Extension staff should educate farmers about science to reduce the current gap in technology and extension. However, the yield level under CFLD was higher than that of the local mustard variety, and by implementing suggested

management techniques, the performance and potential of the chosen varieties might be further enhanced. When it comes to sharing innovations with nearby farmers, the participating farmers are crucial. The use of improved cultivars is significantly impacted by the CFLD. Due to CFLD programs carried out by KVK in the district, the majority of the low-yielding native varieties were replaced by high-yielding varieties like RH-749, RH-409, and Giriraj, which may assist in increasing oilseed crop production at the micro, meso, and macro levels.

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