



Comparing the Yield and Knowledge Level of Cluster Frontline Demonstration (CFLD) Beneficiaries and Non-Beneficiaries

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HIGHLIGHT

- CFLD significantly increased the mustard yield, with a 32.93% increase from non-beneficiaries to beneficiaries.
- Knowledge gains were highest in seed-related practices because of direct input support and technical guidance.
- Minimum knowledge levels in plant protection reveal a critical gap and suggests the need for more targeted training.
- Kruskal-Wallis and Mann-Whitney tests confirmed a significant difference in knowledge across all groups.

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ABSTRACT

The research was conducted during 2024-25, aimed to assess the benefits of the Cluster Frontline Demonstration (CFLD) programme on mustard cultivation knowledge and yield among farmers in Uttar Pradesh (UP). By employing the quasi-experimental design, comparing non-beneficiaries (B_0), previous beneficiaries 2021–2024 (B_1) and current beneficiaries 2024-25 (B_2) with 120 participants each and a total sample size of 360, across three Krishi Vigyan Kendras (KVKs) of UP. The data was collected through a personal interview. Knowledge scores (% correct) and yield ($q\ ha^{-1}$) were measured and compared by using Kruskal-Wallis and Mann-Whitney U tests. Results showed a significant difference in yield, i.e. $14.00\ q\ ha^{-1}$ (B_0) and $18.61\ q\ ha^{-1}$ (B_2), and median knowledge increased significantly in variety (27.27% to 63.64%) and harvesting and threshing (50.00% to 100.00%) across three groups. All practices show a significant difference ($p < 0.00625$), with effect sizes up to 0.293. Results show that the CFLD programme significantly increases knowledge and yields, due to targeted training and resource support. Non-significant initial differences in some practices suggested overcoming barriers with sustained participation.

INTRODUCTION

The Indian Council of Agricultural Research (ICAR) has established various Krishi Vigyan Kendras (KVKs) across India as an institutional innovation to facilitate the application of agricultural

technologies at farmers' fields, with a multidisciplinary team of agricultural scientists (Sahoo et al., 2021; Kumar et al., 2024). One of the important functions of KVKs for technology transfer is the Cluster Frontline Demonstration (CFLD) programme, implemented under the *national food security mission*, which serves as a long-

term educational initiative. This programme conducts systematic demonstrations on farmers' fields under the close supervision of scientists to showcase the efficiency of recommended practices and technologies (Bhowmik & Biswas, 2024; Lahiri et al., 2025). CFLDs promote a scientific Package of Practices (PoP), like high-yielding varieties, integrated pest management, and balanced fertilizer on farmers' fields. This approach increases farmers' knowledge regarding recommended PoP, allowing real-time feedback, encourages farmer-scientist interactions and supports localised adoption and increases the adoption of improved agricultural technologies (Kumar et al., 2023).

Oilseeds have been considered as one of the oldest cultivated plants in human civilisation (Kalia et al., 2021). Mustard crop in India is grown in diverse agro-climatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rainfed timely/late sown, saline and mixed cropping conditions (Gupta et al., 2020). It significantly contributes to edible oil production and food security, particularly in northern states like Uttar Pradesh and produces approximately 20% of the country's oilseed production (Sachan et al., 2024). Though mustard is a traditional crop, from the health and economic point of view, its demand will always remain same (Kumar et al., 2022). Despite its economic importance, mustard yields remain suboptimal due to the limited adoption of the recommended package of practices (PoP) like land preparation, variety selection, seed treatment, irrigation, fertiliser application, intercultural practices, plant protection, and harvesting techniques. The low yield is often due to inadequate knowledge, resource constraints, and limited access to extension services, which together make it difficult for farmers to implement these practices effectively (Giordano et al., 2012 and Raj, 2013; Nain et al., 2014; Nain et al., 2015; Lahiri et al., 2020). To address these challenges, the CFLD programme, initiated by the ICAR and implemented through KVKs, provides farmers with training, quality inputs (e.g., seed and fertiliser), and on-farm demonstrations to promote the adoption of recommended PoP. Implemented in high-potential regions like the Indo-Gangetic Plains, CFLDs aim to increase farmers' knowledge and yields. However, the long-term effects of CFLDs on farmers' knowledge, particularly when comparing current participants, past participants and non-participants, remain underexplored, highlighting a gap in the literature and research. The study pursues two primary objectives: (1) to compare knowledge levels of recommended PoPs across the three groups and (2) to identify specific parameters where significant knowledge differences exist. By addressing these objectives, the research seeks to provide evidence-based insights for refining extension strategies, thereby informing policy to improve mustard productivity and enhance farmer livelihoods in India.

METHODOLOGY

The study was conducted during 2024-25 in KVKs under Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (SVPUA&T). Three KVKs, namely Meerut, Shahjahanpur and Muzaffarnagar, were selected purposively on the basis of the highest CFLDs conducted on mustard during 2021-22, 2022-23 and 2023-24. The study adopted a quasi-experimental design with a mixed-methods approach to linking quantitative outcomes (e.g.,

yield) and qualitative insights (e.g., Knowledge gained) to evaluate the CFLD programme's effectiveness in technology diffusion among mustard farmers. The research is based on Bennett's Hierarchy of Programme Evaluation (Bennett, 1975) and Diffusion of Innovations Theory (Rogers, 2003).

The CFLD programme, implemented by Krishi Vigyan Kendras (KVKs) under Sardar Vallabhbhai Patel University of Agriculture and Technology (SVPUA&T), Meerut, provides training, seed provision (2.5 kg to each farmer for 0.4 ha), sulphur inputs and on-farm demonstrations to enhance knowledge of improved mustard package of practices. The study compared three independent groups: non-beneficiaries (B_0), previous CFLD beneficiaries (2022-2024, B_1) and current CFLD beneficiaries (2025, B_2). Knowledge was assessed across eight parameters selected on the basis of recommendations of ICAR-Indian Institute of Rapeseed-Mustard Research and Experts in KVKs i.e. Land Preparation (K_1), Variety (K_2), Seed Rate and Treatment (K_3), Irrigation and Sowing (K_4), Fertiliser Application (K_5), Intercultural Practices (K_6), Plant Protection (K_7) and Harvesting and Threshing (K_8), consisting of 6, 11, 4, 10, 6, 11, 15 and 2 questions respectively. Each question was multiple choice and scored binarily (1 for correct, 0 for incorrect), with per cent correct calculated as $[(\text{number of correct answers})/(\text{total questions})] \times 100$, without partial credit. The questionnaire was pre-tested on 30 farmers, with revisions. Personal interviews were conducted for data collection. Quantitative knowledge scores were complemented by qualitative insights from focus group discussions (FGDs) to explore adoption constraints, such as non-availability of recommended varieties and high input costs.

The stratified sampling technique was used, and three strata/independent groups were made, i.e. non-beneficiaries (B_0). Out of 627 mustard growers, 120 (40 per KVK) were selected from the villages within a 10 km radius of the selected KVKs. Out of 940 previous beneficiaries of CFLD from 2021-22 to 2023-24 (2021-2024) (B_1), 120 were selected (40 per KVK), and (2024-25) (B_2). Out of 580 current beneficiaries of CFLD in 2024-25, 120 were selected (40 per KVK). Data were tabulated and analysed using SPSS and Excel. Mean and % increase over B_0 were reported in the descriptive statistics. Due to non-normal distribution (Shapiro-Wilk and Kolmogorov-Smirnov $p < 0.001$, $K_8 = 0.538$), Kruskal-Wallis tests were used to compare median per cent correct scores across groups with Bonferroni-adjusted ($\alpha = 0.05 \div 8 = 0.00625$). Post-hoc pair-wise Mann-Whitney U tests were conducted with manual Bonferroni correction ($\alpha = 0.05 \div 3 = 0.0167$).

RESULTS

It can be observed from Table 1 that the average yield and knowledge over 8 practices differ significantly across three groups: non-beneficiaries (B_0), previous beneficiaries (B_1 , 2021-2024) and current beneficiaries (B_2 , 2024-2025). It can also be observed that the yield and knowledge were highest in B_2 and were lowest in B_0 across all parameters. Average yield increased from 14.00 q ha⁻¹ in B_0 to 15.78 q ha⁻¹ in B_1 and 18.61 q ha⁻¹ in B_2 , resulted in a 32.93% increase from B_0 to B_2 , which suggest that CFLD helps in increasing productivity. The highest increase (112.73%) in knowledge over B_0 was seen in seed rate and seed treatment (K_3), followed by plant

protection (K₇), which rose from 22.17 in B₀ to 43.39 in B₂ (95.74% over B₀), and variety (K₂) increased from 30.45 in B₀ to 56.14 in B₂ (84.33% over B₀). While the lowest increase (16.67) was observed in land preparation (K₁), followed by 20.31% increase over B₀ in harvesting and threshing (K₈), which was already high in B₀. This means farmers were already familiar with those practices. In other practices, i.e. irrigation and sowing (K₄), fertiliser application (K₅) and intercultural practices (K₆), knowledge level was also higher among B₂ respondents as compared to B₀. These results suggest the CFLD training helped farmers improve their knowledge in all areas. As for B₁ respondents, regardless of prior training under CFLD through KVKs, their knowledge and yield were less than those of the B₂ respondents, but yet higher than those of the B₀ respondents.

The Kruskal-Wallis test results (Table 2) reveal that there was a significant difference in median knowledge scores (% correct) across the three groups for all eight mustard cultivation practices. The median scores and interquartile ranges (IQRs) show differences in knowledge levels across the group with the Bonferroni-adjusted significance threshold (p < 0.00625). Among all the practices, the median knowledge and IQR were higher in B₂ as compared to B₀, with a different effect size. Variety (0.293), plant protection (0.211), irrigation and sowing (0.153), Seed rate and seed treatment (0.152), intercultural practices (0.141) shows a significant difference in median knowledge level regarding recommended mustard cultivation practices across groups with a large effect size, indicating a strong influence of CFLD interventions on knowledge level of beneficiaries (B₁ and B₂) regarding these practices. Whereas fertiliser application (0.138), harvesting and threshing (0.096), and land preparation (0.069) show significant differences in median knowledge level regarding recommended mustard cultivation

practices across the group with moderate effect size, due to farmers' pre-existing familiarity with these practices. The effect sizes (η²) indicate that respondents (B₀, B₁, B₂) explains a significant portion of variance in knowledge scores, with large effect sizes (η² ≥ 0.14) for K₂, K₃, K₄, K₆ and K₇ showing a strong influence and moderate effect sizes (η² = 0.06–0.14) for K₁, K₅ and K₈ shows a noticeable influence.

Mann-Whitney U Test (Table 3) shows detailed post-hoc pairwise comparisons of B₀, B₁ and B₂ for K₁–K₈. It reveals that there was a significant difference across groups, all comparisons were significant (p < 0.0167, Bonferroni-adjusted α = 0.05 ÷ 3) except K1 (B₀ vs. B₁, p = 0.075), K6 (B₁ vs B₂, p = 0.030) and K₈ (B₀ vs. B₁, p = 0.123), confirming the Kruskal-Wallis findings of overall significance. Comparison of knowledge regarding land preparation (K1) between B₀ and B₁ was not significant (p = 0.075, r = -0.14), but significant difference was observed between B₀ and B₂ (p = 0.000, r = -0.33) and B₁ vs B₂ (p = 0.036, r = -0.16), indicating a delayed but moderate increase in knowledge (r = -0.33). All pairwise comparisons regarding knowledge of mustard varieties were statistically significant (p = 0.000), and effect sizes increased from B₀ vs. B₁ (r = -0.35) to B₀ vs. B₂ (r = -0.59), reflecting a large knowledge gain (68.18% increase from B₀ to B₂ as per median scores). Results of the Mann-Whitney U Test confirm that CFLD training significantly increases knowledge in most PoP, particularly K₂, K₃ and K₇, where large effect sizes were recorded. The non-significant significant difference in K₁ (B₀ vs. B₁), K₆ (B₁ vs. B₂) and K₈ (B₀ vs. B₁) suggest areas where early exposure or prior knowledge may have limited programme effectiveness.

As the three groups have different levels of knowledge, it is important to understand the factors influencing the knowledge level

Table 1. Percentage increase in yield and knowledge of recommended practices over control (B₀)

Yield and Knowledge on Package of Practices	B ₀ (%)	B ₁ (%)	B ₂ (%)	% Increase over B ₀
Y Yield (q ha ⁻¹)	14.00	15.78	18.61	32.93
K ₁ Land preparation	68.33	73.75	79.72	16.67
K ₂ Variety	30.45	41.89	56.14	84.33
K ₃ Seed rate and treatment	22.92	37.08	48.75	112.73
K ₄ Irrigation and sowing	40.58	50.08	57.08	40.66
K ₅ Fertilizer application	32.64	45.56	56.25	60.43
K ₆ Intercultural practices	31.81	48.11	52.35	34.70
K ₇ Plant protection	22.17	29.61	43.39	95.74
K ₈ Harvesting and threshing	80.00	86.25	96.25	20.31

Yield of B₀, B₁, and B₂ is in q ha⁻¹ and others parameters are in per cent

Table 2. Comparison of knowledge scores among groups using Kruskal-Wallis test

Parameter	B ₀ Median (IQR)	B ₁ Median (IQR)	B ₂ Median (IQR)	χ ² (df = 2)	p-value	η ²
K ₁	66.67(50-83.33)	66.67(50-83.33)	83.33(66.67-100)	24.683	0.000*	0.069
K ₂	27.27(18.18-45.45)	45.45(36.36-54.55)	63.64(45.45-63.64)	105.118	0.000*	0.293
K ₃	25.00(0-50)	50.00(25-50)	50.00(25-75)	54.730	0.000*	0.152
K ₄	40.00(30-50)	50.00(40-60)	60.00(40-70)	54.814	0.000*	0.153
K ₅	33.33(16.67-50)	50.00(16.67-66.67)	50.00(33.33-66.67)	49.406	0.000*	0.138
K ₆	36.36(27.27-45.45)	45.45(36.36-54.55)	54.55(45.45-63.64)	50.491	0.000*	0.141
K ₇	20.00(6.67-26.67)	33.33(13.33-40)	40.00(33.33-53.33)	75.832	0.000*	0.211
K ₈	50.00(50-100)	100.00(50-100)	100.00(100-100)	34.304	0.000*	0.096

Note: *p < 0.00625 indicates significance (Bonferroni-adjusted). Medians and IQRs to be inserted after rerunning K Independent Samples with the Quartiles option. η² = χ² / (n - 1), n = 360; interpretation: small (η²< 0.06), medium (η²=0.06 to < 0.14), large (η² ≥ 0.14).

Table 3. Pairwise Comparison of Knowledge Scores Across Groups

Parameter	Comparison	U	Z	p-value	Adjusted p-value	r
K ₁	B ₀ vs. B ₁	6042.00	-2.235	0.025	0.075	-0.14
	B ₁ vs. B ₂	5889.00	-2.523	0.012	0.036*	-0.16
	B ₀ vs. B ₂	4566.00	-5.077	0.000	0.000*	-0.33
K ₂	B ₀ vs. B ₁	4344.00	-5.373	0.000	0.000*	-0.35
	B ₁ vs. B ₂	3445.00	-7.074	0.000	0.000*	-0.46
	B ₀ vs. B ₂	2350.00	-9.099	0.000	0.000*	-0.59
K ₃	B ₀ vs. B ₁	5035.00	-4.193	0.000	0.000*	-0.27
	B ₁ vs. B ₂	5445.00	-3.387	0.001	0.003*	-0.22
	B ₀ vs. B ₂	3407.00	-7.296	0.000	0.000*	-0.47
K ₄	B ₀ vs. B ₁	4816.50	-4.534	0.000	0.000*	-0.29
	B ₁ vs. B ₂	5453.00	-3.296	0.001	0.003*	-0.21
	B ₀ vs. B ₂	3415.50	-7.135	0.000	0.000*	-0.46
K ₅	B ₀ vs. B ₁	5186.50	-3.804	0.000	0.000*	-0.25
	B ₁ vs. B ₂	5483.00	-3.248	0.001	0.003*	-0.21
	B ₀ vs. B ₂	3487.00	-7.008	0.000	0.000*	-0.45
K ₆	B ₀ vs. B ₁	4629.00	-4.858	0.000	0.000*	-0.31
	B ₁ vs. B ₂	5847.50	-2.561	0.010	0.030	-0.17
	B ₀ vs. B ₂	3617.50	-6.754	0.000	0.000*	-0.44
K ₇	B ₀ vs. B ₁	5171.50	-3.796	0.000	0.000*	-0.25
	B ₁ vs. B ₂	4236.00	-5.548	0.000	0.000*	-0.36
	B ₀ vs. B ₂	2758.00	-8.297	0.000	0.000*	-0.54
K ₈	B ₀ vs. B ₁	6300.00	-2.043	0.041	0.123	-0.13
	B ₁ vs. B ₂	5760.00	-4.069	0.000	0.000*	-0.26
	B ₀ vs. B ₂	4860.00	-5.903	0.000	0.000*	-0.38

Note: *p < 0.0167 (Bonferroni-adjusted $\alpha = 0.05 \div 3$) indicates significance. Medians and IQRs are reported in Table 1 (Kruskal-Wallis Test Results). Adjusted p-value = $p \times 3$ (capped at 1.0). Effect size $r = Z / \sqrt{240}$, where $\sqrt{240} \approx 15.49$; interpretation: small (0.1), medium (0.3), large (0.5).

Table 4. Constraints Affecting Knowledge Level of Mustard Growers

S.No.	Constraints Affecting Knowledge Level	B ₀ Mean Score	B ₁ Mean Score	B ₂ Mean Score	Overall Mean
C ₁	Lack of awareness about recommended mustard varieties	2.68	2.14	1.72	2.18
C ₂	Inadequate knowledge about seed treatment practices	2.74	2.26	1.81	2.27
C ₃	Limited exposure to training programmes/demonstrations	2.61	2.03	1.55	2.06
C ₄	Lack of timely advisory services from extension personnel	2.52	2.11	1.83	2.15
C ₅	Difficulty in understanding plant protection measures	2.41	1.98	1.69	2.03
C ₆	Lack of knowledge regarding fertiliser application	2.32	1.92	1.63	1.96
C ₇	Limited access to ICT / information sources	2.48	2.05	1.74	2.09
C ₈	Insufficient interaction with progressive farmers	2.29	1.84	1.51	1.88

(Mean score based on 3-point constraint scale: 3 = Severe constraint, 2 = Moderate constraint, 1 = Least constraint)

of the three groups. The results indicate (Table 4) that the severity of constraints was highest among non-beneficiaries (B₀), followed by previous beneficiaries (B₁), whereas the lowest was observed among current beneficiaries (B₂). This trend is in line with the earlier findings, where knowledge scores across all eight practices indicate that participation in CFLD programmes helped reduce informational and technical barriers faced by farmers. It improves farmers' exposure to training, demonstrations and extension services. Previous beneficiaries (B₁) showed moderate constraint levels, suggesting that although prior exposure to CFLD improved knowledge, continuous engagement and training are essential to sustain knowledge gains. The findings highlight that extension education interventions such as demonstrations, training programmes and regular advisory services play a critical role in reducing knowledge gaps and of recommended mustard cultivation practices.

DISCUSSION

The yield increased significantly in B₂ respondents as compared to B₀ respondents, while B₁ showed a significant decrease in yield, suggesting that the CFLD programme enhances productivity through training and scientific know-how of the KVK experts, it was also in conformity with the findings of Chahal et al. (2014), Singh et al. (2022), Sarkar et al. (2025), and Jha et al. (2025). Sharma et al. (2022) reported that, upon realising the superior yield potential of the recommended mustard variety Giriraj, all beneficiaries shifted from using hybrid varieties developed by private sector companies and local mustard seed companies to Giriraj, leading to enhanced yields. This growth surpassed the average mustard yield in Uttar Pradesh, which is around 11 Q/ha, according to the Government of India Ministry of Agriculture and Farmers Welfare, which also shows the broader impact of the CFLD programme. Though the yield increases in B₂ (current beneficiaries,

2025), the benefits for previous beneficiaries (B_1) may have been limited due to inadequate follow-up. Mean knowledge scores also follow a consistent upward trend ($B_0 < B_1 < B_2$), highlighting the programme's overall benefits to the farmers (Samajder et al., 2016). Current Beneficiaries (B_2) outperformed in all mustard PoP knowledge, particularly in Variety (K_2) and Seed Rate and Treatment (K_3), likely due to direct and immediate support like recommended seed, knowledge regarding recommended varieties, demonstrations and timely technical guidance. Similar results were observed by Kalita et al. (2019), Jha et al. (2021), and Sangwan et al. (2021). Regardless of the above-mentioned support, knowledge of B_1 (previous beneficiaries 2021-2024) significantly decreases over time, as explained in Ebbinghaus' Forgetting Curve, also explained by Murre and Dros (2015). Practices such as Harvesting and Threshing (K_8) showed high initial knowledge levels, which may be due to traditional familiarity or routine adoption. As well, the lowest scores were seen in Plant Protection (K_7), where scores increased from 22.17 per cent to 43.39 per cent, underlining a critical gap in earlier awareness. This suggests that CFLD efforts should emphasise these technically demanding practices, where farmer knowledge remains limited.

The Mann-Whitney U post-hoc results further validate these findings, that there was a significant difference between non-beneficiaries (B_0) and Current Beneficiaries (B_2) (e.g., K_2 , $r = -0.59$; K_3 , $r = 0.47$), demonstrating CFLD's similar impact. Meanwhile, non-significant differences in K_1 (B_0 vs. B_1) and K_8 (B_0 vs. B_1) indicate practices where initial CFLD exposure made a limited difference, due to baseline knowledge, lower resource dependency, or implementation lag (Kumar & Lahiri, 2023). However, the increase in knowledge between B_1 and B_2 suggests that more intensive or targeted interventions are required for certain practices to increase the yield further. The consistent pattern of knowledge gains, i.e. low in B_0 , moderate in B_1 and highest in B_2 confirms that exposure to CFLD interventions contributes to learning progression. However, due to a lack of follow up results in decreased, the knowledge and yield in B_1 decreased. Furthermore, CFLD should focus more intensively on low-scoring practices like Plant Protection, which can also reinforce knowledge retention (Lankinen et al., 2024)

CONCLUSION

The study shows that the CFLD programme significantly improves mustard cultivation knowledge and yield among participating farmers in Uttar Pradesh, with current beneficiaries (B_2) achieving the highest median scores and yield. The consistent increase in medians across practices, particularly in variety and seed rate and seed treatment, underscores the programme's effectiveness in addressing knowledge gaps, and the yield increase highlights the practical impact. The significant Kruskal-Wallis and Mann-Whitney U results, supported by moderate to large effect sizes, validate the hypothesis that CFLD training enhances agricultural outcomes. Reasons for these improvements were targeted training and resource support provided under the CFLD programme, such as seed distribution and technical guidance, which significantly boosted knowledge in practices like K_2 and K_3 . Future efforts should focus on low-scoring practices like Plant Protection (K_7) and integrate

qualitative insights to refine programme delivery, ensuring sustained yield and knowledge gains across all farmer groups.

DECLARATIONS

Ethical statement: The study was conducted in accordance with ethical research standards. Participation was voluntary, and informed consent was obtained from all respondents. The confidentiality and anonymity of participants were strictly maintained throughout the research process.

Conflict of interest: The authors declare that there are no conflicts of interest regarding the publication of this paper.

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