



Evaluating the Performance of Cluster Frontline Demonstration (CFLD) on Mustard in North Bengal

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HIGHLIGHTS

- The study evaluated the performance of three improved mustard variety namely PM30, PM 26 and Pusa Vijay in North Bengal.
- The highest yield was observed in Pusa Vijay (18.60 q/ha) followed by PM 26 (17.30 q/ha), PM 30 (13.80 q/ha) and local check B-9 (9.50 q/ha) variety.
- Highest B:C ratio was reported in Pusa Vijay (2.84) followed by PM 26 (2.72), PM 30 (2.57), and local check B-9 (1.85) variety.
- The study proved the effectiveness of extension method i.e. cluster frontline demonstration in promoting new improved varieties among the farming communities.

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ABSTRACT

The production and productivity of mustard in terai and dooars region of North Bengal was comparatively low than national and state average, and farmers were still following decade old varieties and traditional practices. Hence, IARI regional station-Kalimpong promoted advance mustard varieties like PM 30, PM 26 and Pusa Vijay in the region through 600 CFLDs in 6 blocks of Jalpaiguri, Kalimpong and Darjeeling district in North Bengal. The demonstrations were conducted in five consecutive rabi seasons from 2019-2023 and their performance were assessed each year against the control variety. The study used a mix of control- treatment and before-after experimental research design. The findings revealed that the maximum yield was recorded in Pusa Vijay (18.60 q/ha) followed by PM 26 (17.30 q/ha) and PM 30 (13.80 q/ha). The Pusa Vijay reported yield advantage of 48.92 per cent followed by PM 26 (45.09%) and PM-30 (31.16%). The study proved the effectiveness of CFLD in speedy outspread of suggested technologies of mustard horizontally among the farming communities. So, it is recommended that policy bodies should come up with sufficient financial support to frontline extension system for conducting CFLD under the guidance of scientists and extension professionals.

INTRODUCTION

Mustard (*Brassica species*) is one of the most important oilseed crops in India, contributing significantly to the country's agricultural economy and food security. Despite being the largest producers of oilseeds in the world, India imports about half of its

demand because of changing lifestyle in dietary pattern and enhanced per capita income. The rise in production of domestic edible oils has not been able to keep pace with the rise in consumption and the difference between production and consumption is being fulfilled through imports. In India, Mustard was grown over 6.69 million hectares area with a productivity of 1511 kg ha⁻¹ (Directorate of

Economics & Statistics, 2021). With the rising demand for edible oils and the challenges posed by climate change, pests, and diseases, the adoption of improved mustard varieties has become crucial for enhancing its production. The adoption of improved mustard varieties is not just a matter of agricultural advancement; it is essential for ensuring food security, economic stability, and sustainable farming practices in India. But, many farmers still rely on traditional mustard varieties, which often have lower yields compared to improved varieties. Traditional mustard varieties often suffer from lower yields, typically ranging between 800 to 1,200 kg per hectare. In contrast, improved mustard varieties have been developed through modern breeding techniques, offering yields of up to 2,500 kg per hectare or more. By adopting these improved varieties, farmers can significantly increase their productivity, ensuring better income and livelihood. However, the adoption of high-yielding and disease-resistant hybrids is not widespread specially in North Bengal due to lack of awareness, access, and financial constraints. All though the agricultural research have made much progress in advancement of the production technologies of the mustard crop, the farming community of Terai region of North Bengal is yet to utilize the benefits of these developments (Barma et al., 2021). Therefore, IARI Regional station-Kalimpong, took an initiative to introduce the different improved variety of mustard through cluster frontline demonstrations to increase the production and productivity of mustard crop in the region.

METHODOLOGY

The CFLDs were conducted in Maynaguri and Dhupguri block of Jalpaiguri district, Kalimpong I block and Gorubathan block of Kalimpong district, Kurseong and Khoribari block of Darjeeling district. The demonstrations were conducted in five consecutive rabi seasons from 2019-2023 in these six blocks. A mix of experimental (control- treatment and before-after) and ex-post factor research design was used for the present study. The experimental design was used for the variable in which direct manipulation was done, and ex-post-facto design was used where direct manipulation of variable was not possible. Initially, a baseline survey was done in all the blocks to know the existing cultivation practises of the mustard growers. A total of 600 mustard farmers with total land holding of 400 ha. were selected using purposive sampling for conducting the CFLDs as per the interest and risk bearing capacity of the farmers. The farmer's current mustard cultivation practises were treated as the local check plot. In identified plots for CFLDs, the suggested package of practises was adopted for growing the mustard. Prior training programme was conducted to expose the farmers toward new technology before demonstration. The demonstrations were laid out preferably in an area near to the roads where both recommended as well as local varieties can be grown for better comparison. The data on crop yields, growth parameters and morphological parameters were immediately collected both from the check plots as well as the demonstration plots to identify the yield gaps. The economic performance of each variety was calculated taking the inputs' prevailing market prices for the particular year (2024). The effectiveness of the CFLDs was calculated by the formula of Samui et al., (2000). The structured interview schedule was used to collect information on the adoption

of recommended technologies, varietal replacement, and horizontal spread of recommended variety. The extension gap, technology gap, technology index along with the benefit cost ratio (BC ratio) were worked out using the following formula:

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - Farmer's yield

Technology index = Technology gap / Potential yield X 100

RESULTS

Current production and productivity of mustard in the region

The findings in Table 1 revealed that the production and yield of all the three districts namely Jalpaiguri, Darjeeling and Kalimpong was quite low in comparison to national and state average. The area in Jalpaiguri district declined from 9170 ha in 2013 to 4600 ha by 2018. The production also declines from 6009 tonnes in 2013 to 4369 tonnes by 2018. The average yield of the district varied between 0.60 tonnes/ha to 0.96 tonnes/ha which was very low in comparison to national and state average. In Darjeeling, maximum area under rapeseed and mustard was recorded in 2022 (435 ha) and lowest area of 333 ha was recorded in 2020. The production of only 111 tonne was recorded in 2014 with a productivity of 0.30 tonnes/ha. The average productivity in the district varied between as low as 1.26 tonnes/ha to 0.78 tonnes/ha. In Kalimpong, the area under rapeseed and mustard varied from 92 ha in 2018 to 2017 ha in 2022. Highest production of 289 tonne was recorded in 2022 while the lowest production of 75 tonne was reported in 2019. The lowest productivity was reported in 2019 (0.62 tonne/ha). However, the average productivity made a significant jump in 2022 (1.4 tonne/ha). The poor production and productivity scenario in all these districts indicates the existing technological gap and need for adoption of improved technologies for enhancing the production and productivity in mustard crop.

Details of technological interventions

The performance of demonstrated variety was compared with the local popular variety to assess the superiority of selected technology. The major inputs for demonstration were supplied to the farmers by the IARI Regional station, Kalimpong. Other inputs like fertilizers, pesticides, herbicides and irrigation were managed by the farmers themselves as per the suggestions of scientists of IARI. The mustard variety were sown during first week of November with a seed rate of 5-6 kg/ha in furrows with 30 cm row spacing using seed drill. The seed was treated with carbendazim @ 2 g/kg of seed or mancozeb @ 2g/kg. Application of N, P, K and S @ 80 kg, 40 kg, 30 kg and 40 kg/ha were followed in demonstration plot. Split application of N @ 50% and full dose of P and K as basal and remaining 50% dose of N were applied at the time of flowering stage. Phosphogypsum was applied two days before seed sowing. Two irrigation-one at the time of flowering and second one during pod formation i.e. 65-70 days after sowing were followed by the selected farmers. The CFLD farmers followed pre-emergence application of pendimethalin (30EC) @ 3.3 l/ha to control weed in mustard field and spraying of imidacloprid 17.8 SL @ 0.2 ml/l water to protect the crop against aphid problem. In control plot, the fields

Table 1. District-wise area, production and yield of rapeseed and mustard from 2013-2022

Year	Jalpaiguri			Darjeeling			Kalimpong		
	Area (ha)	Production (tonne)	Yield (t/ha)	Area (ha)	Production (tonne)	Yield (t/ha)	Area (ha)	Production (tonne)	Yield (t/ha)
2022	5959	5483	0.92	435	254	0.58	207	289	1.4
2021	5692	5466	0.96	336	262	0.78	113	101	0.89
2020	5676	5109	0.90	333	240	0.72	111	82	0.74
2019	5658	4727	0.84	336	424	1.26	116	75	0.65
2018	4600	4369	0.95	427	173	0.41	92	57	0.62
2017	5453	4953	0.91	368	129	0.35	-	-	-
2016	2594	1759	0.68	375	189	0.5	-	-	-
2015	7535	5412	0.72	450	214	0.48	-	-	-
2014	7754	4640	0.60	365	111	0.3	-	-	-
2013	9170	6009	0.66	400	260	0.65	-	-	-

Source: Ministry of agriculture & farmers welfare, Government of India

Table 2. Details of technological interventions in CFLD practices vs. traditional farmers practices

Particulars	CFLD	Farmers Practices
Farming situation	Rainfed	Rainfed
Variety	PM-30, PM-26 and Pusa Vijay	B-9
Seed treatment	Seed treatment with carbendazim @ 2 g/kg of seed or mancozeb @ 2 g/kg seed	Nil
Time of sowing	The first week of November for early sowing variety and mid-November for late sown variety like PM 26	Last of week of November to first fortnight of December
Method of sowing	Line sowing using seed driller	Broadcasting
Spacing	30*10 cm	No specific spacing was maintained
Irrigation	Two irrigation-one at the time of flowering and second one during pod formation i.e. 65-70 days after sowing	Nil
Weeding	Pre-emergence application of pendimethalin (30EC) @ 3.3 l/ha	Nil
Seed rate	5-6 kg/ha	8-10 kg/ha
Fertilizer dose	Application of N, P, K and S @ 80 kg, 40 kg, 30 kg and 40 kg/ha, and application of N in two split doses.	80 kg N and 40 kg P
Plant protection measurement	Spraying of imidacloprid 17.8 SL @ 0.2 ml/l water to protect the crop against aphid problem.	Nil

were managed by the farmers as per their own traditional farming practices. Irrigation and seed management was done as per the actual need in field condition. Finally, one field day was conducted involving all the farmers, scientists, officials from State Department of Agriculture, local extension workers to demonstrate the superiority of technology.

Impact on growth and yield attributes

The findings of growth and yield parameters of mustard crop revealed that the maximum plant height was recorded in PM 30 variety (185 cm) followed by Pusa Vijay (184 cm), PM26 (170 cm) and control variety B-9 (105 cm). Highest number of siliqua per plant was recorded in Pusa Vijay variety (239) followed by PM 26 (105), B- 9(91) and PM-30 (85). The maximum number of seed per siliqua was recorded in PM 26 variety (14) followed by

Pusa Vijay (13), PM-30 (12), and B-9 (10). The highest siliqua length was observed in PM 30(4.80 cm) followed by PM-26 (4.80 cm), B-9 (4.70 cm) and Pusa Vijay (4.55 cm). The maximum oil content was found in PM 30 and Pusa Vijay (35%) while minimum oil content was observed in PM 26 (33%) variety of mustard. Highest test weight was 4.88 g in PM 30 variety of mustard whereas the lowest test weight was 3.20 g in B-9 variety of mustard. The longest maturity period was recorded in Pusa Vijay variety (145 days) while the shortest maturity period was observed in B-9 variety (90 days) of mustard.

Performance of mustard crop and gap analysis

The average yield of 13.80 q/ha was observed in case of PM-30 variety in demonstration plot. The variety has a yield advantage of 31.16 per cent against the local check variety. The extension gap

Table 3. Growth and yield attributes of mustard varieties under CFLD and control plot

Variety	Plant height (cm)	Siliqua/plant	Oil content (%)	Seed/siliqua	Siliqua length (cm)	Test weight (g)	Maturity
PM 30	185	85	35	12	4.80	4.88	137
PM 26	170	105	33	14	4.80	3.45	126
Pusa Vijay	184	239	35	13	4.55	4.80	145
Farmers control-B9	105	91	34	10	4.70	3.20	90

Table 4. Evaluation of yield performance of different mustard varieties

Variety	Potential yield (q/ha)	CFLD plots (q/ha)	Local check plots (q/ha)	% increase over local check plots	Z-value	Extension gap (q/ha)	Technological gap (q/ha)	Technology index
PM 30	18.24	13.80	9.50	31.16	3.13*	4.30	4.44	24.34
PM 26	22	17.30	9.50	45.09	7.26**	7.80	4.70	21.36
Pusa Vijay	25	18.60	9.50	48.92	7.98**	9.10	6.40	25.60

**Significant at 1% level, *Significant at 5% level

of 4.30 q/ha and technological gap of 4.44 q/ha was observed. The average yield of PM 26 variety was 17.30 q/ha and had a yield advantage of 45.09 per cent over its local counterpart. The extension gap of 7.80 q/ha and technological gap of 4.70 q/ha indicates the unexplored potential of the variety. The variety Pusa Vijay recorded an average yield of 18.60 q/ha with a yield advantage of 48.92% over its local counterpart. This variety recorded highest extension gap of 9.10 q/ha and technological gap of 6.40 q/ha.

Increased rate of adoption

The findings on 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 86 farmers adopted any IARI mustard varieties in the region which increased to 538 farmers with an increase of 84.01 per cent and difference was significant at 1% level of significance ($t=5.31$). Maximum 88.25 per cent increase in adoption of recommended seed rate ($t=5.89$) was reported followed by weed management (87.14%), farm mechanization (85.36%, $t=4.70$) and seed treatment practices (84.08%, $t=4.62$). Other significant technological adoption was reported in case of nutrient management practices (83.11%, $t=3.76$), plant protection management (82.93%, $t=2.90$), sowing time (82.89%, $t=3.53$) and irrigation management (82.46%, $t=1.96$).

Decline in pest and disease incidence

The recommendation under CFLD to control pest and diseases in mustard field has helped to lower down the incidence of major pest and disease problem in the region. Only 5 per cent farmers reported about stem rot problem in their field under CFLD while 15 per cent farmers from the control village reported about the same in their mustard field. The problem of aphid was reported by only 7 per cent farmers who participated in CFLD while 25 per cent farmers from the control village reported about the aphid problem in their mustard field. The problem of powdery mildew was

reported by 8 per cent farmers from the treatment village against 30 per cent farmers from the control village. The application of recommended pesticides like imidacloprid helped to control the menace of aphid problem in mustard field under CFLD. This indicates the effectiveness of CFLD in controlling the pest and disease in the mustard field.

Impact of CFLD on horizontal spread

The CFLD conducted for introduction of new mustard varieties gained quick popularity among the farming communities. In 2019, only 70 farmers adopted the IARI mustard varieties in 35 ha area. In 2020, 46.15 per cent more farmers ($f=130$) adopted the IARI mustard varieties and cultivated in 86 ha area. In 2021, total 221 farmers adopted the variety which was 41.18 per cent more than the previous year and total 110 ha area was brought under IARI variety. In 2022, 28.71 per cent more farmers adopted the variety in 200 ha area which was 45 per cent more than the previous year. In 2023, total 400 farmers adopted the IARI mustard variety in 315 ha area which was 36.51 per cent more than the previous year.

Impact on income

The economics of mustard production under cluster frontline demonstration was calculated and the result of the study has been given in Table 7. The inputs and outputs prices of commodities prevailed during the study were taken for calculating gross return,

Table 6. Horizontal diffusion of IARI mustard varieties

Year	No. of farmers adopted	Change in Area (ha)	% Change in no. of farmers	% change in area
2019	70	35	0	0
2020	130	86	46.15	59.30
2021	221	110	41.18	21.82
2022	310	200	28.71	45.00
2023	400	315	22.50	36.51

Table 5. Technology adoption in mustard

Technology/practices	Before CFLD	After CFLD	% change	t-test
Adoption of IARI mustard variety	86	538	84.01	5.31*
Seed rate	53	451	88.25	5.89*
Seed treatment practices	75	471	84.08	4.62*
Sowing time	51	298	82.89	3.53**
Nutrient management practices	65	385	83.11	3.76**
Plant protection management	70	410	82.93	2.90**
Farm mechanization	47	321	85.36	4.70*
Irrigation management	50	285	82.46	1.96**
Weed management	63	490	87.14	4.65*

*Significant at 1% level of significance, **Significant at 5% level of significance

Table 7. Economic advantage of IARI mustard varieties

Particular	Average Cost of cultivation (Rs./ha)	Average gross return (Rs./ha)	Average Net return (Rs./ha)	Benefit cost ratio
PM 30	25200	90000	64800	2.57
PM 26	25500	95000	69500	2.72
Pusa Vijay	26000	100000	74000	2.84
B 9	24200	45000	20800	1.85

cost of cultivation, net return and benefit : cost ratio. The average cost of cultivation was calculated for both demonstration plot and control plot to understand the economic feasibility of CFLD variety in the region. The total average operational cost in demonstration plot was Rs. 25200/ha whereas in control plot it was Rs. 24200/ha. Though farmers' cost of cultivation in demonstration plot was marginally higher than the control plot but the yield and profit from demonstration plot was much higher than the control plot. The average gross return in demonstration plot of PM-30 was Rs. 90,000/ha whereas in control plot it was only Rs. 45,000/ha. The average net return in demonstration plot was Rs. 64800/ha, much higher than the control plot (Rs. 20,800 /ha). The B:C ration in demonstration plot was 2.57 while in control plot it was 1.85. the highest B:C ration of 2.84 was reported in demonstration plot of Pusa Vijay with average gross return of Rs.100000/ha and average net return of Rs. 74000/ha. The B:C ratio of PM-26 variety was 2.72 with average gross return of Rs. 95000/ha and average net return of Rs. 69500/ha. So, all these findings indicate the better potential of higher profitability of IARI mustard varieties than the traditional mustard varieties. Therefore, the farmers should adopt the new improved recommended mustard varieties based on their cropping pattern and land type for better production and productivity.

DISCUSSION

The findings of growth and yield parameters of mustard crop revealed that the maximum plant height was recorded in PM 30 variety (185 cm) followed by Pusa Vijay (184 cm), PM 26 (170 cm) and control variety B-9 (105 cm). A plant's height is controlled by genetical characteristics, and different varieties will grow to varying heights depending on their genetic make-up in a given environment (Dongarkar et al., 2005). Highest number of siliqua per plant was recorded in Pusa Vijay variety (239) followed by PM 26 (105), B-9 (91) and PM-30 (85). The number of siliqua varies between kinds, which could be attributable to genetic variation (Kumar et al., 2018; Biswas et al., 2019). Number of seeds per plant is one of the most significant criterion in yield attributes and the rapeseed-mustard varieties under testing differ significantly in terms of number of seeds per siliqua. The maximum number of seed per siliqua was recorded in PM 26 variety (14) followed by Pusa Vijay (13), PM-30 (12) and B-9 (10). The highest siliqua length was observed in PM 30 (4.80 cm) followed by PM-26 (4.80 cm), B-9 (4.70 cm) and Pusa Vijay (4.55 cm). The observed variation in the number of seeds/siliqua for different mustard varieties could be attributable to the photoperiodic response of the rapeseed-mustard to day-length duration. The maximum oil content was found in PM 30 and Pusa Vijay (35%) while minimum oil content was observed in PM 26 (33%) variety of mustard. Highest test weight was 4.88 g in PM 30 variety of mustard whereas the lowest test weight was

3.18 g in PM 28 variety of mustard. Test weight (1000 Seed weight) of grains varied significantly mainly due to the effects of variety. The weight of 1000 seeds differ from variety to variety and species to species (Mondal et al., 1992). The longest maturity period was recorded in Pusa Vijay variety (145 days) while the shortest maturity period was observed in B-9 variety (90 days) of mustard. Dkhar et al., (2022) in their study reported about plant height of 89.30 cm in PM-26 variety with 7.03 branches, 111.50 siliqua per plant, 4.81 cm siliqua length, 11.75 number of seeds per siliqua, 40.30 per cent oil content. The findings are in line with the present study. It's possible that the influence of cumulative favourable effects of crop characteristics like number of branches/plants, siliqua/plant, and seeds/siliqua contribute to higher yield by different varieties (Helal et al., 2016). Singh et al., (2023) reported that the cultivation of PM-30 variety of mustard gave higher net returns of Rs. 32135 and Rs. 47350/ha in 2021-22 and 2022-23 respectively with B:C ration of 2.77 and 3 respectively. The results are in conformity with the findings of Jha et al., (2021). The B:C ratio of 2.79 was reported by Kumar (2022) in his study in south-eastern plate of Jharkhand. All these findings highlight the need of improved variety selection to enhance the production and productivity of mustard crop in North Bengal.

CONCLUSION

The cluster frontline line demonstrations (CFLDs) conducted by IARI Regional station-Kalimpong had contributed significantly to enhance the yield of mustard and helped to spread recommended technologies among the farming communities through different extension activities under CFLD programmes. The study proved that the potential yield of mustard varieties can be realized by imparting scientific knowledge to the farmers, making available the need-based quality inputs and their proper utilization. The demonstration trails also enhanced the relationship among different stakeholders and built up the confidence among the farmers about new mustard growing technologies. The participant farmers of CFLD also played an important role in wider dissemination of the improved varieties of mustard to the nearby farmers. Therefore, it is suggested that policy maker should provide sufficient financial support to the frontline extension system for timely planning and organizing CFLD for promoting such new varietal technologies in mustard to lower down its dependency on import of edible oil.

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