



Extent of adoption of mustard production technologies under cluster front line demonstrations in Bikaner district of Rajasthan

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Abstract

Edible oil production is a prime need of the India; and needs to enhance the productivity of crops with the help of improved technologies. Among the oilseeds, mustard is playing a key role by sustaining harsh climate and diversity in soil health properties. Adoption of improved agricultural technologies is a crucial determinant of productivity enhancement and livelihood improvement among farmers. The present study examined the extent of adoption of mustard production technologies demonstrated under Cluster Front Line Demonstrations (CFLDs) among beneficiary and non-beneficiary farmers. The study was conducted on a sample of 160 respondents comprising 80 beneficiary and 80 non-beneficiary farmers. Adoption was measured using a structured adoption index, and respondents were categorized into low, medium, and high adoption levels based on mean and standard deviation. Results revealed that a majority of beneficiary farmers belonged to the high adoption category, whereas most non-beneficiaries exhibited low to medium adoption levels. Aspect-wise analysis further indicated significantly higher adoption among beneficiaries for most recommended practices. The findings clearly demonstrate the effectiveness of CFLDs in accelerating adoption of improved mustard production technologies.

Keywords: Adoption, Cluster Front Line Demonstration, extension impact, mustard, production technologies

Introduction

Indian mustard [*Brassica juncea* (L.) Czern and Coss.], popularly known as 'rai,' 'raya,' or 'laha,' is one of the most important oilseed crops cultivated in India (Rai *et al.*, 2022). Along with rapeseed (*Brassica campestris*), mustard constitutes the major rabi oilseed crops, contributing significantly to the edible oil economy (Sachan *et al.*, 2024). Globally, India is the third-largest producer of rapeseed–mustard after Canada and China, contributing about 11% of world production (Jat *et al.*, 2019). Mustard cultivation is widespread across tropical and subtropical regions, with India, Canada, China, Pakistan, Poland, Bangladesh, and Sweden being the leading producers (Akhatar *et al.*, 2025). Mustard is a good source of income for poor farmers particularly under rainfed conditions (Sangwan *et al.*, 2021). ICAR launched an “On-farm Research Project” in 1988 for oilseeds. The success of On-farm Research generated tremendous interest among farmers, planners and administrators (Byerlee *et al.*, 1981). Ultimately the Indian Council of Agricultural Research (ICAR) presented the idea of “First Line Demonstration” under the “Oilseed Technology

Mission” and the GOI sanctioned First Line Demonstrations for oilseeds under the Ministry of Agriculture, in 1991. It was started by the All-India Coordinate Research Project on oilseeds (AICORPO) with a network of 64 locations/centres and 104 functional units covering 8 crops (groundnut, rapeseed-mustard, sesame, niger, sunflower, castor, safflower and linseed) in 17 oilseed growing states (Reddy and Kiresur 1995). Later on, “First Line Demonstration” (FLD) was renamed as “Front Line Demonstration” to reflect the practice of researchers introducing new technologies directly to farmers in their own fields before integrating them into the broader extension system of the state’s agricultural division. Front Line Demonstrations differ from conventional demonstrations conducted by extension agents (Deshmukh *et al.*, 2014 and Meena *et al.*, 2012).

The primary goal of FLD is to showcase the production potential of cutting-edge technologies within the context of farmers’ own agricultural practices and gather direct feedback on the factors constraining the realization of the demonstrated technology’s production potential. Additionally, FLD plays a role in fostering technical

leadership at the village level by organizing tailored training programs based on farmers' specific needs (Dangi *et al.*, 2025 and Prajapati *et al.*, 2025). The Cluster Front Line Demonstration (CFLD) program for groundnut not only promises improved yield realization but also presents an opportunity to enhance the production of high-quality seeds (Raju *et al.*, 2024). This potential is firmly based on the adoption and continuous implementation of advanced management practices, rendering CFLD an appealing endeavour for wider adoption throughout agricultural regions (Ghosh *et al.*, 2023). The improved technologies consisted of improved high yielding variety, pre-emergence weedicides, use of biofertilizers as a seed treatment, vermicompost, neem-based pesticides and yellow sticky card as insect-pest management (Bezbaruah and Deka 2020). Extension participation is another key determinant of knowledge and adoption, with studies done by Raghava and Rao (2013) and Kumar and Sharma (2018) showing that farmers actively involved in extension activities, such as Frontline Demonstrations (FLDs), exhibit higher levels of adoption. Moreover, age and income are also important variables influencing adoption, with older farmers generally showing lower levels of adoption, as seen in Mandavkar *et al.* (2013). Conversely, higher income tends to facilitate the adoption of advanced agricultural technologies, providing farmers with the necessary resources to invest in new practices. These findings collectively underline education, social the importance participation, of extension services, and economic factors in enhancing agricultural knowledge and adoption among farmers.

Adoption is a behavioural process through which individuals decide to accept and use an innovation on a sustained basis. According to Kumawat *et al.* (2018), adoption reflects the mental and practical decisions of individuals to fully utilize recommended technologies. In agriculture, several improved practices and technologies are continuously developed; however, their adoption largely depends on farmers' awareness, knowledge, innovativeness, and perception of relative advantage. Cluster Front Line Demonstrations (CFLDs) play a vital role in bridging the gap between research and field-level adoption by exposing farmers to proven technologies under real farming conditions (Hooda and Jangra 2025). Assessing the extent of adoption of CFLD-demonstrated technologies provides valuable insights into the effectiveness of extension interventions. Therefore, the present study was undertaken to analyze the extent of adoption of mustard production technologies among beneficiary and non-beneficiary farmers (Kumar *et al.*, 2016).

Materials and Methods

Frequency was calculated to find out the number of respondents in a particular cell. Percentage values were calculated to make simple comparisons. These were calculated by dividing the frequency of a particular cell by total number of respondents and multiplying by 100.

$$P = \frac{n}{N} \times 100$$

Where,

n=Frequency of a particular cell

N=Total number of respondents in that particular cell

P = Percentage

Mean score for each category were worked out separately by the formula

$$\bar{X} = \frac{\sum X_{ij}}{N}$$

Where,

X_{ij} =Sum of each of the individual comparisons I = 1, 2, 3,...N

N=Number of observations in a group

$\bar{X}$ =Mean

Standard deviation is a measure of variability in a set of scores, found by summing up the squared differences from the mean, dividing by the number of cases and extracting the square root. Standard deviation was computed for the purpose of analysis and further categorization. The formula was used for calculating standard deviation was as follows.

$$\sigma = \sqrt{\frac{\sum (X - \bar{X})^2}{N - 1}}$$

Where,

σ =Standard deviation

X=Value of individual variable

$\bar{X}$ =Assumed mean

N=Total number of items

(N-1 is unbiased estimate of the variance in the population)

Mean per cent score (MPS) was computed by multiplying total obtained score of the respondents by 100 and dividing by the maximum obtainable score under each practice.

$$MPS = \frac{\text{Total score obtained by the respondent}}{\text{maximum obtainable score}} \times 100$$

In order to know the relationship between any two variables, correlation coefficient was frequently used. Correlation coefficient between dependent variables 'Y' and selected independent variable X1,X2,X3 ,..... X11 were calculated. It has been calculated by using the

following formula:

$$r = \frac{\sum X_i Y_i - (\sum X_i)(\sum Y_i)/N}{\sqrt{\sum X_i^2 - (\sum X_i)^2/N} \sqrt{\sum Y_i^2 - (\sum Y_i)^2/N}}$$

Where,

r=correlation coefficient

n=Number of pair of X and y value

X_i = Value of X variables for ith pair

Y_i = Value of Y variables for ith pair

The value of 'r' always lies between -1 to +1. Positive value of 'r' indicates a tendency of 'X' and 'Y' to increase or decrease together, respectively. When 'r' is negative, it indicates a tendency of decreasing one variable with the increase of the other variables. The significance of correlation coefficient was tested by using 't' test formula.

't' Test (Student 't' test) was used to observe significant difference between two sample mean for small sample. The formula of as under:

$$Z = \frac{|\bar{X} - \bar{Y}|}{Sp \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$Sp = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$$

Where,

X=mean of the group of beneficiary respondents

Y=mean of the group of non-beneficiary respondents

S1= Standard deviation of first sample

S2=standard deviation of second sample n1= size of first sample

n2=size of second sample,

d. f.=n1+n2-2

'Z' test was used to find out comparison between the beneficiary and non-beneficiary respondents of the CFLD. This test was used to observe significant difference between two sample mean for large sample. The formula used for it was as follows:

$$Z = \frac{|\bar{X}_1 - \bar{X}_2|}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$$

Where,

X1=Mean of the group of beneficiary respondents

X2=Mean of the group of non-beneficiary respondents

S1= standard deviation of first sample

S2=standard deviation of second sample

n1= size of the first sample

n2=size of the second sample

Spearman's Rank Correlation (rs) was applied to determine the relationship between the ranks assigned by the two

categories of respondents.

$$r_s = 1 - \frac{[6(\sum d_i^2)]}{n(n^2 - 1)}$$

Where,

d_i=different of rank of the beneficiary and non-beneficiary respondents

n = number of items/observations

For repeated value of items, the formula of rs was used as given under:

$$r_s = 1 - \frac{[6(\sum d_i^2) + 1/12(t^3 - t) + 1/12(t^3 - t)]}{n(n^2 - 1)}$$

t = Number of item value was repeated, thus if measurement 'x' is repeated two items then the value of 't' will be 2. If repeated three times then the value of 't' will be 3. The significance of correlation coefficient was tested by using following formula:

$$t = \frac{\sqrt{n-2}}{\sqrt{(1-r^2)}}$$

The value of 'r' always lies between -1 to +1. Positive value of 'r' indicates attendance of 'x' and 'y' to increase together where 'y' for the test of significance 'r' tabulated is located at (n-2) degree of freedom.

Multiple linear regression analysis is a measure of average relationship between two variables. For the purpose of the study the relationship between dependent variable 'Y' and the selected independent variables (X1, X2, X3 X11), the following multiple linear regression equation was fitted:

$$Y = a + b_1X_1 - b_2X_2 - b_3X_3 \dots \dots \dots b_{11}X_{11}$$

Where,

Y=Predicted value of dependent variable

a=intercept concept which is calculated by the following manner

$$a = y - b_1X_1 - b_2X_2 - b_3X_3 \dots \dots \dots b_{11}X_{11}$$

$$a=y-b_1X_1-b_2X_2-b_3X_3 \dots \dots \dots -b_{11}X_{11}$$

b1 = partial regression coefficient, which represent the amount of change in 'Y' that can be associated with a unit change in any one of the X_i when the remaining independent variable held fixed.

Results and Discussion

Extent of Adoption of Mustard Production Technologies

The data (Table 1) clearly reveals that among the beneficiary respondents, a substantial majority (57.50%)

Table 1: Distribution of respondents according to extent of adoption about CFLD

Categories	Respondents					
	Beneficiary respondents (n=80)		Non-beneficiary respondents (n=80)		Overall respondents (N=160)	
	F	%	F	%	F	%
Low (<33.05 score)	1	1.25	36	45.00	37	23.13
Medium (33.05 to 45.08 score)	33	41.25	42	52.50	75	46.87
High (>45.08 score)	46	57.50	2	2.50	48	30.00

Mean: 39.07; S.D.: 6.01

belonged to the high adoption category, while 41.25% exhibited medium adoption, and only a marginal proportion (1.25%) fell into the low adoption group. Conversely, among non-beneficiary respondents, the majority (52.50%) were medium adopters, followed by a notable proportion (45.00%) with low adoption, and just 2.50% as high adopters. Looking at the overall sample, nearly half (46.87%) of all respondents were medium adopters, with 30.00% in the high adoption category and 23.13% in the low adoption group.

These findings underscore that beneficiary farmers, exposed to CFLD interventions, adopted mustard production technologies to a significantly greater extent compared to their non-beneficiary counterparts. These observations are consistent with the findings of Patel et al. (2016), Gorfad et al. (2018), and Bagenia & Lakhera

(2017), who also reported that a majority of mustard and mustard growers were classified under the medium to high adoption categories for improved agricultural technologies.

Aspect-wise extent of adoption

The aspect-wise extent of adoption of mustard production technologies among respondents was also examined and is presented in Table 2. Beneficiary respondents demonstrated the highest adoption for “Time of sowing, seed rate and spacing” (99.17 MPS; rank 1), “Selection of land, soil testing and field preparation” (98.33; rank 2), and “Nutrient management” (94.06; rank 3). Other aspects, such as “Improved varieties,” “Plant protection measures,” and “Seed treatment,” also recorded high adoption scores among beneficiaries, while “Irrigation management” and “Weed management” ranked lowest.

Table 2: Aspect-wise extent of adoption of respondents about CFLD

Adoption Aspects	Respondents					
	Beneficiary respondents (n=80)		Non-beneficiary respondents (n=80)		Overall respondents (N=160)	
	MPS	Rank	MPS	Rank	MPS	Rank
Selection of land, soil testing and field preparation	98.33	II	47.92	X	73.13	VIII
Improved varieties	93.75	IV	69.58	V	81.67	IV
Time of sowing, seed rate and spacing	99.17	I	83.54	I	91.35	I
Seed treatment	90.63	VI	56.88	VII	73.75	VII
Nutrient management	94.06	III	81.72	II	87.89	II
Irrigation management	78.13	X	77.71	III	77.92	V
Weed Management	85.42	IX	54.17	IX	69.79	X
Plant protection measures	92.95	V	74.09	IV	83.52	III
Harvesting	87.50	VIII	55.63	VIII	71.56	IX
Storage	89.38	VII	63.13	VI	76.25	VI
Pooled	91.35		71.43		81.39	

rs= rank correlation

MPS = Mean Percent Score

** Significant at 0.01 level of probability

rs = 0.28
t = 0.84NS

Among non-beneficiary respondents, the highest adoption was noted for “Time of sowing, seed rate and spacing” (83.54; rank 1), followed by “Nutrient management” (81.72) and “Irrigation management” (77.71). However, their adoption scores were considerably lower across most aspects compared to beneficiary farmers, especially for “Selection of land, soil testing and field preparation” (47.92), “Weed management” (54.17), and “Seed treatment” (56.88). When all respondents were considered collectively, “Time of sowing, seed rate and spacing” (91.35 MPS; rank 1), “Nutrient management” (87.89; rank 2), and “Plant protection measures” (83.52; rank 3) were the top adopted aspects, while “Weed management” (69.79) and “Harvesting” (71.56) lagged behind (Table 2).

The overall pooled Mean Percent Score (MPS) for adoption was higher among beneficiary respondents (91.35) than non-beneficiaries (71.43), with an overall average of 81.39 MPS. The rank correlation coefficient (r_s) between the aspect-wise adoption ranks of beneficiaries and non-beneficiaries was 0.28, which was non-significant ($t = 0.84NS$), indicating only a weak similarity in ranking patterns. These findings are in agreement with Mahadik & Talathi (2016) and Tunvar et al. (2017), who also reported higher adoption rates for critical aspects like time of sowing, irrigation, and seed treatment among farmers with greater exposure to extension activities.

Comparison of adoption between beneficiary and non-beneficiary respondents

A more detailed aspect-wise comparison, as shown in Table 3, revealed that in nine out of ten adoption aspects,

there was a statistically significant difference ($p < 0.01$) between beneficiary and non-beneficiary respondents, as indicated by the calculated ‘Z’ values exceeding the tabulated threshold. The most pronounced differences were observed in “Selection of land, soil testing and field preparation” ($Z = 11.36^{**}$), “Plant protection measures” ($Z = 9.46^{**}$), “Weed management” ($Z = 8.58^{**}$), and “Seed treatment” ($Z = 7.82^{**}$). The only aspect where the difference was non-significant was “Irrigation management” ($Z = 0.17NS$), suggesting similar adoption levels among both groups for this aspect. The pooled adoption score was significantly higher among beneficiary respondents (43.85) compared to non-beneficiaries (34.29), with an overall ‘Z’ value of 16.57^{**} , confirming a substantial difference in adoption extent between the two groups. The higher adoption levels among beneficiary farmers may be attributed to their participation in CFLD activities, regular contact with extension personnel, and exposure to trainings, demonstrations, and technical guidance. In contrast, non-beneficiary respondents, lacking such support, adopted the recommended technologies to a lesser extent. This finding is further corroborated by Pokar et al. (2014), who found significant differences between beneficiary and non-beneficiary farmers regarding the adoption of groundnut demonstrated technologies.

In summary, it is evident that CFLD interventions have played a crucial role in enhancing both the knowledge and adoption of improved mustard production technologies among beneficiary farmers. This not only facilitates the spread of innovation but also fosters sustainable improvements in mustard cultivation practices in the region.

Table 3: Aspect-wise comparison of extent of adoption of respondents about CFLD

Adoption Aspects	Beneficiary respondents (n=80)		Non-beneficiary respondents (n=80)		‘Z’ Value
	Mean	SD	Mean	SD	
Selection of land, soil testing and field preparation	2.95	0.31	1.44	1.15	11.36 ^{**}
Improved varieties	2.81	0.50	2.09	0.69	7.58 ^{**}
Time of sowing, seed rate and spacing	5.95	0.22	5.01	1.94	4.30 ^{**}
Seed treatment	1.81	0.57	1.14	0.52	7.82 ^{**}
Nutrient management	7.53	0.50	6.54	1.05	7.61 ^{**}
Irrigation management	4.69	0.70	4.66	1.13	0.17NS
Weed management	2.56	0.57	1.63	0.80	8.58 ^{**}
Plant protection measures	10.23	1.08	8.15	1.64	9.46 ^{**}
Harvesting	1.75	0.46	1.11	0.85	5.89 ^{**}
Storage	3.58	0.65	2.53	1.37	6.20 ^{**}
Pooled	43.85	2.46	34.29	4.54	16.57 ^{**}

^{**}Significant at 0.01 level of probability; NS= Non-significant; SD=Standard deviation

Conclusion

The study conclusively demonstrated that Cluster Front Line Demonstrations significantly enhanced the adoption of mustard production technologies among beneficiary farmers. Beneficiaries exhibited higher overall and aspect-wise adoption compared to non-beneficiaries, particularly for critical practices such as time of sowing, nutrient management, plant protection, and seed treatment. The findings underscore the effectiveness of CFLDs as a powerful extension tool for accelerating technology adoption and reducing the gap between recommended practices and actual field-level implementation. Strengthening CFLD interventions and ensuring wider coverage may further promote sustainable adoption of improved mustard production technologies in most of the states.

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