Eco. Env. & Cons. 31 (4) : 2025; pp. (1567-1572)

ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2025.v31i04.036
Website: www.envirobiotechjournals.com

Factors Influencing Adoption of Recommended Mustard Cultivation Practices in Western Uttar Pradesh

Rishabh Yadav[1], L.B. Singh*[2], R.N. Yadav[2], D.K. Singh[2] and Harsha[1]

Department of Agricultural Extension Education, Sardar Vallabhbhai Patel University of Agriculture and Technology Meerut 250 110, U.P., India

(Received 25 July, 2025; Accepted 11 September, 2025)

ABSTRACT

The study investigates the constraints influencing the adoption of recommended Package of Practices (PoP) for mustard cultivation under Cluster Frontline Demonstrations (CFLDs) in western Uttar Pradesh. The data collection of respondents was done in 2024-25and a stratified random sample of 240 farmers, including CFLD beneficiaries and non-beneficiaries across three Krishi Vigyan Kendras, was surveyed through structured interviews conducted after harvest. Data were analysed using the Garrett Ranking Technique, and Principal Component Analysis (PCA) to identify and interpret the major barriers and their effect on yield. The results revealed that the non-availability of improved varieties, along with the high cost of inputs and labour, emerged as the most critical adoption constraints, highlighting gaps in seed supply and economic feasibility. PCA grouped eight identified challenges into three dimensions, i.e. economic, technical, and availability-related constraints, which together explained 50.38% of total variance which significantly influenced yield, suggesting that farmers facing higher costs or input shortages tend to optimize resources when supported through demonstrations. Technical barriers, such as complex fertilizer recommendations, had a minor effect, likely mitigated through extension services and adaptive practices. Overall, the study underscores the need to strengthen input supply chains, reduce input costs, simplify technical guidance, and enhance policy support to ensure sustainable adoption of improved mustard technologies.

Key words: *Mustard cultivation, Adoption constraints, Cluster Frontline Demonstrations (CFLDs), Principal Component Analysis (PCA)*

Introduction

Mustard (*Brassica juncea L.*), commonly known as rapeseed-mustard, is a cornerstone of India's oilseed economy, contributing approximately 25-30% to the nation's total oilseed production. As the second-largest oilseed crop after groundnut, it plays a critical role in meeting domestic edible oil demands and supporting the livelihoods of millions of smallholder farmers. In the 2024-25 rabi season, area under mustard cultivation was estimated to be 9-10 million hectares, yielding around 11.5 million tonnes, primarily in states such as Rajasthan, Uttar Pradesh, Haryana, and Madhya Pradesh (Chauhan *et al.*, 2024). Beyond its economic significance, mustard provides high-quality edible oil, livestock feed through its oilcake, and supports sustainable farming practices via crop rotation and soil health im-

([1]Ph.D. Scholar, [2]Professor)

provement (Sharma and Singh, 2023).

Despite India's position as a leading global producer in terms of mustard area, average yields remain below the international standards, which can reach up to 2.2-2.7 tonnes per hectare with high-yielding varieties boasting 39-42% oil content (Kumar *et al*., 2023). This productivity gap contributes to India's heavy reliance on edible oil imports, straining foreign exchange reserves and highlighting the need for enhanced domestic production through improved technologies and agronomic practices (Meena *et al*., 2022). High-yielding, disease-resistant varieties, with recommended practices such as seed treatment, balanced fertilizer use, integrated pest management, and efficient irrigation, are essential for closing this gap and achieving sustainable intensification (Singh *et al*., 2024).

Government initiatives such as Cluster Frontline Demonstrations (CFLD) under national oilseed missions, promote technologies by providing farmers with on-field training, inputs, and extension services (Directorate of Rapeseed-Mustard Research, 2024). While CFLDs have shown increasing yields and profitability, widespread adoption remains inconsistent, particularly among resource-poor farmers in rainfed regions. Existing research highlights multiple barriers to adoption, including economic constraints such as high costs of seeds, fertilizers, pesticides, and labor; technical challenges like complex fertilizer calculations and limited access to extension services; and availability issues, such as inadequate supply of certified seeds and distant input distribution centers (Gupta and Sharma, 2023). These constraints are particularly observed in semi-arid regions like Rajasthan; where water scarcity, soil degradation, and fluctuating input prices exacerbate yield variability (Rathore *et al*., 2022).

Social networks, market access, and policy support also influence adoption rates. Inadequate training, poor marketing infrastructure, and lack of awareness further complicate the adoption of improved practices (Yadav and Kumar, 2023). While CFLDs have demonstrated potential in mitigating some of these barriers, their effectiveness varies, and a comprehensive understanding of how these constraints interact to affect productivity is lacking. The study addresses this gap by examining the perceived barriers in adopting recommended mustard production practices among both farmers participating and not participating in CFLD programs. Using Principal Component Analysis (PCA), which categorizes these constraints into underlying dimensions. By identifying and analyzing these barriers, the research aims to provide actionable insights for policymakers, extension agencies, and agricultural researchers to strengthen input supply chains, enhance policy support, and promote sustainable mustard cultivation in India.

Methodology

The study was conducted in western Uttar Pradesh, an important region for mustard cultivation. Out of the 21 Krishi Vigyan Kendras (KVKs) under Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, three KVKs, i.e. Meerut, Muzaffarnagar, and Shahjahanpur were purposively selected. These KVKs were chosen because of their extensive implementation of Cluster Frontline Demonstrations (CFLDs) on mustard between 2021-22 and 2023-24. This ensured that the study focused on areas with active CFLD programs, providing access to farmers with practical exposure to improved cultivation practices (Fakayode *et al*., 2016).

A stratified sampling method was used to divide farmers into two groups: CFLD beneficiaries (B) and non-beneficiaries (NB), so that constraints faced by both can be adressed. For the beneficiary group, lists of mustard farmers enrolled in the 2024-25 CFLD program were collected from each KVK, which included their names, villages, and contact details. From these lists, 40 farmers per KVK were randomly selected using Microsoft Excel's RAND function, giving a total of 120 beneficiaries across the three KVKs. For the non-beneficiary group, farmers with no CFLD participation were chosen from the same or nearby villages to maintain similar agro-climatic and socio-cultural conditions. With the help of local leaders and Gram Pradhans, lists were prepared, and the same random method was used to select 40 non-beneficiaries per KVK, again totalling 120 farmers.

Data Collection was conducted from February 25 to April 20, 2025, immediately after harvest. This timing reduced recall errors and improved accuracy in reporting barries and yields. Data were collected through structured interviews with 11 constraints sorted after pilot study. The interview schedule was prepare on basis of constraints suggested by 30 farmers (10 in each KVK area), who were excluded from the final sample.

Analytical Tools

Garrett Ranking Technique: To prioritize constraints, the Garrett Ranking method was applied. Farmers ranked constraints, and these ordinal ranks were converted into scores using Garrett's table. The percent position was calculated as:

$$Percent\ Position\ (P) = \frac{100 \times (Rij - 0.5)}{Nj}$$

Where:

- P = Percent position of the i^{th} item by the j^{th} respondent
- R_{ij} = Rank given for the i^{th} item by the j^{th} respondent
- N_j = Number of items ranked by the j^{th} respondent

Mean scores across respondents determined the final ranking of constraints (Garrett and Woodworth, 1969).

Principal Component Analysis (PCA): PCA was employed to group correlated constraints into broader factors. Three constraints with low Measure of Sampling Adequacy (MSA) were excluded, which improved data suitability (Jolliffe and Cadima, 2016).

Results

The analysis revealed that the non-availability of recommended seed varieties (73.61) was the most serious problem, showing that adoption is not only limited by farmers' willingness but also due to access of quality seeds. The next major determinants were the high cost of inputs (70.16) and labour (64.13), which highlight the economic burden on small and marginal farmers and explain why majority of respondents cannot fully adopt the package of practices. Weak policy support (63.68) and low market returns (53.09) further discourage mustard growers in adoption of improved PoP, reflecting systemic gaps where farmers are unsure of recovering their costs. Technical difficulties such as distant supply agencies (47.32) and the complexity of fertilizer calculations (33.34) suggest that logistical barriers and technical know-how also hinder adoption. Lower-ranked issues, including inadequate government support (28.29), lack of awareness (21.60), and doubts about effectiveness (9.73), indicate that while knowledge gaps exist, they are less pressing compared to financial and institutional challenges. Interestingly, lack of extension services (4.04) was perceived as the least important, possibly because farmers undervalue extension or are more concerned with immediate economic constraints. Overall, the findings suggest that adoption challenges are shaped more by economic and policy-related barriers than by awareness, and improving input availability, affordability, and market assurance could significantly increase adoption rates.

Principal Component Analysis (PCA)

To reduce dimensions and group related constraints, PCA was applied to identify the underlying dimensions among the constraints perceived by the respondents.. Prior to PCA, three constraints- 'Low Market Returns', 'Insufficient extension services or technical guidance' and 'Lack of Awareness and Knowledge about recommended practices'- were removed due to low Measure of Sampling Adequacy (MSA) values, which improved the overall

Table 1. Constraints in Adoption of recommended package of practices

Adoption related Problem	Total Garret score	Mean Garret score	Rank
Non-Availability of recommended varieties	26501	73.61	1
High cost of Inputs	25256	70.16	2
High cost of labours	23087	64.13	3
Weak Policy Support for input and technology	22924	63.68	4
Low Market Returns:	19112	53.09	5
Distant Supply Agencies:	17036	47.32	6
Complex calculations and weighing for recommended dose of fertilizer	12004	33.34	7
Insufficient government support for inputs or technology.	10185	28.29	8
Lack of Awareness and Knowledge about recommended practices	7777	21.60	9
Doubts about the effectiveness of recommended practices	3503	9.73	10
Insufficient extension services or technical guidance	1455	4.04	11

KMO measure and suitability of data for factor analysis with a KMO Measure value of 0.590 and Bartlett's Test (Sig.) at 0.001. The KMO value of 0.590 is acceptable, and Bartlett's Test is significant ($p < 0.001$), indicating that the dataset is suitable for PCA.

Using Kaiser's criterion (eigenvalues > 1), the analysis extracted three principal components. First component with an eigenvalue of 1.894 explained 21.04% of the total variance, making it the most influential factor. The second component (eigenvalue = 1.379) explained 15.32% and third component (eigen value = 1.261) explained 14.01%. Together these three components explained 50.38% of the overall variance, showing that about half of the information in the original dataset and could be effectively represented by these dimensions. Components were retained for further interpretation through factor loadings. To clarify the structure of constraints, a Varimax rotation was applied. The rotated component matrix identified three distinct dimensions, based on factor loadings greater than 0.5.

Component 1: Perceptions and Policy Concerns factor reflected farmers trust and policy-related issues. It showed a strong loading for doubts about effectiveness (0.771) and high cost of inputs (0.536), along with a negative loading for weak policy support (-0.691). This indicates that skepticism about the usefulness of technologies with high input prices and dissatisfaction with institutional backing reduces farmers' willingness to adopt innovations.

Component 2: Accessibility and Technical Complexity, this component grouped constraints related to complex fertilizer calculations (0.808), distant supply agencies (0.660), and government support for inputs and technology (0.516). The results suggest that while supportive programs exist, farmers face challenges in accessing inputs and dealing with technical complexities. The distance of suppliers and the difficulty of interpreting fertilizer recommendations act as practical barriers to adoption.

Component 3: Resource Availability and Costs, this dimension was defined by the non-availability of improved varieties (0.744) and the high cost of labour (0.712). It highlights that even motivated farmers are often constrained by limited access to quality seed varieties and increasing labour expenses, both of which restrict the adoption of improved mustard practices.

Discussion

The analysis of adoption constraints revealed several systemic challenges affecting mustard cultivation. The most critical issues were the non-availability of improved or recommended varieties, with the high cost of inputs and labour. These findings suggest that farmers struggle to access certified or high-yielding varieties seeds due to weak supply chains, untimely distribution, and an overall gap between the demand and supply. At the same time, high prices of seeds, fertilizers, and pesticides combined with expensive and often scarce labour during peak periodsplace a heavy financial burden on farmers. The situation is worsened by weak or poorly implemented policy support as subsidies, timely input distribution, and technological assistance are either insufficient or inaccessible. Together these factors createsa substantial economic barriers that limit the

Table 2. Total Variance Explained and Varimax

Component	Eigenvalue	% of Variance	Cumulative %
1	1.894	21.04%	21.04%
2	1.379	15.32%	36.37%
3	1.261	14.01%	50.38%
Rotated Component Matrix (Varimax)			
Constraint	Component 1	Component 2	Component 3
High cost of inputs	0.536		
Weak policy support	-0.691		
Doubts about effectiveness	0.771		
Distant supply agencies		0.660	
Complex fertilizer calculations		0.808	
Gov't support for inputs/technology		0.516	
Non-availability of varieties			0.744
High cost of labours			0.712

adoption of recommended practices.

To better understand these issues, Principal Component Analysis (PCA) condensed the eight major constraints into three dimensions: economic, technical, and availability-related constraints, which collectively explained 50.38% of the total variance. This categorization reflects the three dominant challenges perceived by farmers in mustard production.This somewhat counterintuitive result may indicate that farmers under economic pressure tend to optimize available resources more efficiently, possibly driven by participation in programs like CFLD, which aim to improve profitability through demonstrations and support.

Overall, the results underline that mustard adoption and productivity are influenced primarily by economic and availability-related factors, while technical challenges are less critical, possibly due to mitigation efforts. For long-term improvement, however, it is essential to strengthen seed and input delivery systems, expand policy support, reduce input and labour costs, simplify technical recommendations, and ensure continuous extension services. Such measures would not only enhance adoption but also ensure sustainability of improved practices across diverse farming groups.

Conclusion

This study investigated the constraints to adopting recommended mustard production practices among farmers participating in Cluster Frontline Demonstrations (CFLDs) in western Uttar Pradesh. By utilizing Principal Component Analysis (PCA) to identify these barriers. The findings reveal that economic, technical, and availability-related constraints significantly shape adoption patterns. Technical constraints, such as complex fertilizer calculations, suggesting mitigation through CFLD interventions like extension services.

The Economic Constraint Model provides a robust framework for interpreting these results, highlighting how economic barriers, such as high input costs and inadequate policy support, limit farmers' ability to adopt improved practices. The economic constraints indicating that farmers facing greater economic pressures may be more motivated to optimize production through CFLD participation, which offers subsidized inputs and training. However, the need for stronger policy interventions, such as enhanced subsidies and efficient input supply chains, to alleviate these barriers and ensure broader adoption among resource-poor farmers.

Complementing this, the Diffusion of Innovations (DOI) Theory explains the uneven adoption rates observed. The identified constraints map onto DOI's attributes: technical barriers reflect high complexity, reducing adoptability, while availability issues hinder trialability and compatibility with existing systems. The positive effect of availability-related constraints on yield suggests that improving access to certified seeds and timely labor enhances observability of benefits, encouraging adoption among early majority farmers. CFLDs, by demonstrating tangible yield improvements, act as a catalyst for diffusion, particularly for innovators and early adopters. However, the theory indicates that scaling adoption to late majority and laggard farmers requires simplifying technical recommendations and increasing visibility of relative advantages through field demonstrations.

These findings underscore the critical role of CFLDs in addressing adoption barriers, yet long-term sustainability demands systemic changes. Strengthening input supply chains, simplifying technical guidelines, and expanding extension services are essential to reduce economic and technical constraints, aligning with the Economic Constraint Model's emphasis on resource accessibility. Simultaneously, leveraging DOI principles—such as enhancing trialability through small-scale demonstrations and improving observability via farmer networks—can accelerate diffusion across diverse farmer categories. Policymakers and extension agencies should prioritize these strategies to bridge the adoption gap, enhance mustard productivity, and support India's goal of reducing edible oil import dependency.

Conflict of Interest- None

References

Chauhan, J.S., Singh, K.H. and Kumar, A. 2024. Status of Rapeseed-Mustard Production in India: Trends and Challenges. *Indian Journal of Agricultural Sciences*. 94(3): 245-252.

Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences*. Lawrence Erlbaum.

Directorate of Rapeseed-Mustard Research, 2024. *Annual Report on Oilseed Production and Technology Dissemination*. DRMR, Bharatpur.

Fakayode, S.B. 2016. *Journal of Agricultural Extension*. 20(1): 1-14.

Feder, G., Just, R. E. and Zilberman, D. 1985. Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change*. 33(2): 255-298.

Garrett, H.E. and Woodworth, R.S. 1969. *Statistics in Psychology and Education*. Vakils.

Gupta, R. and Sharma, P. 2023. Constraints in Adoption of Improved Agricultural Technologies: A Case Study of Mustard Farmers in Rajasthan. *Journal of Agricultural Extension*. 21(2): 89-97.

Jolliffe, I.T. and Cadima, J. 2016. *Philosophical Transactions of the Royal Society A*. 374(2065): 20150202.

Kumar, S., Meena, R.S. and Singh, R. 2023. High-Yielding Mustard Varieties: Potential and Performance in Semi-Arid Regions. *Agricultural Research*. 12(4): 301-310.

Meena, P.D., Singh, V.V. and Chattopadhyay, C. 2022. Bridging Yield Gaps in Oilseed Crops: Challenges and Opportunities. *Indian Farming*. 72(5): 15-20.

Rathore, S.S., Shekhawat, K. and Babu, S. 2022. Sustainable Mustard Production in Rainfed Agroecosystems: Constraints and Solutions. *Journal of Arid Agriculture*. 8(1): 44-52.

Rogers, E.M. 2003. *Diffusion of Innovations* (5^{th} ed.). Free Press.

Sharma, M. and Singh, D. 2023. Role of Mustard in Crop Diversification and Soil Health Management. *Agronomy Journal*. 115(2): 178-185.

Singh, B., Kumar, V. and Yadav, R. 2024. Impact of Cluster Frontline Demonstrations on Mustard Productivity in Northern India. *Journal of Oilseed Research*. 41(1): 33-40.

Singh, K.M. 2018. *Journal of Agri Search*. 5(3): 167-172.

Yadav, D.B. and Kumar, A. 2023. Socio-Economic Factors Influencing Adoption of Mustard Production Technologies. *Indian Journal of Extension Education*. 59(4): 112-119.