Research Note

Indian Journal of Extension Education
Vol. 62, No. 3 (July–September), 2026, (313-317)

ISSN 0537-1996 (Print)
ISSN 2454-552X (Online)

Assessment of Farmers' Adoption of Improved Groundnut Cultivation Practices in Bundelkhand Region of Uttar Pradesh

Yash Pateriya[1]*, N. R. Meena[2], R. K. Doharey[3], Prateek Kumar[1], Smita Singh[1] and Kumar Sonu[1]

[1]Research Scholar, [2]Assistant Professor, [3]Professor, Department of Agricultural Extension, Acharya Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India
*Corresponding author email id: yashpateriya786@gmail.com

HIGHLIGHTS

- Time and method of sowing recorded the highest adoption index (72.84) among all production technology components.
- Crop diversification was the least adopted practice (49.83), indicating a critical gap in sustainable intensification strategies.
- Information source exerted the highest total effect (0.5822) on adoption, underscoring the centrality of extension access.

ARTICLE INFO

Keywords: Technology adoption, Groundnut, Bundelkhand, Path analysis, Sustainable production.

https://doi.org/10.48165/IJEE.2026.623RN04

Citation: Pateriya, Y., Meena, N. R., Doharey, R. K., Kumar, P., Singh, S., & Kumar, S. (2026). Assessment of Farmers' Adoption of Improved Groundnut Cultivation Practices in Bundelkhand Region of Uttar Pradesh. *Indian Journal of Extension Education*, *62*(3), 313-317. https://doi.org/10.48165/IJEE.2026.623RN04

Reviewed by: Naseeb Choudhary (shivsambhu41@gmail.com); Shanila S (shanila986@gmail.com); Dwity Sundar Rout (routdwitysundar@gmail.com)

ABSTRACT

The study was conducted during 2025–2026 in the semi-arid Bundelkhand region of Uttar Pradesh, India, to examine the socioeconomic, institutional, and behavioral determinants of groundnut production technology adoption and to map pathways linking adoption to sustainable production outcomes. A multi-stage stratified random sampling design was employed to select 480 groundnut-growing households from 32 villages across Jhansi and Mahoba districts. Primary data were collected through a pre-tested structured interview schedule administered via face-to-face personal interviews. Adoption was assessed across 11 technology components covering 61 discrete practices using a three-point scale and summarized as an Adoption Index. Results indicated that time and method of sowing recorded the highest Adoption Index (72.84), while crop diversification was the least adopted (Adoption Index: 49.83). A majority (75.63%) of farmers fell in the medium adoption category. Pearson correlation analysis revealed that family size ($r = 0.459$), information source ($r = 0.582$), and knowledge level ($r = 0.448$) were significantly associated with adoption. Path coefficient analysis identified information source and family size as variables with the highest total effects on adoption. These findings highlighted the need for context-specific extension strategies to bridge adoption gaps in resource-constrained semi-arid farming systems.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a crop of foundational importance to India's food and oilseed economy. In India, groundnut is cultivated across 5.76 million hectares with a total production of 11.94 million tonnes and a yield of 2,073 kg ha^{-1} during 2024–25, accounting for 35.3% of total oilseeds produced (Department of Agriculture and Farmers Welfare [DAFW], 2025). Despite occupying the largest area under groundnut cultivation globally, India's productivity lags significantly behind China and the United States. The primary factors contributing to low productivity include the crop's confinement to rainfed areas (approximately 85%), high susceptibility to weather variability, and soils of low fertility and light texture, compounded by non-availability of quality seed at the right time, uneven fertiliser use, and deficient crop management (Meena et al., 2025).

These structural constraints are further amplified by accelerating climate instability. Groundnut is grown in marginal arid

---

Received 20-05-2026; Accepted 02-06-2026

and semi-arid agro-ecosystems with wide yield fluctuations due to spatial variability of rainfall and soil. Climate change is predicted to increase intra- and inter-annual rainfall variability, further constraining the groundnut economy beyond existing economic and social pressures (Chilwal et al., 2025). The semi-arid Bundelkhand region of central India, spanning thirteen districts across Uttar Pradesh and Madhya Pradesh, exemplifies this convergence of agronomic vulnerability and structural underinvestment.

The prolonged dominance of single-crop-based groundnut systems, unbalanced fertiliser use, and reduced application of organic manure have acutely aggravated production vulnerabilities in the region, threatening both household food security and long-term soil health (Bana et al., 2024). Tripathi et al. (2023) observed declining trends in productivity of oilseed crops across the Bundelkhand region of Uttar Pradesh, reinforcing the urgency for technology-led intensification.

Technology adoption among smallholders in dryland India is, however, neither automatic nor assured. The determinants of adoption differ based on household attributes, the specific technology, and geographical location. One key finding across the literature is the existence of substantial diversity in adoption factors, suggesting that context-specific analysis is essential for accurate policy design (Kumar & Nain, 2012; Ruzzante et al., 2021). In Bundelkhand evidence confirms that socioeconomic and behavioral factors are equally important as agronomic ones. Jatav (2024) demonstrated that entrepreneurial orientation, risk-taking, innovativeness, and pro-activeness, were significant factors influencing farmers' adoption of climate-smart agriculture practices, while education was linked to acceptance of certified seed and soil testing technologies. Jha et al. (2024) similarly underscored that institutional access and information exposure critically shape the multi-technology adoption decisions of smallholder farmers. Despite the region's strategic importance as a groundnut-producing zone and the mounting evidence that technology adoption can raise system productivity by up to 24% (Choudhary et al., 2022), a comprehensive understanding of the determinants of technology adoption and their linkage to sustainable production pathways in semi-arid Bundelkhand remains absent from the literature.

METHODOLOGY

The present study was conducted during 2025–26 in the Bundelkhand region of Uttar Pradesh, India, a semi-arid agro-ecological zone characterised by recurrent drought episodes, high inter-annual rainfall variability, and structurally fragile smallholder farming systems. Two districts, Jhansi and Mahoba, were purposively selected based on two criteria: the significant proportion of gross cropped area under groundnut cultivation, and the documented vulnerability of these districts to climatic stress and resource constraints that suppress productivity below regional potential. Both districts are representative of the broader agrarian challenges confronting groundnut farmers across the Bundelkhand landscape. A multi-stage stratified random sampling design was employed to ensure spatial representativeness and minimize selection bias. In the first stage, four blocks per district were selected purposively, based on the extent of area under groundnut cultivation, yielding eight blocks in total. In the second stage, four villages were selected from each block through simple random sampling, producing 32 villages across both districts. In the third stage, from the complete household listing in each selected village, 15 groundnut farmers were randomly selected, yielding a final analytical sample of 480 groundnut-growing households. Primary data were collected through a structured and pre-tested interview schedule administered via face-to-face personal interviews, supplemented by direct field observation. The schedule comprised multiple thematic sections covering socio-economic characteristics, institutional access (credit, extension contact, and market linkage), psychological attributes (risk orientation, innovativeness, and scientific orientation), and adoption of eleven components of improved groundnut production technology spanning 61 discrete practices, including improved seed varieties, seed treatment, nutrient management, and integrated plant protection measures.

Adoption level was assessed on a three-point scale: fully adopted (3), partially adopted (2), and not adopted (1), with a maximum attainable adoption score of 183 (61 practices × 3). An Adoption Index was computed as the ratio of the respondent's actual adoption score to the maximum possible adoption score, multiplied by 100. The relationship between socio-economic independent variables and adoption scores was examined using Pearson product-moment correlation analysis. To identify variables exerting the strongest net influence on adoption and to quantify the direct and indirect channelling effects of predictor variables, path coefficient analysis was performed following the procedure outlined by Dewey and Lu (1959). All statistical tests were interpreted at the 5% level of significance, and data were processed using SPSS version 25.0 and R studio.

RESULTS

Adoption index across technology components

Table 1 presents the adoption index across eleven components of improved groundnut production technology. Among all components, time and method of sowing recorded the highest adoption index (72.84), ranked first, followed by irrigation management (71.08, rank II) and field preparation (70.67, rank III). Recommended varieties and sowing practices ranked fourth (69.98), while intercultural operations (66.79) and marketing practices (65.85) ranked fifth and sixth, respectively. Manure and fertiliser

Table 1. Adoption index across groundnut production technology components

S.No.	Technology Component	Adoption Index	Rank
1	Field preparation	70.67	III
2	Recommended varieties and sowing	69.98	IV
3	Time and method of sowing	72.84	I
4	Manure and fertilisers	65.84	VII
5	Irrigation management	71.08	II
6	Intercultural operation	66.79	V
7	Crop diversification	49.83	XI
8	Insect and pest management	64.15	IX
9	Disease management	59.44	X
10	Harvesting	65.21	VIII
11	Marketing	65.85	VI

application (65.84) and harvesting practices (65.21) ranked seventh and eighth. Insect and pest management (64.15) and disease management (59.44) occupied the ninth and tenth ranks. Crop diversification recorded the lowest adoption index (49.83) and was ranked last (XI), indicating it as the most critical gap in the adoption of sustainable groundnut intensification practices.

Correlation between independent variables and adoption

The Pearson correlation coefficients between independent variables and adoption score are presented in Table 2. Among the socioeconomic variables, family size ($r = 0.459$, $p < 0.001$), land holding ($r = 0.432$, $p < 0.001$), and annual income ($r = 0.412$, $p < 0.001$) were positively and significantly correlated with adoption. Age showed a significant negative correlation ($r = –0.138$, $p < 0.01$), indicating that younger farmers were relatively more likely to adopt improved technologies. Gender ($r = 0.092$, $p < 0.05$) and family type ($r = –0.101$, $p < 0.05$) were also significantly associated with adoption. Education, formal source, informal source, and extension content did not show statistically significant correlations with adoption. Among psychological variables, risk orientation ($r = 0.283$), economic motivation ($r = 0.261$), cosmopolitan outlook ($r = 0.258$), and scientific orientation ($r = 0.239$) all showed significant positive correlations ($p < 0.001$). Knowledge level ($r = 0.448$, $p < 0.001$) and information source ($r = 0.582$, $p < 0.001$) were the strongest correlates of adoption observed in this study.

Table 2. Correlation between independent variables and adoption score

Variable	Correlation (r)
Age	-0.1382**
Gender	0.0918*
Education	0.0083^{NS}
Family type	-0.1013*
Size of family	0.459***
Land holding	0.432***
Annual income	0.4121***
Formal source	0.0103^{NS}
Informal source	0.0743^{NS}
Extension contact	0.0443^{NS}
Scientific orientation	0.2386***
Economic motivation	0.2606***
Risk orientation	0.2831***
Cosmopolitan outlook	0.2577***
Knowledge level	0.4478***
Information source	0.5822***

NS = Not significant; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Path coefficient analysis of determinants of adoption

Table 3 presents the results of path coefficient analysis examining the direct and indirect effects of independent variables on adoption. Information source (X16) recorded the highest total indirect effect (0.4728), routed substantially through annual income (X7), family size (X5), and risk orientation (X13), while its direct path coefficient was 0.1094. Knowledge level (X15) also exhibited a high total indirect effect (0.3618), channelled through information source (X16), economic motivation (X12), and scientific orientation (X11), with a direct coefficient of 0.0859. Among variables with strong direct effects, economic motivation (X12) registered the highest direct path coefficient ($\beta = 0.2821$), followed by risk orientation (X13, $\beta = 0.2648$), size of family (X5, $\beta = 0.2509$), cosmopolitan outlook (X14, $\beta = 0.2448$), annual income (X7, $\beta = 0.2446$), land holding (X6, $\beta = 0.2419$), scientific orientation (X11, $\beta = 0.2348$), and age (X1, $\beta = –0.2981$). Variables such as education (X3), formal source (X8), and extension contact (X10) showed negligible direct effects, suggesting that their influence on adoption primarily operates through mediating socioeconomic and psychological variables.

DISCUSSION

The predominance of farmers in the medium adoption category aligns with trends reported across smallholder groundnut systems in dryland India, where structural barriers including limited access

Table 3. Path coefficient analysis of independent variables with adoption

Variables	Direct effect	Indirect effect	Substantial indirect effect through single variables		
	Path coeff (β)	Total Indirect Effect	I	II	III
Age (X1)	-0.2981	0.1599	0.0914 (X5)	0.0804 (X6)	-0.0371(X7)
Gender (X2)	0.0319	0.0599	0.0346 (X12)	0.0212 (X5)	-0.0152 (X14)
Education (X3)	-0.0235	0.0319	0.0554 (X1)	-0.0289 (X6)	-0.0281 (X5)
Family Type (X4)	-0.0104	-0.0909	-0.0419 (X5)	-0.0399 (X6)	-0.0273 (X7)
Size of Family (X5)	0.2509	0.2081	0.1726 (X6)	-0.1086 (X1)	0.0345 (X7)
Land holding (X6)	0.2419	0.1902	0.179 (X5)	-0.0991 (X1)	0.0642 (X7)
Annual income (X7)	0.2446	0.1675	0.0635 (X6)	0.0452 (X1)	0.0363 (X16)
Formal source (X8)	-0.0238	0.0341	0.037 (X16)	-0.0311 (X15)	0.0165 (X15)
Informal source (X9)	0.0194	0.0549	0.0344 (X13)	-0.0258 (X15)	0.017 (X16)
Extension content (X10)	-0.0548	0.0991	0.0536 (X9)	0.0307 (X15)	0.0207 (X13)
Scientific orientation (X11)	0.2348	0.0037	-0.0289 (X12)	-0.0282 (X1)	0.0216 (X16)
Economic motivation (X12)	0.2821	-0.0215	-0.0377 (X1)	0.0304 (X5)	-0.0241 (X11)
Risk orientation (X13)	0.2648	0.0183	0.0283 (X16)	-0.0188 (X11)	-0.0129 (X7)
Cosmopolitan Outlook (X14)	0.2448	0.0129	-0.0201 (X7)	0.0164 (X16)	-0.0119 (X6)
Knowledge Level (X15)	0.0859	0.3618	0.0587 (X16)	0.0505 (X12)	0.0479 (X11)
Information source (X16)	0.1094	0.4728	0.0811 (X7)	0.0758 (X5)	0.0685 (X13)

to inputs, credit, and reliable extension consistently suppress adoption below the high-performance threshold. The relatively higher adoption of sowing-related practices, compared to crop diversification and disease management, reflects a pattern common in semi-arid production systems where farmers prioritise technologies that offer immediate, predictable yield benefits with low perceived risk (Slathia et al., 2018).

The significant positive correlation of family size with adoption corroborates the resource endowment hypothesis: larger families provide greater labour availability and social capital, both of which facilitate information sharing and experimental practice of improved technologies (Gajbhiye et al., 2015; Jha et al., 2024, Kumar & Jha, 2025). The strong association of land holding and annual income with adoption is consistent with the broader adoption literature, where economic resources relax liquidity constraints that prevent smallholders from purchasing certified seeds, fertilisers, and pesticides required by improved technologies (Ruzzante et al., 2021; Khawale & Chinchmalatpure, 2023).

The negative association of age with adoption, and the absence of a significant association for formal education, may reflect the particular context of Bundelkhand, where informal learning through peer networks and field demonstration is often more influential than formal schooling. This finding is consistent with Jatav (2024), who reported that entrepreneurial behavioral dispositions, rather than formal education, were the primary drivers of climate-smart technology adoption in Uttar Pradesh. The strong path effects of risk orientation, economic motivation, and cosmopolitan outlook confirm that psychological readiness for innovation is a critical mediating factor between resource availability and actual adoption (Kumar & Jha, 2025).

The finding that information source exerted the highest total effect on adoption, substantially mediated through economic and structural variables, underscores the central role of extension services in unlocking the adoption potential of groundnut farmers. The indirect pathways through which information source influences adoption, via annual income, family size, and risk orientation, suggest that extension must simultaneously strengthen information delivery while addressing the socioeconomic barriers that condition its effectiveness (Kumar & Jha, 2025). Bana et al. (2024) similarly found that system-level integrated management approaches substantially improved productivity and profitability in semi-arid groundnut systems when accompanied by sustained institutional support. The low adoption of crop diversification, despite its documented role in reducing climatic vulnerability (Chilwal et al., 2025), points to the need for market-linked extension approaches that make diversification financially attractive, not just agronomically sound.

CONCLUSION

The study establishes that technology adoption among groundnut farmers in semi-arid Bundelkhand is primarily shaped by a convergence of structural resources (family size, land holding, annual income), psychological dispositions (risk orientation, economic motivation, cosmopolitan outlook), and information environment (information source, knowledge level). While most farmers have achieved medium-level adoption, substantial gaps persist in crop diversification and disease management. Information source exerts the highest total influence on adoption through multiple indirect pathways, making strengthening of extension delivery systems the single most impactful lever for accelerating adoption. Extension programmes designed for this region should integrate behavioural and motivational dimensions alongside technical content, with particular emphasis on market-linked crop diversification to advance the transition toward sustainable groundnut production in Bundelkhand. Future research may incorporate longitudinal approaches, comparative regional analyses, and advanced structural modelling techniques to better understand dynamic pathways influencing sustainable groundnut technology adoption.

DECLARATIONS

Ethical approval and consent to participate: Our study did not require ethical approval, and all the authors agree.

Consent of publication: Participants provided consent for publication

Availability of supporting data: Supporting data are available upon request.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of interest: No competing interests were declared.

Authors' contributions: Conceptualization of research (YP, NRM, RKD); Designing of the experiments (YP, NRM, RKD); Contribution of experimental materials (YP, NRM, RKD); Execution of field survey and data collection (YK, PK, SS); Analysis of data and interpretation (KS, YP); Preparation of manuscript (KS).

REFERENCES

Bana, R. S., Choudhary, A. K., Nirmal, R. C., Kuri, B. R., Sangwan, S., Godara, S., Bansal, R., Singh, D., & Rana, D. S. (2024). High-value crops' embedded groundnut-based production systems vis-à-vis system-mode integrated nutrient management: Long-term impacts on system productivity, system profitability, and soil bio-fertility indicators in semi-arid climate. *Frontiers in Plant Science, 14*, 1298946. https://doi.org/10.3389/fpls.2023.1298946

Chilwal, A., Kothiyal, S., Praharaj, C. S., Reddy, K. K., Detroja, H., & Bera, S. K. (2025). Navigating climate change challenges for a resilient future in groundnut production: A review. *Journal of Agronomy and Crop Science*, *211*(5), e70111.

Choudhary, B. B., Sharma, P., Choudhary, M., Kumar, S., Dwivedi, R. P., Mahesha, H. S., Singh, S. K., & Dubey, S. K. (2022). Does adoption of improved agricultural practices reduce production costs? Empirical evidence from Bundelkhand region, Uttar Pradesh, India. *Current Science, 123*(10), 1232–1236.

Department of Agriculture and Farmers Welfare. (2025). Agricultural statistics of India 2024–25. Ministry of Agriculture and Farmers

Welfare, Government of India, New Delhi. https://agricoop.gov.in/en/agricultural-statistics

Dewey, D. R., & Lu, K. H. (1959). A correlation and path-coefficient analysis of components of crested wheatgrass seed production. *Agronomy Journal, 51*(9), 515–518.

Gajbhiye, R., Nain, M. S., Singh, P., & Chahal, V. P. (2015). Developing linkages for agricultural technology transfer: A case study of research institution and voluntary organization partnership. *Indian Journal of Agricultural Science, 85*(6), 838-844.

Jatav, S. S. (2024). Factors affecting adoption of climate-smart agriculture practices: Evidence from Uttar Pradesh, India. *Indian Journal of Extension Education, 60*(2), 27–32. https://doi.org/10.48165/IJEE.2024.60205

Jha, G. K., Velayudhan, P. K., Bhatia, A., Laishram, C., Kumar, D., Begho, T., & Eory, V. (2024). Transitioning towards sustainable agriculture: analysing the factors and impact of adopting multiple sustainable inputs by paddy farmers in India. *Frontiers in Sustainable Food Systems*, *8*, 1447936.

Khawale, V. G., & Chinchmalatpure, U. R. (2023). Adoption of turmeric cultivation practices by turmeric growers. *Bhartiya Krishi Anusandhan Patrika*, *38*(4), 417-419. https://doi.org/ 10.18805/bkap651

Kumar, P., & Nain, M. S. (2012). Technology use pattern and constraint analysis of farmers in Jammu district of Jammu and Kashmir state of India. *Journal of Community Mobilization and Sustainable Development, 7*(2), 165-170.

Meena, H. N., Ajay, B. C., Rajanna, G. A., Yadav, R. S., Jain, N. K., & Meena, M. S. (2025). Improved production practices for sustainable groundnut cultivation: An Indian perspective. *International Journal of Research in Agronomy*, *8*(10), 394–402.

Pongener, S., & Jha, K. K. (2024). Information sources utilization and adoption behaviour of pineapple growers in Nagaland. *Indian Journal of Extension Education*, *60*(1), 46-52. https://doi.org/10.48165/IJEE.2024.60109

Ruzzante, S., Labarta, R., & Bilton, A. (2021). Adoption of agricultural technology in the developing world: A meta-analysis of the empirical literature. *World Development, 146*, 105599. https://doi.org/10.1016/S0305-750X(21)00214X

Slathia, P. S., Kumar, R., Nain, M. S., Sharma, B. C., & Paul, N. (2018). Land use and technology adoption analysis of paddy cv. Basmati-370 in irrigated sub-tropics of Jammu district. *Indian Journal of Agricultural Sciences, 88*(9), 1469-73. https://doi.org/10.56093/ijas.v88i9.83519

Sonu, K., & Jha, K. K. (2025). Knowledge gap and path analysis of adoption of Makhana (*Euryale Ferox* Salisb) growers in Bihar. *Indian Journal of Extension Education*, *61*(1), 83-88.

Sonu, K., & Jha, K. K. (2026). Unveiling regional disparities in Makhana farming: A multidimensional analysis from Bihar. *Indian Journal of Extension Education*, *62*(1), 15-20.

Thangjam, B., Jha, K. K., Sharma, S., & Singh, H. (2024). Factors affecting on adoption of sustainable agricultural practices in Manipur. *Indian Journal of Extension Education*, *60*(2), 66-70. https://doi.org/10.48165/IJEE.2024.60213

Tripathi, S. M., Kalia, A., Mishra, B. P., Mishra, S., Mishra, D., & Shukla, G. (2023). Trends in area production and productivity of sesame in Bundelkhand region of Uttar Pradesh. *Indian Journal of Extension Education, 59*(4), 40–43. https://doi.org/10.48165/IJEE.2023.59408