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Farmer Adoption of Agricultural Technologies: Factors, Barriers and Policy Perspectives

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Abstract

Agricultural technology adoption is essential for improving farm productivity, profitability, resource-use efficiency, food security, and the sustainability of agricultural systems. However, the adoption of modern technologies remains uneven because farmers face diverse economic, technological, institutional, and socio-cultural conditions. This review examines the major factors influencing farmers' adoption of agricultural technologies, key barriers restricting adoption, and policy perspectives for promoting wider and sustained technology use. The review identifies education, technical knowledge, farm size, access to credit, extension services, information, secure land tenure, and farmer organizations as important adoption factors. Major barriers include high investment costs, inadequate knowledge and skills, poor infrastructure, limited institutional and market support, and perceived risks associated with technological change. The review emphasizes context-specific policies combining financial assistance, strengthened extension, digital literacy, infrastructure development, and farmer-centred technology development.

Keywords: *Agricultural Technology Adoption; Farmers; Adoption Barriers; Agricultural Innovation; Agricultural Policy.*

1 Introduction

Agricultural technology has become an important component of modern farming systems, offering opportunities to improve productivity, profitability, resource-use efficiency and resilience to climate and environmental challenges. Technologies such as improved seed varieties, farm machinery, irrigation systems, precision agriculture, digital advisory services, mobile applications and climate-smart farming practices can help farmers make better production decisions and reduce losses [1]. However, the availability of a technology does not necessarily guarantee its adoption. Many farmers, particularly small and resource-constrained producers, continue to face difficulties in accessing, evaluating and effectively using new agricultural technologies. Evidence from a large meta-analysis demonstrates that technology adoption varies considerably according to the technology, geographical setting and socio-economic conditions of farmers [2], [3].

Farmer adoption is a complex decision influenced by economic capacity, knowledge, access to information, perceived benefits, risk, institutional support and characteristics of the technology itself. Education, farm size, access to credit, land tenure, extension services and membership in farmer organizations have been identified as important determinants of adoption across different agricultural technologies. At the same time, high investment costs, inadequate infrastructure, limited digital skills, weak markets and insufficient institutional support can restrict adoption, particularly among smallholders. Therefore, understanding the factors and barriers affecting farmers' technology adoption is essential for developing effective agricultural policies [4]. This review examines the major factors influencing adoption, the principal barriers faced by farmers, and policy perspectives for creating an enabling environment for wider and more equitable technology adoption.

2 Factors Influencing Farmers' Adoption of Agricultural Technologies

Farmers' adoption decisions are shaped by a combination of individual, farm-level, economic, technological and institutional factors. Evidence from international meta-analyses shows that there are no universally applicable determinants because the importance of individual factors differs according to technology, farming system and local context [5]. The major factors influencing adoption are summarized below.

- **Education and technical knowledge:** Education improves farmers' ability to understand information, evaluate technological benefits and use complex technologies. Training and practical knowledge further increase confidence in adopting unfamiliar technologies.
- **Farm size and productive resources:** Larger farms generally possess greater financial and physical capacity to invest in machinery, improved inputs and other technologies. Farm size is therefore frequently associated with higher adoption levels.
- **Access to credit and income:** Financial resources determine whether farmers can afford initial investments, inputs and operating costs. Access to credit can reduce financial constraints and facilitate technology adoption.
- **Extension and information services:** Contact with agricultural extension agents provides information, demonstrations and technical guidance, reducing uncertainty associated with new technologies. Extension can be particularly important where formal education is limited.
- **Land tenure and farmer organizations:** Secure land tenure can encourage investments with long-term benefits, while membership in cooperatives or farmer organizations can improve access to information, inputs, credit and collective services.

3 Barriers to Agricultural Technology Adoption among Farmers

Although agricultural technologies can provide substantial benefits, farmers often encounter multiple and interconnected barriers that prevent adoption or continued use. These constraints are particularly important for smallholder farmers, who may have limited financial resources, inadequate infrastructure and restricted access to technical services. FAO evidence highlights infrastructure limitations, high technology costs, weak institutional capacity and inadequate digital skills as important constraints to inclusive agricultural digitalization [6]. Major barriers include:

- **High financial costs:** High initial investment, input expenses, maintenance costs and uncertain returns can discourage farmers from adopting new machinery, irrigation systems and digital or automated technologies. Limited access to credit and savings further intensifies this constraint.
- **Lack of knowledge and skills:** Farmers may be unaware of available technologies or lack the technical and digital skills required for their effective operation. Limited training can increase uncertainty and reduce confidence in adoption.
- **Poor infrastructure:** Inadequate electricity, internet connectivity, mobile networks, transportation and repair facilities can restrict access to both conventional and digital agricultural technologies.
- **Limited market and institutional support:** Weak input and output markets, inadequate extension services, insufficient institutional coordination and limited access to reliable information can reduce the perceived benefits of technology adoption.
- **Risk and resistance to change:** Farmers may hesitate to adopt technologies when benefits are uncertain, technologies are difficult to use, or new practices conflict with established farming experience and local conditions.

4 Policy Perspectives for Enhancing Agricultural Technology Adoption

Effective agricultural technology adoption requires policies that address both the capacity of farmers to adopt technologies and the wider conditions that make adoption feasible. Financial policies should improve access to affordable agricultural credit, targeted subsidies, grants, insurance and technology-rental or custom-hiring services, particularly for small and marginal farmers who cannot afford high initial investments. Evidence synthesized by FAO indicates that subsidies, low-interest loans, technical assistance and voucher mechanisms can help overcome investment constraints. Agricultural extension systems should simultaneously be strengthened through farmer demonstrations, practical training, digital advisory services and locally relevant information. Improving digital literacy and providing agricultural information in accessible languages can help reduce the digital divide and improve farmers' ability to use digital technologies [7].

Policy should also prioritize rural infrastructure, including reliable electricity, internet connectivity, mobile networks, transportation, machinery services and local repair facilities. Public–private partnerships can support the development and delivery of affordable

technologies, while cooperatives and farmer organizations can facilitate collective access to machinery, credit, information and markets. Finally, technology policies should be locally adapted and farmer-centred, rather than applying uniform approaches across regions. Since adoption determinants differ by technology, geography and socio-economic conditions, policies should consider farmers' resources, needs, risks and local production systems. Such an integrated approach can improve not only technology uptake but also its sustained and productive use among farmers [8].

5 Literature review

(Pathak, 2024) [9] Adopting improved agricultural technologies is vital for increasing productivity, reducing poverty, and ensuring food security in underdeveloped nations. However, many developing regions experience low adoption rates due to diverse institutional, socio-cultural, technological, economic, and demographic factors. To address these hurdles, policymakers should focus on strengthening irrigation systems, improving the research-extension-farmers linkage, expanding credit accessibility, and providing regular training workshops for development agents and farmers alike. Furthermore, educational sectors should prioritize adult education to raise literacy levels, ensuring that farmers receive timely information. Finally, technology developers must actively incorporate farmers' needs and perspectives during the design phase to foster easier, more widespread technology adoption.

(Aranguri et al., 2025) [10] This systematic review analyzed 109 scientific articles following PRISMA guidelines to synthesize global academic output on digital literacy, technology adoption, digital skills, and the socioeconomic and cultural factors influencing contemporary agriculture. Drawing predominantly from Europe, Asia, and Latin America using quantitative, qualitative, and mixed approaches, the study evaluated precision agriculture adoption barriers in smallholder farming and rural contexts. The findings reveal a strong trend emphasizing the need for robust public policies, continuous training strategies, technological accessibility, and contextualized approaches. Ultimately, the review provides a critical framework and broad overview of the advances and limitations surrounding digital transformation in modern farming sectors.

(Addorisio et al., 2025) [11] The agricultural sector is undergoing a profound transformation driven by innovative technologies, yet adoption remains uneven across regions. To explore this dynamic, this scoping review followed PRISMA-ScR extension protocols, conducting bibliometric and content network analyses across literature from developed countries. The study aimed to capture the systemic dimension of technology adoption, highlighting interactions among knowledge-creating actors. The results indicate that existing literature treats influencing factors inconsistently, heavily prioritizing technological and economic aspects while often overlooking crucial systemic elements like governance, institutional frameworks, and stakeholder interactions. Holistic, systems-oriented approaches are therefore vital for driving sustainable agricultural development and effective technology integration.

(Adnan et al., 2025) [12] This study investigates the adoption and non-adoption behaviors of smart fertilizer technology among farmers in developing countries, addressing critical challenges related to food security, resource efficiency, and sustainability. Guided by the Unified Theory of Acceptance and Use of Technology (UTAUT) and Expectancy-Value Theory (EVT), data were collected via cross-sectional surveys from 353 farmers in Pakistan and analyzed using partial least squares structural equation modeling. The results reveal that economic constraints, inadequate technical support, and traditional practices hinder adoption, whereas education, training, and multi-sectoral collaboration enhance accessibility. The research emphasizes that policymakers must design context-specific interventions, cost-reduction policies, and sustained technical support programs to promote agricultural innovations successfully.

(Viloria et al., 2026) [13] This study examines farmers' perceptions and understanding regarding the adoption of innovative, technology-based agricultural practices to achieve sustainability. Utilizing a descriptive correlational research design with 114 respondents, the findings demonstrate that farmers generally possess a high level of understanding and positive attitudes toward agricultural technological innovation. Key drivers include economic, sociocultural, institutional, and technological aspects. However, major barriers limit wider adoption, including insufficient financial capital, limited access to bank loans, and inadequate farm inputs like quality seeds, machinery, and fertilizers. Statistical analysis revealed significant associations between farming experience and economic factors, tool types and technological aspects, and training participation with sociocultural dimensions. Addressing these structural challenges can significantly boost modern technology integration at the farm level.

(Oli et al., 2025) [14] Understanding farmers' learning attitudes and adoption behaviors is crucial in an era of rapid technological advancement. This study investigated the socioeconomic factors influencing farmers' learning behavior toward farming technologies and assessed their perspectives on the future of precision agriculture in crop and livestock production. Analyzing survey data via binary logistic regression in R-studio, the results indicate that education level and social media use significantly affect learning attitudes, whereas gender, age, income, and farming experience show no significant impact. Furthermore, farmers strongly prefer seminars, workshops, and training sessions as learning methods. The study recommends that extension systems combine these preferred training formats with social media platforms to effectively disseminate knowledge and skills, thereby supporting better technology adoption.

6 Conclusion

The review demonstrates that farmers' adoption of agricultural technologies is a multidimensional process influenced by economic, educational, technological, institutional, and socio-cultural conditions. Education and technical knowledge, access to credit, farm resources, extension and information services, secure land tenure, and farmer organizations can significantly support farmers in understanding, accessing, and using agricultural innovations. Conversely, high investment costs, inadequate technical skills, poor rural infrastructure, limited market and institutional support, and uncertainty regarding technological benefits continue to restrict adoption, particularly among resource-constrained farmers. The reviewed studies also indicate that simply making technologies available is insufficient to ensure their effective and sustained use. Policies should therefore integrate affordable credit and financial incentives with practical training, strengthened extension services, digital literacy, improved infrastructure, and better market linkages. Farmer participation should also be incorporated into technology development and implementation so that innovations are affordable, accessible, locally appropriate, and compatible with existing farming systems. A coordinated, context-specific, and farmer-centred policy approach can consequently promote more inclusive and sustainable agricultural technology adoption.

References

[1] R. Rakholia, J. Tailor, M. Prajapati, M. Shah, and J. R. Saini, "Emerging technology adoption for sustainable agriculture in India– a pilot study," *J. Agric. Food Res.*, vol. 17, p. 101238, 2024, doi: 10.1016/j.jafr.2024.101238.

[2] V. Patil and P. C. Veettil, "Farmers' risk attitude, agricultural technology adoption and impacts in Eastern India," *Agric. Food Secur.*, 2024, doi: 10.1186/s40066-024-00497-x.

[3] P. Dixit and P. B. Singh, "The Impact of Artificial Intelligence on Various Sectors: Benefits, Challenges, and Future Prospects," *Interantional J. Sci. Res. Eng. Manag.*, vol. 3, no. 2, pp. 140–144, 2024, doi: 10.69968/ijisem.2024v3si2140-144.

[4] M. C. Oko-Isu, D. M. Okello, S. Olum, C. Asekenye, S. W. Kalule, and W. Odongo, "Agricultural Technology Adoption Among Smallholder Farmers: Evidence From a Development Project in Northern Uganda," *Adv. Agric.*, 2026, doi: 10.1155/aia/5537348.

[5] U. Romadi, Yastutik, and O. F. Finunda, "The Factors Influencing Farmers' Adoption of Agricultural Technology Innovations in Pacitan Agricultural Technology Park, East Java, Indonesia," *J. Penyul.*, vol. 21, no. 02, pp. 255–266, 2025.

[6] S. P¨ochtrager, N. Bachmann, M. Brunner, S. Tripathi, and H. Jodlbauer, "Addressing challenges in agriculture: Exploring smart farming technologies to support future farming practices," *Smart Agric. Technol. J.*, vol. 13, 2026, doi: 10.1016/j.atech.2025.101694.

[7] R. T. Karbo, L. J. Frewer, F. J. Areal, A. Boaitey, and G. Jones, "Farmers' perception of enablers and barriers to the adoption of renewable energy technologies for farming: a case study of the Lawra Municipality in the Upper West Region of Ghana," *Discov. Agric.*, 2025.

[8] Q. Li, H. Zhao, F. Wang, G. Yang, and Y. Jiang, "Digital technology adoption, agricultural production efficiency, and farmers' livelihood resilience," *Front. Sustain. Food Syst.*, 2026, doi: 10.3389/fsufs.2026.1839388.

[9] B. Pathak, "A REVIEW ON THE FACTORS INFLUENCING THE ADOPTION OF NEW AGRICULTURAL TECHNOLOGIES," *Innov. across Boundaries Bridg. Sci. Technol. Humanit.*, pp. 31–52, 2024.

[10] M. Arangurí, H. Mera, W. Noblecilla, and C. Lucini, "Digital Literacy and Technology Adoption in Agriculture: A Systematic Review of Factors and Strategies," *AgriEngineering*, vol. 7, no. 296, pp. 1–29, 2025.

[11] R. Addorisio, R. Spadoni, and G. Maesano, "Adoption of Innovative Technologies for Sustainable Agriculture: A Scoping Review of the System Domain," *Sustainability*, vol. 17, no. 4224, 2025.

[12] N. Adnan, H. M. Rehman, and M. N. Alam, "Exploring agricultural innovation: an empirical investigation of factors influencing the adoption and non-adoption of smart fertilizer technology among farmers in developing countries," *Agric. Food Secur.*, vol. 14, no. 11, 2025, doi: 10.1186/s40066-025-00529-0.

[13] V. A. Viloria, J. S. Cucio, J. E. C. Navarro, and H. V Portana, "Innovation and technology in sustainable agriculture: Understanding farmers' drivers and barriers to adoption," *Int. J. Adv. Appl. Sci.*, vol. 13, no. 2, pp. 196–202, 2026.

[14] D. Oli, B. Gyawali, S. Acharya, and S. Oshikoya, "Factors influencing learning attitude of farmers regarding adoption of farming technologies in farms of Kentucky, USA," *Smart Agric. Technol.*, vol. 10, p. 100801, 2025, doi: 10.1016/j.atech.2025.100801.