Analysis of Socioeconomic Factors Influencing Farmers' Adoption of Modern Agricultural Technologies.

Ekhlas Thaer Mahmood
Department of Food Sciences, College of Medicinal and Industrial Plants, University of Kirkuk, Iraq.
*Corresponding author's email: ekhlasthaer@uokirkuk.edu.iq

Abstract
This study aimed to evaluate the impact of social, educational, and financial factors on the adoption of agricultural technologies by farmers" with in Rafiya village, located in the Al-Rashad subdistrict, Kirkuk Governorate. Data were collected from 40 farmers using a paper-based questionnaire that included independent variables (e.g., education level, financial support, and social influence) and dependent variables (e.g., technology adoption, its impact on productivity, and social integration). The data were analyzed using SPSS software, employing frequency distribution, percentages, and Spearman's rank correlation to examine the relationships between the independent and dependent variables. The results showed that the majority of farmers had completed secondary education or higher (72.5%), although education had no significant influence on the adoption of agricultural technologies (Spearman correlation = 0.097, non-significant). Regarding financial support, 77.5% of farmers relied on self-financing to cover the costs of adopting agricultural technologies, while 22.5% indicated an inability to afford these technologies. Spearman's correlation revealed a strong negative significant relationship between financial support and technology adoption ($r = -0.532$, $p = 0.000$), indicating that a lack of financial support is a major barrier to adopting modern technologies. Social influence had a positive significant correlation with technology adoption ($r = 0.490$, $p = 0.001$), highlighting the role of social networks and peer influence in encouraging farmers to adopt new technologies. Regarding the level of technology adoption, 55% of farmers adopted only one technology, 30% did not adopt any technology, and 15% adopted multiple technologies. As for the impact of technology on productivity, 27.5% of farmers reported a significant increase in productivity, while others observed a slight to moderate increase. Finally, the social integration was limited, with 35% of farmers reporting no change in their social relations, while 30% noted improved cooperation with other farmers.

Key words: Adoption of agricultural technologies, Social and economic factors, Modern agricultural technologies, Agricultural extension.

.1 Introduction

Agriculture plays a fundamental role in ensuring food security and driving economic development. Its success largely depends on the adoption of modern agricultural technologies, such as precision irrigation systems, advanced mechanization, artificial intelligence applications in farming, and digital agricultural solutions. These technologies significantly contribute to enhancing productivity, optimizing resource use, and promoting environmental sustainability, thereby enabling farming communities to adapt to economic and climatic challenges. [1]. However, despite their proven benefits, adoption rates remain relatively low, primarily due to educational, financial, and social constraints that shape

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farmers' decisions regarding the uptake of modern agricultural technologies. Agricultural extension services play a critical role in facilitating this adoption process by providing knowledge, technical guidance, and training that empower farmers to transition from traditional practices to innovative, technology-driven approaches [2.[

Several studies emphasize the importance of agricultural education in fostering technology adoption. [3] Studies have found that farmers with higher education levels exhibit significantly higher adoption rates than those with lower educational backgrounds, as they are more capable of interpreting technical information and making data-driven decisions rather than relying solely on traditional practices. Similarly, [4] highlighted that farmers who receive structured training through agricultural extension programs demonstrate greater willingness to engage with technology, as they develop better risk assessment skills and technical competencies. Furthermore, [5] demonstrated that extension services incorporating hands-on training and continuous support significantly reduce resistance to change and increase adoption rates. These findings underscore the importance of education and targeted training programs in facilitating the adoption of modern agricultural technologies.

Beyond education, financial constraints are a major barrier to technology adoption, as many modern agricultural technologies require substantial initial investments. [6] found that a lack of access to affordable credit or agricultural financing limits the ability of farmers to invest in innovative technologies, leading to continued reliance on traditional, lower-cost methods. Likewise, [7] study reported that government-supported financial programs and flexible loan mechanisms significantly enhance adoption rates, particularly in rural areas where capital availability is limited. Importantly, agricultural extension services act as a bridge between farmers and financial institutions by guiding them on how to access agricultural credit, secure grants, and make informed investment decisions that align with their farming needs. In this context, [8] concluded that farmers who receive financial literacy training through extension programs are more likely to strategically allocate resources and invest in technology compared to those who lack such support.

From a social perspective, peer influence and community engagement play a crucial role in technology adoption. [9] highlighted that interactions within farming communities facilitate the diffusion of agricultural innovations, as farmers often learn from the experiences of their peers before deciding to adopt new technologies. Similarly, [10] found that farmers who actively participate in cooperative networks or extension-led knowledge-sharing initiatives exhibit higher adoption rates compared to isolated farmers. Furthermore, [11] asserted that agricultural extension services, through farmer field schools and participatory learning programs, strengthen social networks and encourage collective decision-making, thereby accelerating technology uptake.

.1.1 Research Problem

Despite significant advancements in agricultural technology, farmers continue to face socioeconomic barriers that hinder adoption, leading to suboptimal productivity, increased operational costs, and persistent reliance on conventional farming methods. Research indicates that education, financial constraints, and weak social influence are among the primary obstacles limiting

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technology uptake [1]. However, agricultural extension services play a fundamental role in knowledge transfer, capacity building, and overcoming these challenges by equipping farmers with the necessary skills and resources to engage with modern technologies. This study seeks to investigate these factors within the context of Al-Rafiah village, located in the Al-Rashad subdistrict, Kirkuk Governorate, where agriculture is the predominant economic activity. Farmers in this region rely heavily on traditional farming methods while facing financial and social limitations that influence their decisions on technology adoption.

.1.2 Research Objectives

This study aims to provide an in-depth understanding of the factors influencing farmers' decisions regarding modern agricultural technology adoption by addressing the following research questions:

a. How does farmers' educational level influence the adoption of modern agricultural technologies?

b. What is the impact of financial support on farmers' ability to adopt technology?

c. To what extent does social influence affect farmers' decisions to adopt agricultural innovations?

d. How can agricultural extension services enhance farmers' adoption of modern agricultural technologies?

.2 Research Methodology

A sample of 40 farmers was randomly selected from Rafiya village, located in the Rashad sub-district of Kirkuk Governorate. Data were collected through a paper-based questionnaire that was carefully designed to include the following independent variables:

a. Education Level (Illiterate, Primary, Intermediate Education, Secondary Education, University Degree or Higher.(

b. Financial Support (Self-financing, Bank loans, Government support, Support from NGOs.(

c. Social Influence (Influence from the local community and peers on adopting agricultural technologies.(

The dependent variables in the study were:

a. Technology Adoption Level (Did the farmer adopt one or more technologies.(?

b. Impact of Agricultural Technologies on Productivity (Did the technologies result in increased productivity.(?

c. Social integration of Technologies (Did the technologies improve relationships among farmers or within the community.(?

After data collection, statistical analysis was conducted using IBM SPSS Statistics. The analysis included frequency distribution and percentage calculations to examine the basic data distributions, in addition to Spearman's correlation coefficient to explore the relationships between the independent and dependent variables in the study.

.3 Results and Discussion

.3.1 Frequency Distribution and Percentage Analysis of Study Factors:

.3.1.1 Education Levels for Farmers :

The Results indicate that the majority of farmers in the study sample have attained a secondary or higher education level (72.5%), signifying a relatively strong knowledge base within the agricultural sector. Conversely, 27.5% of farmers possess only primary or intermediate education, highlighting a segment of the farming population that may require targeted extension programs to enhance their understanding and application of modern agricultural practices.

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These findings align with a report by [1], which emphasizes that farmers with higher education levels exhibit greater competence in adopting and implementing agricultural innovations compared to those with minimal education. Moreover, [12] identified that low literacy rates in rural areas significantly hinder the adoption of modern agricultural technologies, reinforcing the notion that education plays a pivotal role in facilitating technology transfer. Consequently, fostering educational initiatives tailored to farmers with lower literacy levels could serve as a catalyst for increasing adoption rates and improving agricultural productivity.

Table (1): Frequency Distribution and Percentage of Farmers' Education Levels

Education Level	Frequency	Percent (%)
Illiterate	0	0
Primary Education	6	15
Intermediate Education	5	12.5
Secondary Education	19	47.5
University Degree or Higher	10	25
Total	40	100

.3.1.2 Financial Support for Farmers

Findings indicate that 77.5% of farmers rely on self-financing as their primary means of funding for agricultural technology adoption, while 22.5% reported being financially constrained and unable to afford such investments. Notably, none of the respondents reported utilizing alternative financial mechanisms, such as government subsidies, bank loans, or cooperative assistance.

The absence of external financial support in this study may be attributed to several factors. One possibility is the lack of availability or accessibility of structured agricultural financing programs within the study area. Additionally, some farmers may be unaware of existing funding opportunities or exhibit reluctance to engage with financial institutions due to unfavorable loan conditions. This aligns with findings by [10], who highlighted that inadequate financial mechanisms remain a major impediment to the adoption of agricultural innovations. In contrast, [7] demonstrated that structured government-backed financial programs significantly enhance adoption rates in regions where farmers can readily access such resources.

ISSN 2072-3857

Table (2): Frequency Distribution and Percentage of Financial Support Sources and Their Impact on Farmers

Financial Support	Frequency	Percent (%)
Governmental Support	0	0
Bank Loans	0	0
Self-Financing	31	77.5
Support from Cooperatives or NGOs	0	0
Unable to Afford the Cost	9	22.5
Total	40	100

.3.1.3 Social Influence on Technology Adoption

The role of social influence in farmers' decisions to adopt agricultural technologies appears to be relatively weak, with 52.5% of farmers reporting very weak or weak social influence, while 32.5% perceived a moderate influence, and only 15% considered social influence to be strong or very strong.

These results suggest that farmers' decisions to adopt technology are primarily influenced by individual factors such as education and financial capacity rather than social pressures. According to [9], social influence plays a crucial role in the diffusion of innovations; however, this study indicates that such an effect is limited in this particular farming community. [11] further supports this notion, arguing that social influence is more pronounced in agricultural settings that emphasize cooperative farming, whereas it tends to be less significant in individualistic farming structures. Strengthening cooperative extension services and knowledge-sharing platforms may help bridge this gap and foster a more conducive environment for widespread technology adoption.

Table (3): Frequency Distribution and Percentage of Social Influence in Technology Adoption.

Social Influence	Frequency	Percent (%)
Very Weak Influence	17	42.5
Weak Influence	4	10
Moderate Influence	13	32.5
Strong Influence	4	10
Very Strong Influence	2	5
Total	40	100

.3.1.4 Technology Adoption Levels Among Farmers

The data revealed that 55.0% of farmers adopted only one agricultural technology, indicating a gradual but promising interest in modern agricultural practices. Conversely, 30.0% of farmers did not adopt any agricultural technology, which may reflect economic or social barriers hindering technology adoption. Meanwhile, only 15.0% of farmers adopted multiple agricultural technologies, suggesting that comprehensive technology adoption remains relatively low.

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These findings indicate that technology adoption in agriculture follows a progressive adoption pathway, where most farmers initially experiment with a single technology before committing to multiple innovations. This pattern aligns with diffusion theories in agricultural innovation, as described by [9], who emphasized that technology adoption is typically gradual, with farmers first integrating one innovation and later expanding based on perceived benefits and observed success.

Similarly, [6] highlighted those high costs, limited financial support, and inadequate agricultural extension services are among the primary barriers preventing farmers from embracing multiple agricultural technologies simultaneously. This result also aligned with [13.[

Table (4): Frequency Distribution and Percentage of Technology Adoption Levels Among Farmers.

Tech Adoption Level	Frequency	Percent (%)
Did not adopt any technology	12	30
Adopted one technology	22	55
Adopted multiple technologies	6	15
Total	40	100

.3.1.5 Impact of Technology Adoption on Agricultural Productivity

The findings reveal that 32.5% of farmers had not adopted any modern agricultural technology, while 10% reported no observed impact on productivity. However, 27.5% noted a substantial increase in productivity following technology adoption, while others experienced slight to moderate improvements.

These results underscore the varied effectiveness of agricultural technologies among farmers, which may stem from differences in application methods, training levels, or the suitability of technologies to local farming conditions. [14] emphasized that the extent of productivity gains from technology adoption is largely contingent upon farmers' technical knowledge and the compatibility of new technologies with prevailing agricultural systems. To maximize these benefits, greater investment in extension training and adaptive research is recommended to ensure that farmers can optimize the use of available technologies.

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Table (5): Frequency Distribution and Percentage of the Impact of Technology Adoption on Agricultural Productivity.

Productivity Impact	Frequency	Percent (%)
Have not used any technology yet	13	32.5
No impact observed	4	10
Slight increase in productivity	6	15
Moderate increase in productivity	6	15
Significant increase in productivity	11	27.5
Total	40	100

.3.1.6 Social integration of Technology Adoption

%35of farmers reported that adopting agricultural technologies had no effect on their social relationships, while 30% stated that it enhanced cooperation with other farmers, and 5% felt that it reduced cooperation.

These findings suggest that the social integration of agricultural technology adoption remains limited, emphasizing the need to strengthen cooperative networks among farmers. According to [11], agricultural technologies can enhance social interactions and collaborative learning when robust knowledge-sharing platforms exist, such as farmer cooperatives and digital extension services. Therefore, developing structured community-based extension programs may foster stronger social cohesion among farmers and further accelerate the diffusion of agricultural innovations.

ISSN 2072-3857

Table (6): Frequency Distribution and Percentage of Social integration Following Technology Adoption.

Social integration	Frequency	Percent (%)
I have not adopted any technology yet	12	30
No impact on my social relationships	14	35
Increased my collaboration with other farmers	12	30
Decreased my collaboration with other farmers	2	5
Total	40	100

.3.2 Spearman Correlation Analysis Between Socioeconomic Factors, Technology Adoption, Productivity, and social integration Among Farmers

.3.2.1 The Influence of Education Level on Technology Adoption, Productivity, and social integration

The correlation analysis indicates that education level is not a significant determinant of agricultural technology adoption, with a weak and non-significant correlation of (0.097, P = 0.553). This suggests that formal education alone does not decisively influence farmers' decisions to adopt modern agricultural technologies. Likewise, the correlation between education level and productivity was weak and negative (-0.143, P = 0.378), indicating that higher education does not necessarily lead to increased productivity; rather, hands-on experience and access to technical training may be more critical factors. Furthermore, education level had no meaningful correlation with post-adoption social integration (0.006, P = 0.969), implying that formal education does not play a direct role in shaping farmers' social interactions following technology adoption. These findings align with [15], who emphasized that while education enhances cognitive capacity, its direct impact on technology adoption remains limited unless coupled with effective agricultural extension and advisory services.

.3.2.2 The Impact of Financial Support on Technology Adoption, Productivity, and social integration

The results revealed a strong negative correlation between financial support and technology adoption (-0.532, P = 0.000), suggesting that farmers who rely on financial assistance are less likely to adopt new technologies compared to those who self-finance their agricultural investments. This could be attributed to strict loan conditions, financial risk aversion, or skepticism regarding the economic feasibility of new technologies. However, financial support demonstrated a strong positive correlation with productivity (0.501, P = 0.001), indicating that farmers receiving financial

backing experience significantly higher productivity levels, likely due to their ability to invest in quality inputs, modern machinery, and improved farming techniques. Interestingly, financial support showed a negative correlation with social interaction (-0.475, P = 0.002), suggesting that farmers who depend on external funding tend to be less engaged in knowledge-sharing and collaborative agricultural initiatives. These findings align with [10], who concluded that financial aid alone is insufficient to guarantee technology adoption and must be complemented by well-structured agricultural extension programs to maximize its impact. This result also aligned with [16[

.3.2.3 The Role of Social Influence in Technology Adoption, Productivity, and social integration

Social influence emerged as a key driver of technology adoption, with a strong positive correlation of (0.490, P = 0.001). This suggests that farmers who actively interact with their peers and participate in agricultural networks are significantly more likely to adopt modern technologies. This finding is consistent with existing research highlighting that farmer-to-farmer interactions and exposure to successful adopters play a crucial role in reducing uncertainty and accelerating technology diffusion. However, the correlation between social influence and productivity was weak and statistically insignificant (0.215, P = 0.182), indicating that while social engagement may encourage technology adoption, it does not necessarily result in immediate productivity gains unless the adopted technologies are effectively implemented. In terms of post-adoption social integration, a moderate positive correlation (0.391, P = 0.013) was observed, suggesting that farmers who adopt technology tend to experience greater social integration, often gaining recognition within their farming communities. These results support the findings of [11], who emphasized that social networks serve as crucial platforms for information exchange, reinforcing farmers' confidence in adopting and sustaining new agricultural technologies.

Table (7): Correlation Between Independent Factors (Education Level, Financial Support, and Social Influence) and Dependent Factors (Technology Adoption, Productivity, and Social Interaction) Using Spearman's Coefficient.

Spearman's Coefficient		**Tech Adoption Level**	**Productivity Impact**	**Social integration**
Edu Level	Correlation	.097	-.143	.006
	significant	.553	.378	.969
Financial Support	Correlation	-.532**	-.501**	-.475**
	significant	.000	.001	.002
Social Influence	Correlation	.490**	.215	.391*
	significant	.001	.182	.013

*. Correlation is significant at the 0.05 level.

**. Correlation is significant at the 0.01 level.

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.4 Conclusion

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The results of the study showed that the educational level of farmers did not have a significant effect on the adoption of modern agricultural technologies, as the data revealed no meaningful relationship between education and technological adoption.

.2 It was found that 77.5% of farmers rely on self-financing, and the results showed a negative significant correlation between financial support and the level of technology adoption, indicating that a lack of financial support is a key barrier to adopting modern technologies.

.3 The results indicated that social influence had a positive significant impact on the adoption of technologies, with cooperation among farmers enhancing the adoption of these technologies.

.4 The study recommends enhancing agricultural extension programs, providing sustainable financial support to farmers, and fostering social cooperation to facilitate the adoption of modern agricultural technologies.

.5 References

[1] FAO. (2023). The role of agricultural technologies in sustainable food production. FAO Publications.

[2] Mariano, M. J., Villano, R., & Fleming, E. (2012). Factors influencing farmers' adoption of modern rice technologies and good management practices in the Philippines. Agricultural systems, 110, 41-53 . https://doi.org/10.1016/j.agsy.2012.03.010

[3] Yokamo, S. (2020). Adoption of improved agricultural technologies in developing countries: Literature review. International Journal of Food Science and Agriculture, 4(2). http://dx.doi.org/10.26855/ijfsa.2020.06.010

[4] Ninh, L.K. (2021), "Economic role of education in agriculture: evidence from rural Vietnam", Journal of Economics and Development, Vol. 23 No. 1, pp. 47-58. https://doi.org/10.1108/JED-05-2020-0052

[5] Farhan, Mohammed Khalid Mohammed, Basim Al Badri, Boubaker Dhehibi. (2017). Economic Analysis of the Factors Affecting the Adoption of Sub Surface Irrigation Technology in Iraq. International journal of science and research (Raipur, India), 6 (9), pp. 1777-1783. DOI: 10.21275/ART20176714

[6] Klerkx, L., Van Mierlo, B., & Leeuwis, C. (2012). Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. Farming Systems Research into the 21st century: The new dynamic, 457-483 .doi 10.1007/978-94-007-4503-2_20

[7] World Bank. (2023). Agricultural Finance in Developing Countries. World Bank Publications.

[8] Drewry, J. L., Shutske, J. M., Trechter, D., & Luck, B. D. (2022). Assessment of digital technology adoption and access barriers among agricultural service providers and agricultural extension professionals. Journal of the ASABE, 65(5), 1049-1059. https://doi.org/10.13031/ja.15018

[9] Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.

[10] Feder, G., & Umali, D. L. (1993). The adoption of agricultural innovations: a review. Technological forecasting and social change, 43(3-4), 215-239 . https://doi.org/10.1016/0040-1625(93)90053-A

[11] Pronti, A., Mancinelli, S., Mazzanti, M., & Crudeli, L. (2024). The 'Good Farmer'concept and the diffusion of innovations in rural Africa. Economia Politica, 1-32 .https://doi.org/10.1007/s40888-024-00352-z

[12] Mohammad M., Mohammad A., & Toni T (2015). The Impact of Some Social and Economic Factors on the Farmers Adoption of Fodder, Feeding, and Breeding Technologies in the Middle Area of Syria. Syrian Journal of Agricultural Research. (2)1, 41-54. https://agri-research-journal.net/SjarEn/?p=219

[13] Al-Jubouri, Kh. A. M & Al-Taie, A. O. O. (2009). Adoption rate of corn cultivators for agricultural innovations in hawija district/kirkuk governorate. Tikrit Journal for Agricultural Sciences, 9(1.(

[14] Huang, W., & Wang, X. (2024). The impact of technological innovations on agricultural productivity and environmental sustainability in China. Sustainability, 16(19), 8480 .https://doi.org/10.3390/su16198480

[15] Asfaw, D. M. (2021). Analysis of technical efficiency of smallholder tomato producers in Asaita district, Afar National Regional State, Ethiopia. PloS one, 16(9), e0257366 . https://doi.org/10.1371/journal.pone.0257366

[16] Okla, Kh. A. M. (2010). Training Needs of Al-Abbasy Region Farmers in Kirkuk Governorate in the Field of using and Maintenance of Drip Irrigation Systems and its Relationship with some Variables. Tikrit Journal for Agricultural Sciences, 10(2.(

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