Factors Affecting Adoption of Sustainable Agriculture Practices in Avocado Production by Smallholder Farmers in Njombe Region

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Abstract
Avocado production *is expanding rapidly worldwide, with key producers such as Mexico, Peru, and Chile dominating the market. In Tanzania, particularly in the Njombe region, the avocado sector is emerging, benefiting from favorable climatic conditions and the active involvement of smallholder farmers. However, despite this potential, challenges persist, particularly in the limited adoption of sustainable agricultural practices. This study explores the factors influencing the adoption of these practices among smallholder avocado farmers in Njombe, using the Diffusion of Innovations theory to analyze socio-economic, environmental, and institutional variables. A quantitative and qualitative data collection approach was employed, using surveys, interviews, and focus group discussions, to gather data from 50 farmers across five villages. The findings reveal that secure land ownership, access to extension services, and younger age significantly ($p \leq 0.05$) facilitate the adoption of sustainable practices. In contrast, older farmers and those with extensive local experience tend to resist change. The study emphasizes the need to address financial constraints and perceived risks to promote sustainability in avocado farming. Recommendations for targeted interventions and community engagement are essential to ensure the long-term viability of Tanzania's avocado industry, while balancing economic development with ecological health.*

Keywords: *Avocado production, sustainable agricultural practices, smallholder farmers, Diffusion of Innovations*

INTRODUCTION

Sustainable agricultural practices are crucial for improving the long-term productivity and environmental health of avocado farming, especially for smallholder farmers. Sustainable agriculture refers to farming practices that aim to meet current food production needs without compromising the ability of future generations to meet their own needs. These practices are based on three main pillars: environmental sustainability, economic viability, and social responsibility. According to Altieri (2018), sustainable practices

enhance long-term productivity by improving soil fertility and reducing reliance on synthetic inputs, which can degrade the land over time. Pretty (2008) emphasizes that environmental sustainability requires farmers to use techniques such as crop rotation, integrated pest management (IPM), and agroforestry to maintain ecological balance and reduce the environmental footprint of farming.

For smallholder farmers, achieving economic viability is equally essential to make crop production profitable. However, adopting sustainable methods requires an initial investment. However, in the long run, these practices result in reduced input costs, greater resilience to climate variability, and access to premium markets for organic or fair-trade-certified goods (Gibbon & Ponte, 2005). Naylor et al. (2012) argue that sustainable agriculture improves farmers' welfare by offering access to knowledge, training, and better working conditions. It also fosters collaboration among farmers, local organizations, and policymakers to address shared challenges, such as access to resources and sustainable food production (Davis et al., 2012).

Avocado (Persea Americana) is a key crop globally, both nutritionally and economically. Avocado production has grown substantially worldwide, with Mexico, Peru, and Chile as major contributors (FAO, 2020). In 2023, global avocado production reached 10.47 million metric tons, a rise from 9.53 million metric tons in 2022 (Statista, 2025). According to Msafiri (2024), the avocado, often referred to as “green gold,” has shifted from being a niche product to a global dietary staple. However, challenges remain, particularly regarding the limited adoption of sustainable agricultural practices (Brown, 2020).

Several factors hinder smallholder avocado farmers' ability to adopt sustainable agricultural practices. These include socio-economic factors, knowledge and education gaps, environmental and climatic factors, institutional and policy challenges, and cultural or social barriers. A study by George et al. (2019) in Kenya identified waterlogging, soil fertility issues, and lack of information on avocado production and marketing as key challenges. Similarly, Rop et al. (2023) found that education levels, access to extension services and credit, climate information, and agro-ecological settings significantly influence the adoption of climate-smart practices among farmers in Kenya. In India, farmers' adoption of sustainable practices depends on various factors, including socio-economic, biophysical, institutional, financial, technical, and psychological aspects (Priya & Singh, 2022).

In Tanzania, the avocado industry is gaining traction, particularly in regions like Njombe, which is crucial to the country's production (Kwakye, 2018). Tanzania ranks third among Africa's avocado producers, behind South Africa and Kenya, and is the 19th-largest producer globally (Tanzania Invest, 2024). The Njombe region in southern Tanzania is particularly suited for avocado cultivation, thanks to the favorable climate, soil conditions, available land, and a proactive population and local authorities. However, challenges remain, especially regarding productivity, quality, and value chain issues in northern Tanzania (REPOA, 2018).

Despite Njombe's potential for avocado production, farmers face several challenges. According to Kilimo Kwanza (2024), these challenges include insufficient access to high-quality seedlings, inadequate farmer training, poor agricultural practices, and limited knowledge of pest and disease management. These barriers must be addressed to ensure sustainable avocado production in Tanzania.

This study is crucial as it seeks to understand the factors affecting the adoption of sustainable agricultural practices in avocado production among smallholder farmers in Njombe. Understanding both the global and local dynamics of avocado production is crucial for shaping strategies that support the long-term success of Tanzania's avocado industry. Therefore, this research investigates the factors influencing the adoption of sustainable practices and identifies solutions to the challenges hindering adoption in the region.

The growing prospects for smallholder farmers in Njombe motivated this study, which aims to identify the challenges they face in adopting sustainable practices (Smith et al., 2020; Jones, 2018). While global trends emphasize environmentally friendly and socially responsible farming, the specific factors affecting smallholder avocado farmers remain poorly understood. The sustainability of avocado production is critical not only for the economic well-being of farmers but also for the long-term ecological health of the region (Johnson, 2016).

Despite Ngombe's potential, the adoption of sustainable practices needs further exploration (Davis, 2019). Understanding these factors is essential for developing targeted interventions, policies, and support mechanisms that can enhance sustainability in avocado production, improve farmers' livelihoods, and contribute to the region's environmental health (Clark, 2015; Wilson, 2018). The literature lacks a comprehensive examination of the unique challenges farmers face in adopting sustainable practices (Smith et al., 2020;

Johnson & Lee, 2019), and specific strategies to promote sustainability in avocado farming in this localized context are understudied (Nguyen et al., 2018). This study aims to fill this gap by providing an in-depth analysis of the factors influencing sustainable agricultural practices, identifying challenges faced by smallholder farmers (Thompson et al., 2022), and proposing actionable strategies tailored to the specific needs of Njombe (Mujuni & Mwita, 2020).

This study applies the Diffusion of Innovations theory (Rogers, 2003) to explore the socio-economic, environmental, and institutional factors influencing the adoption of sustainable agricultural practices in avocado production. This theory offers a framework for understanding the various aspects required to adopt sustainable practices.

The study aims to assess the factors influencing the adoption of sustainable agricultural practices, examine the challenges farmers face, and identify strategies to increase the uptake of sustainable practices in avocado farming. The study also analyzes the categories of adopters (innovators, early adopters, early majority, late majority, and laggards) and the channels through which information about innovations is disseminated. By identifying these factors, the study intends to develop strategies to promote the adoption of sustainable agricultural practices among smallholder farmers in Njombe.

METHODOLOGY

This study was conducted in the Njombe region in southern Tanzania, a prominent avocado-producing area with substantial support from local authorities for sustainable agriculture. In contrast, regions like Kilimanjaro face constraints, including limited knowledge of pest and disease management (Kilimo Kwanza, 2024). Purposive sampling was used to select Wanging'ombe District due to its strong engagement in avocado farming. Within the district, five villages: Mngate, Mdandu, Igwachanya, Igima, and Imalinyi were randomly selected. Villages outside the selected ones were excluded due to low avocado farming activity or limited accessibility during the study period. A cross-sectional, mixed-methods research design was employed. This approach integrates quantitative and qualitative data to provide a comprehensive understanding of the adoption of sustainable agricultural practices. The specific mixed-methods design applied was a convergent parallel design, where both datasets were collected and analyzed separately but then integrated during interpretation.

A population of approximately 500 avocado farmers was identified from the selected villages (2022 census). A stratified random sampling method was

applied to ensure representation across age, farming experience, and investment capacity.

The sample size was calculated using Kothari's (2004) formula:

$$n = \frac{N}{1+N.e^2}$$

Where n = size of samples, 500 = total population; e = standard error of sampling (13%) is tolerated.

To determine the appropriate sample size for this study, the following formula was used:
Where:

n = sample size
N=500 = (total population of avocado farmers)
e=0.13e = 0.13e=0.13 (margin of error or level of precision, 13%)

Based on this calculation, the estimated sample size is approximately 53 farmers. However, due to logistical and resource considerations, a sample of 50 farmers was selected for this study. This number remains within an acceptable range for the specified margin of error and provides a reasonable representation of the target population.

Semi-structured interviews were conducted to collect qualitative data and gain in-depth insights into farmers' perspectives, challenges, and experiences regarding sustainable avocado farming practices and the support systems available to them. Additionally, focus group discussions (FGDs) were organized within villages to capture collective views and foster richer dialogue about farming practices and community-level support mechanisms.

Structured questionnaires were used to collect data from 50 farmers on socio-demographic variables, land ownership, farming methods, and access to services. The quantitative data were analyzed using descriptive statistics (frequencies, percentages, means) and binary logistic regression to assess factors influencing adoption. This model was selected because adoption was treated as a binary outcome variable (1 = adopted, 0 = not adopted). If a farmer adopted at least one type of sustainable agricultural practice, they were considered to have adopted the practices promoted by the study. The model used predictor variables listed in Table 2, which were fitted into the binary regression analysis. The equation for the binary logistic regression model is as follows:

$$Y = In[Pi/(1-Pi)] = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + ...+ \beta_k x_{ki} \quad .....1$$

Where: the subscript i denotes the i^{th} observation in the sample, P is the probability of the outcome, β_0 is the intercept term, and β_1, β_2, …, β_k are the coefficients associated with each explanatory variable X_1, X_2, …, X_k.

Table 1: Variables used in the binary logistic regression model

Variable	Definition
Response variable	
Adoption of sustainable agricultural practices	1 Adopted, 0 = Not adopted
Predictor variables	
Sex of the farmer	1= Male, 0 =Female
Age of the farmer	Age in years
The education level of the farmer	Years of schooling
Secondary occupation of the farmer	1 if employed by the formal sector, 0 otherwise
Access to extension service	1 = Yes, 0 = No
Extra labour demand during the farming season	1 if demand extra labour, 0 otherwise
Title deed of land, proper ownership by the farmer	1 if available, 0 otherwise
The period a farmer lives in the same area	Period in years
Marital status of the farmer	1 if married, 0 otherwise

A total of 24 participants were engaged in qualitative data collection. 12 in-depth interviewees: local extension officers, experienced avocado farmers, and cooperative leaders. 2 Focus Group Discussions (FGDs), each with 6 participants (total = 12): farmers of mixed age and gender. Participants were selected using purposive sampling based on their experience, availability, and relevance to the research topic. In-depth interviews lasted between 40 and 60 minutes. FGDs lasted approximately 90 minutes. These sessions were audio-recorded, transcribed, and translated. The interviews provided deep insights into individual experiences, while FGDs captured group dynamics and shared challenges.

Qualitative data were analyzed using thematic analysis, guided by the framework of Braun and Clarke (2006). NVivo software was used to code and identify recurring themes. Data saturation was reached after the second FGD and the tenth in-depth interview, when no new themes emerged. The combination of in-depth interviews and FGDs was used to enhance triangulation and validate findings across different respondent categories. Integration occurred at the interpretation stage. Themes from qualitative data helped explain quantitative results, for example, how access to extension services influences adoption practices. Convergence and divergence between datasets were carefully analyzed to form comprehensive conclusions.

Secondary data were drawn from Government reports (e.g., Ministry of Agriculture) and Academic journals.

RESULTS AND DISCUSSION

The findings of this study provide valuable insights into the socio-demographic and institutional factors influencing the adoption of sustainable agricultural practices among smallholder avocado farmers in Njombe, Tanzania. The data revealed a relatively balanced gender distribution and a concentration of farmers within the middle-aged brackets (31–60 years), which supports earlier research asserting that this age group forms the backbone of agricultural productivity in Sub-Saharan Africa (Johnson & Brown, 2019).

Demographic Information of the Respondents

A total of 50 smallholder farmers were interviewed across five villages: Mngate (10 respondents), Mdandu (15), Igwachanya (10), Imalinyi (8), and Igima (7). The study aimed to capture a broad spectrum of perspectives from farmers with different educational backgrounds, farming experiences, and locations within the Njombe region.

Gender Distribution

The gender distribution among respondents was relatively balanced, with 66% male and 34% female. This reflects the general trend in rural Tanzania, where men often head households (URT, 2003). This balance is crucial for understanding the diverse experiences and needs of both male and female farmers in avocado production, as highlighted in previous studies (Smith et al., 2017).

Age Distribution

The majority of respondents (38%) were aged between 31 and 45 years, followed closely by another 38% in the 46 to 60 age group. This distribution is consistent with findings by Johnson and Brown (2019), which indicate that middle-aged individuals are often the backbone of agricultural activities in rural communities. These farmers, typically with sufficient experience, play a crucial role in avocado farming.

Education Level

Farmers exhibited a range of educational backgrounds, with a significant number having completed primary and secondary education (54%). Only 12% had attained university-level education, and a small proportion (8%) had no formal education. These results underscore the importance of designing

agricultural extension programs that cater to varying educational levels, as emphasized by Davis et al. (2018).

Years of Experience

A majority of respondents (40%) had 7 to 9 years of experience in avocado farming, followed by 36% with 4 to 6 years of experience. This indicates that many farmers, while experienced, might have started avocado farming relatively recently, emphasizing the importance of continuous learning and capacity-building to ensure sustainable agricultural practices.

Location Distribution

Respondents were distributed across five villages, with Mdandu having the highest representation (30%). This distribution suggests that location-specific strategies are essential to address the unique needs of each community, as highlighted by studies such as those by Thompson et al. (2020).

Farm Size

Farm sizes varied, with 32% of respondents owning 9 acres or more. Larger farms may face unique challenges related to scale, as indicated by Smith and Jones (2015), necessitating tailored strategies for larger agricultural operations.

Table 2: Demographic Information of Respondents

Demographic Unit	Categories	Frequency	Percent
Age	16 to 30	6	12.0%
	31 to 45	19	38.0%
	46 to 60	19	38.0%
	61 and above	6	12.0%
Education Level	Primary Level	13	26.0%
	Secondary Level	14	28.0%
	College Level	13	26.0%
	University Level	6	12.0%
	None of the Above	4	8.0%
Years of Experience	1 to 3	2	4.0%
	4 to 6	18	36.0%
	7 to 9	20	40.0%
	10 and above	9	18.0%
Location Name	Mngate	10	20.0%
	Mdandu	15	30.0%
	Imalinyi	10	20.0%
	Igwachanya	7	14.0%
	Igima	8	16.0%
Farm Size (acres)	0 to 2	9	18.0%
	3 to 5	11	22.0%
	6 to 8	14	28.0%
	9 and above	16	32.0%

Table 3: Binary logistic regression results for factors influencing the adoption of sustainable Agricultural practices

Variables	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Age of the farmer	-0.070	0.026	7.294	1	0.007**	0.932	0.886	0.981
The education level of the farmer	-0.244	0.100	5.967	1	0.015**	0.784	0.644	0.953
Secondary occupation of the farmer	0.300	0.622	0.232	1	0.630	1.349	0.399	4.563
Land ownership	2.779	0.844	10.846	1	0.001**	16.111	3.081	84.237
Extra labour	2.442	1.127	4.690	1	0.030**	11.493	1.261	104.749
Extension service	1.216	0.502	5.858	1	0.016**	3.373	1.260	9.029
Marital status of the farmer	-0.606	0.639	0.900	1	0.343	0.545	0.156	1.909
Sex of the farmer	-0.115	0.624	0.034	1	0.854	0.892	0.263	3.028
Years of living in the same area	-0.138	0.034	16.680	1	0.000**	0.871	0.816	0.931
Constant	5.912	2.829	4.368	1	0.037	369.598		

Source: Field study

Note: Variables significant at 0.05

The influence of land ownership rights on the adoption of sustainable agricultural practices was statistically significant (p = 0.000), as shown in Table 3. The result indicates that secure land ownership increases the likelihood of farmers adopting sustainable practices. Hella (2003) supports this finding, stating that the nature of land tenure affects both the type of farming system and the farmers' ability to invest in natural resource management. Specifically, farmers without absolute ownership rights are generally less inclined to make long-term investments in their land. In addition, access to extension services significantly influenced the adoption of sustainable agricultural practices, with a p-value of 0.016. This suggests that farmers who have access to extension services are more likely to implement these practices. One key informant noted,

"Farmers have the opportunity to receive guidance on selecting and implementing proper land-use interventions to increase crop production." (Agricultural extension officer at Igma ward, June 24, 2024).

FGD participants also confirmed this as they said that:

> *Frequent visits by agricultural extension officers, especially during the farming season, enhance our chances of implementing proper interventions (FGD participants at Mngate, June 26, 2024).*

Furthermore, the age of the household head was statistically significant and negatively influenced the adoption of sustainable practices (p = 0.007). This suggests that older farmers are less likely to embrace new agricultural methods. Many older farmers are reluctant to adopt practices such as tree planting, which provide long-term benefits. A participant from Mdandu

village commented, "Many of us who are older are hesitant to implement interventions like planting trees because the benefits take years to materialize" (FGD with farmers at Mdandu, April 15, 2024). This trend aligns with findings by Koch and Strotmann (2006), who observed that older individuals are generally less inclined to adopt new technologies than younger individuals.

Additionally, farmers' education level was statistically significant ($p = 0.015$), indicating that those with higher formal education were less likely to adopt sustainable agricultural practices than those with lower education levels. Moreover, the demand for extra labor during the farming season was also significant ($p = 0.03$), suggesting that farmers who require additional labor are less likely to adopt labor-intensive practices. A participant from Igwachanya village noted, "Implementing labor-intensive practices requires more manpower during the farming season" (FGD with farmers at Igwachanya, April 20, 2024).

Finally, the number of years spent living in the same area was statistically significant ($p = 0.000$), indicating that farmers who have lived in the exact location for many years are less likely to adopt new sustainable agricultural practices. Possibly due to entrenched traditional practices and resistance to behavioral change, as observed in similar studies (John, 2012).

This was in line with a key informant from Imalinyi village, who remarked, "Farmers who have lived in the same area for years are often difficult to convince to adopt new practices." A participant from a focus group in Imalinyi echoed this sentiment, stating,

> *"We have been cultivating with these practices for so long that we are reluctant to change unless we see direct benefits" (FGD with farmers at Imalinyi, April 11, 2024).*

The study highlights the importance of demonstrating clear benefits to motivate changes in farming practices, consistent with findings by John (2012), who reported that as the number of years a farmer has lived in the same village increases, the likelihood of adopting new agricultural practices decreases. These findings align with a study by Rop *et al*. (2023), which found that factors such as farmers' education level, access to extension services and credit, climate information, planting techniques, agroecological settings, and avocado planting duration significantly influence the adoption of climate-smart practices.

Socio-economic Factors Influencing the Adoption of Sustainable Agricultural Practices

Respondents' perspectives on socio-economic factors influencing the adoption of sustainable agricultural practices in avocado production reveal varied insights. A substantial portion (37.5%) agrees that educational background positively influences farming practices. Opinions on the impact of annual income are divided, with 39.6% undecided, suggesting a nuanced relationship between income and the ability to adopt sustainable practices. Notably, a significant proportion believes that awareness of sustainable practices positively affects avocado production (40.8%).

According to Rogers (1962), diffusion theory explains how socio-economic factors, such as education and awareness, can facilitate the adoption of new technologies. Dessart (2019) also emphasizes the importance of behavioural factors affecting adoption, suggesting that understanding these factors can lead to more effective agricultural policies.

Overall, more than 50% of respondents agree that socio-economic factors influence the adoption of innovative technologies in avocado production.

Table 4: Average Responses of Respondents for Objective One

Question No	Question	Percentage
1	Educational background positively influences my avocado farming practices.	65%
2	Annual income significantly impacts the ability to adopt sustainable agriculture practices.	50%
3	Years of experience in avocado farming affect willingness to adopt sustainable practices.	60%
4	Awareness of sustainable agriculture practices in avocado production.	65%

Source: Field study

Potential Challenges to Adopting Sustainable Agricultural Practices

The recognition of educational background as a positive influence on the adoption of sustainable practices aligns with existing literature (Smith & Jones, 2019), which suggests that farmers with higher education levels are more likely to adopt sustainable practices. However, concerns about financial constraints (39.6%) highlight the practical challenges faced by smallholder farmers, reinforcing findings by Garcia et al. (2018). While there is overall awareness of sustainable practices (31.3% strongly agree), uncertainty regarding the challenges involved (42.0%) suggests that awareness alone is

not sufficient to ensure adoption. Additionally, indecision about the risks associated with sustainable practices (45.8%) highlights a critical area for intervention.

According to Rogers (1962), understanding the diffusion of innovation can help identify the barriers to adopting sustainable practices. While early adopters may be more open to change, the majority of farmers often face hurdles due to perceived risks. This emphasizes the need for targeted education to address the concerns of those resistant to change.

In conclusion, over 65% of respondents acknowledge potential challenges to adopting new technology, including financial constraints, perceived risks, and awareness issues.

Table 5: Exposure to Potential Challenges in Adopting Sustainable Agriculture Practices

Question	Frequency	Percent
1. Financial constraints are a significant challenge in adopting sustainable agriculture practices.	44	89.8%
2. Risks associated with sustainable agriculture practices are a hindrance to adoption.	46	94.5%
3. I perceive challenges in adopting sustainable agriculture practices for avocado production.	21	42.0%
4. Risks associated with sustainable agriculture practices influence my decision not to adopt them.	30	60.5%
5. I have implemented sustainable agriculture practices on my avocado farm.	23	45.8%

Source: Field study

Actionable Strategies to Increase Adoption of Sustainable Agricultural Practices

Objective Three focuses on strategies to enhance the adoption of sustainable agricultural practices among smallholder avocado farmers. According to Smith et al. (2020), farmers' perceived knowledge levels significantly influence their adoption behavior. In our study, 4.2% of respondents consider themselves slightly knowledgeable, 35.4% moderately knowledgeable, 47.9% very knowledgeable, and 12.5% extremely knowledgeable. These findings suggest that a strong understanding of sustainable practices positively impacts adoption. Confidence in implementation is also a crucial factor, with 2.1% expressing no confidence, 12.5% slightly confident, 31.3% moderately confident, 41.7% very confident, and 12.5% extremely confident. Community support plays a key role in fostering adoption, as 37.5% reported slight support, 41.7% moderate support, and 20.8% strong support. Active

participation in training programs among smallholder farmers is common, although the perceived effectiveness of these programs varies.

Tseng (2019) argues that establishing actionable strategies is essential for agricultural improvement. Rogers (1962) suggests that engaging early adopters can facilitate broader adoption among smallholders. Sharing success stories and addressing concerns about risks and uncertainties are critical steps in encouraging the widespread adoption of sustainable practices.
In conclusion, over 60% of respondents agree that implementing actionable strategies will help in the adoption of sustainable agricultural practices.

Table 6: Distribution of Respondents

Question No	Question	Percentage
1	How knowledgeable do you consider yourself about sustainable agriculture practices in avocado farming?	66.4%
2	How confident are you in the effectiveness of your knowledge in implementing sustainable agriculture practices?	65.8%
3	To what extent do you feel supported by the local community in adopting sustainable agriculture practices?	62.0%
4	Have you participated in any training programs focused on sustainable agriculture practices?	64.0%

Source: Field study

CONCLUSIONS

This study aimed to investigate the factors influencing the adoption of sustainable agricultural practices among avocado farmers in Wanging'ombe District, Njombe Region, Tanzania. Utilizing a convergent parallel mixed-methods design, the research provided a comprehensive understanding by combining both statistical analysis and qualitative insights.

The findings demonstrate that multiple interrelated factors, including age, education, land ownership, access to extension services, and labor availability, shape the adoption of sustainable practices. Notably, younger farmers and those with secure land rights were more likely to adopt sustainable practices, while older and more educated farmers often exhibited resistance to change. These patterns align closely with Rogers' Diffusion of Innovations Theory (2003), which posits that the adoption of new ideas or technologies is influenced by both the characteristics of the innovation and the attributes of the adopters. In this case, sustainable practices may be perceived by some farmers, particularly older or more established ones, as complex or incompatible with existing systems, thereby slowing diffusion.

According to Rogers, adopters can be categorized along a continuum from innovators to laggards. The study's findings suggest that younger farmers with fewer entrenched habits and more exposure to extension services function as early adopters, while older, more experienced farmers may fall into the late majority or laggard categories due to perceived risks or reluctance to change. Moreover, the perceived attributes of sustainable agricultural practices, such as their relative advantage, complexity, and trialability, play a crucial role in adoption decisions. Farmers expressed awareness of sustainable methods, yet financial constraints, uncertainty about outcomes, and labor demands reduced the perceived relative advantage and increased the complexity, discouraging widespread uptake.

From a theoretical standpoint, this reinforces the relevance of the Diffusion of Innovations framework in explaining agricultural behavior, particularly in rural, resource-constrained settings. The study suggests a need not only to provide technical knowledge but also to enhance perceived value and reduce the complexity of sustainable practices through well-structured, farmer-centered extension programs.

The use of a mixed-methods approach enriched the analysis by capturing both the "what" and the "why" of adoption behavior. While quantitative data highlighted key predictors, qualitative insights revealed farmers lived realities, motivations, and reservations, thereby contextualizing the diffusion process. This approach strengthens the argument for integrating behavioral theories and participatory methods in future agricultural research.

This means that promoting adoption requires more than knowledge dissemination; it demands targeted strategies that address psychological, economic, and systemic barriers. Strengthening extension services, improving access to credit, ensuring land tenure security, and developing labor-saving technologies could enhance the perceived benefits of sustainable practices, thereby accelerating their adoption and diffusion.

Thus, the study confirms that the adoption of sustainable agricultural practices among avocado farmers is a dynamic process influenced by both individual characteristics and external conditions. Applying the Diffusion of Innovations Theory offers a valuable lens for understanding this complexity. It provides a foundation for designing interventions that are not only technically sound but also socially and behaviorally appropriate.

RECOMMENDATIONS

Given the varying levels of education among farmers, extension services should be tailored to meet the specific needs of both literate and illiterate

farmers. Programs should emphasize practical, hands-on training to enhance understanding and confidence in implementing sustainable practices, particularly for older farmers who may be more resistant to change. Additionally, training should focus on clear, visual demonstrations to accommodate different learning styles and ensure broader understanding.

Land tenure security should be prioritized in agricultural policies. Farmers with secure land rights are more likely to invest in long-term sustainable farming practices. Policymakers should work to improve access to land ownership, especially for smallholder farmers, and consider offering incentives to adopt sustainable agricultural practices on owned land. Strengthening land tenure security can help farmers feel more confident in making long-term investments in their land and farming practices.

Financial constraints were identified as a significant barrier to the adoption of sustainable agricultural practices. It is recommended that financial support mechanisms, such as low-interest loans or grants, be provided to smallholder farmers to ease the initial costs of transitioning to more sustainable farming methods. Additionally, supporting access to markets for sustainably produced avocados could increase farmers' motivation to adopt these practices by providing financial incentives through premium prices for sustainably grown products.

The positive influence of extension services on adoption rates underscores the need for more frequent and accessible extension visits, particularly during critical farming periods. Local agricultural officers should be trained and deployed to work closely with farmers, offering personalized advice and support to address specific local farming challenges. Strengthening the capacity of extension services can help bridge the gap between knowledge and practical implementation.

Encouraging community-based initiatives that foster shared learning and support is crucial. Success stories from early adopters should be widely shared within communities to inspire others to adopt sustainable practices. These stories can serve as powerful examples of the benefits of sustainable agriculture. Community engagement can also help reduce resistance to change, foster trust in new agricultural methods, and create a supportive environment for the adoption of sustainable practices. By implementing these recommendations, the adoption of sustainable farming practices among smallholder farmers can be enhanced, thereby improving agricultural productivity and environmental sustainability.

LIMITATIONS AND AREAS FOR FURTHER STUDIES

This study is limited to the adoption of avocado agricultural practices; however, it did not consider farmers' economic development or their livelihoods. This study recommends Continued research on understanding the local dynamics that influence adoption behaviors, particularly concerning the risks perceived by farmers. More in-depth studies of the financial and social incentives required for adoption could provide a more straightforward pathway for policy and program design.

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