Factors Influencing Tomato Farmers to Adopt Agricultural Technologies in Mlali Mvomero District, Tanzania

Magenge Deborah[1], Kyaruzi Athman[2] , Nsenga, Justus[3]

[1]Department of Policy Planning and Management, Sokoine University of Agriculture.

[2]Department of Agricultural Extension, Sokoine University of Agriculture.

[3]Department of Development and Strategic studies, Sokoine University of Agriculture.

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ABSTRACT

This study was carried out in Mlali, Mvomero District, Morogoro. The objective of this study was to identify the key factors influencing the adoption of agricultural technologies among the tomato farmers in Mlali ward. Cross-sectional research design was employed. The study was conducted in five villages in Mlali, employing a structured questionnaire to interview 130 farmers who were selected following a random sampling technique. Additionally, two focus group discussions were conducted each with 10 participants and Key informant interview was conducted with an extension officer. Data collected were processed and analyzed using SPSS version 20. Descriptive statistic was used to assess demographic information and a multivariate logistic regression model was used to determine factors influencing tomato farmer's adoption of agricultural technologies. The findings revealed that the key factors influencing technology adoption among farmers include age ($p= 0.042$), education level ($p< 0.05$)), cooperative membership ($p= 0.001$), type of labor ($p= 0.023$), access to loans ($p= 0.041$) on which all these factors are significant at ($p< 0.05$). In conclusion, tomato farmers are more likely to adopt agricultural technologies when they have better access to resources like loans, are members of cooperative, have certain level of education, and are engaged in specific types of labor. The study recommend that local governments should assist farmers in locating market both regionally and internationally, also it is essential that intermediaries receive education on how to assist farmers in accessing market effective.

Keywords: Agriculture, Agriculture technology, Adoption of agricultural technology, Tomato

INTRODUCTION

Background Information

Tomatoes are the second most important vegetable worldwide in terms of the number of vitamins and minerals contribute to the diet. They are famous for their nutritional and economic value (Mwatawala, 2019). China leads in tomato production, followed by India and Turkey (Mwaipungu & Nzali, 2023). The crop is ranked sixth among the most consumed crop worldwide. In Africa, alone produce 21 million tons are produced from 1.3 million hectares and in East Africa, 1.9 million tons of tomatoes are produced annually, with Tanzania and Kenya leading as producers, followed by Uganda (Ddamulira, 2021). In Tanzania, a total of 129,578 tons of tomatoes are produced annually representing 51% of the total vegetable production (Michael, 2021). Tomato production in Tanzania is mainly produced by small-scale farmers (Tesha & Kongolo, 2023). The main production areas for tomato are in the country's southern regions of Iringa, Njombe, Morogoro and Mbeya, where approximately 70% of tomatoes output are produced (Siyao & Sanga, 2023). The remaining 30% is produced in the northern and coastal areas of Arusha, Tanga, Mwanza and Kilimanjaro regions (Tesha & Kongolo, 2023). In Tanzania tomato is grown during the dry season from early May and November (Zekeya, 2019) escaping the wet season

which is characterized by high level of pests and diseases (Dabalo *et al.,* 2024). Seasonal production affects the supply and demand of the crop with high supply during the dry season, which also affect the market price (Lyimo et al., 2022). In all tomato producing areas almost the entire tomato harvested is intended for market in major urban markets such as those in Arusha, Zanzibar, Dar es salaam and even as far as Nairobi and Mombasa in Kenya (Nyamba et al., 2020).

In the recent years, tomato is highly affected by climate change and variability because the crop is highly dependent on climatic conditions like rainfall, temperature and water. Therefore, effects brought by climatic change have the adverse effect to its production (Sanga & Elia, 2020). The greatest challenge in tomato production is use of agro-chemicals particularly in pests and diseases management. Misguided use of pesticides has resulted in heavy accumulation of chemical residues which is the threat to production of safe tomato in the world market where people are conscious about the diet, environment and workers welfare (Gatahi, 2020). In addition, Rutta (2022), according to lack of proper storage infrastructure and knowledge among small-scale farmers in Tanzania and several parts of sub-Saharan Africa is another critical challenge that often forced to sell their fresh tomatoes at low price, which negatively impact their income. Mrosso (2022). Informed that other factors that contributing to low tomato production are pests and diseases, harsh weather, and poor soil fertility. Despite of the existing challenges, tomato production is an important activity for smallholder farmers and provide an opportunity for poverty reduction (Minyiheri et al., 2023). Tomatoes play a crucial role in the economy for farmers in rural, urban and peri-urban areas. It generates income, create job opportunities, and supply essential nutrients to millions of people in Tanzania (Mwatawala et al., 2019). To deal with the challenges mentioned above, research has continuously been done leading to production of technologies which are disseminated through agricultural extension officer services.

The government has made significant efforts to support tomato farmers in Mlali Ward through various initiatives. These include providing transportation allowances for extension officer to facilitate their visits to farmers, ensuring timely advice and support. Additionally, the government has established reasonable prices for essential agricultural input to make them accessible to farmers. There is also investment in the redevelopment of irrigation scheme to enhance water usage efficiency and agricultural technology. Furthermore, the government has provided soil testing kits to farmers to help them assess soil quality and make informed decision regarding their agricultural practice (KII, Mhonda June 25, 2024). Furthermore, Mhonda (2024) reported that also there are different efforts done by different institutions or projects like Adra Kilimo Masoko, Fair planet, East West, Cyngentar which have taken several initiatives to assist tomato farmers in Mlali. These include organizing a farmer's days to raise awareness and provide training, creating demonstration farms to showcase best practices and supplying quality seed samples while instructing farmers on advanced agricultural technologies. They have also established farmer groups to facilitate access to essential inputs and provide low-interest loans to help farmers adopt improved farming techniques. Additionally, a peer education system has been implemented by different agricultural expertise like agro-dealers where trained farmers pass on their knowledge to others in the community.

Adopting appropriate agricultural technologies is critical for improving crop production, thereby increasing income, attaining food security, and reducing poverty (Muhaimin et al., 2020). Agricultural technologies adoption is assumed to improve the welfare of adopters through higher crop yields, reduced per unit cost of production which leads to higher own personal consumption and saving money (Feyisa, 2020). Khoza et al. (2021) informed that the perceived ease of use and usefulness of technology, labors requirements, the degree of promotion, the education and risk preference of farmers, have a significant positive impact on the willingness of a farmer to adopt. Example of technologies include tractors, drip irrigation, pesticides and herbicides, Improved seeds and organic fertilizers. Despite the potential benefits of agricultural technology in enhancing productivity and sustainability a large proportion of vegetable growers in Mlali Ward remain hesitant to adopt these technologies. Also, Fundikira et al. (2023) reported that farmers in Mlali, struggle to adopt and effectively implement agricultural technologies because farmers are limited in their ability to use agricultural technologies effective due to lack of knowledge and training. Hence this study aims to identify the key factors influencing tomato farmer’s decision to adopt the agricultural technology. Understanding these factors is crucial for developing targeted interventions that promote technology adoption, improving yields, efficiency, and the livelihoods of tomato farmers.

RESEARCH METHODOLOGY

Study area

The study was conducted in Mlali Ward, which is among the seven wards of Mvomero District in Morogoro Region. It is found in the southern part of Mvomero district bordering Morogoro Urban to the south and Morogoro rural to the East (Liberio, 2012). The ward is 30km to the west of Morogoro Municipality (Sieber et al., 2014). Mlali ward is on lowlands adjacent to the Uluguru Mountain. The climate in the area is semi- arid with annual rainfall ranging from 500-800mm. Biophysical, lowland and river valleys are the predominately agro- ecological zone of the ward (URT, 1997). The elevation is between 520 and 760 meters above sea level. The Mlali ward lies in Lattitude. -6.9667°, Longitude. 37.5500°. The average temperature ranges from 18 - 30°C and the dominant soil type in Mlali is sandy loam (Ombaeli et al., 2022).

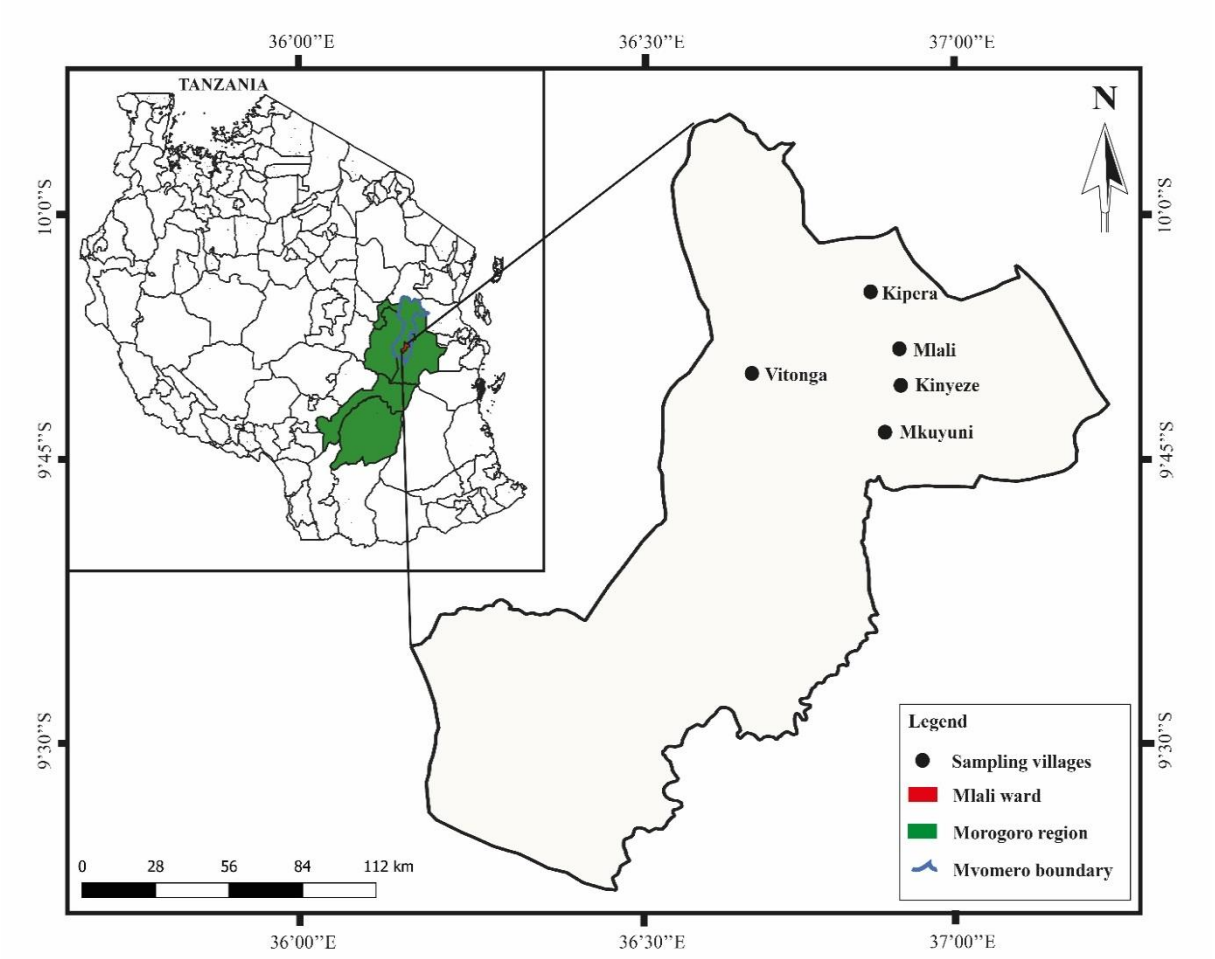

Figure 1.0: Map showing the tomato production area in Mlali ward, Mvomero District in Morogoro Region

Mlali division, with a population density of 31 people per square kilometer is characterized by sparsely populated plains and areas with high agricultural potential (Lyatuu & Urassa, 2014). Crops cultivated in Mlali includes sweet peppers, Eggplants, scarlet eggplant, Okra, Tomatoes, Cabbage, Maize, Rice, Sesame and Peas. The population of tomato growers in the study area is about 2,500 smallholder farmers each with less than five acres. The area has a long-standing reputation for tomato production both in rain season and off-season (Wenaty & Mkojera, 2024). To further enhance tomato production the government, constructed a market in Kipera village (Malisa, 2019).

Research design, Sampling procedure and sample size, and Data collection.

The study employed the cross-sectional research design since involves the collection of data from tomato farmers at one point of time and the design is cost effective and its take short time while assuring the quality data. The

study population is tomato famers from five villages in Mlali ward, Mvomero district. The villages included were Mlali, Kipera, Kinyeze, Mkuyuni and Vitonga selected purposively. The study sample size was 130 obtained through probability sampling technique where farmers were selected through randomly sampling. Each village provided two groups of participants; first group consisted of 16 tomato farmers per village (totaling 80

farmers) who adopted more than three agricultural technologies among the following drip irrigation, pesticides, herbicides, tractor, improved seeds, organic fertilizers and wooden crates. The second group consisted of 10 tomato farmers per village (totaling 50 farmers) who had adopted only three agricultural technologies of the seven like improved seeds, pesticides, and organic fertilizers. The selection of Mlali ward for this study was done purposively and selection of farmers (respondents) within each village, were selected using simple random sampling techniques for interviews. Quantitative data were collected using structured questionnaire and for qualitative data, two focus group discussions conducted with 20 participants where, the first one with 10 tomato farmers from the group of farmers who adopted only three technologies and the second with 10 tomato farmers from the group of farmers who adopted more than three technologies. Additionally, one key informant interview was conducted with an extension officer of Mlali Ward.

Data analysis

Collected data were analyzed by using the computer based Statistical package for social science (SPSS) version 20. The descriptive statistics analyzed included frequencies and percentages. Multivariate logistic regression model was used to analyze the factors influencing the adoption of selected agricultural technologies among tomato produces. In multivariate logistic regression we model the probability $(P(\mathrm{Y}=1))$ of a binary outcome Y based on multiple predictor variable $X_1, X_2 \ldots + X_n$. The log odd of outcome $\mathrm{Y}=1$ is expressed as

$$logit(P(Y=1)) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n$$

The probability itself is given by logistic function.

$$(P(\mathrm{Y}=1)) = \frac{1}{1+\exp((\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n))}$$

This model allows for the examination of relationship between the multiple predictors and a binary outcome while accounting for the influence of each predictor variable on probability of the outcome.

Whereby

$P(Y=1)$ Is the probability that the outcome Y equals to 1 (the event of interest)$logit\big(P(Y=1)\big)$ is the log-odds of the probability$P(Y=1)$

β_0 is intercept.

$\beta_1, \beta_2 \ldots \beta_n$ are the coefficients of the predictor's variables $X_1, X_2 \ldots X_n$

X1= Age

X2=Education

X3=Years of farming

X4= Market availability

X5= Family labor

X6= Farm size

X7= Access to extension

X8=Availability of loan

X9=Cooperative membership

X10=Infrastructure (markets)

For the qualitatively collected data from the focus group discussions and key informant interviews were analyzed using the thematic analysis technique to identify and interpret patterns and themes within the data. This involved systematically coding the transcripts, categorizing the data into meaningful themes, and exploring the relationships between them. By focusing on participants perspectives, and the objective of the study as well as information from literature, the study identified key issues and trends relevant to the research objective by analyzing the data. To ensure the themes were accurate and comprehensive, I share the initial list with experts, including my supervisors from the department of agricultural extension and community development of Sokoine University of Agriculture for validation. After several round of discussion, we agree on a final list of themes and then used for presenting the data.

Theoretical Framework

This study guided by the theory of Diffusion of Innovations Theory also known as the Perceived Innovation Attributes theory was developed by Everett Rogers in 1962 (Choshaly, 2019). This explains how and why individuals or groups decide to adopt an innovation or technology. This theory suggests that people evaluate technology based on several key attributes or characteristics, and these attributes influence their decision to adopt or reject the technology farmers consider attributes like Relative Advantage, this attribute help us to understand how farmers perceive the benefit of new technologies in terms of increased efficiency, cost savings, and improve performance compared to what they are currently using. In the context of this study, we will explore how tomato farmers assess whether the new agricultural technologies offer advantages that can significantly impact their productivity and income. Compatibility, this dimension will guide us in assessing how well the new technologies align with the farmers existing farming practice, beliefs, and values. It will help identify whether the technologies are compatible with social-cultural and economic conditions of tomato farming in the ward, which could influence farmers willingness to adopt them. Complexity by evaluating the complexity of the new technologies, this study will examine how easily tomato farmers can understand and use these technologies. Farmers who find the technologies too complex or difficult to implement may be less likely to adopt them, which could directly affect their labour use and productivity. Trialability factor will be important in understanding how the opportunity to experiment with the technologies before full implementation influences the farmers adoption decision. Farmers may be more willing to adopt a technology if they can test on a small scale without significant risk or cost. Observability, this aspect of the theory will help us examine how visible the benefits of the technologies are to the broader community of farmers. If the benefits are clearly observable, such as increase yields or reduce labour demands, other farmers in the community may be more likely to adopt the technologies as well. Farmers weigh these attributes differently based on their personal preferences, needs, and the specific context in which the innovation is introduced. Together, these attributes will help us to understand why tomato farmers in Mlali, Morogoro, choose to adopt or reject new agricultural technologies. By using the diffusion of innovation theory, we can also predict how these technologies might impact their income and labour cost. Thus, the theory directly informs the study's investigation of the adoption process and its outcome for tomato farmers.

RESULTS AND DISCUSSION

Demographic information of respondents

Table 1.0: Demographic characteristics of the respondents

Variables	Frequency	Percentage
Age		
19-30	33	25.4

31-42	64	49.2
43-54	27	20.8
55+	6	4.6
Sex		
Male	77	59.2
Female	53	40.8
Marital status		
Single	16	12.3
Married	109	83.8
Divorce	2	1.5
Widow	3	2.3
Education level		
Primary level	65	50
Secondary level	36	27.7
Tertiary level	11	8.5
Informal education	18	13.8
Years of farming		
1-10	98	75.4
11-20	26	20
21-30	6	4.6

The findings in Table 1.0 shows that 95.4% of respondents were aged between 19-54 years and few aged above 55 years. This suggests that the majority of the farmers are within the economic active age range and possess substantial experience in tomato farming. According to Yeboah et al. (2019) the ages between 15 to 64 is typically considered as the working age population. This age range captures the years when individuals are most productive and capable of contributing to the work force, reflecting both the economic necessity for a working age population and the societal norms related to education, career development and retirement planning. In terms of years of farming (farming experience) the study results further, shows that about 75.4% had farming experience of between one and 10 years indicating a varied experience (different experience, backgrounds and skills) among the group. A small proportion of respondents (20%) had farming experience of between 11-20 years reflecting a more moderate view, while only 4.6% had a farming experience of up to 30 years. This shows that at least 25% of respondents had farming experience above 10 years. This implying that experienced tomato farmers have a deep understanding of the crops needs and local condition, making them caution about adopting modern technologies due to perceived risk (Pivoto *et al.,* 2019). Moreover, the study revealed that the majority of respondents (59.2%) were males while 40.8% were females. Most males are engaged in the tomato production because of high demand at the market, its economic benefit like high returns and frequent harvest and lastly tomato production generate income quickly. While the lower involvement of women in tomato production is due to fact that women are often involved in growing crops that are considered less physical demanding and can be easy managed alongside household duties. Eviness *et al.* (2022) reported that males tend to venture into production of agriculture commodities that generate sizable income and that are risk takers compared to women who like to grow crops for home consumption. Despite some gained grounds, consistently, studies have shown that women tend to be very much involved in producing food crops than cash crops (Onyalo, 2019).

In terms of marital status, the study findings as shown in Table 1.0 revealed that most of respondents (83.8%) were married and 12.3% were single. Similarly, about 3.8% of respondents were widowed or divorced. The study

findings suggest that married farmers are more actively engaged in tomato production because it enables them to fulfill their family responsibility by generating income. These findings are consistent with Mwatawala *et al.* (2019), suggested that most of the African producers lives in families to facilitate the production of their farm products. Additionally, as far as education level is concerned, 86.2% of respondents reported to have received a formal education, meanwhile 13.8% had never attended to a formal school (Table 1.0). This suggests that the majority of farmers are likely better equipped to understand and adopt the agricultural technology due to their education background, leading to improve their productivity and efficient resource management. In contrast, the respondents who do not receive formal education may face challenges in accessing or utilizing these technologies effectively. These study finding are similar to Dissanayake *et al.* (2020) reported that education level has the positive relationship with the adoption of agricultural technology by farmers because education gives the farmers ability to change their knowledge, attitude and skills.

Factors influencing tomato farmers to adopt the agricultural technologies

Table 2.0: Performance measures for logit regression model

Accurate rate.	**Sensitivity.**	**Specificity.**	**AUC (ROC CURVE).**	**AIC**	**BIC**	**Pseudo R^2**	**Hosmer Lemeshow test**
96.83%	98.77%	93.33%	0.9915	63.25444	114.3075	Adj R^2 = 0.8341	$chi^2(107)$ = 69.52 Prob >chi^2 = 0.9981

Table 2.0 shows that the model exhibits outstanding performance with an accuracy of 96.83% reflecting its reliability in classification. A sensitivity of 98.77% means the model correctly identifies 98.7% of the actual events. The area under the ROC curve (AUC) of 0.9915 reveals that the model has an excellent ability to discriminate between classes. The Akaike information criterion (AIC) and Bayesian information criterion (BIC) values (63.25444 and 114.3075, respectively) suggest a well-fitting model with a manageable level of complexity. The Adjusted R^2 value of 0.8341 indicates that approximately 83.41%of the variability in the dependent variable is explained by the model. This high value suggests a strong fit of the model data. Additionally, the Hosmer-Lemeshow test results with (chi-square = 69.52, p = 0.9981) indicate that the model's predictions align well with the observed data confirming its good calibration and fit.

Table 3.0: Multivariate logistic regression analysis for factors influencing farmers to adopt the agricultural technologies

Adoption of the agricultural technology	**Category**	**Coefficient (β)**	**Odd ratio (OR)**	**95%confidence interval**	**P-values**
Age		0.174	1.19	1.006-1.400	0.042**
Education level	Informal education	1	1		
	Tertiary education	4.491	89.2	1.242-6407.261	0.039**
	Secondary education	4.235	69.1	1.281 - 3722.571	0.037**
	Primary education	10.853	51706.4	18.426 - 1.45e08	0.007**

Years of farming		-0.041	0.96	0.675 - 1.365	0.821
Type of labor	Family labor	1	1		
	Hired labor	3.655	38.7	1.646 - 907.967	0.023**
Farm size	Below 1acre	1	1		
	Above 1acre	1.063	2.89	0.158 - 53.132	0.474
	Rarely	1	1		
Access to extension services	Occasionally	1.087	2.97	0.163 - 54.108	0.463
	Frequently	1.598	4.94	0.054 - 451.759	0.488
	Very frequently	0	1		
Availability of loan	No	1	1		
	Yes	3.89	48.9	1.177 - 2032.746	0.041**
Cooperative membership	No	1	1		
	Yes	12.487	264952.4	202.698 - 3.46e+08	0.001**
Marital status	Single	1	1		
	Married	-4.199	0.02	0.000 - 18.045	0.245
	Divorce	0	1		
	Widow	-10.873	0	6.58e-57 - 5.47e46	0.857
Availability of information	Extension services	1	1		
	Fellow farmers and farmers	0.680	1.97	0.088 - 44.180	0.668
	Agricultural research	6.215	500	0.111 – 2250.144	0.148
	Agricultural cooperatives	5.265	193	1.19e-10 -3.14e+14	0.714
	Online resources and media	-1.938	0.14	0.002 - 10.078	0.371

Age

Table 3.0 shows the study results on the impact of age to the adoption of agricultural technologies. Based on the odds ratio, that is 1.188, implies that for each unit increase in the age the chances of adopting modern technologies increased by approximately 18.8%. The coefficient for the age is 0.173 indicates a direct relationship between the age and the likelihood of technology adoption, that the older farmers are the more likely to adopt this technology, and this was statistically significant at ($p< 0.05$). The findings suggest that age is among crucial factors influencing farmer's decision to adopt modern technologies, with aged farmers were more likely to adopt probably due to high experience in farming which might have positively influenced them. However young farmers may be less inclined to adopt modern technologies immediately, possibly due to limited experience and financial constraints. These findings are in agreement with that of Mwaipungu *et al.* (2023) who conducted the study on factors influencing adoption of modern technologies among tomato farmers, a case of

Mboga na Matunda project in Iringa and that of with the Dissanayake *et al.* (2022) that focused on factor affecting technology adoption in agriculture sector in Sri Lanka.

However, the current study findings differ with that reported by Gebre *et al.* (2019), Vecchio *et al. (*2020), Kehinde (2021) and Balana *et al.* (2022) that age does not significantly influence farmers to adopt agricultural technology. These differing results may be attributed to varying local context, access to resources or cultural factor that influence the adoption process. Despite this inconsistency the current study emphasizes the importance of age and experience in driving the adoption of modern agricultural practice, particularly in the context of tomato farming. In conclusion, the study reinforces the idea that older farmers with higher levels of experience are more likely to adopt modern technologies. Future initiatives should aim at increasing technology adoption among young farmers may need to focus on bringing the knowledge and experience gap through targeted training and support.

Education level

Study results in Table 3.0 revealed that education is among of the factor influencing adoption of agricultural technology. Primary level of education had p-value of 0.007 significant at ($p<0.05$), indicates that access to primary education has a statistically significant impact on tomato farmers decision to adopt technology. The odd ratio was 51706.4 suggesting that individuals with primary education were 51706.4 times more likely to adopt compared to those without access. The coefficient of 10.853 signifying that by increasing the level of education, the likelihood of adoption will increase by 10.853. The secondary level had an odd ratio of 69.1, suggesting that farmers with access to secondary education are 69.1 times more likely to adopt compare to those without access a coefficient of 4.235 suggesting that, the increase in the level of education would result to the increase the likelihood of adoption by 4.235 and p- value of 0.037 significant at ($p<0.05$) indicating a strong and significant influence on adoption. Similarly, the tertiary level showed an odds ratio of 89.2, suggesting that farmers with access to tertiary education are 89.2 times more likely to adopt compare to those without access. The coefficient of 4.491 signifying that an increase in the level of education among farmers associated with an increase the likelihood of adoption and p-value of 0.039 significant at ($p<0.05$) reflecting a significantly affect. These results suggest that all three levels of the predictor significantly impact the outcome with varying magnitudes of effects**.** Education is essential for farmers in adopting new agricultural technologies. It enables them to read instruction and comprehend training provided by agricultural experts and extension officers. This knowledge empowers them to make informed decision, seek help when needed and critically evaluate the benefit and risks associated with new practice. Ultimately improving their farming practice and increase their productivity.

Studies (Ruzzante et al., 2021; Shang et al., 2021) reported similar findings and they conclude that farmers with better education are earlier adopters of modern technologies. That is education influences adoption through increasing a farmer's ability to perceive, interpret and respond to new events in the context of risk. Furthermore, Oyetunde et al. (2021) reported that majority of the farmers who had at least 6 years of formal education and had knowledge of farm practice and technological information uptake because they can have easy access and comprehend the information. Moreover, the findings by Fadeyi and Azizi (2022) indicate that smallholder farmers with some formal education adopt the modern technologies faster than uneducated smallholder farmers. Lastly the finding is in agreement with several researchers by (Danso-Abbeam et al., 2019; Jha et al., 2019; Vecchio et al., 2020; Warinda et al., 2020; Mugula et al., 2023) who found out that level of education is positively correlated with adoption of agricultural technologies. In conclusion, the findings show role that education plays in the adoption of modern agricultural practice. Educated farmers are more likely to adopt new technologies, which enhance their ability to improve farming practice and boost productivity. The findings emphasize the need for education-focused intervention to facilitate technology adoption especially among the smallholder farmers.

Access to loans

Results in Table 3.0 revealed that the access to loan is a significant factor influencing the adoption of agricultural technologies. The p-value of 0.041 significant at ($p<0.05$), indicates that the access to loan has a statistically significant impact on tomato farmers decision to adopt technology. The odds of 48.922 suggested that individual with access to loans are 49 times more likely to adopt compared to those without access. The coefficient of access to loan was 3.89 signifying that an increase in access to loan would result to the increase the likelihood

of adoption by 3.89. This implies that the access to loan by respondents is positively associated with the adoption of agricultural technologies. Loan access enables farmers to overcome financial constraints, purchase necessary input and invest in modern farming practice. This result concurs with Girma (2022) who argued that the access to loan is the effective to overcome some of the financial obstacles associated with technology adoption by the farmers**.** Also, Balana *et al.* (2022) suggested that credit access offers the farmers with the liquidity they require to purchase inputs as well as adopting agricultural technology**.** Moreover, this finding is similar to Awotide' *et al.* (2019) reported that access to loan increase the smallholder farmers output and income where farmers with access to loan have statistically significant higher yield compared to those without access. According to Udimal *et al.* (2017) and Ullah *et al*. (2020) the lack of proper access to loan facilities ultimately incapacitates farmers to adopt the technologies but their access to credit is likely to influence their acceptance of the technology.

The studies by Simtowe & Zeller (2006) and Yu *et al*. (2020) reported that access to loan makes farmers more likely to adopt modern technology. However, once they adopt it, credit does not lead to more widespread use. This might be because the amount of credit available is not enough to significantly boost how much they use the technology. Sisang & Lee (2023), reported that high cost of adopting new technologies means that access to credit is crucial for farmers. However, when it limited it can be negatively affecting their decision to adopt improved varieties.

Analysis of data from FGDs indicate that access to credit help farmers boost they production. This is demonstrated by following remark during one of FGD session:

"Thanks to access to loan we can now invest in modern farming equipment that boosts our productivity and efficiency... (FGD, 24-06-2024, Kipera village)"

Another extract from FGD data "*Access to a loan has helped us to cover the cost of technologies also we have been able to use various technologies in my tomato farming. It has been crucial for increasing our productivity as well as income... (FGD, 24-06-2024, Kipera village)"*

In conclusion, the findings highlight the critical role that access to loans plays in the adoption of agricultural technologies. However, for credit to lead to more widespread use of technologies the amount and condition of the available credit should be carefully considered. The interventions should focus on improving farmer's access to credit to support the adoption and effective use of modern technologies.

Cooperative membership

Findings in Table 3.0 shows that cooperative is among of the factors influencing the adoption of agricultural technology. The odd ratio for cooperative membership is 264,952.4 suggesting that farmers with access to cooperative membership are 264,952.4 times more likely to adopt compare to those without access. The coefficient of 12.49 quantifies this effect by showing that each additional unit increase in the cooperative membership correspond to a 12.49 increase in adoption of agricultural technology by a farmer. The p values of 0.001 significant at ($p<0.05$) confirms that this relationship is highly statistically significant, strongly suggesting that cooperative membership has a profound and reliable impact on adoption outcomes. The results shows that by farmers being the member in cooperative significantly increases their likelihood of adopting technologies. This is because cooperative was organizing training and initiating collaboration with the research and development entities. Fore example of a cooperative in Mlali called Mlali irrigation scheme cooperates with Agro-dealers expertise, SUGECO and SUA on ensuring that their members get the opportunities to gain experience on good agricultural practice then applied it for their agricultural activities.

Analysis of FGDs data also show that membership in cooperation was beneficial as demonstrated by the following extract:

"Cooperative they offer training and information on the latest technology which really helped us to understand how to use the technology effective. With their support now see a big boost in our production and income… (FGD, 24-06- 2024, Kipera village)"

Another extract from FGD data *"Being a member of the cooperative has opened up access to vital information about new technologies availability as well as training support has made it easier for us to adopt these methods… (FGD, 24-06-2024, Kipera village)"*

The findings are consistent with the findings in previous studies (Ma & Abdulai, 2019; Zhang *et al.,* 2020; Manda *et al.,* 2020; Khan *et al.,* 2022). Moreover, the finding similar with (Kehinde, 2021; Yu *et al.,* 2021; Manda *et al.,* 2020) cooperatives provide farmers with the input support in low price, market support as well as credit support these results to increase the likelihood of farmers to adopt the technology as well as increase their income through increase in yields, reduction of cost of inputs and availability of market (Table 3.0). The study confirms that cooperative membership is a key driver of technology adoption among farmers. The support, training and resources provided by cooperatives significantly increase the likelihood of adopting modern agricultural technologies, leading to improve farming practice and higher income. Future initiatives to encourage technology adoption should prioritize strengthening cooperatives and ensuring that farmers have access to the essential support and resources needed to boost their productivity.

Type of labor used

The results in Table 3.0 indicate that the use of hired labor significantly influence the adoption of agricultural technologies. The odd ratio for hired labor is 38.655, suggests that the likelihood of adoption increased by approximately 38.66 times for individual with the hired labor compared to those without it indicating a substantial positive effect of hired labor on adoption of tomato production technologies. The coefficient of 3.655 reflects that for each unit increase in the hired labor variable the adoption increased by 3. 655. The p-value of 0.023, significant at ($P< 0.05$) indicates that this association is statistically significant reinforcing the conclusion that hired labor significantly impact the likelihood of adoption. These findings emphasize the importance of labor availability in enabling farmers to adopt new technologies, which can improve their overall agricultural practice and income. Many respondents rely on hired labor to assist with labor-intensive activities such as clearing the land, weeding, and managing the technology like tractor when cultivating. These results concur with Kehinde (2021) who conducted a study of Agricultural cooperative and improved technologies adoption among the smallholder farmers in cocoa -based farming system of southwestern Nigeria who revealed that hired labor has a positive effect for farmers to adopt the agricultural technology.

Analysis of FGDs data also show that the use of better tools like tractor plough was beneficial as demonstrated by the following extract:

"The participants expressed that they adopt new agricultural technologies to boost their productivity because through the use of better tools for example tractor drawn plough, now we can grow more tomatoes and earn more which helps us to provide for the family with the essential needs... (FGD, 24-06-2024, Kipera village)"

The ability to employ hired labor allows farmers to manage more intensive tasks, use better farming tools and ultimately increase productivity. Future efforts to promote technology adoption should focus on ensuring that farmers have access to adequate labor, either through hired help or cooperative arrangement to fully benefit from modern agricultural technologies.

Farmers are motivated by the potential for increased profitability and high yields making economic advantage crucial for adoption these findings concur with finding from (Anang *et al.,* 2020; Musafiri *et al.,* 2022; Maraveas, 2022; Takahashi *et al.,* 2023). Equally important is the access to financial resource such as loans which enables farmers to invest in modern technologies these findings similar with (Miine *et al.,* 2023; Regassa *et al.,* 2023; Gelata & Han, 2023; Magazzino *et al.,* 2024). Cooperative member play a supportive role by fostering farmers decision making a sense of community and providing shared resources it is the direct economic and financial incentives that most significantly impact farmers decision making to adopt, these findings are in agreement with that (Liu *et al.,* 2022; Chen *et al.,* 2023; Dumitru *et al.,* 2023; Zhang *et al.,* 2023) where they reported that cooperatives are important because its expose farmers to opportunities to practice good agricultural through training as well as access to loan.

Analysis of data from key informant interview revealed that most of respondent adopt the technologies with the interest of getting profit as revealed by the following extracted:

"In the district tomato farmers, they adopt agricultural technologies primarily driven by the need to enhance productivity and profitability" (KII, Mhonda June 25, 2024).

A further look of FGDs data show that the intention to increase production is critical in adoption of the technologies as demonstrated by the following extract:

"The sole intention of adopting agricultural technology is to increase production that will eventually lead to a substantial increase income which is critical to improvement farm activities hence positively impact on family's well- being… (FGD, 24-06-2024, Kipera village)"

In summary, the finding point out that age, Education level, access to loans, cooperative member, type of labor, are critical strategies for enhancing the adoption of agricultural technologies. These factors collectively lower the barriers and risk associated with the adoption new practice, making it easier and more appealing for farmers to innovate and improve their productivity as shown in (Table 3.0). The influence of factors like years of farming experience, access to extension services, marital status, and farm size on technology adoption can be limited. Farmer's years of experience do not influence the adoption of technology because experienced farmers may stick on the use of traditional methods (Edwards, 2020). Ineffective extension officer in Mlali is due to the fact that the number of farmers who are in need with this service is large and there are few extension officers who can attend to them all that's why it's the factor that does not influence them to adopt the technologies this finding is in agreement with (Amrullah *et al.,* 2023) who reported that ineffective extension services hinder farmers to adopt the technologies. Marital status might not matter if decisions are made collectively rather than individually (Humphrey *et al.,* 2023). Additionally, farm size seems not correlated with farmers adopting the agricultural technology because large scale farmers may hesitate to adopt because of risk aversion, while smaller farmers may lack the resources to implement the technologies meaning that they may hesitate to adopt due to limited resource (Wordofa et al., 2021).

CONCLUSION AND RECOMMENDATION

Conclusion

The adoption of agricultural technologies by tomato farmers in Mlali is influenced by age, cooperative membership, access to loan, type of labor, and education level. These factors providing farmers with the necessary resources, knowledge and financial support to effectively implement modern farming practice and enhance tomato production. These factors not only enhance crop yields but also enable farmers to adopt sustainable practice, resulting in a stronger and more resilient agricultural sector. Additionally agricultural institutions such as SUGECO, SUA and agro-dealers who mainly worked with farmers through their groups/cooperatives have played a crucial role by providing training to farmers on good agricultural practice and offering inputs at reduce prices. However, it was found that the adoption of technologies driven by the above factors resulted to high production of quality tomato but farmers struggled to find markets to sell their produce.

Recommendation

The study provides the following recommendations:

1. The Mvomero District Council through the market and trade section should assist farmers access markets for their tomato products both within various regions of the country and internationally.
2. Since intermediaries form a critical link between farmers and buyers, the agriculture and trade department of the Mvomero district and other stakeholders should provide training them on how to assist farmers in accessing market effectively and on ethical considerations. By equipping intermediaries with the necessary knowledge and ethical guidelines we can foster a fairer marketplace that prioritizes the welfare of the farmers.
3. The Ministry of agriculture should establish agricultural machinery hire services to help farmers with access to modern equipment without the burden of high upfront costs and strengthen the extension

servicers employing more extension staff at farmers level, but also in collaboration with private sector should develop client-oriented loan and credit services to improve access.

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