

# Economic Factors Influencing Adoption of Modern Technologies among Tomato Smallholder Farmers: A Case of Mboga Na Matunda Project in Iringa District.

Asheri Mwaipungu<sup>1</sup>, Asheri Mwaipungu<sup>2</sup>, Dr. Frank Philipo<sup>3</sup>, Dr. Agnes Nzali<sup>4</sup>

<sup>1</sup>Division of Feed For Future Mboga Na Matunda Project in Ilula- Kilolo District, Tanzania.

<sup>2</sup>Department of Community Development, University of Iringa (UoI), Iringa, Tanzania

asherimwaipungu@gmail.com, +255769591171

<sup>3</sup>Department of Community Development, University of Iringa (UoI), Iringa, Tanzania

mwangole76@uoi.aac.tz

<sup>4</sup>Department of Community Development, University of Iringa (UoI), Iringa, Tanzania

aggy.nzali@googlemail.com

**Abstract:** *Tomato is the most useful vegetables in the world and has been contributed smallholder farmers to household income. In Africa, tomato is the most useful vegetables. This study assessed factors leading to adoption of modern technologies among smallholder farmers: A case of mboga na matunda project in iringa district, Tanzania. The data were collected through interview, focus group discussion, and questionnaire from 60 respondents and analyzed by using SPSS version 20, and deductive approach method. The study was conducted to investigate the factors leading to a low adoption to modern agricultural technologies to smallholder tomato producers. A case of Mboga na Matunda project in Iringa district. 38.3% of smallholder tomato producers faced challenges in accessing credit and primarily relied on informal sources and personal savings for capital. Limited credit access was a significant barrier to adopting modern agricultural technologies. Those with restricted credit access had a lower propensity to adopt modern technologies. Access to credit was essential for procuring the necessary inputs for agricultural activities, and it had a positive relationship with technology adoption. Market price fluctuations, particularly during the rainy season, affected the affordability of technology, influencing adoption decisions. The study revealed that 96.67% of smallholder tomato producers had access to both internal and external markets. However, the volatility of prices in these markets significantly impacted technology adoption. The quality of tomato products played a pivotal role in determining market prices. The adoption of modern technologies was positively influenced by fair trade practices that enhanced product quality and, consequently, market prices. Price fluctuations, especially during the dry season, presented a challenge to smallholders, influencing their investment decisions in technology.*

**Keywords:** Technological Adoption, Adoption, Modern Agriculture, Modern Agricultural Technologies, and Smallholder farmers, Mboga na Matunda, Iringa District.

## 1. INTRODUCTION

The global context highlights the significant role of tomato farming in horticulture, with tomatoes being the third most produced horticultural crop worldwide by weight (FAOSTAT, 2020). China leads in tomato production, followed by India and Turkey. Tomato farming contributes to household incomes and employs smallholder farmers, with various modern agricultural technologies being introduced to improve production and address climate change impacts (FAO, 2019).

The tomato farming like other farming use Agricultural technologies to improve production, the introduction of modern agricultural technologies in tomato farming is the one among the technologies to adopt climate change effects. Producers have been using, on farm storage system to avoid post-harvest loss, drip Irrigation technology for inputs efficiency (monitoring of resources), and Improved Seeds technology this is development of new crop varieties that can tolerate climate changes and agricultural extension service that facilitate the transfer of knowledge and good practices to farmers (FAO,2019).

In Africa, tomatoes are vital both in rural and urban areas, with governments investing in eco-friendly agricultural technologies to enhance tomato farming and mitigate climate change effects. Factors influencing the adoption of these technologies include local climate variability (Egypt being a leading producer in Africa, FAO, 2021) and the potential for poverty reduction and employment generation (Adenuga, 2013).

In Tanzania, tomato production is vital for smallholder farmers income and food security. The country ranks highly in tomato farming in Africa (FAO, 2021). Diverse agricultural technologies such as on-farm storage, efficient resource use, pest control, resilient crop varieties, drip irrigation, and extension services are utilized to adapt to climate variability and increase production (Sanga, 2016). Despite the importance of tomato farming, there's a need to explore why advanced technologies are not widely adopted by smallholder farmers. USAID's Feed the Future project aimed to improve food security in Tanzania through horticultural agriculture (USAID, 2018). A study on technology adoption in Tanzania revealed that factors like education, land size, and rainfall patterns influenced adoption, indicating the role of climate change and variability (Mngumi, 2016).

In Tanzania, Iringa, Tanga, Kilimanjaro, and Mbeya are leading tomato production areas, contributing significantly to smallholder incomes. Understanding factors affecting tomato value chain development is essential for improving both production and market access (Iluz, *et al.*, 2017). The Southern Agriculture Growth Corridor of Tanzania (Morogoro, Iringa, Mbeya, and Songwe) has witnessed horticultural industry growth, with farmers adopting basic post-harvest and planting technologies. However, the adoption of a full technology package remains low (USAID/Tanzania, 2022).

Feed for future Mboga and Matunda project at Ilula was the project of four years initiated 2017 and ended 2021. The beneficiaries were smallholder farmers and medium enterprises. The activities of the project were to provide technical assistance, to identify agricultural technology based on cost and likelihood of adoption, use of demonstrations plots for training, capacity building to private and public sector service providers, assist loan application, and link farmers with financial institution such as SACCOS, and Farmer groups. The project, implemented under USAID which spanned four years (2017 to 2021) in Iringa, Mbeya, Morogoro and Songwe region and targeted to medium and smallholder farmers.

Despite the commendable efforts yet the adaption of technology was reported by organization the evaluate assessment of the project by USAID had revealed that on 4% project beneficiaries adopted modern agriculture technology. By "Feed for Future Mboga and Matunda" project's conclusion indicated that, while the majority of farmers had received basic technological training, the adoption of a full technology package remained notably low (USAID, 2022). The repercussions of this low adoption are far-reaching, as evidenced by the persistently low adoption rates of modern agricultural technologies among tomato producers in Tanzania, standing at less than 6%, according to the Comprehensive Africa Agriculture Development Program (UNDP and URT, 2017). This research therefore intended to delve into the factors contributing to this low adoption of modern agricultural technologies.

The Diffusion of Innovation Theory (DIT), developed by Everett Rogers in 1962, seeks to explain how, why, and at what rate new ideas and technologies spread within a population or social system. This theory originated in the field of communication but has been widely applied to various domains, including agriculture and technology adoption. The theory posits that the adoption of innovations is influenced by five key elements: the innovation itself, adopters, communication channels, time, and the social system. Innovations are typically adopted by individuals who have a certain degree of social capital and who are exposed to information about the innovation through various communication channels over time.

DIT is highly applicable to the study of factors leading to low adoption of modern agricultural technologies among smallholder tomato producers. It provides a framework for understanding how and why these farmers may or may not adopt new farming practices and technologies. The theory allows researchers to analyze the role of demographics, social networks, communication channels, economic factors, and institutional influences on technology adoption within this specific context. Several scholars have applied the Diffusion of Innovation Theory in their research. For instance, Klerkx & Leeuwis (2018) used the theory to analyze the dynamics of innovation networks in agriculture, emphasizing the role of social networks and knowledge exchange in technology adoption. Jones (2015) applied it to analyze the spread of sustainable farming technologies. Wang (2018) employed the theory to investigate the adoption of precision agriculture tools. Patel (2019) utilized the theory to understand the adoption of biotechnology in agriculture.

## **2. LITERATURE REVIEW**

### **2.1 The Diffusion of Innovation Theory**

The Diffusion of Innovation Theory (DIT), developed by Everett Rogers in 1962, seeks to explain how, why, and at what rate new ideas and technologies spread within a population or social system. This theory originated in the field of communication but has been widely applied to various domains, including agriculture and technology adoption. The theory posits that the adoption of innovations is influenced by five key elements: the innovation itself, adopters, communication channels, time, and the social system. Innovations are typically adopted by individuals who have a certain degree of social capital and who are exposed to information about the innovation through various communication channels over time.

The DIT is highly applicable to the study of factors leading to the low adoption of modern agricultural technologies among smallholder tomato producers. It provides a framework for understanding how and why these farmers may or may not adopt new farming practices and technologies. The theory allows researchers to analyze the role of demographics, social networks, communication channels, economic factors, and institutional influences on technology adoption within this specific context. Several scholars have applied the Diffusion of Innovation Theory in their research. For instance, Klerkx & Leeuwis (2018) used the theory to analyze the dynamics of innovation networks in agriculture, emphasizing the role of social networks and knowledge exchange in technology adoption. Jones (2015) applied it to analyze the spread of sustainable farming technologies. Wang (2018) employed the theory to investigate the adoption of precision agriculture tools. Patel (2019) utilized the theory to understand the adoption of biotechnology in agriculture.

Despite its usefulness, the Diffusion of Innovation Theory has some weaknesses when applied in agriculture research including oversimplification of the innovation-adoption process, insufficient attention to contextual factors, and limited consideration of power dynamics and social inequalities within the adoption process. To address these weaknesses, the research in applying the theory consider a more nuanced understanding of the adoption process, acknowledging the diverse contexts and power dynamics involved. The Researcher also explored mixed-method approaches that helped to combine quantitative and qualitative data to provide a comprehensive view of technology adoption among smallholder farmers.

In the study of factors leading to the low adoption of modern agricultural technologies among smallholder tomato producers, the Diffusion of Innovation Theory was employed by considering demographic factors, economic conditions, social networks, and individual influences adoption decisions. By considering the theory's elements and incorporating a nuanced approach, the researcher was able to better understand and address the challenges faced by smallholder farmers in adopting modern agricultural technologies. This comprehensive approach thus helped a better understanding of the low adoption of modern agricultural technologies among specifics and contributed to addressing the challenges they face in adopting innovations.

## 2.2 Empirical Literature Review

### 2.2.2.1 Credit Accessibility

Access to credit service is the source of finance for the medium and lower income households to buy inputs for agricultural production. In Ethiopia, the credit service given in kind and cash form especially credit services delivered for agricultural production system. Access to credit is found to be a very important factor influencing the adoption of agricultural technology by the smallholders. Credit can facilitate farm households to purchase the needed agricultural inputs and enhance their capacities to effect long- term investment in their farms.

Limited access to credit and financing options remain significant challenges to agricultural technologies' adoption among rural farmers (Balana *et al.*, 2020). Access to credit is therefore a determinant for the adoption. Engaging in off-farm employment is a strategy for stabilizing household credit and supporting agricultural investments (Anang *et al.*, 2020). Other studies have observed that policies to promote the adoption of rural technologies should include mechanisms for breaking barriers to financial services' access.

Credit access in some countries where female-headed households are discriminated against by credit institutions prevent women who are into agriculture from adopting yield-raising technologies (Kreyling, 2010). Different authors conform that farmers who have access to credit service have more probability to adopt the agricultural new technologies than otherwise. Similarly, Kafle (2015) confirms that access to credit can increase the probability of the adoption of agricultural new technologies by offsetting the financial shortfall of the households. Similar finding indicate that financial resources were necessary to finance the uptake of new technologies. They indicated that households who had more access to formal and /or informal sources of credit significantly adopted technology (Kefle, 2015).

The agricultural technology adoption including the fact that technology is complex and influenced by various factors literature indicates farms and farmers characteristics, finance as well as micro-finance institutions and cultural norms are among of the factors that led decision on adoption of agricultural technology (Fadeyi, 2022).

### 2.2.2.2 Price of Technology

The concept of poverty, which denotes a state in which individuals or households lack the financial resources and essentials necessary for a minimum standard of living, plays a significant role in the adoption of agricultural technology, particularly in the context of pure tomato value addition technology. When the price of technology increases, it can have a profound effect on the probability of smallholder farmers utilizing this technology (Adebayo *et al.*, 2018). This indicates that an increase in the price of technology positively predicts the adoption of agricultural technology. Interestingly, the literature suggests that the price of technology is often a more consistent measure to consider than household income when studying technology adoption patterns. Essentially, this implies that the adoption of agricultural technology is constrained by the expenditure capacity of the household, which is limited by the price of the technology itself without necessarily taking into account the accuracy or effectiveness of the technology in question. Previous studies have explored the welfare implications of farm technology adoption, often using the price of technology as a proxy for assessing its affordability and impact, as seen in the work of Adebayo *et al* (2018).

Limited access to alternative management methods due to high price such as Tanks and fertilizers hinder farmers to use modern technologies to increase their benefits from farming as output have low price to meet with the price of inputs, access to credit, information, and market and services noted to influence and encourage agricultural technology adoption (Fadeyi *et al*, 2022).

Innovation include timing of season production and transportation of production which means that the farmer grows the crop at time of the year when the most other farmers are not in production. The smallholder producers are able to capture good technology. This practice has the advantage of stabilizing prices in the market (Gebey, 2010). The commodity prices tend to stabilize and ensure fairly consistent supply in the market throughout the year. The farmer may diversify into other farming activities in the time and earn more income. For instance, high price fluctuation due to seasonality in production is considered as a major marketing challenges in the tomato value chain in Kenya (Sigei *et al.*, 2014).

### 2.2.2.3 Distance to the Tomato Markets

Market distance of the agricultural products is important for the producers to get attractive market prices through the reduction of transportation cost. The increase in market distance makes farmers to get out-dated market information and becoming out of adopting agricultural modern technologies. Research has shown that technology package adoption improves as the households' residences became closer to markets while the reverse holds true (Kafle, 2011).

The negative relationship between distance of the residences from an all-weather road and fertilizers adoption have also been reported by other studies. For instance, Bekele, and Gebresilassie (2015) found that distance to market centers was negatively and significantly related to the adoption of fertilizers. Decreasing of the distance from the market decreased the transportation cost of agricultural inputs. Hence, nearness to the market and access to credit contribute to farmers' decisions to adopt new technologies (Abdulai & Huffman, 2014).

## 3. RESEARCH METHODOLOGY

### Research Study Approach

The study was cross-sectional in nature and used qualitative approach in collecting, analyzing and interpreting data related to the factors influencing tomato smallholder producers to adopt modern agricultural technologies. This study used Interview, Focus Group Discussion and observation to collect qualitative data.

This approach enabled the researcher to collect views/opinion from smallholder tomato producers on factors influencing them to adopt modern agricultural technology. The quantitative approach was used to simplify analysis by using cross tabulation this involves numbers and calculation such as percentage (Bhattarjee, 2012). The quantitative data in this study collected by using questionnaires.

### The Study Design

#### Data collection Methods

In this study data was collected by using interviews, documentary review, questionnaire and focus group discussion.

#### Questionnaire

The questions or items were used to gather data from respondents about their attitudes, experiences, or opinions. Questionnaires were used to collect quantitative and/or qualitative information. Questionnaires helped since it was cheap, did not require much effort from the questioner as verbal or telephone surveys, and often have standardized answers that make it simple to compile data

#### Interview

In this study, the open-ended questions used in interview. Interviews were conducted to eight key informants included one district agricultural extension service officer, one district business officer, one district community development officer, one ward executive officer, three village executive officers and one ward agricultural extension service officer. The researcher used diary to record data from key informants

#### Focus Group Discussion (FGDs)

FGDs used one group consist 9 respondents three (3) from each villages. Herman (2018) defined FGD as the very essence of the group a technique lies in tapping the unexpected findings that result from the interaction session between the members of the group. Focus group should usually compose homogeneous member for the targeted population. In this study FGDs were formed by picking randomly members from villages that is Ikokoto, Ilula -Itunda, and Masukanzi for the discussions. The methods that were used to get participant is purposive methods because the researcher intended to have sample depending on their knowledge and experiences about tomato and adoption of modern agricultural technologies.

#### Data Analysis

SPSS was used to analyze the data and results presented in frequencies percentages, cross tabulations . For quantitative data Microsoft Excel and Statistical Product for Social Solutions (SPSS) version 20 was used for descriptive analysis.

#### 4. FINDINGS AND DISCUSSION

Respondents' general characteristics

The section presents economic factors influencing smallholder tomato producers adoption to modern technologies. These variables were analyzed and discussed in sub section as follows;

##### 4.3.1.1 Credit accessibility

The findings in Table 1 show that 61.7% did not access credit for the adoption of modern agricultural technologies, and 38.3% accessed credit adoption for modern agricultural technology. Most smallholder tomato producers did not have access to credit therefore they depended on the capital from the informal, self-saving and group contributions. Credit was observed to be among the factors that influenced the SHTPs adoption to modern agricultural technologies. The study shows that the SHTPs had low chances on credit accessibility. The adoption of modern agricultural technologies is largely guided by capital so poor credit accessibility influences the adoption of the technologies as seen in table 6 which shows that few farmers had chances to access the credit although most of SHTPs adopted modern agricultural technologies.

**Table 1 Respondents' Affordability to Credit Accessibility**

| Variables  | Frequency (n=60) | Percent (%)  |
|--|------------------|--------------|
| Access   | 23               | 38.3         |
| Not access                                       | 37               | 61.7         |
| <b>Total</b>                                     | <b>60</b>        | <b>100.0</b> |
| Factors hindering credit accessibility<br>(n=37) |                  |              |
| Condition of Bank loan                           | 19               | 31.7         |
| Lack of financial education                      | 16               | 26.7         |
| Condition of loan From DED office                | 7                | 11.6         |
| Condition of loan from One acre fund             | 18               | 30           |
| <b>Total</b>                                     | <b>60</b>        | <b>100</b>   |

Some of the respondents gave more than one answer categories, number of cases will not necessarily add to 37 (data set was based to multiple responses).

The findings indicate that financial resources were necessary to finance the uptake of new technologies. They indicated that households who had more access to formal and /or informal sources of credit significantly adopted agricultural technologies. Access to credit service is the source of finance for the medium and lower income households to buy inputs for agricultural activities. Findings show that an access to credit associates with increased technology adoption. The study found that technology adoption was greater among farmers to some technologies such as fertilizer and pesticides because they had market for tomato which increased their credits for investing in farming.

The study also observed that the SHTPs were many but at the time of dry season most of SHTPs who had no enough capital were not in farming activities waiting for rainy season. This indicates that the SHTPs were influenced by capital to adopt drip irrigation. That is, those who cannot access credit cease cultivating in the dry seasons simply because they cannot afford the adoption of irrigation system. So, credit accessibility is among the factors that influence SHTPs on the adoption of modern agricultural technologies.

Credit accessibility in some countries where female-headed households are discriminated against by credit institutions, prevent women who are into agriculture from adopting yield-raising technologies (Kreyling, 2010). Different authors conform to the face that farmers who have access to credit service have more probabilities to adopt the agricultural new technologies. Daniel and Kafle (2015) confirm that access to credit can increase the probability of the adoption of agricultural new technologies by offsetting the financial shortfall of the households. Similar finding indicates financial resources were necessary to finance the uptake of new technologies. They indicated that households which had more access to formal and /or informal sources of credit significantly adopted agricultural technologies (Kefle, 2015).

In the study done by Kefle, (2015) in Ethiopia, the use of improved seeds show that human capital, asset owned, access to credit, membership in cooperatives strongly influences farmers' adoption of improved varieties, and were influenced by areas under



cultivation, education levels of the household heads, contact with extension agents, experience, household size, and fertilizer usage. Also, policy and innovations were responsible for improved production. For the continued adoption of improved seeds, number of female family members were found to be negatively influencing. On the other hand, the proportion of area under cultivation and extension services, frequency of visit of extension agent, experience in labor hiring, continued use of fertilizers, involvement in cooperative were also found to positively promoting continuous adoption.

In this study a low number of smallholder tomato producers had access to credit at about 38.3%. So, the modern agricultural technologies adoption had the relationship with the credit accessibility that is low accessibility to credit led to the low adoption to modern agricultural technologies in the area of study. The reason for this is that the people in the study area who made the production decisions and also control on the productive resources such as land, labour and capital which were critical for the adoption of new technologies which in turn helped them to access credit for further investment in tomato farming due to the low accessibility of credit which influenced the low adoption of modern agricultural technologies.

In Ilula as part of the Tanzania tomato farming, they have been suffering from low quality and production due to low use of modern technologies for example on farm storage system and Drip irrigation which were not used by 100%. This relates with the study of Proloy Barua, (2015) which shows that 7.2% of all farmers used inorganic fertilizer and 9% of the total areas planted used pesticides. The study also relates with the study of Lavison (2013) which indicated that male farmers were more likely to adopt organic fertilizer than female counterparts. Similarly, Kairuki (2015) found that male led households are more likely to embrace agricultural technologies because of their leading role, facilitating their planning and operating of the farm to improve productivity and maintain the wellbeing of their families. Obisesan (2014) also found that male farmers had a significant and positive influence on the adoption of modern agricultural technologies due to their access to resources.

According to the studies, findings found that capital resulted from the possession of resources is among the factor that influence the adoption of agricultural technologies. In the study, it was observed that the number of respondents who engaged in tomato farming in dry season were those who at least had capital which was obtained from personal saving or as loans from One-acre fund or the district executive director's office. Those who had no capital could not afford the cost of irrigation technology. The participants reported that most of the agricultural inputs especially pesticides were poor and this causes poor yield to tomato farmers. Participants said that on other side, not only tomato farmers who were affected by poor agricultural inputs but even the users who would use the tomatoes which were produced through poor agricultural inputs. The interview done to Key informants interview in the Kilolo district (CDO, Business Officer and District Extension Officer). Resulted to the following quotations

*".....There is the need for the government to hire as many extension officers as possible because the need of extension services is high especially in our district..... (Kilolo Extension Officer,11-07-2023),"*

Another respondent said the following during the key informants interview:

*"People are aware on the presence of credit in the district but the problem is that sometimes, people are reluctant to form groups so as to benefit from the loans without any interest from the DED;s office....(Kilolo CDO,11-07-2023)"*

Similarly, the Kilolo District Business officer had the following to say.

*"...Smallholder tomato producers face the problem of poor credit accessibility due to the conditions posed by financial institutions such as business plan where it become a challenge for tomato producers to acquire credit simply because most of tomato producers are not well educated. They have only basic education...Again, smallholder tomato producers are required to must possess 20 acres so as to be considered in loan while most of farmers are cultivating less than 2 acres...., (Kilolo District Business Officer,11-07-2023)"*

Another respondents in the Masukanzi Village said the following:

*"Most of the agricultural inputs which are found in this area are not good to be used; most agricultural inputs contain low qualities. The peasant can decide to spray or use in their farms but do not give up expected results. So, this leads to problems and cost to the peasants because they use a lot of money to buy those inputs..." (Masukanzi,13-07-2023),"*

Due to that explanations, it reflects to the theory of diffusion of innovation which explains the complexity of the perceptions of smallholder farmers on the adaptation of the agricultural technologies. So, credit accessibility and cost have impact on technologies adoption. So, the effectiveness of technology may not be considered by the farmers.

In the further interviews, the following was also quoted:

... In the rainy season, a number of tomato farmers increase and the market also expand because traders from Dar es salaam, Kenya and nearby areas are coming. Tomato products never miss the markets though there is the price that the fluctuation due to seasonal production in dry season we remain few who have capital to afford irrigation cost and the market of our products rely internal consumers such as surrounding industries and nearby areas. (Masukanzi,13-07-2023).

In relation to this, the following views were also given:

“The credit is provided with conditions. One of the conditions is to be in groups in which the groups must have political direction in order to be given credit...of cause the credit is given with no interest rate but the difficult is for people who are not members of political parties. For them, it takes time to get the credit and sometime it is difficult to get credit at all (Masukanzi,13-07-2023).

#### 4.3.1.2 Price of Technologies

The findings in table 7 show that 43.3% did not afford the price of technologies and 56.7% did afford the price of technologies. Smallholder tomato producers lack the financial resources and essentials for minimum standards of living. This suggests that an increase in income increases the probability of utilizing pure tomato value addition technology. The study had also reported that the price of technology had positive impact on technology adoption. This is because income acts as an important strategy for overcoming credit constraints faced by the rural households in many developing countries. Price of technology is expected to provide farmers alternative source to balance capital for purchasing productivity enhancing inputs such as improved seed and fertilizers.

Some technologies were not adopted by the SHTPs such as drip irrigation and on farm storage system and also, some technologies had shown a positive relationship between price and their adoption due to its price. For example, flood Irrigation Technology was adopted by 98.3%, Pesticides Technology by 100%, Seedling Technology by 76.7%.Therefore this suggests that the pesticides technology was adopted by 100% of the respondents due to it price being low and fertilizer was about 81.7% due to incentives introduced by the government and some private sectors such as One Acre Fund which provide technology for reasonable interest.

The findings from the study in Table 2 show the responses on significant factors that lead the smallholder tomato producers to fail to afford the price of technologies were 20%, High price of technology were 18.4%, Price fluctuation by 33.4% and Low government incentives by 28.2%. Due to that low adoption of modern agricultural technology to SHTPs is influenced by price of technologies.

**Table 2: Respondents Affordability of Technologies**

| Variables   | Frequency (n=60) | Percent (%)  |
|---|------------------|--------------|
| Yes   | 34               | 56.7         |
| No  | 26               | 43.3         |
| <b>Total</b>  | <b>60</b>        | <b>100.0</b> |
| Reasons for not Affording Price of technology(n=34)           |                  |              |
| High price of technology                                      | 12               | 20           |
| Price fluctuation   | 11               | 18.4         |
| Low government incentives                                     | 19               | 33.4         |
| High interest to technology provided by One acre fund as loan | 18               | 28.2         |
| <b>Total</b>  | <b>60</b>        | <b>100</b>   |

Some of the respondents gave more than one answer categories, number of cases will not necessarily add to 34 (data set was based to multiple responses).

This aligns with the study of Fade-in that income positively predicts the adoption of agricultural technologies. Similarly, the result showed that the probability of years of processing experience increases with increase in income. Literature suggests that household expenditure is more consistent measure than household income. Hence, this expenditure of the household limits the type of technology to be adopted without considering the accuracy of the technology. Previous studies studied the welfare effect on farm technology adoption using income as a proxy (Adebayo *et al.*, 2018). Key informant interview gave the following quotation:

. “...There is high price of technology and the government provide incentives for only fertilizers did not consider other agricultural inputs such as pesticides, sim Tank and Irrigation machine....”(Agricultural extension officer 15-07-2023) Ilula.

The Kilolo CDO has also the following to comment in relation to this;

“...the price of technology sometimes hinder the peasants to adopt the technolog, for example, drip irrigation is so complicated. Pipes and sim tanks and water pumps require capital and at Ilula, there are water source nearby so they prefer to use flood irrigation due to the availability of water and the use of local technology such as watering cans....”(Kilolo CDO,11-07-2023)

In the same issues, the Kilolo District business officer had the following to contribute:

“The Price of technology is dynamic, it depends on the season. During rainy season,the price of technology such as fertilizers and improved seeds rise due to the rise of needs of such technology and increase of farmers who influenced by traders from Kenya, Dar es salaam and Morogoro to come Kilolo to buy tomato so the demand of tomato become high and the producers increased...(Kilolo District business officer,11-07-2023).

Also, reasonable price led to some SHTPs to afford the prices such as the price of seeds, pesticides and Irrigation machine. in the focus group discussion, The respondents said the following:

“I prepare early before starting cultivation by making some calculations before farming so to as to afford cost...due to My low income, I fail to afford the cost of improved modern technology. The changes in the price of technology especially during rainy season is the challenge...”

“FGD at Masukanzi (13-07-2023)...Due to needs of agricultural inputs in rainy season, most agricultural inputs such as fertilizer and pesticide its price become high also in dry season most smallholder tomato producers fail to accommodate the price of irrigation that is why we remain few who can afford cultivation while others are waiting rain season....”

“The price of technology make me to opt to use simple technology such as manure when the price of fertilizers become high also sometime the price of technology decreases due to government incentives this influence us to adopt the technology though not meet the need of all framers hence local technology such as manure is inevitable for me....”

Table 2 shows that the prices of technology have direct impact to the choice of SHTPs on the adoption of the technology though the necessity of technology also have a vital role. Then, 56.67% said that that they did not afford the price of technology and 43.33% reported to afford the price of technology. The Adoption of modern technology that is Fertilizer was by 81.7% of the respondent due to its efficiency .The low price influences the adoption of technology that is why some technology such as Pesticides was adopted by 100% fertilizer was adoped by 81.7% and seeds by 76.7%. However in real sense, they did not meet the price of Drip irrigation and on farm storage system that is why they did not at all adopt them in the study area.

In this study lack the financial resources and essentials for minimum standard of living suggested by respondent as factor to hinder adoption of some of technology and the increase probability of utilizing technology to tomato farming (Adebayo, 2018). The price of technology once decreases can lead smallholder tomato producers to sustain its access, so the price of technologies has direct effect on technological adoption.

Price has also been reported to have positive impact on technology adoption. This is because the strategy for overcoming credit constraints faced by the rural households in the study area relate with the price of technology needed to be adopted. Farmers expected to provide alternative source of capital for purchasing price of technology such as improved seed and fertilizers. However not all technologies has shown positive relationship between price and their adoption.

The study findings show that price and quality is the factor that many producers are unable to value their own tomato in the same way that buyers and consumers do. This make difficult to both improve farming methods or technology and negotiable with buyers. In focus group discussion one tomato farmer explained that,



“...smallholder producers who primarily focused on their basic needs from tomato in order to survive from day to day life...” (Masukanzi, 13-07-2023)

#### 4.2.1.3 Distance to the Tomato Markets

The findings in Table 3 show that the distance to market of the tomato products is not an issue 96.67% smallholder tomato producers agreed the presence of tomato market internally and externally only 3.33% face the problem of market so only the challenge is the price fluctuation in the market which depend the quality of tomato this show that due to fair trade which increase the quality of products so failure to compete leads some farmers to face problem in the market so adoption of modern technology is influenced by nature of market that is fair trade once the products is poor the price become poor too. The weak farmers are failing to sustain the cost of technology hence they waiting until rain season so as to minimize the cost of production thus lead the decrease of SHTP during dry season to only 60 who can afford the cost of irrigation. The responses of respondents in table 8 show the market available in the study area 49.1% responses of respondent said TASAF market 33.9% responses of respondents said Dabaga Industries and 17% Responses of respondent said domestic user market.

Market of the product is not an issue to the respondent of the study. There are various factors for smallholder tomato producers (SHTP) to adoption of modern agricultural technologies in farming. The factors are different from one smallholder to another according to economic situation and geographical location of tomato producers. But in this study the focus was to know the economic factors that influence SHTP to adoption of modern agricultural technology on their farming and make their choice on technology to use for their production. The various factors that influencing SHTP to adoption of modern technology were outlined according to the findings such as Fair trade is among of the factor which reported by participant as one which influence to adoption of modern technology which increases their production and quality of tomato hence to sustain its value in the market. The quality of product determines the price of the products and the quality of technology and its efficiency determine the price of technology.

The image of SHTPs or small-scale farmers facing up price fluctuation of the internal and external market access. The SHTP are powerless against any slight shake of the market forces which can bring the fall down crashing him and his/he family. The most obstacles to SHTP are price fluctuation. The researcher found large number of participants explained that the government is not serious to SHTP on controlling price fluctuation of both tomato products and technology so the market of tomato products and technologies is controlled by nature the government have introduced agricultural incentive to fertilizers only.

**Table 3: Market of Tomato Products**

| Variables                                | Frequency (n=60) | Percent (%)  |
|--|------------------|--------------|
| Short distance                           | 58               | 96.7         |
| long distance                            | 2                | 3.3          |
| <b>Total</b>                             | <b>60</b>        | <b>100.0</b> |
| <b>Market allocated near SHTPs(n=58)</b> |                  |              |
| TASAF                                    | 38               | 63.3         |
| Dabaga Industry                          | 12               | 20           |
| Domestic user market                     | 10               | 16.7         |
| <b>Total</b>                             | <b>60</b>        | <b>100.0</b> |

Some of the respondents gave more than one answer categories, number of cases will not necessarily add to 58 (data set was based to multiple responses).

The study relates with the study of Bekele and Gebresilassie (2015). Found that distance to market centers was negatively and significantly related to adoption of fertilizer. Decreasing of the distance from the market led to the decrease of the transportation cost of agricultural inputs. Hence market distance and use of inorganic fertilizer had a negative relationship. Limited access to alternative management methods due to high price such as Tanks and fertilizers hinder farmers to use modern technologies to increase their benefits from farming as output have low price to meet with the price of inputs. Access to credit, information, and market and services noted to influence and encourage agriculture technology adoption and Kafle, (2011).

Market distance of the respondents is important for the producers to get attractive market price through reduction of transportation cost. The increase in market distance makes farmers to get out-dates market information and becoming out of adopting agricultural modern technologies. The findings showed that technology package adoption improved as the households' residences became closer to market while the reverse held true for wheat technology package adoption. An interview of Key informants show

“...Market of tomato at Kilolo District is not a problem there is market called TASAF market and Dabaga Industry, and processing industry which consume more tomato products but also there is network with other

*market from other countries like Kenya but the problem is price fluctuation because during dry season tomato producers decreased which lead to more traders to find another parts like Morogoro to find more tomato products this resulted to price fluctuation” (Kilolo District Business Officer 11-07-2023).*

The government have action plan aimed to help the SHTPs on how to maintain the price to tomato products which can help SHTP to get capital for adoption of technology so the only way for farmers to improve their production to survival to the need of fair trade is to adopt modern technology. Some participants said”, challenge is price fluctuation during rainy season “One participant reported that in the issue of market of price influence on technological adoption. One of respondent in FGD said the following:

*“...Challenge of price during rainy season.... The rise of insect pesticide...during rainy season the price rise due to increase of tomato diseases.....”.*

Due to that the study observed that Market of tomato products affects adoption of modern agricultural technology because price fluctuation make the tomato producers sometime to fail to get income for further investment in technology.

## CONCLUSION AND RECOMMENDATIONS

### 5.1 Conclusion

This research sought to understand the economic factors influencing the adoption of modern agricultural technologies among smallholder tomato producers in the study area. The study was guided by specific objectives, and the following conclusions drawn basing on these objectives:

Economic considerations, such as limited credit accessibility and market instability, particularly concerning fluctuating tomato prices and the cost of modern agricultural technologies, exert a substantial influence on the adoption of advanced farming methods. Addressing these economic challenges is vital to encouraging more smallholder farmers to adopt modern agricultural technologies.

### 5.2 Recommendations

#### 5.2.1 Recommendations for Actions

- Facilitating improved access to credit for smallholder farmers to help them invest in modern agricultural technologies. This could involve partnerships with financial institutions or the introduction of microcredit programs.
- Implementing measures to stabilize tomato prices by promoting fair trade practices and creating market linkages that reduce price fluctuations. Additionally, the should be incentivize to the adoption of modern technologies by providing subsidies or grants to reduce the cost burden on farmers.

#### 5.2.2 Recommendations for Further Studies

Further studies should delve deeper into

Exploring the economic factors affecting agricultural technologies adoption and to explore the specific challenges and opportunities associated with credit accessibility, market dynamics, and the costs of modern agricultural technologies.

## REFERENCES

- Abdulai, A., & Huffman, W. (2014). *The adoption and impact of soil and water conservation technology: An endogenous switching regression application. Land Economics*,
- Adebayo, A.G, Akintoye H.A and Adeoye B.O (2018).Socio- Economic analysis of okra (*Abelmoscus esculentus* (L.) Moench) under different live mulches in southwest Nigeria. *Nigerian Journal of Horticultural Science*, 23: 98-203
- Adenuga, A.H., Muhammad-Lawal, A. and Rotimi, O.A. (2013). *Economics and Technical Efficiency of Dry Season Tomato Production in Selected Areas in Kwara State, Nigeria. Agris on-line Papers in Economics and Informatics*.
- Anang, B. T., Nkrumah-Ennin, K., & Nyaaba, J. A. (2020). *Does off-farm work improve farm income? Empirical evidence from Tolon district in Northern Ghana. Advances in*
- Balana, B., Mekonnen, D.K., Haile, B., Hagos, F., Yiman, S., & Ringler, C., (2020). *Are smallholder farmers credit constrained? Evidence on demand and supply constraints of credit in Ethiopia and Tanzania. IFPRI Discussion Paper 1974. Washington, DC: International Food Policy Research Institute*
- Bekele A, Gebresilassie L., (2015). *Factors determining allocation of land for improved wheat variety by smallholder farmers of northern Ethiopia. Journal of Development and Agricultural Economics* 7: 105-112.
- Bhattacharjee, A.(2012) *Social Science Research: Principles, Methods, and Practices*: University of Florida.
-

- Fadeyi, Azizi and Arlyawardana (2022). *Factors influencing technology adoption among smallholder farmers: a systematic review in Africa*
- FAO (2019). *Fruit and vegetables become UN's centerpiece for 2021*. <http://www.fao.org/new-york/news/detail/en/c/125632>
- FAO (2021) *Food and Agricultural Organization of the United Nations, Statistics*
- FAO, (2021). World Food and Agriculture - Statistical Yearbook 2021. Rome. <https://doi.org/10.4060/cb4477en>
- FAOSTAT (2020) Statistical Database. *Food and Agriculture Organization of the United Nations, Rome*
- FAOSTAT. (2020). The *Food and Agricultural Organization of the United Nations Production Databases*.
- Gebey, T., Berhe, K. & Hoekstra, D. (2010). *Vegetables value chain development in Fogera district: experiences from IPMS project interventions*.
- ILuzi-K, Kashenge-K & C., Bonsi, (2017). *A Review of Maize, Rice, Tomato and Banana Research in Tanzania*.
- Jones, A. (2015). The Spread of Sustainable Farming Technologies: An Analysis Using the Innovation Diffusion Framework. *Sustainable Agriculture Research*, 4(3), 72-84.
- Kafle B (2011). *Factors affecting adoption of organic vegetable farming in Chitwan District, Nepal*. *World Journal of Agricultural Sciences* 7: 604-606.
- Klerkx, L., & Leeuwis, C. (2018). Analyzing Innovation Networks in Agriculture: Theoretical and Methodological Challenges. *Agriculture and Human Values*, 35(2), 259-267.
- Kreyling, J. (2010). "Winter climate change: a critical factor for temperate vegetation performance," *Ecology*, vol.91
- Lavison, R. (2013) *Factors Influencing the Adoption of Organic Fertilizers in Vegetable Production in Accra*. Msc Thesis, Accra Ghana.
- Mngumi (2016). *Perceptions of climate change, environmental variability and the role of agricultural adaptation strategies by small-scale farmers in africa: the case of Mwanga district in northern Tanzania*
- Mwangi, M., & Kariuki, S. (2015). *Factors Determining the Adoption of New Agricultural Technology by Small Scale Farmers in Developing Countries*.
- Obisesan, Adekemi (2014): *Gender Differences In Technology Adoption And Welfare Impact Among Nigerian Farming Households*
- Patel, R. (2019). Understanding Biotechnology Adoption in Agriculture: An Application of the Innovation Diffusion Theory. *Biotechnology Journal*, 14(7), e1800223.
- Proloy Barua, 2015, *Factors Affecting Technology Adoption among Smallholder Maize Farmers in Tanzania*
- Rogers, E.M. (1962). *Diffusion of innovations 3rd Edition*. New York: The Free Press.
- Sanga, A. & Mgimba, C. (2016). An Analysis of constraints that affect smallholder farmers in the marketing of tomatoes in Mbeya Urban and Peri-Urban, Tanzania. *Imperial Journal of Interdisciplinary Research* 2(3): 603-611.
- Sigei, G., Ngeno, H., Kibe, A., Mwangi, M. & Mutai, M. (2014). Challenges and Strategies to Improve Tomato Competitiveness along the Tomato Value Chain in Kenya. *International Journal of Business and Management*, 9(9): 205-212.
- United Nations Development Programme (UNDP); United Republic of Tanzania (URT). *Tanzania Human Development Report 2017. Social Policy in the Context of Economic Transformation; Economic and Social Research Foundation: Dar es Salaam, Tanzania, 2017*.
- USAID (2018) *The U.S. Government Global Hunger and Food Security Initiatives*.
- USAID/Tanzania (2022). *Feed For Future Tanzania Mboga na matunda evaluation*
- Wang, S. (2018). Investigating Precision Agriculture Adoption: A Study Using the Innovation Diffusion Theory. *Journal of Agricultural Technology*, 45(1), 32-45.
- Herman, G. (2018), *Educational Research Methods. A Practical Guide*. Mahelo Book Centre, Mwanza Tanzania, pp.77-105.