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*Erasmus*

**The Adoption of Agriculture Technology in Small-Scale  
Farming in the Adumasa Community in Ghana**

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## **List of Acronyms**

CTA	Centre for Agricultural and Rural Cooperation
FAO	Food and Agricultural Organization
FASDEP	Food and Agricultural Sector Development Project
GPRSP	Ghana Poverty Reduction Strategy Papers
IAP	Inter-Academy Partnership
MTASIP	Medium-Term Agricultural Sector Investment Plan
MoFA	Ministry of Food and Agriculture
NGO	Non-Governmental Organization

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## **Abstract**

The paper examined the factors that had informed the adoption decision of small-scale farmers in the Adumasa community in adopting new agricultural technologies; namely fertilizer application, pesticides use, modern irrigation systems and use of the motor tricycle (Aboboya) for conveying farm inputs and harvest to and from the farms. From the study, it has been found that multiple institutional and political factors, as well as socio-economic factors facilitate the adoption decision of the farmers. Institutional factors that have informed adoption decision of the farmers were access to extension services and advice, support from farmer cooperatives, access, and closeness to input markets and workshops, and community training programs. The socio-economic factors were capital and productive resources available to farmers and educational levels, the size of the farmland, age, and gender.

However, factors including limited capital and resource base of some of the farmers, low access to credit facilities, high prices of inputs, as well as the fear that some of the farmers have with regards to the long term effects on the fertility and quality of the soil, and experiences of losing their capital and incurring debts have become obstacles for these farmers. It could therefore be argued that multiple indicators which may be institutional, as well as socio-economic tend to facilitate decisions of the farmers to employ or not employ the technologies and not necessarily a single factor. Nevertheless, economic factors which are realized in the form access to productive resources, credit facilities, capital, as well as services of extension officers come as the more pressing indicators for the farmers.

## **Relevance to Development Studies**

This research paper is relevant for development studies in many ways. In the first place, considering the fact that agriculture stands as the backbone of Ghana's economy with many of the rural inhabitants engaged in small-scale farming, identifying and understanding the underlying factors that influences farmers adoption decision is much relevant for the government and major stakeholders, including NGOs and agricultural development agencies in structuring and planning their projects on technology adoption in line with the peculiar needs of farmers in a specific community. This will help in streamlining their programs, workshops, and training programs for farmers to factor in the different dynamics within the adoption process.

Furthermore, the research contributes significantly to the downsides of new agricultural technology adoption and the effect that encompasses it. With this, key policy makers and extension officers are able to effectively educate farmers on the application of new technologies, taken into key consideration the impacts of the technologies with its pros and cons. Lastly, the research provides knowledge and understanding on the point that farmers decision to take up or not employ new technologies may be informed by a number of factors that could be institutional and political, as well as social and economic, and as such it becomes necessary to look into the specific dynamics that determines adoption decisions and not just on universal set of factors. This is essential for ensuring agricultural development and the sustainability of the farms, which comes as important for food production, food security and entire livelihoods of the farming community.

## **Keywords**

Small-scale farming, agriculture technology, technology adoption, socio-economic factors, institutional and political factors, Adumasa, Ghana.

## **Chapter 1 Introduction**

### **1.0 Background to the Research**

This study examines the underlying factors that determines the adoption of farming technologies by small-scale farmers in the Adumasa community in the Ashanti region of Ghana. It considers socio-economic and institutional factors, as well as the different dynamics that intersect to affect farmers adoption of technologies. The study focus on four main technologies that have been employed in recent times by the farmers, namely irrigation systems, pesticides and herbicides use, fertilizer application, and the use of motor tricycle popularly known as ‘Aboboaya’ for conveying farming tools, materials and farm harvest to and from the farm to storage facilities and to the market. These technologies have been mainly introduced with the help of public extension services and support from the community farming cooperative groups. The intersection of multivariate factors interplays in determining the decision by small-scale farmers to adopt modern techniques. The factors may encompass to some extent availability and access to farming technology information, size and location of the farm, availability and intensity of extension services on improved technologies of farming, access to financial support and resources in effectively adopting farming technologies (Annan 2018; Akudugu et al., 2012). It is relevant to unravel the factors that enables farming technology adoption within specific small-scale farming households in Ghana. This will help address the problem giving attention to varying dynamics within the small-scale farming community in question.

With this, I argue that the examination of socio-economic and political factors that explains farmers adoption of technologies in specific contexts is important for understanding the informed decisions and significant for policy makers in employing significant interventions. Most parts of Ghana’s agriculture are based on small-scale agriculture. About 80% of the country’s agricultural production comes from small-scale farming in rural communities (FAO 2013; Adjei 2012; IMF 2007). One-fourth of Ghana’s GDP is from agricultural production, with 52% of the people in the labour force engaged in agricultural activities (FAO 2013; 2012). With this, almost 30% of the farming labour are women (FAO 2013; 2012). Common crops grown include cocoa, cassava, vegetable, grains, and fruits.

Rural households depend heavily on small-scale farming for their livelihoods. Most of the households despite current trends in climate change issues like drought, flooding, still rely on traditional methods of farming (Kuwornu et al., 2011; Bako et al., 2007). Some of the traditional methods include use of cutlasses and hoes for weeding and preparing the land,

fetching of water manually from wells for irrigation. The farmers over the years depended on rain-fed farming system and other traditional methods which has negatively impacted on farm production and income and has affected food security context of rural areas and the country at large (Adjei et al., 2012).

Notwithstanding this, small-scale farmers have adopted technologies including fertilizer and pesticides application, modern irrigation systems such as shallow-well irrigation practices and weedicides in recent times (FAO 2012; Parvan 2011; Kuwornu et al., 2011). Due to uncertainties of climate change and its adverse effects on the weather, most small-scale farmers are adopting technologies such as farm irrigation systems, fertilizer application, post-harvest storage facilities in sustaining their farms. This has helped increase production and total yield and has positively impacted on their income, food security (Adjei et al., 2012; Boateng 2011). According to Akudugu et al., (2012) adoption of modern farming production techniques has helped rural farmers expand production and further increase incomes and enhance their livelihoods. Similarly, it has been noted by Annan (2018), that the mechanisation of farming and employment of improved rice varieties have contributed to productivity and sustainability of rice farmers in the Northern regions of Ghana.

Within the rural farming community, small-scale farmers have adopted agricultural technologies. This has facilitated improvement in efficiency of farmers from the start of the farming process, through harvesting to the storage stage and finally reaching the consumer (Boateng 2011). Several factors have the potential of influencing these farming households to embrace technologies. It should be emphasized that adoption and transfer of agriculture technologies does not come with only positive impacts but may also have several negative effects on farming communities and the environment. For instance, studies conducted by Fianko in Ghana has indicated that use of agrochemicals including fertilizers and pesticides heavily in farming communities affect the health of farmers and the farming communities at large (Fainko 2010). The overuse of pesticides and fertilizers have also been reported to have serious consequences on the environment such as, volatilization within the atmospheric sphere which negatively affect quality of air, soil, water and result in dangers for farmers and the community in terms of pesticides intoxication through inhaling (Fianko 2010; 225-6; Ntow et al., 2006). Also, it has been noted that massive employment of pesticides and fertilizers in farm production leads to the production of foodstuffs including vegetables, fruits and in some cases fish production that are found to contain pesticides that are detectable such as organochlorines (Fianko 2010: 226-7; Yeboah et al., 2004).

Also, with employment of top-down approach to technology adoption within small-scale rural farming, the autonomy of farmers could be lost, with no power to decide on issues on adoption process and expression of their knowledge and ideas on the technology introduced (Ntow et al., 2006; Yeboah et al., 2004). Adoption of agriculture technologies could render farmers in a situation of indebtedness when the concerns of farmers are not taken into consideration with regards to their access to credit facilities and materials for farming (Ntow et al., 2006). Therefore, in considering adoption of technologies in farming, it is necessary to look-into the downside of the technologies being adopted and how different groups can adopt the technologies.

Additionally, it has been seen in the past years that agriculture technology adoption in Ghana and other parts of Africa have become more of a top-down approach, without considering cultural and socio-economic situations of the people, and innovations that emerges from the small-scale farmers. It could be emphasized here that small-scale farmers in rural communities are not adamant when it comes to technology use (Akudugu et al., 2012; Fianko 2010). Rural farmers in Ghana have been seen to be innovative in employing technologies that are locally-driven and not necessarily coming from the developed world in the past and continue to use some of these in their farming activities (Boateng 2012). Some of these local technologies are organic manure by using animal residue and plant by-products that are used as manures in enriching the soil (Houssou et al., 2013). Also, the use of animal traction has been seen to be continuously used by local farmers in the past and some farmers continue to employ it in ploughing. The use of draft animals such as, donkeys and bullocks have been employed within several activities by farmers in Ghana especially in the Northern and Ashanti regions for preparing their land (Benin et al., 2012). This has been employed in the weeding of farmland, as well as on and off-farm transportation of farming tools, good, and farmers to and from the farm (Houssou et al., 2013; Benin et al., 2012). These to an extent suggest that farmers are not at all ignorant when it comes to technology innovation and adoption. It is important to consider more of bottom-up approach and take into concern knowledge and local innovations of farmers and cultural and socio-economic context of farmers.

Several policy measures and frameworks have been implemented by the government in ensuring that small-scale farmers use improved methods of farming in enhancing their production. An important framework that has been initiated and implemented by the government of Ghana is under its Poverty Reduction Strategy Papers (Boateng 2011:2; Food and Agricultural Sector Development Policy (FASDEP) 2012). This emphasizes employment

and enhancement of agricultural technologies such as, modern irrigation practices, fertilizer and pesticides application, techniques for crop harvesting and storage systems especially for small-scale household communities in increasing their food quality and production which further improve their food security (FASDEP 2012; PRSP 2012; Boateng 2011: 2-3).

Furthermore, the government through its Food and Agricultural Sector Development Policy has implemented measures in assisting farmers on enhancing their knowledge and skills on agricultural methods and technologies (Boateng 2011: 3-4; FAO 2012). This has been carried out through deployment of extension officers across the districts and communities under supervision of the Ministry of Food and Agriculture and district offices on agriculture, food, and crop production (Boateng 2011; FAO 2013). Rural farmers under this system are given regular trainings and workshop programmes to ensure effective application of modernized irrigation, pesticides, fertilizer application, modernized harvesting, and storage systems (FASDEP 2012; FAO 2013).

According to FASDEP (2012) the adoption of advanced farming tools and technologies will improve agricultural productivity of small-scale farmers. It will enhance food security in rural communities and ensure a connection between agricultural sector and other sectors of the economy in creating employment and improved livelihoods (FASDEP 2012; PRSP 2012). This will raise agricultural contribution towards economic development.

Other stakeholders including private companies, NGOs and individual entrepreneurs have also initiated programs and products to help small-scale farmers to adopt modern technologies. Companies like Farmerline, Netherlands-based Technical Centre for Agricultural and Rural Cooperation (CTA), Acquahmeyer, and others have programs that educate farmers at the grassroot on modern farming practises and help them acquire modern equipment (Nagasaki 2019). Some of this farming technology promoted by these stakeholders are irrigation systems, drones, use of mobile phones, new ways of applying fertilizer, use of tractors and tricycle (Motor king) and storage facilities (Nagasaki 2019; Njagi 2014; Reynolds 2019).

## **1.1 Problem Statement**

Small-scale farming remains the backbone and source of livelihoods for rural households within the Adumasa community. In the last few years small-scale farmers in the Ashanti region have embraced agriculture technologies such as, modern irrigation systems, systems of pest and disease control, harvesting and post-harvest systems (Asante et al., 2014; Donkor

et al., 2014). During my stay in the community some few years ago, I realized that small-scale farmers have employed some of these farming technologies.

It is important to examine and understand the socio-economic, as well as institutional factors that influences farmers in the community to adopt (or not) these new technologies. It is also significant to unveil the varying dynamics that influence and explain rationale behind the adoption.

Furthermore, examining social, economic and institutional factors that shape the adoption of these technologies, and constraints that affects the adoption is essential for policy makers, both state and non-state actors (Asante et al., 2014; Wiredu et al., 2010), in designing relevant interventions. With this, I aim to contribute to the literature on adoption of agricultural technologies in the context of the rural farming households in Adumasa. Examining multiple factors that influences adoption decisions in this specific context is important for addressing concerns of the farmers, considering their situations, and not generalizing the scope and dynamics of adoption.

## **1.2 Justification and Relevance of the Research**

The employment of modernized agricultural technology and tools are crucial for harnessing improved livelihood and increase productivity among small-scale farming households (Kuwornu et al., 2011). With majority of poorer Ghanaian households living in rural communities and engaging in subsistence farming (Adjei 2008; Boko et al., 2007), it becomes necessary to adopt adequate farming methods to enhance farm production. The study is important as it attempts to identify underlying factors that facilitates choices of farmers to adopt new technologies.

This is important because unravelling the factors behind farmers' decision to embrace modern technology serves as reference point for relevant stakeholders including government and its department on food and agriculture, NGOs, cooperatives and civil society in streamlining their services and measures in addressing the needs of farmers (Boko et al. 2007; Kuwornu et al. 2011; Parvan 2011). In addition, this helps to understand the factors that push some farmers to adopt farming technology for farming in rural settings, while others decide not to employ new technologies. The research further adds to the literature on adoption of farming technology in Ghana, and Africa at large.

### **1.3 Research Objectives**

The objective of the research is to identify and understand underlying socio-economic and institutional factors that influences small-scale farmers in the rural community of Adumasa to adopt new technologies for farming. This helps in exploring the kind of technologies that are being used by the farmers and the possible factors that determine the informed decisions of adoption. Additionally, the research helps to understand different dynamics with technology adoption considering benefits and downsides.

Furthermore, the research is relevant for major stakeholders and policy makers including government, the department in charge of food and agriculture, NGOs, and local farming cooperatives on understanding the factors informing farmers decisions on adoption. This will enhance effectiveness and efficiency in improving food security and livelihoods.

### **1.4 Research Questions**

#### **1.4.1 Main Research question**

What underlying factors influence the adoption and use of farming technology and methods by small-scale farmers in the Adumasa community?

#### **1.4.2 Sub-questions**

1. What are the socio-economic and institutional factors that influences decisions of the farmers to adopt or not adopt new farming technologies?
2. What policy measures have been implemented by the government in ensuring the employment of farming technology among small-scale farmers?
3. How does the process of adoption affect the small-scale farmers?
4. How does the employment of farming technology enhance the livelihood and wellbeing of the farmers?
5. What is the downside of the adoption of farming technology?

### **1.5 Scope of the Research**

The research focuses on the underlying factors that facilitate adoption of agricultural technology by small-scale farmers in Ghana. In doing this, the research uses the Adumasa community in the Ashanti region as the case for the research. This creates room for making in-depth examination on the extent to which the farmers adopt, as well as different conditions that influence and enhance the process.

## **1.6 Organization of the Research**

The research is categorized into five chapters. Following this introductory chapter, the second chapter addresses the conceptual and theoretical framework. This considers the conceptualization of technology adaptation in farming and its relevance for enhancing improved farming and enhanced livelihoods. It also looks at methodology and methods used in the research and techniques used for data collection. Additionally, it looks at limitations of the research, ethical considerations, positionality, and reflexivity of the research.

The third chapter reviews literature on agricultural technology adoption and examine some farming technologies that are being used by small-scale farmers and the community at large. It further looks at how these technologies are used by farmers and how it impacts their farming activities, productivity, and livelihoods. It also explores constraints that affect adoption of technologies.

The fourth chapter looks at analysis and presentation of the study findings and examine underlying factors influencing farmers to adopt (or not). It examines socio-economic and institutional factors and how these intersects to influence the adoption. This considers extent to which the factors determine decisions to adopt. The fifth chapter concludes the paper.

## **Chapter 2 Conceptual, Theoretical framework and Methodological Strategies employed in the Paper**

### **2.1 Introduction**

This part of the paper addresses the conceptual framework, as well as methodology and methods used for the analysis of the research. It considers the conceptualization of technology adoption in farming and its relevance for enhancing and improving farming. Furthermore, it considers the existing farming technologies that are being used by farmers.

The methodological strategy also takes into account the methodology that is used in the research. It further examines methods that are used in the collection of data and information that is used for the research. Additionally, it looks at limitations, some broader ethical considerations, positionality, and reflexivity.

### **2.2 Conceptual and Theoretical Framework**

#### **2.2.1 Technology Adoption**

Technology encompasses the conditions and factors that necessitates the changing of functions of production, taken into consideration existing uncertainties that may be objective or even perceived (Gershon and Umali 1993). The uncertainties together with their resulting ambivalence may weaken and abbreviate in the course of time. This comes as a result of the accretion of substantial experience, as well as adequate and relevant information to people which would in turn influence the function of production. In this way, the people adopting the changes become much effective and capable in applying and using the adapted technology (Gershon and Umali 1993; Feder, Just and Zilberman 1985).

Technology adoption in this context, entails extent of recognizing, adopting, as well as using new improved methods and technologies with the goal of enhancing improvement in productivity and enhancing livelihoods (Annan 2018; Sunding and Zilberman 2001; Feder, Just and Zilberman 1985). With regards to small-scale farming households, their adoption of new technologies and methods is facilitated by availability of information and resources that are needed in using the technologies within the short run and an extension and continuation into the long run (Annan 2018; Sunding and Zilberman 2001).

For small-scale farmers, their decision to adopt and make use of new technologies is informed by several factors. The concern here is the need to make farmers aware of the

existing methods and technologies, and how to successfully employ them in meeting production needs and more importantly improving their livelihoods in the short and long runs (Annan 2018; Feder and O' Mara 1981).

From the discussions, it could be emphasized that small-scale farmers adoption of modern technology is influenced by multi-faceted factors which may include access to productive resources and land, access to credit facilities, nearest to a source of input markets and age. These conditions interact to reinforce each other in determining extent to which farmers make informed decisions towards advancing practices that are geared at using the technologies (Annan 2018; Akudugu et al., 2012).

It is significant for government, policy makers, development agencies, as well as national and district level governance structures to understand the variegated dynamics that necessitates adoption of new technologies (Akudugu et al., 2012). This would help to comprehend the dynamism in the factors facilitating the adoption, and how these factors are interwoven to determine farmers decisions in practicing improved farming.

It would also help the numerous development agencies, national and local structures of government, the Ministry of Food and Agriculture and NGOs in effectively addressing concerns of farming households in their adoption and continues use of technologies.

## **2.2. 2 Adoption of Agriculture Technologies and its Use in Farming**

The adoption and use of agriculture technology come as an important mechanism for ensuring transformation in agriculture (Minten and Barret 2008). Additionally, it can reduce the levels of poverty and improve livelihoods of small-scale farming households (Minten and Barrett 2008; DeJanyry and Sadoulet 2002; Adesina and Baidu-Forson 1995). This issue becomes relevant for modern agricultural advancement. Facilitating technical transformations towards technologies of farming implies the need for adequate research on one side, and for conveying relevant information and tools to small-scale farmers in relation to their adoption (Annan 2018; Mapila 2011; Minten and Barret 2008). This provides adequate spaces in improving and enhancing farming productivity and significant enhancement of the livelihood of small-scale farming households and farming communities at large.

Technical changes that are experienced through adoption of advance technologies for farming are seen to be important and helps in yielding much positive effects, enhanced income of farmers and their entire livelihoods in developing countries (Annan 2018; Nin et al., 2003; Boahene and Folmer 1999). The agriculture sector of Ghana despite its being the

largest sector which employs majority of the people of the country, and contributes to quite a good part of the country's overall economy, shows a very low level of farming technology adoption, especially among small-scale farmers who are mostly engaged in the production of food crops (Annan 2018; Akudugu et al., 2012).

The low technological adoption has been seen to be a key factor affecting agricultural productivity and livelihoods within farming communities in the country (Ministry of Food and Agriculture 2010). This calls for scrutiny of the factors influencing adoption and improvement in farming methods with the aim of enhancing livelihoods and ensuring substantial productivity. Notwithstanding low technology adoption that has been seen to characterize agriculture and food production in the country, some technologies have been employed by small-scale farmers for enhancing their farming (Akudugu et al., 2012; MoFA 2010). The technologies include modern irrigation systems, pesticides and herbicides use, fertilizer application and use of the motor tricycle in conveying tools and farm produce.

For the purpose of this study, the conceptualization of technology adoption in small-holder farming, is essential for unleashing dynamics that are displayed in technology adoption. It further helps in teasing out multiplicity of conditions that pushes for the acceptance of new technologies by farmers.

### **2.3 Technology Transfer and the Adoption Problem**

Technology transfer encompasses a multi-faceted process that involves movement of innovative knowledge, ideas, tools, and materials from one end to the other with a variety of senders and receivers within and across borders (Takahashi et al., 2019). Within the development arena, technology transfer may entail introduction and sharing of new techniques and knowledge followed by expansion and utilization of new methods and tools from the innovators to the recipients. The transfer of technology could be seen within public sector institutional structure and from private sphere, as well as from groups and individuals to others (Takahashi et al., 2019).

Agricultural technology has been seen as important for small-scale farmers in increasing productivity and enhancing efficiency within their farming activities (Thornton et al., 2017). The spread and adoption of technologies creates potential for ensuring the resistance and sustainability of farming within developing countries (Inter-Academy Partnership 2018; Thornton et al., 2017). Despite this, how to efficiently transfer technology and enhance

technological changes within small-scale farming considering the numerous constraints that entangles technology transfers and adoption is still a matter of debate.

According to Glover et al., (2019), the concept of technology transfer and adoption comes with an over-simplification of structures and models with regards to what takes place within the process in the course of technological change. Such change therefore entails complex process which involves diverse socio-political and structural facets (Glover et al., 2019; Temple et al., 2016). It is important to stress that the agency of the adopters and practitioners in this case, small-scale farmers are significant when adopting technological change.

A key problem that may arise with technological change and adoption is the tendency of seeing and addressing technology as a black box (Glover et al., 2016). This comes in most cases where technology is treated as encompassing an embodiment of knowledge through its innovations, techniques, and tools (Glover et al., 2016; Shih and Chang 2009). In a way, the notion of technology as a black box reinforces the simple conceptualization of technology as something that is generic and discrete, and easily taken from one end and adopted and used at another place. Conceptualizing technology in this way may lead to the challenge of bringing up technical, as well as material characteristics of technology, and rather leaving out or given less attention to institutional, socio-political, cultural and epistemological structures that underpins technological change and adoption (Glover et al., 2017; Latour 2005).

Another constraint that limits technological transfer and adoption relates to the labelling and application of technology as a simple linear flow process from inferior methods, materials, and tools towards new and more efficient ones (Glover et al., 2019). This creates an explanation of technological adoption that puts practitioners of technology into an oversimplified binary of adopters and non-adopters. This implies giving less attention to diverse processes and dynamics of experimentation and learning which is nevertheless, relevant within the process (Glover et al., 2016; Leeuwis and Pyburn 2002). In considering technological change, it is essential taking into concern agency of farmers, their knowledge, and ideas as well as socio-economic relations that underpins their adoption.

## **2.4 Rogers Theory of Adoption and Diffusion**

A major theory on adoption that has gained wide recognition is Rogers theory of adoption and diffusion. Such theory therefore becomes significant in studying the underlying socio-economic and institutional factors facilitating the adoption and non-adoption of agricultural technologies. The concepts of adoption and diffusion despite being different terms, are

sometimes employed interchangeably when discussing issues of technological transfer and innovations (Rogers 2003).

#### **2.4.1 The Individual Innovativeness Theory**

Rogers (2003) has noted that within a social system, different individuals and groups may take up or adopt new innovations or technology at different points in time. As such, different time series may encompass adoption and use of new innovations, technologies, and ideas by individuals in a society (Rogers 2003). With regards to this, farmers within a farming community may also adopt (or not) new innovations and technologies at different time frames and at different rates.

Therefore, different categories of adopters may exist within a social system. The categories are grouped under early adopters, the early majority, the late majority, as well as the laggards (Rogers 2003). The categorization of adopters is made on the notion of innovativeness. Innovativeness in this sense encompasses the rate at which people employ and take up new innovations in relation to other people within a social group. Within this, innovators are seen as people who show the desire to take up new ideas and ready to use them in their work (Dearing 2009). Different motivation characterizes people when it comes to adoption of new ideas, and as such innovators or adopters who show higher desires may employ and use a new idea compared to other people (Dearing 2009). However, it has been noted by Rogers (2003) that innovators may not be necessarily recognized as the best within a social system; due to the reason that they may be characterized as people who deviate from the values and traditions of the social systems by other groups and individuals in the social system.

Within the scope of the adopter categorization, early adopters are seen usually to be respected farmers who mostly take key positions in the community or social system (Rogers 2003). They sometimes occupy the position of cooperative leaders, opinion leaders and the like within the community. Also, they may possess much wealth in terms of land and other productive resources compared to other farmers. With the position occupied by early adopters in a community, they tend to be seen as point of approval when it comes to the adoption of new innovations and technologies. In view of this, early adopters may be recognized as examples for other members of the social group to take up new ideas and innovations (Rogers 2003). The adoption or use of a new idea or innovations could therefore be passed from the early adopters, in this sense the farmers who first embrace the technology

to the other categories of adopters through continuous interaction, information sharing in groups and on levels of individuals.

Furthermore, the early majority are the category that are next to the early adopters with regards to employing and using a new technology that is introduced. A major characteristic of early majority category is that they normally deliberate and ponder ideas with their fellows before deciding on whether to adopt or not adopt new technology or innovation which is brought within the social system (Rogers 2003). With this group, it could be said that they normally are not necessarily leaders of the community or social system or occupy higher positions within the community, but are influential in decision making concerning the spread and diffusion of new technology due to their active interactions and communications with their fellows in the social system (Rogers 2003).

On the other hand, the late majority are more likely to employ and use new technology in view of the economic benefits and necessities that are associated with the new idea (Dearing 2009; Rogers 2003). The late majority category is very keen with the social and economic effects which may encompass the new technology and ideas. In addition, the group of farmers that are within this category mostly adopt the technology with the information, ideas, and persuasions that they encounter from their immediate peers and fellows (Rogers 2003). This is in most cases due to lack of confidence, as well as uncertainties and misconceptions which they may have in relation to new ideas and technologies that are being employed. The category on deciding on whether to employ the technology or not take consideration regarding that their fellows who may also be conservatives just like them have embraced the technology and appreciated its significance both economically and socially (Dearing 2009). Therefore, it is necessary for implementers of agricultural projects and agricultural agencies to give substantial attention to socio-cultural norms and ideas in addition to the importance that characterises new technologies and ideas when considering adoption decisions of the late majority category and all the other categories in adoption process (Sahin 2006).

Lastly, the laggard category represents the last group of adopters within the adoption process. This category of farmers usually has less access to resources and as such are much reluctant when it comes to taking up risks and adopting technologies introduced (Rogers 2003). Additionally, interactions that they have within the social structure is very low and in turn only make decisions at employing new technologies with keen consideration and careful attention given to desirability and workability of the new idea. Therefore, the laggards occupy the category of farmers who may have greater doubts in employing new technology and have higher desire for the benefits that the technology will bring. In view of this, it could take

much longer time for them in adopting (Rogers 2003). Nevertheless, it should be noted that certain category of farmers could show characteristics of early adopters, but may not necessarily embrace the technology at an early stage of the adoption process; some farmers who may not show characteristics of early adopters may take up new technology on a faster pace due to multiple factors such as extension services, education, support and discussions that may be received from project implementing teams, as well as information and communication among farmers (Dearing 2009). In addition, class may come as an important factor that may determine the pace of farmers adoption. With this, farmers who occupy a higher social class and have access to much productive resources including land and capital may show signs of adopting new technologies compared with those within lower class. In this case, economic constraints may act as major limitation for lower classes in employing new technologies.

## **2.5 Agricultural Technology Treadmills**

The notion of agriculture treadmills looks at the impacts of new technologies especially the effects that are experienced by the late adopters (Cochrane 1958). The nature of agriculture products which is to an extent elastic assume that small-scale farmers have to persistently ensure an increase in their farm produce. This could result in lowering of prices of the produce as elaborated within the economic principle of elasticity (Cochrane 1958).

The adoption of the new technologies may result in increasing productivity for early adopters, however, with many other farmers embracing the technologies total productivity by the farmers continuously rise which could in turn lead to fall in prices of the produce (Suppan 2020; Cochrane 1958). According to Cochrane for farmers to match with the situation, they have to continuously employ the technologies which eventually leads to the notion of technological treadmill (Cochrane 1958).

In such situation, farmers who are not able to stay within the new technologies, continue their usage and keep within the treadmill may face the challenge of even losing their land to other farmers to take over (Hansen 2019; Ward 2008). This could create the problem of accumulation where few farmers who are well-to-do will control productivity and the market at large.

According to Howard (2009) off-farm treadmill may also be experienced as key aspect of treadmill within agriculture. This entails three forms of treadmills which are grouped into synthetic fertilizer treadmill, pesticide treadmill as well as commercial seed treadmill (Howard

2009: 1269). The use of the technologies by the farmers have the tendency of enhancing production and overall yields of farmers, however, the challenge that comes is that farmers must keep to the use of the off-farm treadmills to avoid the possibility of being left out of business and the market. This situation could make cost high for farmers as they must put in more money in maintaining their production and staying in business (Howard 2009; Weis and Weis 2007). With this, farmers may be rendered as losers with the larger companies dealing in inputs and multinationals engaged in the sale of inputs becoming winners, making profits at the expense of the small scale farmers (Hansen 2019; Weis and Weis 2007).

## **2.6 Methodology and Methods**

The methodology used for this research is qualitative research methodology. A qualitative research methodology may involve amongst others the technique of observing a specific domain or a particular setting (O' Leary 2017; 2013). This may encompass observing and studying group of people within a distinct geographical space or environment in order to understand how people behave, their culture, general habits, as well as their customs (O' Leary 2017; Denzin and Lincoln 2008: 3-4).

Some key characteristics of qualitative research methodology entails collecting information and gathering relevant data on the behaviours and activities of specific social group of people within a designated space (O' Leary 2017; Strauss and Corbin 1998). The process of gathering information may be undertaken through analysis of relevant documents including web files and academic papers that are important for the research.

It may also encompass interviews and observations of the area of study and its inhabitants to comprehend people's activities and behaviours (O' Leary 2017; Strauss and Corbin 1998). This could help in adequately understanding why specific group of people or even individuals may behave or perform certain activities in certain ways.

Another relevant part of qualitative research methodology is the process of organizing information which is collected and further interpreting the information to allow for constructive analysis to be made on the gathered information and data (Denzin and Lincoln 2008: 3-4). Last but not the least, it entails writing up of the findings and outcomes of the research within a report. The outcomes could be reported in the form of written report which may be in the design or pattern of a research article or even in structure of a verbal report (O' Leary 2017).

### **2.6.1 Plan and Process of Data Collection**

The Adumasa community was selected for the research because with my stay in the community in last ten years, the adoption of new agricultural technologies were not common among farmers, however in the last few years, farmers have begun to employ new technologies. It is therefore important to explore the factors behind their adoption. Due to the current situation of the Covid-19 pandemic, it was not possible for me to do an in-person field work in the community. In view of this, I used the help of two research assistants who are high school teachers and live in the community. In avoiding the influence of the assistants in selection process, I advised them on the need to be neutral and not to bring in their preferences in the process.

Through their assistance, I identified the farmers to be interviewed employing a purposive sampling technique. A total of fifteen farmers were interviewed. Out of this, ten were farmers who had adopted the technologies and five were non-adopters. The sample size of fifteen was taken to create room for advancing an in-depth analysis of the research. Additionally, with the aim of the research to be more of a people-centred one, the interviews with the farmers allows for getting the views and perspectives of farmers on the dynamics and significant factors that influence their adoption. Gender was taken into consideration, with the aim to create gender balance, and as such out of the fifteen, eight were men with the remaining seven being women.

Through the assistants, the farmers were identified and briefed on the nature and purpose of the research. The selection was done based on the criteria of farmers who had lived in the community for five years or more and had either adopted the technologies or not. Their concerns were sought in including them in the research and interviewing them. The assistants ensured that right participants who included adopters and non-adopters were selected. Additionally, the assistants were asked to do observations on the technologies being used, nature of farming and conditions of the farmers. With this, three days were used by the assistants to visit the farms of farmers.

Furthermore, I arranged for telephone interviews with the farmers in their convenient times, respectively. I did the telephone interviews myself to allow me to at least have a direct contact on phone with the farmers. Telephone interviews could be characterized by some challenges. A limitation of telephone interviews is seen on how to ensure trust. As noted by Block and Erskine (2012), the building of trust between study participants and the researcher is vital for getting comprehensive data and information. The absence of trust could also limit the research with regards to obtaining complete responses from the participants (Schweiter

and Duxbury 2006). Therefore, in building trust with the farmers, I made it clear to the farmers the purpose of the research and the importance it could have for the community in relation to their farming. The interviews for each farmer took approximately 40 minutes. Upon approval of the farmers notes were taken from the responses.

Also, analysis of the collected data was done by organizing the results into various themes. The themes included the technologies being used, institutional and political factors influencing the adoption, socio-economic factors that influences the adoption and challenges that have prevented some farmers from adopting. The Atlas-T Software was employed in analysing the data from the qualitative research interviews.

## **2.7 Limitations**

This study experienced challenges in the form of the limited time that is available for collecting and gathering the information that are relevant for the analysis. This to some extent explains why the sample size for the qualitative interviews of the research is placed at fifteen to allow and give room for facilitating in-depth interpretation and analysis.

## **2.8 Ethical Considerations, Positionality and Reflexivity on the Research**

Ethical considerations are relevant when conducting a social research of this type. It is necessary to apply standard research ethics for the research approach and seek concerns and interest of participants involved (Serantakos 2012; O' Leary 2013). For this to be achieved, I sought for permission of the community and the participants. Additionally, I also made attempt in ensuring anonymity of the participants and only used the information and data given for purpose of the research and not their names.

Furthermore, it was essential to consider my positionality. Positionality brings out the relations which manifests social and power relations that is brought out between the research that is being organized, research participants and the researcher (O' Leary 2013). Therefore, considering the position that is upheld by the researcher within the scope of the research is significant for facilitating adequacy and objectivity (Crossa 2012).

The social and power relations that may exist between participants and the social research could influence the direction and analysis of the research in a way (O' Leary 2013). The relation could alter and affect the kind and nature of responses that are provided, as well as ways in which responses are provided. It is important to comprehend and examine opinions, ideas, and scope of the researcher on the research that is undertaken (Crossa 2012). It

is vital to consider views and concerns which are upheld by the researcher as perspectives on the research.

This is because my position as a researcher with regards to the ideas that I upheld is important for the study and this may to some extent affect and distort objectivity of research which may alter adequacy and effectiveness of the research. From this, it could be noted that it is significant for me to give maximum attention and concerns of the research that is carried out vis a vis the participants and their views, ideas, and perspectives to allow for adequate analysis and further help in ensuring clear objectiveness.

I also considered positionality of the research assistants. The position and power relations between research assistants and participants could influence the objectivity of a research (Stevano and Deane 2017). Considering their position as teachers in the community and as leaders, their stance could influence the study in a way. In view of this, I discussed with the assistants the purpose of the research and the importance of not allowing their position and preferences in the research. They were also advised not to allow their familiarity with the community and the people to influence the research and to remain neutral. This was significant because it allowed for assistants not to bring their views, stance, and perceptions in the research.

Considering the discussions here, I made a provision for the consent of the participants. The participants were allowed to voluntarily take part in the research and hold their right to discontinue with the study if they decide to. Additionally, the reasons behind the research and its relevance are explained to them. I also try not to consider the farmers as adamant to technology adoption on their own but give concern for their knowledge and ideas in dealing with technology adoption.

## **2.9 Conclusion**

This chapter has addressed the conceptual definitions and theoretical framework, in addition to methodology of the research and methods that are used for the analysis. This has considered conceptualization of technology adoption and its relevance for enhancing farming. It has also looked at agricultural technology transfer and the adoption problem, as well as agricultural technology treadmill. It has further considered Rogers theory on adoption and the individual innovativeness theory giving attention to different categories of adopters.

From the chapter, it has been realized that technological adoption encompasses conditions and factors that necessitates the changing of functions of production, taken into

consideration existing uncertainties that may be objective or even perceived. The uncertainty together with its resulting ambivalence may weaken and abbreviate in the course of time. Therefore, is relevant to tease-out specific conditions facilitating adoption decision of farmers in the specific context.

## **Chapter 3**

### **3.0 Overview of the Adoption and use of Agricultural Technology**

#### **3.1 Introduction**

This part of the paper reviews literature on the adoption and use of agricultural technology in farming. It also looks at the determinants of agricultural technology adoption, considering factors that facilitate technology adoption as well as factors that hinders it. This examines socio-economic and the institutional determinants of agricultural technology adoption and use. It also explores perception of farmers on the use of agricultural technologies. It further explore factors that influences farming productivity and consider the relevance and role played by technology within agricultural development.

#### **3.2 Technology's Role in Agricultural Development**

Technology has been seen to contribute an important impact on agricultural development and improvement in developed countries, as well as in the developing world. New technologies provide significant impact on agriculture thereby providing sustainable and productive way of farming. Considering an increasing growth rate of the World population with a figure above 7-million people, more needs to be done in meeting the food needs of people more especially in developing countries (Matthews 2013). Population growth rates in developing countries have been predicated to increase rapidly in the next forty years, and as ensuring a pro-poor technological development that sees to growth of the world, especially for farmers in less-developed economies is important for making-up with the increasing global population rates with regards to food and consumption needs (FAO 2012).

Technological development and change in agriculture are significant for enhancing production and increasing profit base of farmers. According to Nin et al., (2003), utilization of agricultural technologies and new systems of farming have generated an increased yield in developing countries and led to enlarging the size of farmlands for crop cultivation. This enhances and improves livelihoods of farming communities which further strengthens economic growth and development of the developing economies (Albrecht and Bauckhage 2012; Akudugu et al., 2012). For instance, in Kenya, the employment of new varieties of maize by commercial farmers have witnessed greater production which has subsequently led to large quantities of the beans been produced for the local market and beyond (Gabre Madhin and Haggblade 2001). Notwithstanding this, technological change, and adoption of new technologies within agriculture in many Sub-Saharan African countries such as, Ghana have

been low (Annan 2018; Akudugu et al., 2012). Therefore, ensuring availability of agricultural technologies to small-scale farmers and their adoption of technologies through extension services and education is critical for promoting agricultural development and growth.

The problems of malnutrition as well as hunger especially in developing countries created attention and called on international agencies and organizations such as, the Rock-Feller Foundation in making concrete attempts within international research on agricultural technologies (Kumar 2020; Minten and Barrett 2008). Within this, key research was carried out on appropriate agricultural technologies that could be conducive for developing countries. This saw research in major areas including improved irrigation systems, pesticides applications, new varieties of seeds and crop production, especially with wheat and rice production (Kumar 2020). This gradually led to substantial increase in outputs of such crops within the developing economies. The technological advancement become known as the Green Revolution as noted by the USAID.

The Green Revolution is therefore characterized by comprehensive use of modern inputs, utilization of pesticides and fertilizer application, new seed and crop variety and new practices of irrigation in agricultural production (DeJanvry and Sadoulet 2002; Akudugu et al., 2012). This came with a technology revelation comprising use and adoption of modern technological innovations which makes essential engagement of advanced systems of water, seed, and fertilizer utilizations (Kumar 2020; Moser and Barret 2003).

Furthermore, the Green Revolution became highly utilized in Asia, particularly in India and China. This led to massive output in agricultural production in Asia. For example, agricultural production in India became of a capital-intensive system with the coming of the Green Revolution (Minten and Barret 2008; Evenson and Gollin 2003). This promoted the growth of cereal production with wheat and rice achieving greater outputs and profound increase in farming land sizes. However, it should be noted that with the pro-capitalist trend of the Green Revolution, it has subsequently led to the dilemma of inequality mostly among rural farming areas in developing countries (Patel 2013). Also, innovations that is characterized by labour saving mechanisms without key consideration for labour, then labour within the rural farming areas are likely to be displaced if adequate and substantial attentions are not given to cater for them (Akudugu et al., 2012). Therefore, technological innovations in line with the Green Revolution and technological advancements need to be made with a pro-poor motive in its design and planning. It should also be made to adjust and incorporate local techniques.

### **3.3 Determinants of Technology Adoption in Agriculture.**

Several studies have shown some factors that influence adoption of new technologies by farmers in developing countries. Most of the studies have in most cases looked at factors that influence, why and how certain groups of farmers may decide to employ particular farming technologies or not (Boateng 2003; Leathers and Smale 1995). Other studies have focussed on determinants of conditions, as well as the diffusion patterns of technology innovations within a population of farmers (Boateng 2003). Notwithstanding many studies that have been conducted on agriculture technology, it has been argued that several of the studies have not helped much as a number of the statistical models employed by the studies have shown levels of explanatory power that are less irrespective of the numerous variables of explanations that are often used (Boateng 2003).

Several of the studies on agricultural technology tended to produce contradictory explanations with regards to significance of the factors that influences decisions of farmers in adopting technologies (Boateng 2003; Amir 1999). For instance, decision within developing countries to adopt technologies have been seen to be facilitated by multi-faceted range of institutional, social, economic, technical as well as demographic factors. Additionally, the decision of farmers may be influenced and have a dependence on cost and effects that come with the technology in question, as well as the objectives and challenges that characterizes adoption of the said technology (Annan 2018; Obeng-Ofori et al., 2014; Akudugu et al., 2012). With this, agricultural technology adoption should encompass benefits for farmers that are relevant in relation to cost of adoption and use.

Furthermore, in considering the fact that, the adoption decision of farmers come with dynamic and complex levels of institutional and socio-economic factors (Loevinsohn et al., 2012), it should be noted that farmers may not necessarily employ a particular technology forever. Prior to the adoption of new technologies, farmers take into concern several factors that could encourage their adoption process. A major consideration that comes into mind for farmers in the adoption process is the resources that may be involved and needed (Annan 2018; Dos 2003). These resources entail land and capital resources that are important for taking up technologies. Another factor could be consideration for the possibility of an existing technology that might be more effective than the one been adopted. This could for example be the existence of high yielding or improved variety of seed, crop or methods than the one been adopted (Dos 2003).

Pattanayak et al., (2003), for instance have identified four dimensions of agricultural technology adoption. The categories identified include resource endowments, biophysical

elements, uncertainty, risk factors and market incentives (Pattanayak et al., 2003). These factors may act and reinforce each other in determining decisions in adopting technologies. A similar categorization has been identified by Doss et al., 2003. With this, Doss et al., established four categorical dynamics that characterizes adoption decisions. This encompasses social and demographic features of farmers, the economic characteristics of farmers, institutional determinants and perceptions that surround the technologies been introduced (Doss et al., 2003).

Also, Langyintuo and Mekuria (2005) have given several determinants of small-scale farmers adoption of technologies which is in one way or the other similar to that of Pattanayak et al., 2003 and that of Doss et al., 2003. The conditions that were identified entailed institutional determinants, including state agricultural policies, extension advice, access to markets and information, production area access, access to credit facilities, as well as input characteristics and socio-economic characteristics of farmers (Langyintuo and Mekuria 2005). The input characteristics identified may include perceptions and ideas that farmers may have with regards to the state and qualities of inputs that are been employed (Adesina et al., 1993). The farmers' characteristics on the other hand included, size of the farmland, the gender, age, the size of the farming household, as well as knowledge and education of the farmers on agricultural technologies. This suggests that decision to employ agricultural technologies may be shaped as well as constrained by multiple socio-economic and political factors.

Additionally, it could be emphasized that studies that have been empirically conducted on adoption of agricultural technologies in farming activities have made attempts at drawing a link between adopters of technologies and the non-adopters (Khanna 2001). It has examined explanations, meanings and analyses of determinants and variables that influences adoption or non-adoption and institutional processes and elements, social and economic dynamics, and characteristics (Boateng 2003; Khanna 2001). In the next sub-sections, I turn to examine various categorization of factors, including social and economic factors, institutional and technical factors and how they influence farmers decisions.

### **3.3.1 Socio-Economic Determinants on Farmers Adoption of Technology**

Social and economic determinants have been seen to occupy important space and facilitator of technology adoption by farmers. Factors including gender, age, size of farming household, size of farmland, knowledge and educational levels of farmers are important elements that

could influence decisions of farmers on adoption or non-adoption (Annan 2018). For instance, studies conducted on technology adoption in developing countries, including Sub-Saharan Africa have indicated that social and demographic characteristics of farmers such as household size, gender, age and education levels are significant in determining technology adoption (Annan 2018; Doss et al., 2003).

On the household level for example, research in developing countries have shown that households that are headed by men have potential of adopting new technologies when compared to the ones with women as the heads (Doss et al., 2003). This is as a result of the discrimination and patriarchal dominance that characterizes families and households in developing countries including Sub-Saharan African countries (Boateng 2003; Doss et al., 2003). A research that was carried out in the Bawku West District in Ghana have shown that, male-headed households are more likely to adopt and use new technologies in comparison to households led by females (Akudugu et al., 2012). The reasons were the dominance of males and their inclusion in extension advice and services compared to their female counterparts who were scarcely involved (Akudugu et al., 2012).

The age of farmers is also an important determinant of adoption decisions. Research on technology adoption for Sorghum farmers within Guinea as well as Burkina Faso, revealed that farmers who are younger stand higher chance at employing new technologies than much older farmers (Adesina and Forson 1995). From this, the younger farmers are seen to embrace modern technologies because of their level of education, their desires in taking-up potential risks, as well as the foreseeable long-run plans that they may have compared to the older generation (Akudugu et al., 2012; Boateng 2003). The older generation farmers on the other hand may employ technologies in view of their access to credit facilities as a result of their long-term capital accumulation (Boateng 2003). Nevertheless, it should be noted that the age of farming household heads does not in all cases show positive link with adoption. This is because some older farmers as noted earlier on may be reluctant to embrace technologies due to old age, while younger farmers with their levels of education and ambitions to make changes in their farming and ensure strengthening of their farming activities take advantage of agricultural technologies.

The knowledge and level of education of farmers is also significant for technology adoption. The educational attainments of farmers have been seen to be important for their capacities in the use, acquisition and processing information that are necessary for new technologies (Namara et al., 2013; Mignouna et al., 2011). Studies in Mozambique on agricultural technology have revealed that, there are much positive impacts on the level of education of

farming household heads and the rate of technology adoption in farming activities (Uaiene et al., 2009). Similarly, Akudugu et al., (2012) have noted in their research in the Bawku West District in Ghana that, educational levels of farming households are important determinant for adoption of technologies for enhancing farm productivity. Also, higher education amongst farmers are relevant for technology innovations and their introduction within the process adoption. On the other hand, low level of education among small-scale farmers negatively impacts on farming innovations, technology adoption and entire farm production process (Ishak and Afrizon 2011).

Gender also comes as another important determinant of farmers adoption decision. Considering gender as a key factor within the decision of farmers to employ technologies in farming is significant because in making comparison between male and female headed households, the latter is poor compared to the former (Asante 2013; UBOS 2010). However, it should be noted that, this is due to several other factors including access, control and ownership of productive resources and access to land in developing countries. This is normally because of social, cultural norms and values that gives more access and control over land and production resources to men (Mignouna et al., 2011). With this, male-headed households have higher possibilities of employing new technologies than the female headed-households (Lavison 2013). In Nigeria for example, research has shown that due to some of these socio-cultural norms and values that gives control over land and productive resources to men, they are more able to adopt technologies for their cassava farming compared to women (Obisesan 2014).

Moving on, size of the farming household occupies an important position in the decision and process towards adopting new technologies. Larger farming households could stand the chance of having the possibility in relaxing the limits to labour that may be a requirement for new farming technologies that are to be adopted and used (Mignouna et al., 2011). This is because members of the households who are of age and ready to offer their labour in the farming activities could contribute and influence the processes of adopting new technologies. This comes from the point that, availability of the labour and new technologies introduced could bring down constraints of labour that may occur (Akubuilu and Gbegeh 2013; Bonabana Wabbi 2002).

Despite this, it should be noted that size of farming households may have both positive and negative impacts on adoption of technologies as many studies have shown (Kafle 2010). For instance, Perz (2003) has indicated that, larger size of farming households could have a positive influence on employment of new technologies such as fertilizer and application of

pesticides that are labour intensive. Therefore, with the availability of the labour needed the application and use of new technologies is likely to be much positive compared to the unavailability of it (Perz 2003). Nevertheless, studies conducted by Muhammed et al., (2012) in Northern part of Ghana indicated there was no important impact of the size of farming households on adoption of technologies for maize farming. The next section examines institutional factors influencing adoption decisions.

### **3.3.2 Institutional Factors that Influence the Employment of New Technologies for Farming.**

Institutional factors are crucial for farmer's decision whether to adopt or not adopt new technologies. Institutional factors that are relevant for influencing adoption decision of farmers have included access to credit facilities, membership, and support from cooperative societies, as well as availability and access to services on extension advice and programmes (Akubuilu and Gbegeh 2013).

The membership of farmers within farmer associations and cooperatives give them access to information on new technologies and its benefit (Akubuilu and Gbegeh 2013). Farmers associations organize workshops for members and introduce farmers to new methods. The workshops help farmers to significantly gain knowledge and vital information on modern practices and processes essential for enhancing farm production and improving farming activities.

Additionally, farming cooperatives and associations can liaise with other stakeholders like the government, companies, and NGOs to organize resources such as, credit facilities and training for members. This creates space for farmers to make informed-decisions in using new technologies to their advantage compared to people who are not members.

Also, provision of extension services, advice on farming practices and technologies and processes that are involved are essential for farmers adoption decision (Kudi et al., 2011; Trudy et al., 2001). The extension advice is provided by governmental institutions as well as from NGOs. Therefore, services that come in the form of workshops, training programmes and community discussions through extension advice can bring farmers closely to decision of embracing farming technologies (Kudi et al., 2011). Agriculture extension programs and services enable farmers to share ideas with agricultural extension officers and ask questions that are important for adoption of technologies and farming practices including fertilizer, pesticides application and new varieties of seeds and crops that may exist (Trudy et al., 2001).

The availability and access to credit facilities for small-scale farmers is another important determinant of farmers behaviours and decisions in using new technologies and innovations (Boateng 2003). In a situation where farmers have easy access to credit and loan systems to finance their farming activities; they are able to embrace technologies at higher rates compared to where they lack access to such facilities (Boateng 2003). This positively impact on adoption of technologies. This further enhances productivity of crop yields and could increase incomes of farmers. Studies conducted in Malawi in the 1990s indicated that farmers access to credit facilities had positive impact on the application of fertilizers and pesticides use for farming activities (Green and Ngong Ola 1993). Credit constraints could therefore hinder farmers decision to make use of technologies and ensure its application.

Furthermore, availability and closeness to ready markets in securing agro-inputs and other farm inputs is significant for use and adoption of technologies (Khan et al., 2008; Boateng 2003). The closeness of market in accessing the inputs enables farmers to easily acquire inputs and apply them. Earlier studies that were conducted in West Africa indicated that the closeness and access to input markets are crucial, and show positive impact for farmers in adopting technologies to their advantage (Inaizumi et al., 1999; Adesina 1996; Matlon 1994). Studies carried out by Inaizumi et al., (1999) in Nigeria showed that, closeness of input markets enable farmers to easily access inputs and adopt new ways of farming in comparison with those who were far from markets. Similarly, Boateng (2003), has noted that in Ghana, the nearest and availability of input markets provides positive impact on use of new innovations and technologies.

Additionally, prices of farm inputs play vital role in adoption of new technologies. Where input prices are affordable, farmers are able to purchase inputs including new varieties of seeds, the use of fertilizers and pesticides to enhance farming activities. Kherallah et al., (2001) have noted that in the case of Benin, higher prices of fertilizer, particularly affected farmers in making use of it and applying them in farming. This negatively impacted the decision of farmers in adopting fertilizer and using it to their advantage (Kherallah et al., 2001). As the prices of inputs shoot up, farmers are more likely to limit their adoption of technologies and inputs that come with higher prices, and rather keep to their old ways of farming in order not to incur costs that could affect them.

### **3.4 The Perception of Farmers on the use of New Agricultural Technologies**

The perception that farmers may have about new technologies and its use is significant when measuring the rate of farmers' adoption decision. Therefore, understanding farmers' viewpoint on the characteristics and importance of technologies becomes significant for agricultural agencies, government, and extension officers in understanding and educating farmers on adoption of technologies and seed varieties (Neil and Lee 2001). Farmers may have different perceptions about use of new technologies which in turn informs their decision to adopt or not adopt them.

A major perception that farmers have could be based on the production cost that comes with a new technology (Martel et al., 2000). Perception of high cost of production with new technologies compared with benefits that the technology brings may inform farmers whether to adopt. Additionally, farmers may be informed by perception of the initial capital investment that may be needed in employing a technology (Martel et al., 2000).

Furthermore, the perceived risks as well as labour requirement that comes with adoption of technologies could inform farmer's decision on using the technology. Martel et al., (2000) have noted in their studies in Honduras that farmers in most cases try to consider risk of production and the cost involved in using new technologies by deciding on whether to keep to their local beans varieties or to embrace new varieties. In a situation whereby a new variety gives greater yields compared to local varieties, farmers are more likely to use the new varieties. Also, with a consideration of whether the new variety may be productive under harsh environmental conditions and able to stand all pest and diseases, then farmers may show higher chances of using them (Martel et al., 2000). In addition, with perceived notion that the new varieties could stand greater chance of providing much higher profit, farmers are likely to use them for their farming.

Another consideration in relation to farmers' perception of the characteristics of the use of new technologies can be linked to agro-ecological trends as well as environmental patterns within the farming areas (Doss 2003; Ramirez 2003). With perception of farmers on the environmental patterns and agro-ecological dynamics within the farming zones, farmers may decide whether to employ technologies that could stand the changes in environmental conditions and patterns of the weather (Ramirez 2003). With a situation where farmers predict the likelihood of adverse climate condition and changes in the agro-ecological structures, they may employ a new technology, for example crop or seed variety that could stand diverse environmental conditions and produce expected yields. Therefore, where new technology including new seed varieties comes with more advantages technically and economically, it

could be likely for farmers to use the technologies instead of the older ways of farming (Doss 2003).

### **3.5 Conclusion**

The chapter has reviewed empirical literature on adoption of agricultural technologies in developing countries and across the world. It has been found that several multi-faceted factors influence farmers decisions on adoption. The factors encompass socio-economic and political as well as institutional factors that enhances adoption.

The socio-economic factors include characteristics of farmers such as size of the farming households, size of farm, availability of capital to the farmer, educational level of farmers, gender, and age. The institutional and political factors include availability of extension services, access to information on agricultural technologies, subsidies on the use new technologies from the government and other project developers. It also entails access to input markets, availability and access to credit facilities and membership of farmers in agricultural cooperatives. These factors interrelate and reinforce each other in determining farmers adoption decision. The next chapter presents analysis and presentation of the research findings.

## Chapter 4

### 4.0 Analysis and Presentation of the Study Findings.

#### 4.1 Introduction

In this chapter, the research findings will be presented and analysed. The chapter starts by looking at the socio-demographic characteristics of the research respondents. It then proceeds to examine the specific agricultural technologies that have been employed in the study area. Subsequently, it examines the underlying factors that have facilitated adoption of the new technologies. These include the socio-economic, as well as institutional and political factors. Lastly, it considers the factors that have facilitated non-adoption of the technologies by some of the farmers and challenges that they encounter in the process.

#### 4.2 Socio-demographic Characteristics of the Farmers

In all, fifteen farmers were selected for the interviews. Out of this, eight were males and seven females. This was to allow for a gender balance in the responses from the participants and the research analysis.

The age distribution of the farmers ranged from twenty to sixty years, with the majority between (25 and 40 years). (see Table 1.0). With regards to educational levels of the farmers, many of them had a low education. Majority of them lacked basic formal education. The few who were educated had a basic and secondary level education.

**Table 1.0 Socio-demographic characteristics of the farmers.**

Farmer	Gender	Age (Years)	Educational Level	Size of Farm (Hectare)
1	Male	30	Basic	3
2	Male	25	Secondary	2
3	Male	27	Basic	2
4	Male	28	None	2
5	Male	45	None	4
6	Male	60	None	4
7	Male	33	Tertiary	3

8	Male	29	Basic	3
9	Female	45	Basic	4
10	Female	36	None	3
11	Female	28	Secondary	1
12	Female	54	None	4
13	Female	41	None	4
14	Female	29	Secondary	2
15	Female	39	None	3

**Source: Author's Interviews, August 2020.**

### **4.3 New Agricultural Technologies that are Adopted in the Study Area.**

The adoption of new agricultural technologies is important when it comes to the development of agriculture within small-scale farming. Within the Adumasa community, the desire and interest in the employment of new technologies was low in the last twenty years (Boateng 2011). However, in the last five to ten years with my stay in the community, I have come to realize that farmers have embraced new technologies for their farming.

For the purpose of this research, four technologies that have been adopted and used frequently by the farmers have being analysed and taken into consideration. It further takes into concern the motivations and main stakeholders, as well as actors who are behind the adoption of the technologies. The technologies that have been adopted in the community have included new irrigation systems, use of pesticides, fertilizer application and the use of the motor tricycle, popularly referred to as 'Aboboya'.

Most of these technologies have been introduced with the help of extension services from public sector community agricultural officers and private farming associations. The technologies that have been adopted through the support of extension advice and services are fertilizer applications, pesticides, and new irrigation technologies (GoG 2017; Asante 2013).

The application of pesticides has been possible with the use of sprayers. The farmers who have adopted the use of sprayers have employed the sprayers in mainly applying the pesticides to their vegetable farms and crops including, maize and cassava. This according to the adopters has being beneficial for getting rid of pest which in the previous years have been a major challenge for the growth of their farm production.

The irrigation technologies that have been adopted are the use of permanent-shallow wells, shallow-tube well systems and the ground water irrigation systems. These have been mostly carried out through efforts of the community farmers and their associations, in connecting water pumps from river and stream sources to the farm sites. Additionally, sprinklers and pipes have been used in distributing water to farmlands in ensuring that crops receive the needed water. The use of efficient systems of irrigation become significant for ensuring crop growth in Ghana, particularly in times of drought, which is significant for maintaining water supply to crops and ensuring higher yields (Asante 2013). This has become important now due to climate change and the current challenges of drought in the country.

With regards to the permanent-shallow wells, they are used during the entire year and good for vegetable farming, including tomatoes and cabbage production. Techniques that have been used by farmers in distributing and lifting water from wells have included, use of buckets and rope pumps that are supported by motorized pumping systems. The permanent nature of this type of irrigation system makes it more efficient as it contributes to farming in dry season as well as the rest of the farming season (Namara et al., 2010). In the Keta district of Ghana for example, use of permanent-shallow well systems for irrigational purposes have witnessed substantial improvement in farmers productivity, which has facilitated improvement in production and contributed to other aspects of the livelihoods of farmers including food security and farm profit (Namara et al., 2010). This has made the irrigation process faster and easier compared to the earlier manual systems that were used. A farmer who has employed the use of the new irrigation system noted;

*‘Through the use of the permanent-shallow water system that pumps water to the fields for vegetable and crops, our burden of carrying water everyday has been reduced; with much time saved for carrying out other activities on the farm; This has improved my efficiency and crop production and has helped our household’s food consumption needs throughout the year’.* (Respondent 1, Interview; August 2020).

This could suggest that through efforts of farmers’ cooperatives and extension services which have engaged farmers, they have been able to employ new irrigation systems which have enhanced farming in the community. Farmer cooperatives and extension services are therefore vital in farmers decisions of adopting agricultural technologies (Kudi et al., 2011; Trudy et al., 2001).

Furthermore, with regards to the use of the motor tricycle which is used for conveying farmers, their households, as well as farm inputs, and harvest to and from the farmland have been facilitated with the innovations and decisions of farmer categories who are mostly opinion leaders and hold significant positions in the community. In view of this, most of the

farmers who mostly are within the early majority and late majority categories have employed the motor tricycle with the advice and communications with early adopters who are in most cases opinion leaders. This come in line with Rogers (2003) argument that with early adopters embracing new innovations, they are more likely to spread the message on adoption through the positions they occupy within the social system to other categories including early majority and the late majority. It was noted by a farmer during the interview that;

*“With the support and advice through regular communication and information sharing from the early adopters who are our leaders and opinion leaders in the farmers’ association, I was convinced about the importance of the motor tricycle in facilitating my farming: Since I started using the tricycle, conveying farm inputs to the farm and yields to the market have been much faster and has saved a lot of time and energy”.* (Respondent 2, Interview; August 2020).

The next section examines the institutional and political factors that have facilitated adoption of the technologies.

#### **4.4 Institutional and Political Factors Facilitating Farmers Adoption of the New Technologies.**

The study identified multiple institutional and political factors that influences the decision of the farmers in adopting (or not) new agricultural technologies in the study area. The factors included the availability and access to extension services, government subsidies on fertilizers application and pesticides use, availability and closeness of input markets. These factors are discussed in rest of this section.

To begin with, availability of extension services for farmers was very significant for the decision to adopt the technologies. Most of the farmers interviewed (9) agree that information and knowledge acquired through extension services from public department of agriculture in the district was beneficial for them in taking up the technologies. This to an extent has strengthened and positively impacted on their farming activities. One of the interviewed farmers stated;

*“Regular contacts and communication with agricultural extension officers have provided them with substantial knowledge and information which has been significant in adopting the technologies particularly use of pesticides and fertilizer application”.* (Respondent 3, Interview; August 2020).

This advice come as independent for the farmers as they have to decide upon the recommendation of the extension officers which inputs to use. Availability and access to extension

services are therefore important in farmers adoption decision as it could fill up the consequences that may have emerged; lack of education of some farmers affect their decision to employ new technologies negatively (Yaron et al., 1992). This could counter-balance the number of years that farmers might have engaged in farming without any form of formal education. Similarly, Kudi et al., (2011), have argued that, extension advice to farmers in the form of workshops and trainings on technology use are essential for farmers in adopting agricultural technologies for farming. Another farmer noted in the interview that;

*“Through regular workshops, community forums and training programs organized by extension officers, I have come to understand the use and benefits of new technologies; and as such have come to embrace the technologies”.* (Respondent 4, Interview; August 2020).

Farmers’ access to extension services and their regular contacts with agricultural extension officers open-up space for acquiring knowledge and obtaining important ideas and information on existing and new methods. This is significant for bringing down the uncertainties and doubts which farmers may have with regards to the suitability and benefits that could come with the technologies. It further helps farmers in making objective decisions over subjective ones concerning adoption of technologies.

Another important factor that informed farmers adoption decision in the study area was existence and membership in agricultural cooperatives. As we have seen in the previous chapter, farmers membership within cooperatives and farming associations have been seen to be essential for farmers in deciding on new technology use. Cooperatives that provide support for their members in the form of access to credit facilities and farm inputs creates avenues for farmers in making use of agricultural technologies that are introduced (Akubuilu and Gbegeh 2013; Pattanayak et al., 2003). Majority of the farmers interviewed asserted to the fact that their membership in cooperatives and associations in the community have significantly informed them in their decisions in using the technologies. One of the farmers stated that;

*“With membership and participation in the activities of the farming cooperatives, I have been able to acquire farm inputs and credit which is necessary for the adoption of the technologies”.* (Respondent 5, Interview; August 2020).

Furthermore, the availability and closeness to agricultural input markets were reported to be a determinant factor for the farmers. The existence of markets which provide for the input needs for farming are seen to be critical for informing farmers decisions in using new technologies for farming. Through the interviews, it was revealed by most of the them that

availability and closeness of the farms to market centres with farm input and materials have been significant for using the technologies. Through the interviews a farmer emphasized that;

*“The closeness of their farms to the market centre has enabled them to easily get access to the needed farm inputs that are essential for them in using the technologies more especially use of pesticides, fertilizers, and the motor tricycle”. (Respondent 6, Interview; August 2020).*

Therefore the closeness and availability of markets with the needed farm inputs which facilitate the use of agricultural technologies to an extent provide a platform for farmers in accessing and taking advantage of technologies to enhance farm production and their livelihoods (Khan et al., 2008; Boateng 2003).

#### **4.5. Socio-economic Factors Facilitating the Farmers Adoption of the New Technologies**

Through the interviews with the farmers multiple interacting socio-economic factors were identified as facilitating farmers decisions in adopting the technologies. The factors included, size of the farmland, the age of the farmer, gender, farmers educational level, the expected outcomes of the technologies, as well as the capital and resources available to the farmers.

The size of the farming land came as an important factor in determining the decision of the farmers in adopting the technologies. From the study it was noted that farmers with larger farming households were mostly the ones able to adopt new technologies. Due to the household labour, they have more resources and stand a higher possibility of employing the technologies in enhancing their farm production and entire farming. This comes in line with literatures on agricultural technology adoption, which states that farmers with large farm sizes are more likely to employ and take advantage of technologies when compared to farmers with smaller farm size (Akudugu et al.,2012; Boateng 2003; Kasenge 1998; McNamara et al., 1991). During the interviews, a farmer noted that;

*‘Due to my large farm size, it has become necessary for me to adopt the technology, especially fertilizers and pesticides use.’ (Respondent 7, Interview; August 2020).*

Some farmers (five) with a small farm size on the other hand reported that the size of their farms and the limited resources available to them has affected their decision to adopt and take advantage of the technologies. It is therefore important for policy makers and major stakeholders who are engaged in the introduction and promotion of agricultural technologies to give substantial attention to the farm sizes of farming households in the process of

adoption. This will provide adequate space for identifying workable strategies for addressing the challenge of small farm size in technology adoption.

Furthermore, age of the farmers was significant in determining the adoption decision. With this, age was seen to impact on the adoption decisions both positively and negatively. According to Mignouna et al., (2011), farmers who are much older tend to have greater level of skills and experience which might have developed over a longer time, and therefore they are more likely to assess and consider the use and benefits of farming methods and information on technology compared to younger ones. However, age may also entail negative impact on technology adoption, as Mauceri et al., (2005) has argued that much older farmers may be characterized by not having the desire to take up new risks in employing new technologies, as they could have a reduced interest with regards to making long-term investment in adopting new technologies. Younger farmers may have the desire to take up new risks in employing new technologies, but they could be challenged by their limited access to capital and productive resources that are required for adoption (Dewi 2011).

From the study, it has been found that most of the farmers who had adopted the technologies were the younger farmers (seven). This is due to their desire and readiness to take up new risks and increased their farm production and accumulate more capital for their farming. A young farmer aged twenty-five emphasized during the interview that;

*“I have to improve and increase my farm production and be able to invest in accumulating more resources and capital for my future and as such, I have to employ and take advantage of the new technology”.* (Respondent 8, Interview; August 2020).

Some older farmers were also seen to have adopted the technologies and used them in their farming. This was mainly because traditional inheritance law gives control of family resources like land to elders in the family. Therefore, most older farmers had much access to resources and had accumulated lot of capital than younger people, this has enabled them to easily embrace new technologies.

Another important determinant of farmers adoption decision that was found was the gender of the farmers. Gender has been noted by studies to have an influencing effect on decision of farmers to adopt new technologies (Asante 2013; Mignouna et al., 2011). Through the study and the interviews, it came out that gender has been a determinant in the adoption process. It was noticed that most of the farmers who had adopted the new technology were males. This was to an extent due to the socio-cultural norms and traditions of the community that gives access to productive resources including land, capital and labour which are key

when it comes to adoption of technologies. In addition, production decisions are in most cases made by men in the community and this also stand to give more possibility for the men and male-headed households to employ new technologies when compared with the women. A female farmer who had not adopted the technology said that;

*‘I have not been able to adopt the new technology because I have limited productive resources and capital to enable me keep up with the requirements of the technology’*. (Respondent 9, Interview; August 2020).

Also, the education of farmers was identified as an influencing factor in the decision of the farmers. The education level of farmers was seen through the interviews to have a significant impact on farmers decision in taken up the technologies, as most of the farmers who had adopted and making use of it were educated. This come to explain the point that, farmers who have high level of education stand at a higher chance of inquiring about modern technologies of farming compared to those who may not be educated (Caswell et al., 2001). This comes in line with research on technology adoption which have indicated that education for farmers provides much space for improving farmers knowledge on new technologies, especially with management and information intensive practices for farming (Namara et al., 2013; Mignouna et al., 2011; Waller et al., 1998).

Table 4.0 below shows a summary of the main factors influencing the adoption decisions of the farmers.

**Table 4.0 Factors influencing the adoption decisions of the farmers.**

<b>Factor</b>	<b>Number of Farmers</b>
Access to productive resources (land, capital)	8
Size of farmland	8
Extension services	6
Age	6
Level of education	3
Gender	2

**Source: Author’s Interviews: August 2020.**

From the table above, it could be realized that several factors influence the adoption decision of the farmers. What was much fascinating and came up during the interviews is that the access to productive resources including land and capital comes as an important

factor facilitating use of the modern technologies. The size of the farmland was also a significant factor that has determined the decisions of farmers. This to an extent comes to explain the economic factor with regards to wealthier farmers in the community who have access to much productive resources, as well as larger farmlands compared to less wealthier farmers. It is in line with the Roger's theory on adoption and diffusion in terms of how economic capacities in the form of larger capital base and productive resources acting as determinant for wealthier and influential farmers to be the first to adopt new technologies and become early adopters. On the other hand, less wealthier farmers may be limited by economic constraints in the form of lower access to productive resources and less capital base to enable them adopt and benefit from technologies that are introduced.

Additionally, extension services are seen from the interviews as important when it comes to identifying and examining adoption decisions. It is necessary to look into the more pressing factors such as, access to productive resources including high capital base, size of farmland, as well as extension services vis-à-vis other factors including age and gender. A major finding that this research unravels is that economic factors as discussed earlier in the form of access to land and productive resources, as well as larger capital is essential when it comes to technology adoption.

Moving on to consider the impacts of the adoption of the new technologies, it was found out through the interviews with the farmers who have adopted the technologies that, since their adoption, they have witnessed some improvement and enhancement of their livelihoods in the community. The impacts have included increased production and food consumption.

It has also resulted in raising the farm earnings and total income of the farmers who have adopted. This has brought more youths into farming which to an extent has reduced the migration of youths into the city centres. A farmer stated that;

*“Since I started using fertilizers and pesticides in my farming, my total yield has increased and this has helped to increase my farm earning”* (Respondent 5, Interview; August 2020).

This suggest to some extent that the technologies have improved the farming of the adopters which have positively impacted on their livelihoods.

#### **4.6 Factors that Facilitate the Non-Adoption of the New Technologies and the Challenges Farmers experience in the Adoption Process.**

Despite the impressive levels of adoption of the agricultural technologies in the farming activities of the farmers and the numerous factors that had led to their decisions of adoption, it was found during the study that several factors have also acted as constraints for some of the farmers. In this section therefore, I examine some of the factors that have created a challenge for some of the farmers and led to non-adoption of the technologies.

A major challenge for some of the farmers has been limited access to credit facilities in enhancing their farming. The availability and access to credit facilities for small-scale farmers is seen as vital for them in taking advantage of new technologies (Boateng 2003; Adesina 1996). During the interviews it was found that some of the farmers have not been able to adopt the technologies due to their limited productive resources and less access to credit facilities in purchasing some of the new technology tools. This has limited the farmers in question from adopting the technologies in their farming. A non-adopter of the new technologies noted that;

*“I am unable to adopt the technology because of my limited productive resources and low access to credit schemes to facilitate the process of adoption; the high cost of the motor tricycle and pesticides have acted as a challenge for me”. (Respondent 11; Interview August 2020).*

The findings with regards to the availability and access to credit facilities therefore come in line with studies by Boateng (2003), which noted that access to credit schemes and limited capital affects farmers' decision in embracing new technologies. Low access to credit facilities is in a way linked with the low land holdings of some of the farmers. In making reference to Roger's adoption and diffusion theory therefore, it could be seen that economic challenges in terms of low access to capital and productive resources limits farmers who lack such economic capacities from adopting new innovations. Those who are privileged to have such economic capacities and resources stand to gain, as they are able to capitalize on their capital and productive resources and use new technologies.

Additionally, prices of farm production inputs especially fertilizers and pesticides were found to be another factor that has facilitated non-adoption of the technologies. This was mostly with the farmers with small farms. High prices of inputs that are significant for using the technologies came as a factor that limited some of the farmers in adopting the technologies. Kherallah et al., (2001), have argued that high cost of agricultural input prices tends to act as a challenge for small-scale farmers in using new technologies and taking advantage of

the benefits that come with it. Farmers who had not adopted the technologies asserted the fact that high prices of inputs and tools needed for adopting the technologies have prevented them from using the technologies. A farmer who had not adopted the technologies emphasized this point;

*“Due to my limited capital and resources coupled with high prices of fertilizers and pesticides required for the technology, my household has been unable to adopt”.* (Respondent 12, Interview; August 2020).

Furthermore, an important factor that has been noted to prevent some of the farmers from adopting the use of the agro-chemicals was fear of the long-term effects on their land and water bodies. This was with the use of herbicides, pesticides and fertilizers. It was revealed by farmers who had not embraced the application of fertilizers and pesticides that their fear of the effects on the land; for instance, the effects on the quality of the soils in the long run has necessitated them not to adopt. A farmer noted;

*“The effects on my farmland in terms of a loss of soil fertility in the long-run and quality of the yield has made me not to use the agro-chemicals; when the fertilizers and pesticides were first introduced I started to apply them in my farming, however with complaints from my customers on the change of the taste of my tomatoes and its quality, I had to stop using it”.* (Respondent 13, Interview; August 2020).

This is in line with the argument by (Fianko et al., 2011) that excessive use of agro-chemicals for farming in Ghana to an extent affects quality of the soil and the food that are produced. This has discouraged some farmers from using such technologies. It shows that the long-term environmental impacts and effects on the soils may prevent the application of agro-chemicals by small-scale farmers. It also reflects on why some of the farmers interviewed are reluctant in using fertilizers and other agro-chemicals.

Also, farmers fear of incurring losses of income in using the technologies especially the fertilizers and pesticides were noted as a challenge. The farmers who had not taken up the technologies indicated that, high cost involved in acquiring farm inputs, coupled with their fear of running into debt and losing their land had prevented them from adopting. Farmers fear of the negative effects that may come with a new technology such as the purchase of new inputs including fertilizers, herbicides and pesticides and the indebtedness that could come with it might stand as an obstacle for them (Akudugu et al., 2012). A farmer emphasized this in the course of the interviews;

*“ I have not taken up the new technologies because of fear of losing my capital and incurring debts that comes with the use of the technologies”.* (Respondent 14, Interview; August 2020).

Furthermore, some farmers who had adopted the technologies particularly fertilizer application also shared a challenge with regards to the losses and decline in their profits they have begun to experience with new farmers and many other larger groups coming in to employ the technologies. It was noted by a farmer that;

*“When the fertilizers and pesticides were first introduced at the early stages, I was one of the people to use it in my farming; things were better then, with higher yields and profits; however, with many other farmers and more wealthier farmers joining in, yields have increased but prices of our produce have been low”.* (Respondent 15, Interview; August 2020).

This reflects on the technology treadmill by Cochrane, which predicts that only early adopters reap the benefits of new technologies; when everyone adopts, prices go down and benefits disappear or turn into a negative effect (Levins and Cochrane 1996).

Also, some early adopters of the technologies who employed the pesticides and fertilizers indicated running into losses and incurring debts. It was revealed during the interview by some of the farmers who adopted fertilizer application that, they had to borrow money from people and buy on credit in order to use the new innovations which was good for them in making higher profits at the early stages. Nevertheless, with the expansion of the technology use, especially pesticides and fertilizer applications by many farmers, yields for their produce including tomatoes and garden eggs have risen and this has lowered the prices compared to the initial stages. This has resulted in some of the farmers suffering losses in the form of debts and unpaid credits.

In Table 4.1 below, I show a summary of the factors preventing the non-adopters from using the technologies. This helps in understanding the factors which are more important for the farmers in the community with regards to their non-adoption decisions.

**Table 4.1 Factors preventing some farmers from adopting the new technologies**

Factor	Number of Farmers
Limited access to credit facilities	5
Low access to productive resources (land, capital)	5
High prices of inputs	2
Fear of incurring losses in income and running into debts	2
Loss of the quality of the farm produce	2

**Source: (Author’s Interviews: August 2020).**

From table 4.1 above, it could be seen that economic constraints come as the main factor that limits many of the non-adopters from embracing and taken advantage of the technologies. The economic constraints include limited access to credit facilities, lower levels of

capital, less access to productive resources, as well as high prices of farm inputs which are necessary for adopting the technologies. This reemphasizes the point that economic challenges occupy significant role with regards to examining and addressing the decision of small-scale farmers to adopt new technologies.

With regards to the agency and knowledge of the farmers when it comes to adoption agricultural technologies, it was realized in the interviews with some of the farmers (four) that in most cases of the adoption process, they are influenced in many instances by extension officers who bring down the ways and techniques of adoption to them, given less attention to their local knowledge and pre-existing ideas and methods. Also, some of the farmers emphasized the point that cooperative heads and community leaders have also influence their adoption decisions. Providing less attention and consideration for local knowledge of farmers and their ideas may limit and affect the agency and decisions of farmers in using new technologies.

This reflects the aspect of Roger's adoption and diffusion theories which emphasize the need for factoring in the local knowledge, ideas, and practices of adopters with regards to the use of new innovations. Therefore, it could be noted that the engagement of farmers in terms of their existing knowledge and ideas are important in the introduction of new technologies and adoption by farmers.

#### **4.7 Conclusion**

The chapter has examined the factors that influence farmers in Adumasa to adopt or not adopt new technologies including fertilizer application, pesticides use, modern irrigation systems, and use of the motor tricycle. From the discussions, it has been found that multiple set of factors have influenced majority of the farmers interviewed in adopting the technologies. The factors have included institutional and political factors as well as socio-economic indicators. Among the institutional and political factors are the availability and access to extension advice and services, membership and support of farmers cooperatives, workshops, and community training programs for farmers within cooperatives, and availability and closeness of input markets. The socio-economic factors include the capital and productive resources available to the farmers, size of the farmland, age of farmers, gender of head of the farming household, and educational level of the farmers. The institutional and political factors as well as the socio-economic factors interact and reinforce each other in determining farmers adoption decision.

Furthermore, through the analysis, it was found that several other factors such as limited access to credit facilities, high cost of input and productive prices needed for taken up the technologies, and limited capital and resources of some farmers have prevented them from adopting. Also, it has been found that the fear and experiences of some farmers regarding the long-run effects on the fertility of the soil, especially the use of the agro-chemicals including fertilizers and pesticides and the fear of losing their capital and running into debts have acted as challenges for these farmers.

Amongst all the factors it has been seen that economic factors in the form of access to capital, productive resources, credit facilities, as well as extension services comes as the more important for the farmers in the study area in relation to their decision of adoption or non-adoption. This suggest that economic constraints come as very relevant when addressing the use of modern technologies by small-scale farmers.

## **Chapter 5 Conclusions**

### **5.1 Introduction**

This chapter presents the summary and conclusions of the research. It also considers key recommendations and policy measures. Last but not the least, the chapter looks at the key areas that will be important for further research in the future.

### **5.2 Summary and Conclusions**

The study has examined the factors that influence small-scale farmers in the Adumasa community in their decision to adopt or not adopt new technologies in their farming activities. The new technologies used in the community include fertilizer application, pesticides use, modern irrigation systems and use of the motor tricycle for conveying farm inputs and harvest to and from the farms.

From the study, it was seen that the adoption of the technologies has to an extent help improve the livelihoods of the adopters. This was in terms of increased productivity, increased income and bringing of more youth into farming. Furthermore, it was identified that multiple institutional and political factors, as well as socio-economic factors facilitate the adoption decision of the farmers. The institutional factors that have influenced majority of the farmers in adopting the technologies were access to extension services and advise, support from farmer cooperatives, access, and closeness to input markets, workshops, and community training programs. The socio-economic factors are capital and productive resources available to farmers, farmers' educational levels, size of farmland, age, and gender of the heads of the farming households.

On the other hand, factors including limited capital and resource base of some of the farmers, low access to credit facilities, high prices of inputs necessary for adopting the technology, as well as the fear that some of the farmers have with regards to the long-term effects on the fertility and quality of the soil, and experiences of losing their capital and incurring debts have become obstacles for these farmers.

Based on the discussions and the analysis, it could be argued that multiple indicators which may be institutional, as well as socioeconomic facilitate decisions of the farmers to adopt or not adopt the technologies, and not necessarily a single factor has influenced the farmers decision. Nevertheless, economic factors which are seen in the form of access to productive resources, credit facilities, capital as well as services of extension officers come as the more pressing indicators for the farmers with regards to their adoption decision.

From this, I argue that specific set of factors which could be institutional and or socio-economic influences decisions of farmers in a particular farming area to adopt or not adopt new technologies and as such, universal set of indicators should not just be used in determining farmers adoption decisions.

With regards to factors that have prevented some of the farmers from adopting the technologies, economic factors including limited access to productive resources, credit facilities and high prices of farm inputs were seen as more important factors. Other factors such as the fear of some farmers of losing their capital and incurring losses, as well as loss of the quality of the farm produce were also seen as limiting farmers adoption decision.

In making policy recommendations therefore, it is important for the government and its Ministry of Food and Agriculture, as well as non-governmental agricultural agencies to take into consideration peculiar needs of particular group of farmers and their farming areas when planning programs on adoption of technologies. In this case, the economic factors and challenges which have been identified as the more relevant should be given much consideration. Also, it is essential to factor in their programs, trainings and workshops, the multiple factors that facilitate farmers adoption and non-adoption, and how they interrelate to determine the decisions of farmers. The government and other stakeholders could encourage the development of indigenous knowledge, ideas, and innovation alongside new technologies. Most of these traditional farming practices such as, using animal dungs as fertilizers, shifting cultivation are sustainable and do not cause much harm to the environment and does not affect quality of farm products, and does not affect the health of farmers.

Lastly, further studies could make a comparative study on the different intersectional factors that determines farmers adoption decisions in different farming communities in the country. This would allow for an in-depth analysis into the different dynamics, intersecting and interrelated factors that influences different farmers to employ new technologies.

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## **Appendices**

### **Appendix 1 Interview Questions for the Farmers**

#### **Socio-demographic Characteristics of the Farmers**

- a) Gender
- b) Age
- c) Educational level
- d) Size of farmland

#### **Interview Questions for the Adopters**

1. What crops are grown in the community?
2. What crops do you grow?
3. What is the staple food of the people in the community?
4. What new farming technologies are being used in the community?
5. Which of the technologies have you employed in your farming?
6. Which of them do you see as more important and why?
7. How did you hear about the new technologies?
8. Which people introduced the technologies to the community?
9. Who are those who made you aware of the new technologies?
10. What factors influenced you take up the new technologies?
11. Did the government play a role in the introduction and adoption of the technologies?
12. How did agricultural extension officers play a role in your adoption?
13. How has your gender influenced the adoption?
14. Which factors are more pressing for you in the adoption?
15. What factors have influenced you more to adopt the technologies?
16. How did farmer cooperatives in the community contribute to your adoption?
17. How has the adoption helped you?
18. How has the technologies helped to improve your livelihoods and that of your household?
19. How has the adoption increased your crop yield?
20. Has the adoption improved your income?
21. What factors limit you in the adoption process?
22. Why do you think some farmers have not adopted the technologies?
23. Do you think there are some negative sides of the new technologies?
24. What are some negative sides of the technologies and its adoption?
25. How can the adoption of the technologies be improved?
26. What should be done by the government?

#### **Questions for the Non-Adopters**

1. What crops do you cultivate?
2. Are you aware of the new technologies being used in the community?
3. What are some of the new technologies being used?
4. Why have you not adopted the technology?
5. What factors have prevented you from taken up the technologies?
6. What are the more challenging factors that have prevented your adoption?

7. Why do you think some farmers have adopted?
8. How is the adoption helping them?
9. Do you see any improvements in the farmers who have adopted?
10. What do you see as downsides of the new technologies and its adoption?
11. Do you plan to adopt any of the technologies in the near future?
12. What could be done to improve the adoption?