UNIVERSITY OF CAPE COAST

ADOPTION AND EFFECT OF IMPROVED MAIZE VARIETIES ON THE POVERTY OUTCOME OF MAIZE FARMERS IN THE AKUAPEM-NORTH MUNICIPALITY

ABOAGYE RICHARD TWENEBOA

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BY

ABOAGYE RICHARD TWENEBOA

Thesis submitted to the College of Humanities and Legal Studies School of Economics Department of Economic Studies, in partial fulfilment of the requirements for the award of Master of Philosophy degree in Economics

FEBRUARY 2023

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature …………………….…. Date ………..……………..

Name: ……………………………………………………………………..

Supervisor's Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature …………………….... Date ………………..

Name: ……………………………………………………………………..

Co-Supervisor's Signature …………………………… Date ………………

Name: ………………………………………………………………………

ABSTRACT

Maize constitutes more than 50 percent of Ghana's total cereal production and the basic source of staple food for a majority of households in Ghana. Despite CSIR releasing several agricultural technologies, improved maize varieties, maize production in Ghana is heavily below what is economically and technically feasible. The persistent low productivity, which may be attributed to the low adoption of agricultural technologies results in low farm yield, reduced farmers' income and derail their welfare. It is in this light that this study sought to assess the adoption and effect of improved maize varieties on poverty outcomes among maize farmers in the Akuapem-North Municipality, one of the leading districts in maize production in Ghana. Specifically, the study sought to highlight the factors influencing the adoption of improved maize varieties in the Akuapem-North Municipality; examine the effect of the adoption of improved maize varieties variety on the poverty outcome of farmers in Akuapem-North Municipality; and lastly, investigate the factors hindering farmers in Akuapem-North Municipality from adopting of improved maize varieties. The study employed a cross-sectional survey research design and the quantitative research approach to achieve the research objectives. Employing the multistage sampling technique, the study sampled 367 smallholder farmers from the top five maize-producing communities in the Akuapem North Municipality. These communities are Saforo, Tinkon, Mangoase, Adowso, and Konko. Data was collected with a questionnaire in the year 2021 from the sampled smallholder farmers and the binary logistic regression was used as the estimation technique. The study revealed that out of the 367 farmers sampled, 258 representing 70 percent adopted improved maize varieties whereas 109 representing 30 percent did not adopt improved maize varieties. The study further revealed that farm yields, membership in farm-based organizations, access to credit or finance, government policies, farmers' income, and market prices for maize products significantly increased the likelihood for farmers to adopt improved maize varieties. Contrarily, the high cost of improved seeds, unavailability of seeds, and unfavourable government policies hindered farmers from adopting improved maize varieties. Furthermore, the study revealed that farmers who adopted improved maize varieties fell in the non-poor category while the majority of the farmers who did not adopt improved maize varieties were in the poor category. To address this, government policies should prioritize increasing educational opportunities for farmers and reducing the cost of improved seeds. It also recommends that farmers join farm-based organizations to gain access to valuable insights and keep up with the latest agricultural technology trends.

KEY WORDS

Adoption

Improved Maize Varieties

Poverty Outcome

Maize Farmers

Akuapem-North Municipality

Agricultural Technology

Improved Seeds

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DEDICATION

To my wife Albertina and children; Ruby Ampofoa, Kwabena Offei and Kwaku Yirenkyi

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CHAPTER ONE

INTRODUCTION

This chapter encompasses the background of the study, problem statement research objectives, questions and hypothesis, justification, delimitation and limitations of the study and the organization of the study.

Background to the Study

Poverty is a persistent challenge worldwide, affecting millions of people, especially in developing nations (Hite & Seitz, 2021). As of 2020, around nine percent of the world's population were extremely poor, with the highest poverty rates found in South Asia and Africa (Mahmood, 2022). The majority of people living in these two regions live in rural areas, where agriculture is the main source of income (Wudil et al., 2022; Rasul, et al., 2021). However, poverty persists in these areas (Jayne, Fox, Fuglie, & Adelaja, 2021). Farmers in these regions often struggle with poverty due to factors such as low productivity, limited access to resources, and their vulnerability to environmental and market risks (Fan & Rue, 2020; Pandey & Pandey, 2023). According to Dhahri, and Omri (2020), technological advancements in agriculture have the potential to address food security and hunger (SDG 2), economic growth, and environmental sustainability (SDGs 8 and 13), and alleviate poverty (SDG 1).

Agriculture plays an essential part in the development of every economy, particularly developing economies (Pawlak, & Kołodziejczak, 2020; Norton, Alwang, & Masters, 2021). Not only does the sector ensure that food is accessible for consumption in homes, but the sector contributes to economic growth by job creation for farmers - significantly reducing poverty, especially in rural areas (Fan & Rue, 2020). Although its contribution to Ghana's GDP has been declining recently, agriculture still makes up a sizeable portion of it (Badiane, Diao & Jayne, 2021). Per the quarter-on-quarter seasonally adjusted growth rate, the growth of agriculture in the first quarter of 2021 was 1.2 percent, with crops in the least growth category at 0.9 percent. The Agricultural sector share of GDP at basic prices was 23.5 percent (Bank of Ghana, 2022). This contribution had dropped to 20.6 percent as of the end of the second quarter of 2021. However, the sector's contribution increased by 5.5 percent in the second quarter of the year 2021 (Bank of Ghana, 2023).

In Ghana, peasant farmers typically grow maize using traditional farming techniques and practices (Anang, Dokyi, Asante, & Donkoh, 2022). The adoption of modern agricultural technology is still very low among smallholder farmers who constitute the larger share of farmers in the country (Fadeyi, Ariyawardana, & Aziz, 2022). The majority of farmers rely on rainfall as their primary source of irrigation, so abrupt changes in water availability have an impact on their crop yield (Anang et al., 2022). A lack of soil moisture for one-to-two days during the tasselling stage of maize reduces output by up to 28 percent, and a lack of soil moisture for 6-8 days during the wilting stage can also reduce output by 50 percent, both of which cannot be made up for by later rains (Cakir, 2004). Similarly, other agricultural technologies like improved crop and seed varieties, sensors and even fertilizers are less utilized among these smallholder farmers (Rehman, Jingdong, Khatoon, Hussain, & Iqbal, 2016). According to Lobell et al. (2009) and Liu et al. (2020), there continues to be a huge gap between actual and potential farm output, something that could be bridged by modern agricultural technology.

Improved maize varieties (IMVs) encompass a diverse range of improved maize seeds that seek to address various agricultural challenges that farmers face. These varieties include hybrid, drought-tolerant, climate-resilient, disease- and pest-resistant strains, and open-pollinated varieties (Eriksson, Akoroda, Azmach, Labuschagne, Mahungu, & Ortiz, 2018; Cvejić et al., 2022). The hybrid varieties are generated through crossbreeding for enhanced traits like higher yields and disease resistance (Gedil, & Menkir, 2019). Similarly, the open-pollinated varieties are generated purposively to allow for seed saving (Sigigaba, Mdoda & Mditshwa, 2021). Drought-tolerant and climate-resilient varieties help mitigate the effects of changing environmental conditions, while disease- and pest-resistant strains combat prevalent threats to crop health (Prasanna et al., 2021; Cairns., & Prasanna, 2018; Blanco et al., 2014). Other varieties focus on traits such as early maturation, nutrient enhancement, and quality attributes varieties (Hossain et al., 2023). In Ghana, all these varieties are widely deployed; however, the most used are the drought and pest-tolerant, and early-maturing varieties (Poku, Birner, & Gupta, 2018). According to the Accelerating Impacts of CGIAR Climate Research for Africa - AICCRA (2023), these IMVs increased farm yields by more than 60 percent.

Statement of the Problem

The Ministry of Food and Agriculture has made significant efforts towards reducing poverty and improving agricultural productivity in rural areas, especially in places where the greater proportion of the population depend on agriculture for their livelihoods like the Akuapem North Municipality (Danso-Abbeam, Ehiakpor, & Aidoo, 2018). To achieve this objective, the government has implemented several interventions, including the recent Planting for Food and Jobs and the one-village-one-dam initiatives (Ali, Agyekum, & Adadi, 2021; Owusu & Obour, 2023). Also, many IMVs have been established and distributed throughout the country by the Council for Scientific and Industrial Research. This was done with the assistance of the Crop Research Institute of Ghana and Savanah Agricultural Research Institute for use by farmers throughout the nation, including Akuapem North Municipality (National Seed Trade Association of Ghana [NASTAG], 2022).

These interventions are aimed at enhancing the productivity of farmers and improving their livelihoods. However, poverty rates remain persistently high among farming households in the Akuapem area (Okae-Adjei, Akuffo & Amartei, 2016). Ghana's maize production is still not up to half of what is economically practical even after CSIR released all IMVs there (Obour, Arthur & Owusu, 2022). Additionally, there is low productivity, which could be attributed to the low adoption of IMV. NASTAG (2022), reported that less than five percent of farmers have access to certified seeds from approved sources (NASTAG, 2022). Furthermore, it reported that farmers are reverting to the archaic practice of on-farm seed saving, which is not effective. These farming practices have the potential to worsen the issue of food insecurity since the seeds used cannot withstand challenges such as adverse weather conditions which affect their productivity and yields (Adu-Boahen, Dadson, & Halidu, 2019; Fagariba, Song, & Soule, 2018). Whereas evidence from numerous on-station and on-farm tests predicted that the crop could achieve yield averages of 4-6 tonnes per hectare, the country's average production is 1.9 metric tonnes for a given hectare of land (Ministry of Food and Agriculture, 2013).

Many studies have been conducted on the adoption of improved seed varieties for various food crops in different regions of Ghana. Mensah et al. (2021) and Etwire, Ariyawardana, and Mortlock (2016) examined the factors influencing the adoption of ICV among farmers, while Setsoafia, Ma, and Renwick (2022), Madin, Nyantakyi-Frimpong, and Inkoom (2022), and Forkuor, Amponsah, Oteng-Darko, and Osei (2022) analysed the impact of adopting ICV on food security in Ghana. Additionally, Bruce, Donkoh, and Ayamga (2014) and Buah et al. (2011) conducted studies highlighting the effect of improved seed varieties on farmers' productivity and profitability, while Sugri et al. (2013) and Madin (2022) focused on improved seed varieties and seed security. Furthermore, Ahmed and Anang (2019), Agyeman et al. (2021), Maredia et al. (2019), and Asiedu-Darko (2014) explored farmers' perceptions of improved seed varieties and their adoption.

This study identifies a knowledge gap within the existing literature. According to Danso-Abbeam., Bosiako. Ehiakpor & Mab. (2017), the implementation of IMV has the potential to significantly alleviate farmers' poverty. However, the scope of the studies listed above does not cover that, especially for the Akuapem North Municipality. Given this knowledge gap, this study seeks to assess the effect of the adoption of newly improved seeds on the poverty outcome of maize farmers in the Akuapem-North Municipality.

Purpose of the Study

The main objective of this research is to assess the adoption and effect of improved maize varieties on the poverty outcome of maize farmers in the Akuapem-North Municipality.

The specific objectives of this research are to:

1. highlight the factors influencing the adoption of improved maize varieties in the Akuapem-North Municipality.
2. examine the effect of the adoption of improved maize varieties on the poverty outcome of farmers in the Akuapem-North Municipality
3. Investigate the factors hindering farmers in Akuapem-North Municipality from adopting of improved maize varieties

Research Questions

1. What are the factors influencing the adoption of improved maize varieties in the Akuapem-North Municipality?
2. How does the adoption of improved maize varieties affect the poverty outcome of farmers in the Akuapem-North Municipality?
3. What are factors hindering farmers in Akuapem-North Municipality from adopting of improved maize varieties?

Research Hypothesis

I. H_0: Socio-economic characteristics do not significantly affect farmers' likelihood to adopt newly improved maize varieties.

H_1: Socio-economic characteristics significantly affect farmers' likelihood to adopt newly improved maize varieties.

II. H_0: Adoption of improved maize variety does not lead to a reduction in poverty levels among farmers in Akuapem-North Municipality.

H_1: Adoption of improved maize variety leads to a reduction in poverty levels among farmers in Akuapem-North Municipality.

Significance of the Study

This study seeks to determine whether newly improved seeds are adopted and what effect they have on poverty among maize farmers in the Akuapem-North Municipality. All parties involved in Ghana's fight against poverty are expected to receive proof from the study. This study would be beneficial to the Government of Ghana and policymakers by providing them with an evidence-based report on the potential effect of the adoption of IMVs on farmers' poverty outcome. Additionally, it will aid in the planning of initiatives for rural development.

The District Assemblies and MOFA would be informed by the study's findings about the potential of using improved seeds through maize development project which is geared towards poverty reduction. As was already stated, there is a dearth of thorough and rigorous data on adoption rates and the effects of IMVs on outcomes related to productivity and poverty. It is hoped that the conclusions and suggestions made in this work will contribute to the body of academic knowledge by acting as a resource for upcoming investigations.

Delimitation

This study was restricted to one variety of maize that is grown. The variety that farmers used in the study area was the local type which was improved to Obatampa, and now Lake (hybrid). The study areas include the following communities: Saforo, Tinkon, Mangoase, Adowso and Kwamoso. These communities are low-lying areas and are noted for maize cultivation in

Akuapem North. The researcher is time-bound to submit this work for grading or scoring. It is therefore not possible to extend this research to all communities in Akuapem North before the research deadline and for that matter, the findings of this work will be limited to these communities.

Limitations

Firstly, the researcher is limited in their ability to generalize the findings of the study due to the specific context and sample characteristics chosen for the study. The study was conducted among smallholder maize farmers in the Akuapem North Municipality and not in the whole of Ghana and so the findings cannot be generalised as reflective of all smallholder farmers in Ghana, especially farmers who plant other crops.

Secondly, the analysis might not have captured all the possible factors that might affect farmers' willingness to adopt the IMVs resulting in an omitted variable bias.

Lastly, since the data collection procedure was a self-assessment by the farmers on their poverty outcome, there could have been a self-assessment bias which might affect the validity of the findings. However, multiple question were asked to check the validity of previously stated responses to ensure that the respondents were giving false information.

Organization of the Study

This study was grouped into five chapters. The introductory chapter, chapter one of the study, comprises the background of the study, statement of the problem, objectives of the study, hypothesis, justification, delimitation and limitations of the study and how the rest of the study was organized. The second chapter was dedicated to the review of the theories, and definition of concepts on IMVs and the link it has with poverty reduction. The chapter also presented an empirical review which fit the purpose of the study, summary and contribution to research.

In the third chapter, the methodology employed for the study was discussed as well as relevant data on the study area. It also captured topics such as research design, profile of the study area and target population, sampling, sample size determination, data source, data collection instruments, ethical consideration and techniques used in data analysis. In the fourth chapter results of analysis of data gathered were presented and analysed. An in-depth discussion on the results generated from the data gathered for the study was presented. Tables, charts, cross tabulations and regression analyses were used to simplify the data gathered and discussed in the context of the study and in relation to relevant literature. In the last and final chapter, a summary of the whole study was provided, conclusions were drawn and recommendations provided.

CHAPTER TWO

LITERATURE REVIEW

Introduction

Chapter two presents a detailed discussion of theories underlying the study, review of empirical literature on the impact of technology adoption on poverty reduction. Specifically, it will review the adoption and impact of newly improved seeds on poverty reduction among maize farmers. The chapter also presents the contribution to literature and the conceptual framework of the study.

Theoretical Review

This section reviews the relevant theories that undergird this study. Two main theories that underlie this study are the theory of non-separability of household production and consumption decisions and the random utility theory.

The Theory of Non-separability of Household Production and Consumption Decisions

This theory was introduced by Singh, Squire and Strauss in 1986 in their book titled "Agricultural Household Models: Extensions, Applications, and Policy". Unlike traditional economics, a perfect market, where production and consumption are treated as separate activities, the theory of non-separability of production and consumption acknowledges that production and consumption within households, especially agricultural households are intertwined (Upadhyay, Solberg & Sankhayan, 2006). Singh, Squire, and Strauss (1986) posit that the traditional notion of firms producing goods and services for households to consume does not accurately reflect the reality of developing economies or the agricultural sectors within these economies. Instead, they propose that there exists a complex interdependence between production and consumption.

The agricultural household model is considered non-separable because the household's decisions regarding production, such as the use of inputs, choice of activities, and production level, are influenced by their characteristics like consumption preferences and demographic make-up - income, size of family labour, available land size (Louhichi, Tillie, Ricome, Gomez, & Paloma, 2020). This interconnectedness and inseparability of production and consumption decisions are evident in decisions regarding production, consumption, and labour allocation that may depend each other. Household production and consumption decisions are considered non-separable when at least one production or consumption good's shadow prices are not determined externally by the market, rather, they are determined within the model by the interaction of household demand and supply.

The theory of non-separability of production and consumption is based on the concept of utility, which refers to the satisfaction or benefit that agricultural households seek to maximize from the goods and services they consume (Afful Jr, 2021; Schreinemachers & Berger, 2006). Essentially, households make choices that will provide them with the maximum satisfaction given their circumstances. In developed economies with well-functioning markets, this can usually be achieved by trading in the market. However, in developing economies where market imperfections exist, shadow prices act like the market prices in the decision process of the households. The shadow price and marginal utility have a relationship that indicates the amount a household is willing to pay to relax a constraint of similar magnitude (Arslan & Taylor, 2009). Therefore, household characteristics such as total time availability, exogenous cash transfers, and consumption prices play a role in production decisions, unlike the separable household model. Households maximize their utility within the limitations and constraints that affect their production and consumption choices (Afful Jr, 2021). These constraints may include limited access to credit, technology, information, and sometimes unpredictable weather patterns.

In the context of the adoption of improved maize varieties, the theory of non-separability of household production and consumption is highly applicable. It emphasizes the need to consider both production and consumption decisions and factors that may trigger or deter farmers from adopting the improved maize varieties. The same theoretical framework was employed by Afful Jr (2021) in his work which sought to examine the drivers of weedicide adoption among peasant maize farmers. While some critics argue that the concept of non-separability can complicate economic models, it's important to note that this theory sheds light on how a farmer's demography, institutional factors, and other decisions can influence their decision to adopt IMVs. By understanding these factors, we can better tailor our approach to encourage the adoption of IMVs and improve our agricultural practices.

Random Utility Theory

The Random Utility Theory was propounded by Domencich and McFadden in the year 1975. The random utility theory suggests that individuals base their decisions on the utility they expect to derive from each option and is foundational for understanding how individuals make choices among a set of alternatives (Hess, Daly & Batley, 2018). Unlike the simple concept of utility, the random utility theory acknowledges the uncertainty inherent in human choices, arising from factors such as incomplete information, risk aversion, or psychological biases (Schoemaker, 2013). That is, it captures the preferences of individuals and the relative desirability they associate with different alternatives. The theory explains the likelihood that an individual will choose a particular option based on its utility relative to other alternatives and how changes in prices, incomes, or other factors influence consumer behaviour (McFadden, 2001). One criticism of the theory is that it prioritizes individual preferences and utility maximization over other factors that affect decision-making, such as social norms, cultural influences, and cognitive biases (Hess et al., 2018).

The Random Utility Theory is suitable for the study because farmers' preferences are reflected in the highest price they would pay for adopting improved maize varieties. Their willingness to pay depends on factors such as socioeconomic status, market access, infrastructure, input quality, and personal risk tolerance.

Definition of Concepts

This section defines the various concepts and terms in the topic.

The Concept of Poverty

The concept of poverty has changed gradually, being defined in various ways by various researchers and organisations. Wagle, (2002) defines poverty as “the lack of necessities such as food, shelter, and clothing”. Another definition by Spicker (2013), is poverty as a social condition that results from a person's inability to access resources, opportunities, and power.

The United Nations (2010) defines poverty as earning an income of less than 2 dollars each day. Poverty can be defined in absolute and relative terms (Hagenaars, 2017; Spicker 2013; Hulme & Shepherd, 2003). The most commonly used way of defining and measuring poverty is through economic indicators such as welfare, income, and consumption (Jorgenson, 2018). However, recent measurements of poverty have adopted a multidimensional phenomenon that goes beyond the mere lack of financial resources (World Health Organization, 2021; Banerjee & Duflo, 2007). Other dimensions of poverty captured are energy poverty, healthcare, living standards and the lack of access to some utilities (Day, Walker & Simcock, 2016).

Poverty among farmers encompasses poor access to modern farming techniques, quality seeds, fertilizers, and irrigation systems limiting small-scale farmers' productivity and income (Eneyew, Alemu, Ayana & Dananto, 2014). Several factors contribute to the perpetuation of poverty such as unequal distribution of resources, limited access to education and healthcare, discrimination and political instability (Royce, 2022). These factors often keep the individuals in a cycle of poverty, making it difficult for them to escape (Green, 2012).

Agricultural Technology

Agricultural technologies encompass a range of tools, practices, and systems that are designed to enhance farming and food production (Pretty, 2018). These innovations include biotechnology, mechanization, remote sensing, smart farming, and alternative farming methods (Relf-Eckstein, Ballantyne & Phillips, 2019). Advancements in genetic engineering have led to the development of genetically modified organisms, and improved seeds and crops with desirable traits, making biotechnology an essential part of modern agriculture (Relf-Eckstein et al., 2019). Similarly, precision agriculture, mechanization and robotics which integrate technologies like GPS, sensors, and drones have optimized farming practices and increased efficiency by automating labour-intensive tasks (Botta et al., 2022). Furthermore, smart farming systems with remote sensing and imaging technologies, including satellite imagery and drones have made it easier to monitor crop growth and detect pests and diseases by providing real-time data (Mohamed, et al., 2021). Vertical farming, controlled environment agriculture, artificial lighting, and hydroponic or aeroponic systems are some of the other agricultural farming practices.

Overview of Ghana's Maize Economy

Majority, about fifty percent of Ghana's total cereal production comes from maize, making it a significant food crop. In Ghana in particular, maize accounts for 50 percent of the country's basic calories and is a food that is considered to be a staple for majority of the population, even in sub-Saharan Africa. It is a significant source of minerals, iron, protein, vitamin B, and carbohydrates. The starchy base of many of the porridges, pastes, grits, and beers consumed in Ghana is maize. One can eat fresh green corn on the cob by boiling, baking, roasting, or drying it. The high nutritional value of maize grains comes from their "72 percent starch, 10 percent protein, 4.8 percent oil, 8.5 percent fibre, 3.0 percent sugar, and 1.7 percent ash content" (Chaudhary, 1983; Hussan et al., 2003). "Ghana's per capita maize consumption was projected to be 42.5 kilograms in 2000 (MoFA, 2000), with a predictable national consumption of 943,000 metric tons in 200, (SRID, 2007)."

Major investments were made to increase maize yield through the Ghana Grains Development Project between 1979 and 1997 and the Food Crops Development Project between 2000 and 2008 In spite of these initiatives, Ghana continues to have one of the lowest average maize yields in the world and yields. Additionally, it produces less than tropical lowland, rain-fed settings like those in southern Mexico and Thailand, which are more productive. In Ghana, yields have only been rising by 1.1 percent annually. In comparison to the 4-6 mt/ha potential yield reached in on-station testing, maize yields in Ghana in 2012 ranged from 1.2 to 1.8 metric tons (mt) per hectare (ha).

In Ghana, rising populations, urbanization, and the expansion of the poultry and fish industries have all increased demand for maize. White maize accounted for the majority of the consumption per person, which increased 43.8 kg in 2011 compared to 38.4 kg in 1980. (MoFA 2010; MoFA 2012). "The demand for maize used as feed in the chicken business, however, was predicted to have climbed by 10% yearly between 2000 and 2009 and would presently reach 540,000 mt if birds were fed a correct ration (Hurelbrink & Boohene 2011). Yellow maize, which currently accounts for virtually all of maize imports, is preferred by the feed industry (FAO, 2013). According to Ghana's Ministry of Food and Agriculture (MoFA), in order to meet domestic demand in 2015, 267,000 mt of maize will need to be imported if productivity improvements are not made, particularly for yellow maize" (FAO, 2013).

The cost of inputs is favourable for Ghanaian producers of maize. The Ghanaian government provides subsidies for fertilizer. In comparison to the value of maize grain, the cost of fertilizer is less expensive in Thailand but slightly more expensive in southern Mexico. In relation to the price of maize grain, the cost of open-pollinated variety (OPV) seeds is higher, however, public hybrid seeds are substantially more expensive.

With the exception of local maize grown in the Sudan Savannah zone without fertilizer, using information acquired from medium and large-scale farmers in Ghana, it was estimated that gross margins from maize production in various agro-ecological zones under various seed and fertilizer compositions were marginally positive in 2013. However, when family labour costs are factored into the equation, gross margins are almost always negative. Even when the costs of family labour are not taken into account, the returns from maize production vary greatly. In the Transition and Sudan Savannah zones, using fertilizer to increase the yields of the open-pollinated variety (OPV) Obatanpa are around 20 percent, but they are significantly lower in the Guinea Savannah zone. We noticed comparable outcomes when using hybrid seeds.

Even after accounting for family labour costs, earlier studies found positive and significantly higher profits (Akramov & Malek, 2012). They discovered that effective producers, with or without additional costs for family work, can turn a profit from the production of maize at both private and societal rates. However, after subtracting the cost of family labour, most farmers can only make a small profit from the production of maize. In the Upper West and Brong Ahafo regions, all of the maize systems that Winter, Nelson, and Aggrey-Fynn (2008) investigated were profitable at both private and public rates.

Also, 61 percent of Ghana's maize fields were planted with modern varieties in 2012, up from 54 percent in 1997. (Morris et al. 1998). Yet, only 15 percent of the entire maize acreage was planted by maize growers with verified seeds. According to econometric research, plots with improved varieties and fertilizer produced roughly 330 kg/ha more in yields than those with unapproved seeds. The most widely planted maize variety is Obatanpa, an OPV introduced in 1992, and there are signs that its popularity is growing despite the introduction of newer varieties. Currently, Ghana's maize varieties have a total average age of 23 years, despite the country's agricultural research sector producing seven new varieties on average every 10 years. The new kinds might not perform noticeably better than Obatanpa or that farmers are not getting enough access to them thanks to an efficient seed system.

Empirical Review

This section presents a comprehensive overview of various studies and empirical literature that seek to establish a relationship between the adoption of IMVs and the poverty outcomes of farmers. The study also delves into the research design and methodology employed by these studies, and further identify a research gap and its valuable contribution to the literature.

Determinants of Agricultural Technology Adoption

A study by Danso-Abbeam et al. (2017) sought to examine the determinants of IMV adoption among farm households in the Tolon district of Ghana and the intensity of adoption. The study sampled a number of 200 smallholder farmers. Using the multinomial logit and tobit estimation techniques, the study revealed that households' socio-demographic characteristics such as farmers' age, years of formal education, farm experience, size of household, and farm workshop attendance influenced farmers' adoption of the IMV. Similarly, the following institutional factors: membership of a farmer-based organisation, having access to loan and extension services were significant factors that determined the adoption and the intensity of adoption of IMV.

Anang and Owusu (2023) conducted a study among smallholder farmers in the Tolon district to analyse the determinants of IMV usage and the productivity effect of utilising IMV. The study sampled 340 smallholder farmers and employed an endogenous switching regression in the analysis. The findings of the study show that farmers who adopted IMVs realised higher farm yields relative to those who relied on the traditional varieties. The study further revealed that sociodemographic factors (years of education of farmers) and institutional factors (membership of farmer-based groups, and accessing credits and extension services) were significant factors affecting farmers' adoption of IMV.

Likewise, the study conducted by Cropenstedt et al. (2003) revealed that the adoption of better-quality seed and fertilizer is significantly influenced by gender, agro climate zone, manure use, hired labour, and extension services. In contrast, two Kenya coastal lowlands studies by Wekesa, Mwangi, Verkuijl, Danda, and De Groote (2003) and Autio et al. (2021) reveal that low soil fertility, unfavourable climate conditions, perception, lack of availability and high cost of seed were significant factors that negatively impacted the adoption of agricultural technology.

Furthermore, Biru, Zeller, and Loos (2019) sought to explore the adoption of complementary technologies among farm households. The study used a panel dataset which was collected in during a survey between 2012 and 2016. A total of 390 smallholder farmers were surveyed for the study. The study accounted for the unobserved heterogeneity for adoption decisions and variations in farmers' demography and farm characteristics. The study employed the two-stage multinomial endogenous switching regression model, an ordered probit model and the Mundlak approaches to examine the effect on poverty outcome, It was discovered that utilising the various complementary technologies rendered smallholder farmers less likely to be poor or vulnerable.

Mather, Minde, Waized, Ndyetabula, and Temu (2016) conducted a research to investigate the influencing factors that are affecting the adoption of better-quality maize seed and the usage of fertilizer in Northern Tanzania and revealed that farm size, years of farmers' education, and the regularity of extension agent official visits significantly affected the adoption of maize seed, while other factors like farmers' ages, family labour, and yield variability had no significant impact on the adoption of better-quality maize seed. Similarly, Mutegi (2015) conducted a study in the Kenyan district of Meru sought to highlight the factors determining the ratio and speediness of agriculture technological adoption. The study revealed that farmers were more likely to use technologies they perceived as less hazardous. Furthermore, the study discovered that farmers' knowledge, which they can gain through education, training, and access to information and farm loans, significantly contributes to the adoption of better farm technology

Effect of Adopting Agricultural Technology on Farmers' Income and Poverty Outcome

Olusayo, Adebayo, Kayode, Olagunju, Ayodeji, and Ogundipe (2019) conducted a research that sought to assess the effect of improved cassava varieties on the productivity, level of income generated and livelihood outcome of farmers. The study employed the Heckman two-stage model to analyse primary data collected from 446 farm households in the Oyo and Osun states in Nigeria. The study revealed that adopting improved cassava variety had a positive consequence on farmers' productivity and significantly reduces poverty among farmers. Furthermore, the study highlighted that the occupation of household heads and total nonproduction assets of farmers significantly affect their usage of improved cassava varieties. The finding corroborates the findings of Samuel, Adebayo, Kayode, Olagunju, Ayodeji, and Ogundipe (2016) who highlighted that adopting improved cassava varieties significantly reduced poverty among farmers by increasing their farm yields, income and food security. The study was conducted in the same farming communities and similar results were highlighted that adopting improved cassava varieties reduces poverty by increasing farm yields and income.

A study by Ali, Rahut, Behera and Imtiaz (2015) sought to examine how the adoption of certified wheat seed reduces poverty among smallholder farmers in Pakistan. The researchers sampled 367 farm households were sampled for the study and the propensity score-matching estimation technique was adopted for the analysis. The study revealed that farmers who adopted certified wheat seeds were richer since they experienced higher yields and income than those who did not. The study further highlighted that the years of education of farmers, income, access to financial credits and market for products positively increased their adoption of certified wheat seeds.

Tetteh, Alhassan and Danso-Abbeam (2020) also conducted a study in the Tolon district to examine the effect of IMV adoption on the technical efficiency of small farm households. The study randomly sampled 340 farmers in the Tolon district utilising a questionnaire. The study also utilised the binary probit model and the truncated regression model. The study highlighted that farmers' level of formal education, and membership of farmer-based organisations influenced their adoption of IMV. However, these factors reduced the technical efficiency of farmers. Also, the findings highlighted that the adoption of IMV improved the technical efficiency of farmers. Similarly, Kondo, Cacho, Fleming, Villano, and Asante (2020) undertook a study to explore the impact of information in adopting of improved cassava varieties in the Ashanti and Brong-Ahafo regions in Ghana. A total of 608 smallholder farm households were sampled from these two communities for the study. The study further employed the two-stage cragg's model as the estimation technique. The findings of the study highlight that information (disseminated via demonstrations, media publicity and distribution of planting materials) significantly affected the adoption of improved cassava varieties. The study also corroborated the conclusion of earlier studies that household size of farmers, rearing of larger herds, having a ready market; and institutional factors including farmers' association with a farmer-based organisation intensified the usage of improved cassava varieties.

Acheampong, Addison, and Wongnaa (2022) conducted a study which sought to highlight the impact of adopting improved cassava varieties on farm yields. The study employed the multistage sampling technique to sample a total of 216 cassava farming communities and a total of 1296 farmers from these communities. The study utilised the endogenous switching regression and showed that the adopting improved cassava varieties increased farm yields. Similarly, determinants such as having access to extension services, membership of a farmer-based organisation, and farm size were significant factors determining the adoption of improved cassava varieties.

Manda et al. (2020) explored the adoption and effect of improved cowpea varieties on crop yield in northern Nigeria. A total of 1525 farmers were respondents for the study. Utilising propensity scoring models and the marginal treatment effect estimation, the study revealed adopting improved cowpea varieties positively improved yield gains and net returns. Whereas the farmers' years of education and the number of customers a farmer had increased their adoption of improved cowpea varieties. Farmers' age negatively affected their adoption of improved cowpea varieties. Similarly, Seidu (2011) conducted a study to identify the productive activities that reduce poverty among smallholder farmers. One of the study's key conclusions was that irrigation farming improved the socioeconomic circumstances of the beneficiaries by increasing their income levels, ensuring their food security, ensuring their children's education, and reducing household members' emigration to the South. In general, the plan had raised peoples' standards of living.

Udimal, Jincai, Mensah and Caesar (2017) sought to analyse the determinants affecting the adoption of improved rice technology in the northern parts of Ghana. The study sampled 307 farmers from six districts in the northern parts of Ghana using the multistage sampling technique. Using the probit and the logit models, the finding of the study highlighted that farm size, access to farm credit, family labour, and tractor ownership, were significant actors that triggered the likelihood of farmers to adopt improved rice varieties. On the other hand, farmers' age negatively affected their adoption of the improved rice varieties.

Challenges to Adopting new Agriculture Technology

A study by Beyene and Kassie (2015), more than 20 different varieties of maize have recently been made available nevertheless, farmers, especially small farmers, continue to have a low level of acceptance for the improved seeds. The planted area is still quite tiny. Improved seeds have a low adoption rate. Farmers' capacity to use technologies at the agricultural level may also be impacted by a variety of other elements, including socioeconomic, institutional, cultural, and political factors. The adoption of improved seeds is largely influenced by both the seed's cost and the price of innovation. The factors influencing adoption choices in agriculture have been compiled in studies by Knowler and Bradshaw (2007); and Rigby, Young, and Burton (2001).

This is primarily because of benefits like local climate adaptation and climatic variability stability (Turrent, Wise and Garvey, 2012). A well-coordinated sub-sector and mechanized farming system in Mali, as observed by Boughton and de Frahan in 1994, resulted in large rates of technology adoption. However, when guaranteed prices and marketing services were discontinued, maize farmers virtually turned to other forms of technology. It can be seen that unfavourable government policies can thwart the gains from the adoption of new variety.

Climate extremes pose a significant risk to farming. In rain-fed agriculture, rainfall variation is a significant risk factor. The more variable the amount and distribution of rainfall, the more unstable the output of rain-fed crops is. The risk that climate poses to agricultural cultivation directly affects how quickly new technologies are adopted. Farmers are less inclined to spend money on agricultural supplies, which raises the possibility of financial losses in the event of a bad crop. When rainfall is sufficient, some new varieties outperform local varieties, according to Mazzucato and Ly (1994). Additionally, Lowenberg-deBoer et al. (1992) demonstrated that using native varieties in conjunction with conventional agronomic techniques was the cultivation practice carrying the lowest risk in years of poor rainfall. Consequently, climatic changes raise the risk of adopting a better variety.

Summary of Studies and Contribution to Study

It is evident that many studies have been undertaken on the adoption of improved seed varieties for various food crops in different regions within and outside Ghana. Key areas covered by the literature include factors influencing the adoption of ICV among smallholder farmers; the effect of adopting ICV on food security; the effect of improved seed varieties on farmers' productivity and profitability, improved seed varieties and seed security; and farmers' perceptions of improved seed varieties and their adoption.

This study identifies a knowledge gap within the existing literature. Only a few of the studies examined the effect of agriculture technology adoption on alleviating farmers' poverty. These studies, however, covered agriculture technology such as irrigation, improved rice and cassava varieties, and certified wheat seeds. Furthermore, the scope of the studies reviewed above does not cover the Akuapem North Municipality, one of the leading districts in maize production in Ghana. It is in light of this knowledge gap that this study seeks to assess the effect of the adoption of IMVs on poverty outcome among maize farmers in the Akuapem-North Municipality.

Conceptual Framework

A conceptual model serves as an illustration of what the investigation is expected to uncover. It describes the relevant variables for the investigation, their meanings, and any possible relationships between them. One should develop a conceptual framework before beginning the data collection procedure. It is frequently shown in a visual format.

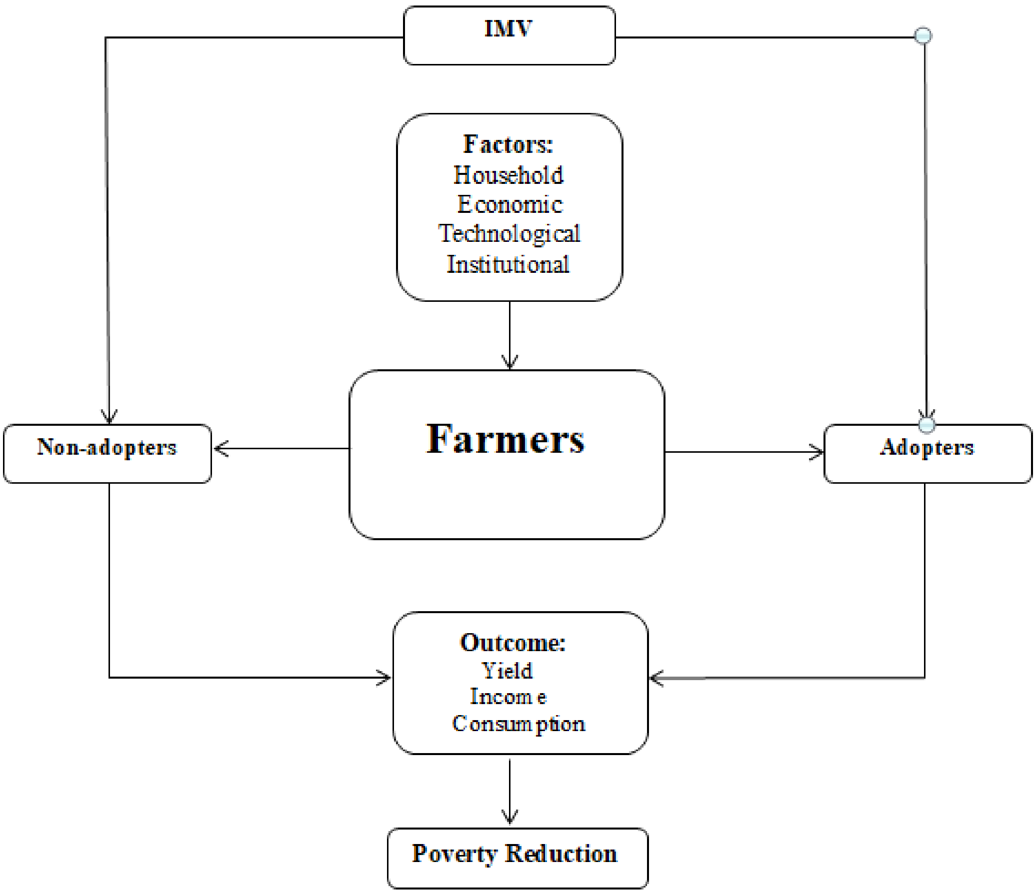

Figure 1: *Conceptual Framework*

In this study's analysis of the adoption of a better maize variety, the random utility framework was used (IMV). The researcher made the supposition that a maize farmer makes rational production decisions and is, therefore, a rational producer. Given that maize farmers can choose to plant an IMV or not, a farmer compares the benefits offered to him or her by the various options available in order to maximize profits from his or her decisions. The researcher assumed that before a farmer decided whether or to not adopt the improved maize variety, he or she must have carefully considered the benefits of both adoption and non-adoption. If adopting the enhanced variety will provide benefits greater than those from not adopting it, a farmer is more likely to do so. A farmer's predicted gain from adopting a package is a latent variable that is driven by observable families and agriculture factors.

Figure 1 shows the growing of improved maize seeds by farmers. These farmers are small holder farmers who sell part of their produce and also consume some. It is seen that farmers are confronted with the decision to either accept to plant IMV or not. The decision to plant or not plant IMV by farmers is not straight forward and is influenced by a number of constraints. The outcome of planting IMV is expected to produce increased yields, increase income after selling on the market and consumption of the remainder by farmers and their households. It is hypothesized that adopters of improved maize seeds will help reduce poverty status.

The framework also shown that, farmers' decision to adopt IMV is driven by a number of factors. These factors come in four categories, which are household, economic, technological or institutional factors. If all these factors are favourable, they will positively influence farmers to adopt the IMV. The researcher calls these as "push factors". On the other hand, there certain challenges that the farmers face and these tend to militate against farmer's decision to adopt IMVs. These are called "pull factors" by the researcher.

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Chapter Summary

The chapter highlighted the theories underlying the study which are the theory of non-separability of household's production and consumption and the random utility theory. The concepts of poverty and agricultural technology were also thoroughly explained. The chapter further presented an overview of maize production in Ghana. After the empirical literature review, the study identified a knowledge gap in literature. Therefore, it sought to assess the effect of the adoption of IMVs on poverty among maize farmers in the Akuapem-North Municipality. The chapter concluded with the conceptual framework of the study.

CHAPTER THREE

Introduction

This chapter encompasses the research design, profile of the study area and population, sampling procedure, research instruments, and data analysis procedure.

Research Design

The study employed the cross-sectional survey research design. This is because the cross-sectional survey research design makes room for the researcher to conduct the study across several entities at one point in time (Almalki, FitzGerald & Clark, 2012). The study seeks to examine the effect of the adoption of IMVs on the poverty outcome of smallholder farmers in the Akuapem North Municipality. In this kind of research study, data is gathered from the entire population or just a portion of it to assist in addressing pertinent questions. Information about the dependent and independent variables to be measured represents what was happening at a specific point in time across several entities, hence the term "cross-sectional” (Ghauri et al., 2020; Creswell and Plano, 2011). This research design is suitable because it records observations and measurements on a number of variables at the same time in order to draw conclusions about the impact of one or more explanatory variables on the dependent variable. The survey's design is suitable for quantitative analysis as well (Gay, 1992).

Profile of Study Area

The Akuapem North Municipality is bordered on the west by Suhum Kraboa Coaltar, on the south by Akuapem South, and in the North by Yilo Krobo and New Juaben. The Municipality makes up around 2.3 percent of the

Eastern Region's total land area, or 450 square kilometres, in size. Figure 2 displays a map of the region's location (Manortey & Acheampong, 2016).

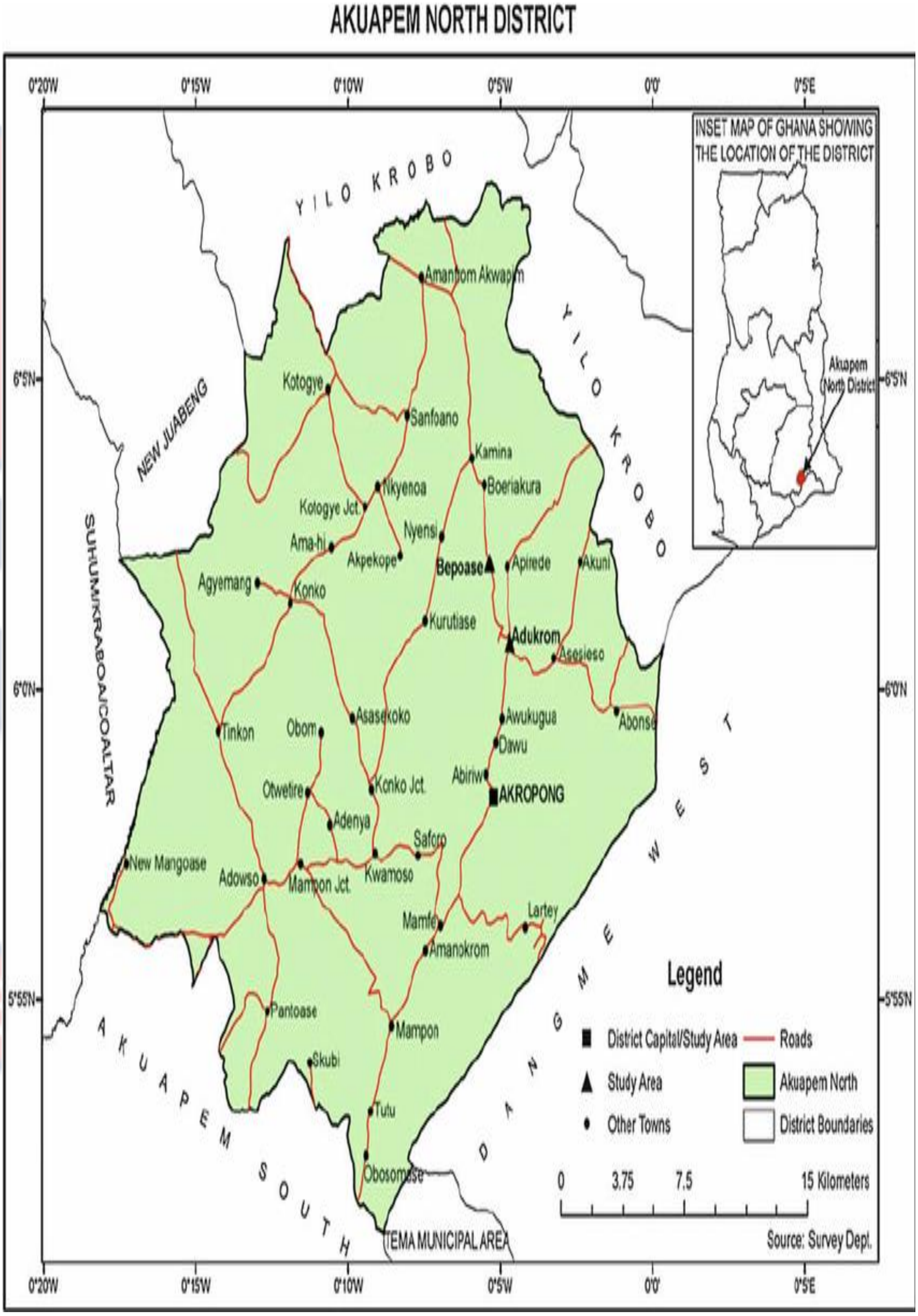

Figure 2: *Map of Akuapem North Municipality*

Source: Owusu, Obour, and Asare-Baffour (2015)

According to the Population and Housing Census (PHC, 2010), the Municipality had 136,483 inhabitants, men constitute 46.9 percent and women make up 53.1 percent, with a growth rate of 2.1 percent. The majority of people's primary occupation is, in essence, farming. Cassava, plantains, cocoyam, maize, and vegetables are the main crops grown (Bekoe, Quartey, Dumolga, & Officer, 2013). Among the agricultural processing businesses in the area are those that process gari and palm oil. Others work in the service or business sectors as well (Bekoe, et al., 2013).

A whopping 67 percent of the working population are into agriculture production and resides in the municipality's rural districts. Traditional and rain-fed farming methods are used. Mix cropping is frequently used. Small farms are prevalent. The average farmer cultivates 1.2 hectares each year (Dumolga, 2012). A mere 2 percent of farmers cultivate more than 2 hectares annually. The most common crops grown by farmers in the Municipality are maize and cassava (Bekoe, et al., 2013). Only in the 1900 ha and 60 ha Kwamoso and Okrakwadwo State land regions, where government leases available lands to farmers to support automated farming (Dumolga, 2012).

Crop production levels have steadily increased from previous years (Otoo, Otoo & Boateng, 2021). According to MOFA, this may be caused by an increase in the rates of agricultural technology adoption and finance availability. Only a small number of farmers are able to use enhanced seeds, fertilizer, and pesticides due to their high cost (Otoo et al., 2021). Only growers of corn and vegetables are mentioned to use enhanced seeds and pesticides.

This municipality was selected because reports from the Ministry of Food and Agriculture (MOFA, 2021) estimate the population for Akuapem North to be 136,483, with 60% in employed in agriculture. This gives an agriculture community of about 81,890. Otoo et al., (2021) has estimated that over 80% of the agriculture population is farmers. This gives an estimate for the farming population to be 65,511.

Sample Size Selection

The researcher used Yamen's sampling calculation technique. The Yamane's sampling formula, also known as the Yamane's sample size formula, is a method used to determine the sample size needed for a research study or survey, particularly in the field of social sciences (Uakarn, Chaokromthong & Sintao, 2021). It was developed by Japanese statistician Tara Yamane (Uakarn, et al., 2021). The formula is given as follows:

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

n is the required sample size

N is the total population

e is the margin of error

The conventional margin of error is 0.05, and the population is 65511 a mentioned earlier.

$$n = \frac{65511}{1 + 65511(0.05^2)}$$

$$n = 397$$

The study therefore sought to sample 397 respondents for the study. Although the researcher sought to sample 397 farmers as respondents for the study, only 367 of the questionnaires were completed and were valid to be used for further analysis. This gave an active response rate of 94.10%. The breakdown is as follows as displayed in Table 1:

Table 1: Sample Selected From Each Community

Community	Sample Selected
Saforo	82
Tinkon	73
Mangoase	73
Adowso	57
Konko	82
Total	367

Sampling Procedure

The multistage sampling method was used in the selection of the smallholder farmers for the study. The multi-stage sampling technique makes room for the sampling process to be carried out in stages (Lavrakas, 2008).

In the first stage, Akuapem North Municipality was purposively selected. The Akuapem North Municipality was selected purposively because of the intensity of maize production there. Akuapem North Municipality ranks among the top 10 maize producing districts in Ghana (Ministry of Food and Agriculture, Ghana, 2021). In the second stage, the top five highest maize producing communities in the district was selected. These communities are Saforo, Tinkon, Mangoase, Adowso and Konko. They were chosen due to their large-scale maize production. The simple random sampling technique was employed in the final stage to select the smallholder farmers at random from each of the five villages. The sampling frame of all smallholder farmers in these communities was employed from the Municipal office.

Data Collection Instruments

Questionnaire

Several questions are included in a questionnaire, a type of research tool used to gather data from respondents (Mellenbergh, 2008). The questionnaire was developed in relation to the research questions. The primary tool for gathering quantitative data was a structured questionnaire that had been evaluated beforehand. Farmers in the villages that were chosen based on the study's objectives were given a questionnaire. The close-ended questions required respondents to select appropriate responses from the choices presented to them. The closed items on the questionnaire have a restricting part by asking respondents to select from already provided options. Each item of the questionnaire dealt with every single aspect of the research objectives.

The questionnaire was organized into five themes (A, B, C, D and E). Theme A constituted questions relating to farmers' demography and socio-economic background. Theme B covered question about farmers' willingness to adopt improved maize varieties, theme C covered questions that sought to measure the poverty outcome of farmers, theme D constituted questions that sought to highlight the effect of the adoption of IMV on the poverty outcome of farmers. Theme E covered the challenges farmers faced in the adoption of improved maize varieties. The data was collected in the year 2021. The data collection process lasted for six months.

Data Analysis

The analysis of the data was largely quantitative. That is, depending on their observed and unobserved traits, smallholder farmers would choose themselves into or out of adoption. Several parametric and non-parametric strategies have been used in previous empirical research to try and overcome this difficulty (Asfaw et al., 2012; Khonje et al., 2014; Shiferaw et al., 2014). For the descriptive statistics presented in Chapter Four, the researcher made use of frequencies and their corresponding percentages. These were displayed in tabular form. The descriptive statistics were done for farmer characteristics and farm characteristics.

Objective One: Determinants of Adopting of IMV

The dependent variable of the model to be estimated for the first objective is the Willingness to adopt improved maize varieties. The response to the question is either a Yes or a No. This implies that the estimated model follows the binary response function where the outcome of the dependent variable or regressand is two and categorical or qualitative (Agresti, 2012). There are several binary response functions like the Maximum Linear Probability Model, the probit model, the Tobit model, and the Poisson distribution (Venkatachalam, 2004). However, the model binary logistic or response function was used.

The binary logistic model was considered the most appropriate for the estimating the factors influencing the adoption of IMVs although there are several binary response functions like the Maximum Linear Probability Model, Probit and Tobit (Gujarati, 2014; Young & Loomis, 2014). The Maximum Linear Probability Model although it is the simplest possible binary response function, has the problem of non-normality of the disturbance term, the problem of heteroscedasticity, and the possibility for the estimated 'ŷ' to lie outside the boundaries of '0 and 1' and the generally coefficient of determination 'R squared' (Gujarati & Porter, 2009; Martin, Hurn & Harris, 2013). The Probit and Logit binary response models solve these flaws in the Maximum Linear Probability Model but the Logit model is preferred to the Probit model because the Logit model is mathematically easier to operate (Breen, Karlson, & Holm, 2018; 2013; Hoetker, 2007). Even though both probit will yield similar results, the major difference is that the probit model utilizes integrals and the normal distribution function as the probability distribution whereas the Logit model uses the logistics distribution (Cramer, 2003). One weakness characterising the logistic regression model is its inability to capture complex relationships. One major assumptions underlying the logistic regression is linear in model specification between the independent variables and the log-odds of the dependent variable (Mood, 2010). However, in the case where the true relationship is non-linear or involves interactions between variables, logistic regression may not perform well (Speelman, 2014). But as other studies such as Acheampong et al., (2022); Kondo et al., (2020) have proven that the relationship between the factors influencing farmers' decision to adopt IMVs and the adoption are linear. Therefore, the problem of non-linearity has been dealt with and the binary logistic regression (binary logit regression) was employed to highlight the significant factors that influence farmers' decision to adopt IMVs in the Akuapem North Municipality.

Model Specification

WTA is a categorical dependent variable taking on the value 0 or 1 where '1' indicates the willingness to adopt IMV and '0' indicates an unwillingness to adopt IMV. For this study, Y may be used interchangeably with WTA.

$$WTA = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + +\beta_{10} x_{10} + \beta_{11} x_{11} + \beta_{12} x_{12} + \beta_{13} x_{13} + \beta_{14} x_{14} + \beta_{15} x_{15} + \beta_{16} x_{16} + \beta_{17} x_{17} + \beta_{18} x_{18} + u_i \quad (1)$$

Where

WTA refers to the farmer's willingness to adopt improved maize varieties

x_1 refers to the gender of the farmer (male or female)

x_2 refers to the age of the farmer in years

x_3 refers to the marital status of the farmer

x_4 refers to the farmers' level of education

x_5 refers to the farmers' household size

x_6 refers to the number of years of planting maize

x_7 refers to the farm size in hectares

x_8 refers to the maize yield per year

x_9 refers to the farmers' income in GhC

x_{10} refers to the price of maize per 100kg bag in GhC

x_{11} refers to the proportion of farm size allocated to IMV

x_{12} refers to Knowledge about IMV

x_{13} refers to access to the market and infrastructure

x_{14} refers to the quality and availability of improved maize varieties

x_{15} refers to membership of a farm-based organization

x_{16} refers to Availability of Extension Services

x_{17} refers to access to credit or finance

x_{18} refers to Favourable Government policy

u_i refers to the disturbance or error term

Y= 1, farmers are willing to adopt improved maize varieties; and Y= 0, farmers are not willing to adopt IMV

$$E(Y = 1 | x_1, x_2, x_3 \dots x_{18}) = P_i \quad (2)$$

Where Pi refers to the probability that farmers are willing to adopt improved maize varieties

X refers to the explanatory variables

$$E(Y = 0 | x_1, x_2, x_3 \dots x_{18}) = 1 - P_i \quad (3)$$

Where $1 - p_i$ refers to the probability that farmers are not willing to adopt improved maize varieties

$x_1, x_2, x_3 \dots x_{18}$ refers to the explanatory variables

$$P_i = \frac{1}{1+e^{-(\beta 0 + \beta 1 X1 + \beta 2 X 2 + \beta 3 X 3 + \beta 4 X 4 + \beta 5 X 5 + \beta 6 X 6 + \beta 7 X7 + \beta 8 X8 + \beta 9 X9 + Ui)}}$$

(4)

But let $\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + +\beta_{10} x_{10} + \beta_{11} x_{11} + \beta_{12} x_{12} + \beta_{13} x_{13} + \beta_{14} x_{14} + \beta_{15} x_{15} + \beta_{16} x_{16} + \beta_{17} x_{17} + \beta_{18} x_{18} + u_i = z_i$

Rewrite Eq (4) as

$$Pi = -\frac{1}{1+e^{-Zi}}$$

(4a)

$Pi = \frac{e}{1+e^{Zi}}$

(4b)

$1 - Pi = \frac{1}{1+ e^{Zi}}$ (5)

To determine the odds ratio, Eq 4b ÷ 5

$$\frac{\mathrm{Pi}}{1-\mathrm{Pi}} = \frac{1+ e^{Zi}}{1+e^{-Zi}} = e^{Zi}$$

Taking the natural log of the odds ratio

$$\ln\left(\frac{Pi}{1-Pi}\right) = \mathrm{Zi}$$

$$\ln\left(\frac{Pi}{1-Pi}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + u_i$$

Expected Results

The decision to adopt IMVs is decided upon and its likelihood is summarized in the Table 2 below. It represents the independent variables (IVs) in the model. It also displays the expected signs when these factors are regressed on adoption. The factors in the table were selected based on the literature reviewed in Chapter Two. The factors were categorized as Household (H), Economic (E), Technological (T) and Institutional (I) Factors. The researcher discretionally abbreviated the factors as HETI. From the table, there are 5 household factors, 5 economic factors, 2 technological factors and 6 institutional factors. Except for gender, age and marriage which could have either a positive or negative relationship with the dependent variable, all other independent variables were expected to have a positive sign.

Table 2: Measurement of Key Factors Influencing the Adoption of IMV

Variable	Measurement	Expected sign
The gender of the farmer	male or female	+ or -
The age of the farmer	in years	+ or -
Marital status	Married or Otherwise	+ or -
Level of education	in years	+
Size of household	Number of persons	+
Number of years of planting maize	in years	+
Farm size	in hectares	+
Maize yield	Bags per year	+
Farmer's income	in GhC	+
Price of maize per 100kg bag	in GhC	+
The proportion of farm size allocated to IMV	in hectares	+
Knowledge about IMVs	Likert Scale	+
Access to market and infrastructure	Likert Scale	+
Quality and availability of IMVs	Likert Scale	+
Membership of farm-based organization [FBO]	Yes/No	+
Availability of Extension Services	Yes/No	+
Access to credit or finance	Yes/No	+
Favourable Government policy	Likert Scale	+

Source: Author's Field Work, (2022)

The Wald Chi-Square was used to assess the overall fit of the estimated model.

Objective Two: Effect of IMV adoption on farmers' poverty outcome

Before assessing the impact of adoption on poverty, the poverty status of farmers was classified and measured. In estimating the poverty status, the procedure used was the Multi-Dimensional Poverty Index (MPI) measure. The

Alkire Foster (AF) method of the Multi-dimensional Poverty Index (MPI) was used to measure the poverty outcome of the farmers in the study area. The AF technique enables the creation of deprivation profiles at the individual and household levels, which may be utilised to identify multidimensionally poor people. It starts with identifying the poor, adding up their deprivations to create a weighted deprivation score, and then combining this data to create a headline and related information platform for a specific community. This method for measuring multi-dimensional poverty has gained popularity due to its straightforward but focused approach.

Table 3: Multi-dimensional Poverty Index: Dimensions, Indicators and Weights

Indicator	Deprivation cut-off definition	Weight
School completion	No one has completed 6 years of schooling	1/6
School enrolment	At least one school-aged child not enrolled in school	1/6
Insurance	**At least one member is does not have health insurance**	1/6
Mortality	One or more children under 5 have died	1/6
Electricity	No electricity	1/18
Drinking water	No access to clean drinking water	1/18
Sanitation	No access to adequate sanitation	1/18
Floor	House has dirty floor	1/18
Cooking fuel	Household has “dirty” cooking fuel (dung, firewood or charcoal)	1/18
Assets	Household has no access to information and has no	1/18

assets related to mobility or assets related to lively hood

Source: Adapted from Alkire and Foster (2011)

The MPI dimensions that this study used followed the Alkire and Foster, AF (2011) approach. From Table 3, it is seen that poverty is categorized into 3 dimensions: education, health and living conditions. Education is sub-divided into enrolment and completion, with equal weights of 1/6. The original AF health dimension had mortality and nutrition as the sub-divisions. However, the Ghana Statistical Service (GSS, 2020) replaces nutrition with health insurance. That is, if at least one person in a household is insured, that household is considered not multi-dimensionally deprived in health. Health sub-dimensions are also weighted 1/6 each. The living condition dimension is sub-divided into 6 indicators namely, electricity, drinking water, sanitation, floor, cooking fuel and asset. Each indicator under living conditions also has an equal weight of 1/18. The sum of all the weight should give you 1 or 100%

A household is considered multi-dimensional poor if it is deprived in at least, 1/3 or 33.33% of the weighted deprivations.

Any MPI must include these three (3) essential components:

- The prevalence of multidimensional poverty, also known as the headcount ratio (H), which is the percentage of the population.
- Intensity (A) is the proportion of multidimensionally weighted indicators that poor people experience on average.
- Multidimensional poverty index, or MPI or adjusted headcount ratio, is the sum of incidence and intensity (MPI = H A).

To illustrate the makeup of multidimensional poverty, the MPI is consistently split down by indicator. The analysis has increased policy significance because to this dimensional detail feature. The MPI can also be broken down into various population groupings, including age ranges, subnational regions, and urban/rural areas. The entity that is classified as being poor or not poor is referred to as the unit of identification. The unit of analysis is the individual person, which pertains to how the findings are presented and evaluated.

After the poverty level has been classified, the researcher then estimated the effect of adoption on poverty status. That is, the level of poverty when there is no adoption.

Objective Three: To highlight the factor hindering farmers from adopting improve maize varieties

In analysing the major challenges that fight against the farmer's decision to adopt newly improved maize variety, the 5-point Likert scale was used. The 5-point Likert were coded as ordinal data as "1 = Strongly Disagree, 2 = Disagree, 3 = Indifferent, 4 = Agree and 5 for Strongly Agree". The responses were categorized as "Agree" as against "Disagree". All responses that were 2 or less were combined to form a new coded category as "Disagreed". All the responses that had a value of 3 and above were also recoded as "Agreed". The outcome of the difference between the frequencies of Agreed and Disagreed was used to determine the major challenges. All outcomes greater than zero (>0) were considered as major challenges. Those below zero (≤) were considered as not major challenge so far as this study is concerned.

Reliability and Validity

Wilson (2010) defined reliability as the extent to which the same results can be produced by utilizing the same tools more than once. Simply said, if a study has a level of consistency, other researchers should be able to achieve similar results using the same research techniques under similar circumstances. In this research, the researcher checked the reliability of the scale for assessing the important influences of the resolution to adopt, major challenges to adopting and the using MPI to measure poverty status of respondents. Achour (2017) gives a guide for the interpretation of the Cronbach alpha. The range for the coefficient and the corresponding decision is given in Table 4 below.

Table 4: Decision Table for Cronbach's Alpha

Range	Decision
Below 0.60	Unacceptable
Between 0.60 and 0.65	Undesirable
Between 0.65 and 0.70	Minimally acceptable
Between 0.70 and 0.80	Respectable
Between 0.80 and 0.90	Very good
Above 0.90	Excellent

Source: Achour (2017)

SPSS was used to measure the Cronbach's Alpha coefficients for the various scales. The scales were:

I. Key factors influencing adoption
II. Major Challenges to adoption
III. Multi-dimensional poverty index (MPI)

The result is displayed in Table 4.2b below.

Table 5: Reliability Statistics

Scale	Cronbach's Alpha	Number of Items
Key Factors	0.778	18
Major Challenges	0.689	10
Multi-dimensional Poverty Index (MPI)	0.976	10

Source: Researcher's Field work (2021)

From Table 5 above the Cronbach's Alpha coefficient for Key factors was 0.778 for 18 items. This can be interpreted as respectable. The scale for major challenges had a coefficient of 0.689. This can be interpreted as minimally acceptable. Lastly, the coefficient of 0.976 is interpreted as excellent for the multi-dimensional poverty index. Overall, the scales could be relied upon to measure what they are intended to measure.

In this research (Oliver, 2010), the researcher ensured validity in several ways. Firstly, the researcher used existing literature to guide him with the various themes in the research instrument used. He then consulted with his supervisor on the correctness and appropriateness of the instrument used. The researcher then did a pilot study in Saforo, one of the six towns in the study area. The findings from analysing data collected from Saforo informed the researcher to make the necessary adjustments to ensure the validity of the instrument used.

Chapter Summary

The chapter discussed the research design underpinning the study, particularly the Cross-sectional survey design. A profile of the study area

(Akuapem North Municipality) and the target population were also presented. The chapter highlighted the sampling procedure, research instruments, model specification, data analysis procedure and the expected results of the study. The chapter concluded with the reliability and validity of the instruments used.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

In this chapter, the data is presented and findings are discussed. The chapter is broken down into subheadings that include descriptive statistics, interpretation, and discussion of the results for each objective.

Descriptive Statistics

This section presents demographic statistics on the farmers. The demographics have been given as farmer characteristics and farm characteristics

Farmer and Farm Characteristics

The farmer characteristics include gender of the respondent, age, marital status, educational level and household size. The farm characteristics include planting years, size of farm, yield, current variety planted, variety planted before, and income from farm.

Table 6: Descriptive Statistics for Farmer Characteristics

Farmer Characteristics	Category	Frequency	Percentage %
Gender	Male	277	75.50%
	Female	90	24.50%
	Total	367	100.00%
Age	Less than 20 years	0	0.00%
	20 to 29 years	101	27.50%
	30 to 39 years	63	17.20%
	40 to 49 years	108	29.40%

	50 to 59 years	85	23.20%
	Above 60 years	10	2.70%
	Total	367	100.00%
Current marital status	Single	155	42.20%
	Married	178	48.50%
	Divorced	34	9.30%
	Separated	0	0.00%
	Total	367	100.00%
Highest educational level	No formal	36	9.80%
	Primary	219	59.70%
	Secondary	83	22.60%
	Vocational/Technical	0	0.00%
	Tertiary	29	7.90%
	Total	367	100.00%
Current household size	1 to 3 people	217	59.10%
	4 to 6 people	99	27.00%
	7 to 9 people	51	13.90%
	10 and more	0	0.00%
	Total	367	100.00%

Source: Researcher's field study (2021)

Table 6 above summarizes the characteristics of the farmers who participated in this research. The table shows that there were more males compared to females. It can be seen in the table that there were 75.5% of the respondents who were males as compared to 24.5% who were females. In terms of age, there were 6 categories. The summary shows that most of the participants (29.4%) were between 40 to 49 years of age. This was closely followed by those between 20 to 29 years with a frequency percentage of 27.5 percent. It was followed by those in the 50 to 59 category with a frequency of 23.2 percent. Those in the 30 to 39 bracket were 17.2 percent. Only 2 percent of the participants were above 50 years. There were no respondents who were less than 20 years. There were more married respondents compared to those who were not. There were 48.5 percent of the respondents who were married as compared to 42.2 percent of the respondents who were not. There were 9.3 percent of the respondents who were divorced. There were no respondents who were separated.

In terms of educational level of respondents, 59.7 percent of the farmers had obtained primary level, with 22.6 percent acquiring secondary education. There were a few (7.9%) who had obtained tertiary education. Only 9.8 percent had not acquired any education. There was no respondent who had vocational/technical training.

Households with sizes between 1 and 3 were in the majority with a frequency of 59.1 percent. This was followed by those with 4 to 6 members having a frequency of 27 percent. Households with 7 to 9 were in the minority with 13.9 percent frequency percentage. There was no household with more 10 or more members in their households. The farmer descriptive statistics is summarized as male dominated, majority in their 20s and 40s in terms of age, more married farmers, with primary education and household size of between 1 and 3.

Table 7: Farm Characteristics

Characteristic	Category	Frequency	Frequency %
How long have you been planting maize?	Less than 2 years	26	7.10%
	2 to 5 years	124	33.80%
	6 to 9 years	44	12.00%
	10 years or more	173	47.10%
	Total	367	100.00%
Average size of farm	Less than 1 acre	35	9.50%
	1 to 3 acres	239	65.10%
	4 to 6 acres	62	16.90%
	More than 6 acres	31	8.40%
	Total	367	100.00%
Average maize yield per year	Less than 2 tons per hectare	74	20.20%
	2 to 5 tons per Hectare	167	45.50%
	6 to 9 per hectare	47	12.80%
	10 tons and above per hectare	79	21.50%
	Total	367	100.00%
Type of variety planted	Lake	276	75.2
	Local	27	7.4
	Obatanpa	64	17.4
	Total	367	100
Variety Planted before	Agric	13	3.5
	Ahumatia	3	0.8
	Lake	20	5.4
	Local	104	28.3
	Obatanpa	227	61.9
	Total	367	100
Farm Income per month in GhC	Below 500	86	23.43%
	500 to 1000	175	47.68%
	Above 1000	106	28.88%
	Total	367	100.00%

Source: Researcher's field study (2021)

The Table 7 above summarizes the farm characteristics in terms of the following: How long farmer has been planting maize; Average size of farm; Type of variety planted; Variety Planted before; Farm Income per month in GhC. With regards to how long farmer has been planting, majority of the farmers had planted maize for 10 or more years. Specifically, 47.1 percent of the farmer respondents had planted maize for 10 years or more. There were 33.8 percent of the farmer respondents who had planted maize between 2 to 5 years. Then those who had planted maize for 6 to 9 years represented 12 percent. There were 7.1 percent of the farmers who had planted maize for less than 2 years at the time of asking.

Majority of the farmers had farm sizes of 1 to 3 acres. Precisely, 65.1 percent were in this category. There was 16.9 percent who had farm sizes of 4 to 6 acres. There were also 9.5% of the farmers who had less than 1 acre farm sizes. Lastly, 8.4 percent had more than 6 acres of farm size.

In terms of maize yields per annum, majority of the farmers (45.5%) had between 2 to 5 tons per hectare. Following, there were 21.5 percent of the farmers with 10 or more tons per hectares per annum. Farmers with less than 2 tons per hectare followed closely with 20.2 percent. Lastly, farmers with 6 to 9 tons per hectare trailed in terms of yields with 12.8 percent. Currently, the Lake variety of maize was the most popular variety planted with a frequency percentage of 75.2 percent. This was followed by Obantanpa with a frequency percentage of 17.4 percent. Farmers who planted the local variety were in the minority with a frequency percentage of 7.4 percent. The researcher investigated maize varieties that farmers have planted before their current ones. It was seen that, Obantanpa was popular with a frequency of 61.9 percent. The local variety followed with 28.6 percent. The Lake and Agric varieties followed with 5.2 percent and 3.5 percent respectively. Ahumatia was the least variety that had been planted before with a frequency of 0.8 percent.

The investigation into the incomes of farmers from their farms revealed that over 47 percent of the farmers had incomes between GhC (500-1000). There were 28.88 percent of the farmers who had farm income of more than GhC 1000. The remaining 23.43 percent had farm income of 23.43 percent. The average price of maize per 100kg bag was Ghc 137.36 with a standard deviation of 18.59. The mean bags of maize per hectare stood at 30.10.

Farm characteristics is summarized that most farmers have been planting for over 10 years, having 1to 3 acres of land for farming maize, with 2 to 5 tonnes per hectare maize yield. Lake variety is the most popular variety planted, with majority of farmers having incomes in the range of GhC 500 to 1000.

Table 8: Cross Tabulations of Demographics

		Gender			
		Male		Female	
Category		Count	Percentage	Count	Percentage
Age	Less than 20 years	0	0.00%	0	0.00%
	20 to 29 years	85	23.20%	16	4.40%
	30 to 39 years	59	16.10%	4	1.10%
	40 to 49 years	38	10.40%	70	19.10%
	50 to 59 years	85	23.20%	0	0.00%
	Above 60 years	10	2.70%	0	0.00%
Current Marital status	Single	83	22.60%	63	17.20%
	Married	165	45.00%	20	5.40%
	Divorced	27	7.40%	6	1.60%
	Separated	2	0.50%	1	0.30%
Highest educational level	No formal	4	1.10%	32	8.70%
	Primary	161	43.90%	58	15.80%
	Secondary	83	22.60%	0	0.00%
	Vocational/Technical	0	0.00%	0	0.00%

	Tertiary	29	7.90%	0	0.00%
Current Household size	1 to 3 people	163	44.40%	54	14.70%
	4 to 6 people	89	24.30%	10	2.70%
	7 to 9 people	25	6.80%	26	7.10%
	10 and more	0	0.00%	0	0.00%
Farm Income per month in GhC	Below 500	65	17.70%	21	5.70%
	500 to 1000	139	37.90%	36	9.80%
	Above 1000	73	19.90%	33	9.00%

Source: Researcher's field study (2021)

Table 8 above is a cross tabulation of gender demographic against the other demographic characteristics such age, marital status, education, household size and income from farm. It can be seen from the table that there were more males in the 20-29 and 50-59 age brackets (23.20% each). Majority of the farmers were married and there were more married males than females. Precisely, there were 8.25 times more married males than females (165/20). Majority of the farmers had also obtained basic education, followed by secondary education. However, there were more males (43.9%) who had received a primary education as compared to 15.8 percent females who had obtained primary education. Majority of the respondents were also having household sizes of 1-3 people. There were 44.4 percent of the males who had household sizes of 1-3 people. Lastly, the table shows that males received more income at every level compared to their female counterparts. There were 37.9 percent males who obtained income levels between GhC 500 to 1000 as compared to 9.8 percent who received in the same category.

Table 9: Adoption of IMV

Community	Adoption	Non-Adoption	Total	Adoption %
Saforo	67	15	82	81.71
Tinkon	49	24	73	67.12
Mangoase	55	18	73	75.34
Adowso	37	20	57	64.91
Konko	50	32	82	60.98
Total	258	109	367	70.30

Source: Researcher's field study (2021)

The table above (Table 9) displays the summary of the 5 communities from which data was collected. The table shows in each community, those who either adopted or did not adopt cultivation of IMV. The overall average percentage for adoption was 70.30 percent. Two communities (Saforo and Mangoase) were above the average adoption percentage. Saforo was the community with the highest adoption percentage of 81.71 percent. This was followed by Mangoase with 75 percent adoption. Tinkon, Adowso and Konko communities fell below the average percentage with 67.12 percent, 64.91 percent and 60.98 percent adoption percentages.

Discussion of Results

This section presents, interprets and discusses the findings of the study.

Objective One: Determinants of IMV Adoption

The results for the Logistic regression model is presented below. The logit regression was employed because the dependent variable was qualitative and can be categorized. When there are only 2 categories, then the binary logistic regression is appropriate, as it is in this case. The researcher employed the binary logistic regression the crucial influences of the resolution to accept a newly improved maize variety. The estimated equation summarized in Table 10 below.

Table 10: Factors Influencing Farmers' Adoption of Improved Maize Varieties

Variable	Coefficient (Standard Error)	Marginal
(Intercept)	-8.52*** (3.33)	0.00
Sex	-0.03 (0.88)	0.97
Age	-0.22 (0.39)	0.80
Marital Status	-0.77** (0.41)	0.46
Level of Education	1.69*** (0.47)	5.41
Household Size	-0.44 (0.81)	0.64
Years for planting maize	0.46 (0.73)	1.58
Farm Size	0.55 (0.57)	1.73
Farm yield	-1.26** (0.56)	0.28

Table 10: Continued

Access to market and infrastructure	1.30*** (0.46)	3.66
Quality and Availability of Newly Improved seeds	0.18 (0.70)	1.19
Proportion of farm allocated to new variety	0.25 (0.35)	1.28
Membership of Farm-Based Organization	0.68*** (0.26)	1.97
Knowledge about newly improved seed	-1.17** (0.63)	0.31
Availability of Extension services	0.32 (0.52)	1.38
Access to credit/finance	-1.24*** (0.44)	0.29
Favourable government policy	0.67*** (0.25)	1.95
Farmer's Income	1.99*** (0.31)	7.30
Price of Maize	0.02** (0.01)	1.02
Total Observation		367
Wald Chi-Square		0.03

**** Statistically significant at 1%, ** statistically significant at 5 % and * statistically significant at 1%*
Source: Researcher's field study (2021)

The criteria for choosing to use a newly improved maize variety are shown in Table 3 above. There were 18 factors in total that were regressed on the decision by farmers to adopt a newly improved maize variety. A total of eight factors were seen to significantly affect the decision to adopt new maize variety. All these eight variables had significant values less than the significance level of 0.05. These significant variables are discussed below.

All things being equal, farmers with higher levels of education are 5.41 times more likely to adopt newly improved maize variety than those with lower levels of education. Farmers with higher education were more likely to adopt improved maize variety as seen in its corresponding coefficient of 1.69 and significant value of 0.000. That is, farmers with higher education are more likely to adopt new improved maize variety. This is because education enhances farmers' access to information, research findings, and training programs, which provide valuable knowledge about the benefits and adoption processes of improved seeds. This result affirms the positive relationship between education and agricultural technology adoption that has been established in literature. Olusayo et al. (2019) and Ali et al. (2015), also highlighted in their study that farmers with more years in formal education were more open minded to appreciate the adoption of improved cassava varieties. This also affirms the theory of non-separability of production and consumption. With more information, households are confident in the decisions they make. Furthermore, helps them to adhere to some specified guidelines for farming procedures.

Farmers with larger farm yields are less likely to adopt newly improved seeds. Holding all other factors constant, a unit increase in yield per hectare will lead to a reduction in probability of adoption by a factor of 0.28. The variable Farm yield was had a negative impact on the decision to adopt improved maize varieties. That is, farmers who already have bigger yields were less likely to adopt newly improved maize variety. This also means that farmers with smaller farm yields were more likely to adopt newly improved seeds. This is seen in the corresponding negative coefficient of -1.26 and a significance value of 0.02. This result supports the hypothesis put forth by Uaiene et al. (2009) that small farm yields may act as a motivator for the adoption of a technology, particularly when that technology requires a significant amount of input, such labour or land. The researcher makes a logical conclusion that, if current yields of farmers were considered as high, then farmers will not be motivated to adopt any other variety. They would have confidence in whatever variety they have been planting. Adoption of IMVs is expected to increase yields. For that matter, there is more motivation for farmers with smaller yields to adopt a newly improved maize variety as they have a higher probability of increasing their yield and sales ultimately.

Access to market and infrastructure increase the likelihood to adopt newly improved maize variety by a factor of 3.66. That is, farmers with more access to market and infrastructure are 3.66 times more likely to adopt newly improved maize seeds. Adequate infrastructure, including transportation networks, storage facilities, and market access points, facilitates the movement of agricultural produce from farms to markets. When farmers have reliable access to markets, they are more incentivized to invest in improved maize varieties, as they have assurance that their produce can reach buyers efficiently.

Farmers who are members of farm-based organizations (FBO) are more likely to adopt new maize varieties. Holding all other factors constant, farmers who are members of farm-based organizations are 1.79 more likely to adopt IMVs than those who are not. The coefficient value was 0.68 and a significance value of 0.01 which is less than the conventional 0.005 significance level. This can be interpreted to mean that, a new member joining a farm-based organization increases his chances adopting a newly improved maize variety by a factor of 0.68. This is because these organizations serve as important channels for disseminating information, providing training, and facilitating access to resources for farmers. Farmers who are members of FBOs often have greater exposure to agricultural innovations, including improved seed varieties, through workshops, field demonstrations, and knowledge-sharing platforms organized by these organizations. Additionally, FBOs provide collective bargaining power, enabling farmers to negotiate better prices for inputs and access to markets for their produce, which can incentivize adoption of IMV. Moreover, membership in FBOs fosters a sense of community and social support among farmers, encouraging peer learning and collaboration in adopting new technologies. This finding corresponds with the concept of how social interactions affect how quickly technology is embraced. The study's findings are in line with those of Danso-Abbeam et al. (2017) and Tetteh et al. (2020) who found that being a member of an FBO increase their likelihood to adopt ICVs.

Access to credit or finance negatively influence farmers' decision to adopt IMV. Access to credit or bank loans reduces the likelihood of adoption by a factor of 0.29, all other things being equal. From the table above, the coefficient of this variable was -1.24 and the corresponding significance level was 0.01. This finding is contrary to the expected sign and the findings of Acheampong et al. (2022) and Manda, et al. (2020). It was expected with the availability of credit facilities, a farmer could purchase newly improved seeds and hire additional labour. The finding of this research however suggests that increased access to credit decreases the likelihood of a farmer adopting newly improved maize variety. This is because many financial institutions are not pro-agriculture and rarely operate in rural areas, where most of these farmers are. Furthermore, these financial institutions charge exorbitant interest rates that make it difficult for the smallholder farmers to repay. Confirming this assertion, the interest rates in Ghana as published by Bank of Ghana suggest that the benchmark monetary rate for the year 2021 is 14.5%. Commercial banks will therefore borrow from the Bank of Ghana at this rate and on-lend to their customers. The commercial banks will also add up to this rate before they lend to their customers in order to make profit. This means that the cost of credit is expensive. Though there may be increased opportunities for credit, they are not affordable to the average farmer and these institutions do not usually give to farmers because the institutions find them risky.

Government policy significantly affected the likelihood for farmers to adopt IMV. This is so because of the positive value of the coefficient of 0.67 and corresponding significant value of 0. Government policies can directly affect farmers' access to resources, information, and incentives, thereby influencing their adoption decisions. Policies that support research and development, promote the availability and affordability of improved seeds, provide extension services, and create favourable market conditions can incentivize farmers to adopt IMV such as improved maize varieties. For instance, Ghana's National Seed Policy published in 2013 shows the effort that the government is making to develop agriculture. Currently, only a very little amount of high-quality seed is used due to the dominance of small-scale farmers. The implementation of the Seed Policy, however, fosters an atmosphere that is favourable for the seed industry's orderly expansion and complete, balanced development.

Farmer's income positively and significantly influence farmers' decision to adopt improved maize varieties. . Farmers' income increases the likelihood of adoption by a factor of 7.3, all other factors held constant. This is seen in the positive coefficient of 1.99 and the significance level of 0.01. As farmers' incomes increase from bracket to a higher bracket, it increased their likelihood of adopting IMVs by 1.99. As farmers' income increase, they will be able to afford purchasing these seeds which are not free, but costly. It is expected that more labour will also be needed on farms as new varieties are introduced. Farmers with increased incomes will be able to employ new labour on their farms. They can now engage the services of extension officers and buy fertilizer and extra farm inputs. This is consistent with Diiro's (2013) explanation that higher income is anticipated to give farmers access to liquid funds for investing in productivity-boosting inputs like better seeds and fertilizer. In agreement with Reardon et al. (2007), income plays a key role in households in many developing nations overcoming credit limitations. In rural economies where credit markets are either non-existent or malfunctioning, income serves as a substitute for borrowed capital, according to Ellis and Freeman (2004).

The price of maize was statistically significant at a five percent level of significance and had a positive influence on farmers' decision to adopt improved maize varieties. Higher prices increase the likelihood of adopting newly improved maize the by 1.02, all other things being equal. This is indicated by the coefficient of 0.02 and p-value of 0.04 in Table 10. A farmer is more likely to adopt newly improved maize seeds with higher prices. All other things being equal, there is a direct relationship between the price of a good and the quantity supplied of that particular good. The law of supply states that there is "a positive relationship between price and quantity supplied". Producers and sellers like to make money or maximize profit, and higher prices mean more money to them. Higher price of newly improved maize produce on the market signals the farmers that they will make more money. Farmers will therefore spend more money, time and effort in cultivating newly improved maize. They will devote more resources to the production of maize. Higher prices of newly improved maize variety will even attract other farmers who are not cultivating this breed to enter the market and start doing so.

Objective Two: Effect of IMV Adoption on Poverty Outcome

Firstly, the researcher estimated the poverty status by using the Multi-Dimensional Poverty Index (MPI) method. The researcher then obtained a new data series known as *poor.* This variable was a binary coded, "Poor" for respondent being deprived in one-third of the weighted indicators; or "Non-Poor" for not deprived.

Measuring Poverty Status

The research sought to know the level of poverty among respondents in the study. In estimating the poverty status, the procedure used was the Multi-Dimensional poverty Index (MPI) measure explained in Chapter Three, Section Three. This approach is a non-income measure of poverty. It has three dimensions: education, health and living conditions. Education is sub-divided into 2; health is also sub-divided into 2. Living conditions is subdivided into six. The table below (Table 11) shows the summary for the various dimensions of the measure, their corresponding deprivation percentage (Deprive %).

Table 11: MPI Summary

Indicator	Weight	No	Yes	Total	Deprive %
Education	**1/3**				
No one has completed 6 years of schooling	1/6	310	57	367	15.53
At least one school-aged child not enrolled in school	1/6	241	126	367	34.33
Sub total		551	183	734	24.93
Health	**1/3**				
At least one member is insured	1/6	252	115	367	31.34
One or more children have died	1/6	227	140	367	38.15
Sub total		479	255	734	34.74
Living conditions	**1/3**				
No electricity	1/18	85	282	367	76.84
No access to clean drinking water	1/18	321	46	367	12.53
No access to adequate sanitation	1/18	122	245	367	66.76
House has dirty floor	1/18	245	122	367	33.24
Household has "dirty" cooking fuel (dung, firewood or charcoal)	1/18	211	156	367	42.51

Household has no access to information and has no assets related to mobility or assets related to lively hood	1/18	158	209	367	56.95
Sub total		1142	1060	2202	48.14
Total (add sub-totals)		2172	1498	3670	40.82

Table 11 above is a summary of the scale used to measure MPI. The table displays the frequencies of responses and their deprivation percentages. From Table 11, the highest deprivations came from living conditions. The average deprivation for living conditions was 48.14 percent. The average deprivation for health was 34.74 percent. The average deprivation for education is 24.93 percent. For the living condition indicator, there were 76 percent of the respondents who had no access to electricity in their households. This was followed by 66 percent who had no access to adequate sanitation. There were 56.95 percent of the respondents who had no informational resources, no means of transportation, and no means of subsistence. The indicators with the least deprivations were access to clean drinking water and school completion. These had 12.53 percent and 15.53 percent correspondingly.

Table 12: Household Deprivation Count

Is the household deprived?	Sum of household size
Poor	932
Non-Poor	415
Total	1347

Source: Author's Field Work (2021)

Table 12 above shows a summary of the household deprivation count. This table is used to calculate the headcount ratio. The figure 932 under sum of household size is summation of household sizes for all respondents who were deprived in any indicator. The headcount ratio shows the proportion of poor people in the sample. From the table above, the headcount ratio is calculated as ratio of individuals considered as deprived in at least one-third of the indicators given divided by total sample.

Head count (H) = 932/1347 = 0.6919

That is, 69.19 percent of individuals are deprived in at least one-third of the weighted indicators for households in the study area.

Measuring Intensity of Poverty (A)

The intensity of poverty reflects the number of weighted deprivations experienced by those who are poor. The intensity of poverty looks at those who were considered poor. It attaches the weight of the indicators in its calculations. In the calculation of the intensity of poverty below, the numerator was obtained by summing the product of each household size with their corresponding weights, for those households who were deprived in at least one-third of their indicators.

The sum of the weight for the whole scale is equal to 1or 100%. Education, health and living conditions all have equal weights of 1/3 or 33.33 percent each. Education is sub-divided into 2 sections, with each having a weight of 1/6. The health dimension is also sub-divided into 2: nutrition and mortality. Each of the health sub-divisions has an equal weight of 1/6. Lastly, there is the living condition dimension with 6 sub-divisions. Each of these 6 subdivisions has an equal weight of 1/18. The respondents were asked to indicate their responses to these indicators. The sum of each deprivation score is then multiplied by its weight to obtain a household deprivation score. The

MPI uses a cut-off point of 33.3 percent such that all respondents with a deprivation score of at least 33.3 percent were considered poor and re-coded as 1 and those below were considered not poor and re-coded as 0. The household sizes for the respondents were used to calculate the headcount ratio by matching them with their corresponding poverty status (Yes/No).

Intensity of poverty (A) = 40093.49/932=43.02. This is interpreted to mean that the average poor person is deprived in 43.02 per cent of the weighted indicators.

Measuring MPI

The multidimensional poverty which is an adjusted poverty headcount ratio measures the proportion of people in the entire sample who endure weighted deprivations relative to the number of poor people. It is actually the product of the head count ratio and the intensity of poverty. That is, Multi-dimensional Poverty Index (MPI) = M x A = 0.6919*43.02=29.77. This is interpreted to mean that, poor people in the study experience 29.77% of deprivation as a share the possible deprivations that would be experienced if all people were deprived in all dimensions.

The MPI result is consistent with the results reported by the “Ghana Statistical Service (GSS, June 2020). According to the report, the Eastern Region has an MPI estimate of 0.217 (21.7 percent) which is about 0.019 points below the National MPI. The MPI of 29.77 percent in this study is above the Eastern Regional MPI. It only falls short by 8.07 percent. The headcount ratio of multi-dimensional poverty is almost 44 percent in the region as compared to 69.19 percent reported in this study. The headcount calculated in this study falls short to the GSS Eastern Regional measure by

25.19 percent. This is over and above the national headcount ratio of multi-dimensional poverty of 45.6 percent. The intensity of poverty in the region is about 49.3 percent as compared to 43.02 percent in this study. This implies that among those who have been identified as multi-dimensionally poor in the region, they are deprived, on average, in 43.02 percent of the weighted indicators. This is also 8.68 percent below the national rate of 51.7 percent".

Effect of IMV Adoption on Poverty Outcome

This section finally measures the contribution of better maize varieties to reducing poverty.

Table 13: Classification Table for Key Factors Influencing Adoption

	Observed		Predicted		
			Poor		Percentage Correct
			0	1	
Step 1	Poor	0	0	117	0
		1	0	250	100.0
	Overall Percentage				68.1

NB: The cut value is 0.500

Source: Researcher's field study (2021)

Table 13 above is the classification table for the model that predicted the effect of adoption on poverty decline. From the table, all those that the model predicted will not be poor were actually observed not to be poor. For those that the model predicted that they will be poor, 117 were actually observed not to be poor. This gave a percentage correctness of 0%. Also, for the 250 farmers who were predicted to be poor, all of them were observed to be poor. This gives a correct percentage of 100% for those predicted to be poor. The overall correct percentage for the prediction was 68.1% which was over and above the cut-off point of 50%.

Table 14: Variables in the Equation for Adoption Impact on Poverty Status

		B	S.E.	Wald	Df	Sig.	Exp(B)
Step 1a	Adopt_sav	- 0.89	0.44	4.10	1.00	0.04	0.41
	Constant	1.49	0.39	15.00	1.00	-	4.45

a. Variable(s) entered on step 1: Adopt_sav

Table 14 above is shows the output for the binary logistic regression of the adoption of newly improved maize variety on poverty status of respondents in the study area. Increased likelihood of adoption reduces poverty levels of households in the survey. If an Additional farmer adopts newly improved maize, this reduces poverty level by -0.888. The coefficient of Adopt_sav (-0.888) was seen to be statistically significant as its significant value of 0.043 was lesser than the alpha value of 0.05. The Exp (B) of 0.411 predicts that the adoption of newly improved maize seed by farmers is expected to reduce poverty levels by a factor of 0.411. This is interpreted that if an additional farmer adopts an IMV, it is 58.9% less likely that that farmer will be poor.

The literature reviewed agrees with this finding such that, Mellor (2001) has shown that increased adoption of new agriculture will increase in productivity, which in turn raises household earnings for those who own land. Most of the money earned from agricultural production is spent by these households on labour-intensive goods and services, which has a double- and triple-round effect of increasing food supply and job possibilities for the underprivileged (Mellor, 2001). There is agreement on the notion that there is a negative relationship between adoption and poverty levels. That is, higher adoption rates will lead to a reduction in poverty levels. The use of agricultural technology, according to Litchfield et al. (2002), Lipton et al. (2003), Hussain et al. (2002), Hussain and Hanjra (2004), may lessen poverty through direct impacts on levels of output, jobs, food security, food costs, earnings, and general socioeconomic welfare.

Objective Three: Major Challenges to the Adoption of IMV

This section answers the final and third research question of the research. The major challenges were measured on a 5-point Likert scale. As explained in section 3.7 in the previous chapter, the result of the computation is displayed in the Table 15 below

Table 15: Challenges to the Adoption of IMV

S/N	Challenges	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Responses
1.	Unavailability of seeds	203	80	12	39	33	367
2.	Bad Farm practices	21	18	228	49	51	367
3.	High cost of seeds	299	62	3	1	2	367
4.	Lack of access to market and infrastructure	42	203	24	56	42	367
5.	Insufficient proportion of farm size allocated to new variety	13	120	186	11	37	367
6.	Members of farm-based organization	18	41	157	93	58	367

7.	Low level of education and training	78	77	53	22	137	367
8.	Inadequate of extension services	164	72	96	21	14	367
9.	Lack of access to credit or finance	189	92	48	26	12	367
10.	Unfavourable government policy	141	85	97	24	20	367

Source: Researcher's field study (2021)

From the results it is evident that the number one major challenge facing farmers is the high cost of seeds, followed by the unavailability of seeds, lack of access to farm credits and loans, and lastly the lack of access to market and infrastructure.

High Cost of Seeds: The majority of respondents (361 out of the 367 respondents) strongly agreed or agreed that the high cost of seeds is a significant challenge. This buttresses the earlier discussion that smallholder farmers in the Akuapem North Municipality do not have sufficient funds to purchase or adopt these new agriculture technologies, especially the improved maize varieties. The price of these seeds deter farmers who are willing but not able to afford these IMVs because of the price. This is in line with López and Filipello (1994) who claim that there is proof that small producers are ready to use better seed if it demonstrates a yield improvement and provided improvements are accessible. But when it comes to the adoption of enhanced seeds, cost-of-innovation and seed pricing are the two main deciding variables

Unavailability of Seeds: The results indicate that a majority of the respondents (283 respondents) agreed or strongly agreed that the unavailability of seeds posed a challenge for them and hindered them from adopting the improved maize varieties. Limited availability of seeds, especially of the desired varieties, hinders farmers' willingness to transition to more productive and resilient crop varieties. These findings agree with existing literature such as Beyene and Kassie (2015).

Lack of Access to Credit or Finance: A significant number of respondents (281 respondents) agreed or strongly agreed that the lack of access to credit or finance is a major challenge. This highlights the fact that smallholder farmers are not able to invest in improved seeds and other inputs since they do not have the personal funds to purchase the IMVs.

Lack of Access to Market and Infrastructure: A substantial number of respondents (245) strongly agreed or agreed that the lack of access to markets and infrastructure is a barrier to adoption. Access to market and infrastructure incentivizes farmers to adopt new technologies and enhances farmers' ability to sell their produce and increase their willingness to invest in improved maize varieties. Therefore, the inadequate access to market poses the fear that their yields may go bad if they don't get ready market so they may not adopt the improved maize varieties.

Inadequate of Extension Services: The data highlights the perceived inadequacy of extension services as a barrier to adoption. Many respondents agreed or strongly agreed that the lack of access to extension services hinders the adoption of improved maize varieties.

Unfavourable Government Policy: Many respondents indicated that unfavourable government policies are hindering the adoption of improved maize varieties. This finding emphasizes the significant role of government policies in shaping farmers' decisions and adoption behaviours. It corroborates the findings of Pingali, Deevi and Birthal (2020), who provided empirical proof that the adoption of enhanced sorghum in Sudan was impeded when the government's pricing strategy changed in a negative way. Again, Dembele, Bett, Mutai and Le Bars (2017), noted that a well-organized sub-sector and mechanized farming system in Mali led to high rates of technology adoption. The removal of marketing assistance and price guarantees, however, forced maize farmers to switch to a different technology and essentially return to their old ways.

However, factors bad farm practices, insufficient proportion of farm size allocated to new variety, low level of education and training were not significant factors hindering the adoption of IMVs in the Akuapem North Municipality. This s because only a minority strongly agreed or agreed that these were challenges they faced. This implies that farmers in Akuapem North Municipality are not engaged in bad farming practices and are also educated so do not see these as possible challenges affecting their adoption of the improved maize varieties.

Chapter Summary

The study revealed that out of the 367 farmers sampled, 258 representing 70 percent adopted IMVs whereas 109 representing 30 percent did not adopt IMV. The study further revealed that membership in farm-based organizations, access to credit or finance, government policies, farmers' income, and market prices for maize products significantly increased the likelihood for farmers to IMV. In addition, the study revealed that farmers who adopted the IMV were in the non-poor category indicating whereas majority of those who did not adopt IMV were in the poor category. In addition, the major hindrances to the adoption of IMV are: the high cost of seeds, followed by the unavailability of seeds, lack of access to farm credits and loans, and lastly the lack of access to market and infrastructure.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Introduction

This is the concluding chapter which summarises the study. It is constituted by summary study, key findings and the conclusion of the study. The chapter further makes recommendation for policy formulation and also for further studies.

Summary of the Study

This study sought to assess the adoption and effect of IMVs on poverty outcomes among maize farmers in the Akuapem-North Municipality. Specifically, the study sought to highlight the factors determining the adoption of IMVs in the Akuapem-North Municipality; examine the effect of the adoption of IMVs variety on the poverty outcome of farmers in Akuapem-North Municipality; and lastly, investigate the factors hindering farmers in Akuapem-North Municipality from adopting of IMVs. The study sought to test the hypotheses that farmers' social-demography, institutional, governmental and technical factors significantly influence on the adoption of IMV and also that the adoption of IMV affects the poverty outcome of farmers.

The study employed a cross-sectional survey research design and the quantitative research approach to achieve the research objectives. Employing the multistage sampling technique, the study sampled 367 smallholder farmers from the top five maize-producing communities in the Akuapem North Municipality. These communities are Saforo, Tinkon, Mangoase, Adowso, and Konko. Data was collected with a questionnaire in the year 2021 from the sampled smallholder farmers. The study utilised the binary logistic regression as the estimation technique.

Summary of Key Findings

The study revealed that out of the 367 farmers sampled, 258 representing 70 percent adopted IMVs whereas 109 representing 30 percent did not adopt improved maize varieties. The study further revealed that membership in farm-based organizations, access to credit or finance, government policies, farmers' income, and market prices for maize products significantly increased the likelihood for farmers to adopt improved maize varieties. Contrarily, the high cost of improved seeds, unavailability of seeds, and unfavourable government policies farm had a negative effect on farmers' adoption of improved maize varieties. Whereas other studies reveal a positive relationship between arm yield and the adoption of ICVs, this study revealed otherwise. That is, farmers who had bigger yields were less likely to adopt newly improved maize variety. The plausible justification is that large farm yields does not motivate the adoption of IMVs since its purpose is to increase farm yields. So, farmers with larger yields do not see the need to adopt the IMVs. Furthermore, the study revealed that farmers who adopted IMVs fell in the non-poor category while a majority of the farmers who did not adopt IMVs were in the poor category. The major hindrances to the adoption of IMVs are: the high cost of seeds, followed by the unavailability of seeds, lack of access to farm credits and loans, and lastly the lack of access to market and infrastructure.

Conclusions

The study has shown that a majority of the smallholder farmers in the Akuapem-North Municipality have adopted IMVs. Farmers' demography, institutional factors, government policies and technical or farm characteristics play a significant role in deterring farmers' adoption of agricultural technology, specifically improved maize varieties. Smallholder farmers income, education and access to market and infrastructure are significant factors that positively influencing the decision to adopt IMV. More so, these same variables have the highest probabilities of influencing the poverty outcome of smallholder farmers. In addition, the poverty outcome of farmers is significantly determined by farmer's adoption of IMVs. Poor farmers were less likely to be adopting IMVs. The finding of this research concludes that the adoption of IMV significantly improve the poverty outcome of farmers.

Recommendations

Education, farm size, high prices and being a member of a farm-based organizations were all seen to have a positive influence on farmers' decision to adopt newly improved maize varieties. In line with this, the government should pay attention to policies in these areas as this will in turn affect income levels positively. The policies should be directed at increasing educational access, land tenure systems that will make it possible for farmers to be able to get arable lands for cultivation. Government should take mediating steps that will offer better pricing systems intended to make farmers better off. This will give positive signals to farmers to yield to adopting to use IMVs since higher prices incentivize producers. The farmers are encouraged to join farm-based organizations as this increases their probability of adopting new agriculture technology. Dissemination of information is also easier when farmers are in groups. It will also give farmers security when seeking assistance.

The researcher recommends that the government should review the cost of seeds downwards as it was the principal challenge to adopting newly improved seeds. The government should further subsidize the cost of these improved seeds. The improved seeds should also be made readily available at easy-to-reach locations.

Suggestion for Further Studies

The utilization of survey data has significantly improved the present research methodology. On the other hand, it is challenging to pinpoint causal effects using cross-section data. Because of this, the researcher advises that future research should concentrate on gathering alternative data sets, such as panel and time series data, and on utilizing new techniques, such as field studies.

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APPENDICES

APPENDIX A

QUESTIONNAIRE

This questionnaire has been designed to elicit responses from respondents who are willing to participate in this research. You are kindly requested to help complete this questionnaire. The main objective of this research is to ascertain the adoption and impact of new maize variety on poverty reduction among maize farmers in the Akuapem-North Municipality. Responses given by the respondent will be treated with utmost confidentiality.

Please tick or fill in where appropriate your answers to the following questions:

Community: Saforo ○ Tinkon ○ Mangoase ○ Adowso ○ Konko ○

Theme A: Farmer's Demography

1. Sex:
   - Male
   - Female

2. Age:
   - Less than 20 years
   - 20-29 years
   - 30-39 years
   - 40-49 years
   - 50-59 years
   - Above 60 years

3. Marital status:
   - Single
   - Married
   - Divorced
   - Separated
4. Education Level
   - No formal education
   - Primary
   - Secondary
   - Vocational/technical
   - Tertiary
5. Which category best describes your income level?
   - Below GhC 500
   - Between GhC 500 and 1000
   - Above GhC 1000
6. Household size:
   - 1-3 people
   - 4-6 people
   - 7-9 people
   - More than 10 people
7. How many years have you been planting maize?
   - Less than 2 years
   - 2-5 years
   - 6-9 years
   - 10 years or more years

8. What is the average size of your farmland cultivated?
    - Less than 1 acre
    - 1-3 acres
    - 4-5 acres
    - More than 5 acres
9. What is your average maize yield per year?
    - Less than 2 tons per hectare
    - 2 to 5 tons per hectare
    - 6-9 tons per hectare
    - 10 tons and above per hectare

Theme B: Willingness to adopt improved maize variety (IMV)

10. Suppose the Government or an NGO initiates/starts a project of planting new maize variety intended to help reduce poverty in the Akuapem North Municipal Assembly. Adopting the improved variety gives the following benefits: increased yields, uniform growth, improved root, increases the plants ability to withstand stalk-root fungi, pests and extreme weather conditions like heat and drought. A pack of this new maize variety in the market currently costs GhC…per … Will you be willing to pay this amount to adopt this new maize variety?
    - Yes
    - No
    - Not sure
11. Based on your response in Question 9, would you be willing to pay higher or lower than the current market price?
    - Higher (Please state how high): GhC…………

- Lower (Please state how low): GhC …………

12. Please give your reasons for adopting or not adopting such new variety in such initiative;

    I. ……………………………………………………………………
    II. …………………………………………...……………………

13. If yes, please how much of your land (in terms of acreage) would you be willing to allocate for the cultivation of the improved maize variety?

14. Have you adopted the use of the new maize variety before?
    - Yes
    - No

Them C: Measuring Multidimensional Poverty

15. Please tick either yes or No from the table below which best describes your status

Deprivation cut-off definition	Yes	No
No one has completed 6 years of schooling	☐	☐
At least one school-aged child not enrolled in school	☐	☐
At least one member is does not have health insurance	☐	☐
One or more children under 5 have died	☐	☐
No electricity	☐	☐
No access to clean drinking water	☐	☐
No access to adequate sanitation	☐	☐
House has dirty floor	☐	☐
Household has "dirty" cooking fuel (dung, firewood or charcoal)	☐	☐

No access to information, no assets related to mobility or assets related to lively hood

16. To what extent do these factors affect your decision to adopt improved maize variety in your farm? *Please tick in the appropriate cell; SD=Strongly Disagree; D=Disagree; I=Indifferent; A=Agree; SA=strongly Agree.*

ITEM	SD	D	I	A	SA
i. Access to market and infrastructure					
ii. Quality of available inputs					
iii. Proportion of farm size allocated to new variety					
iv. Membership of Farmer-based Organization (FBO)					
v. Level of education and training					
vi. Availability of extension services					
vii. Access to credit or finance					
viii. Government policy					

Theme D: Effect of IMV adoption on poverty Outcome

17. To what extent does adoption or non-adoption of improved maize variety impact on poverty reduction?

Please tick in the appropriate cell; SD=Strongly Disagree; D=Disagree; I=Indifferent; A=Agree; SA=strongly Agree.

ITEM	SD	D	I	A	SA
Farmer's household has sufficient resources or obtain credit to purchase improved maize variety					
Yields from improved variety are greater than those from local varieties					
Farmer can sell of increased produce in the market					
There is increased demand for improved maize variety					
Prices for produce from improved maize variety are cheaper than that of local varieties.					
Farmer engages more hands as result of using improved maize variety.					
Farmer has been able to acquire income-generating asset(s) as a result of adoption of improved variety.					
Farmer's income has increased as a result of adopting improved maize variety.					
Output levels have increased as a result of using the same quantity of improved variety as compared to local variety.					
Cost of production have reduced for the production of the same quantity of improved variety as compared to local variety					

Theme E: Major challenges or constraints to the adoption of IMV

18. To what extent do you agree with the items in the table below as to the major challenges or constraints to adopting new maize variety?

Please tick in the appropriate cell; SD=Strongly Disagree; D=Disagree; I=Indifferent; A=Agree; SA=strongly Agree.

Item		SD	D	I	A	SA
i.	Quality of available inputs					
ii.	Access to water supply					
iii.	Cost of seeds					
iv.	Access to market and infrastructure					
v.	Proportion of farm size allocated to new variety					
vi.	Membership of Farmer-based Organization (FBO)					
vii.	Level of education and training					
viii.	Availability of extension services					
ix.	Access to credit or finance					
x.	Government policy					

Thank you