

**IMPACT OF AGRICULTURAL MARKETING INFORMATION TOOLS (AMITs) ON  
INCOME OF MAIZE FARMERS IN THE AKWAPIM SOUTH DISTRICT OF GHANA**

**BY**

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**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN  
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**DECLARATION**

I, NANA AMA DARKWAAH, the author of this thesis, titled; **“THE IMPACT OF AGRICULTURAL MARKETING INFORMATION TOOLS (AMITs) ON INCOME OF MAIZE FARMERS IN THE AKWAPIM SOUTH MUNICIPALITY OF GHANA”**, do hereby declare that with the exception of the relevant references duly cited, the entire research was carried out by me in the Department of Agricultural Economics and Agribusiness, College of Basic and Applied Sciences, University of Ghana, Legon from August 2017 to July 2018. This thesis has never been presented either in whole or in part for any degree in this University or elsewhere.

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## **DEDICATION**

This thesis is dedicated to my parents, Mr. Paul Kwadwo Nti and Mrs. Irene Iris Essiam and my sister for the amazing love, support and encouragement throughout my entire education.

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God Almighty deserves the biggest appreciation as far as this dissertation is concerned. I am grateful for the life, wisdom and strength He gave me to complete this work.

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## ABSTRACT

Agricultural Marketing Information Tools (AMITs) is a technology which is designed to gather, process and distribute information based on the conditions and dynamics of agricultural markets to various stakeholders through one or more information channels to aid in their decision making. An improvement in the participation of market by smallholder farmers in developing countries carries the potential of reducing poverty. The study sought to assess the impact of AMITs on maize farmer's income in the Akwapim South Municipal. Farmers were presented with eight alternatives of AMITs: no tool (0), mobile phone (1), radio (2), TV (3), phone and radio (4), phone and TV (5), radio and TV (6), and phone, radio and TV (7). The factors affecting the choice of any of the alternatives were assessed. Primary data was obtained from farmers in three selected communities including Aburi, Nsakyie and Pokrom. The simple random sampling technique was used to select 420 maize farmers for face-to-face interviewing. Survey data was analyzed using the Multinomial Logit regression, propensity score matching techniques and Kendall's coefficient of concordance. The multinomial logit regression results show that gender (being male or female), years of schooling, AMIT awareness, transport cost and extension contact were the most important determinants of the choice of the various alternatives. The PSM results showed that adoption of AMITs had a positive impact on farmers income. The study recommends that awareness creation should be encouraged further to get more farmers to use the tools, especially the mobile phones. The district agricultural department should use farmer organization during provision of extension service and integrate the message on effective use of AMITs for marketing information sharing.

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## LIST OF ACRONYMS

AIC	Agricultural Information Centers
AMIS	Agricultural Marketing Information Systems
AMITs	Agricultural Marketing Information Tools
ASM	Akwapim South Municipal
CD-ROM	Compact Disc Read Only Memory
CIMMYT	International Maize and Wheat Improvement Center
DAES	Directorate of Agricultural Extension Services
DCBA	Dairy Cattle Breeders' Association
GPRS	Ghana Poverty Reduction Strategy
GSS	Ghana Statistical Service
ICT	Information Communication Technology
ICT4AD	Information and Communication Technology for Accelerated Development
IFDC	International Fertilizer Development Center
IICD	International Institute of Communication and Development
INSTI	Institute for Scientific and Technology Information
KACE	Kenya Agricultural Commodity Exchange
MIS	Marketing Information System
MIT	Marketing Information Tools
MoFA	Ministry of Food and Agriculture
NCA	National Communication Authority
NGO	Non-governmental Organization

SMS	Short Message Service
TAHA	Tanzania Horticultural Association
USAID	United States Agency for International Development
WAAPP	West Africa Agricultural Productivity Program

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background to the Study

Kizito (2011) explains Marketing Information System (MIS) as a structure for gathering, operating and distributing information based on the conditions of agricultural markets to various stakeholders through one or more information channels to aid in their decision making. The modern medium is Information Communication Technology (ICT), which can also be referred to as an agricultural marketing information tool (AMIT). Marketing information is a critical constituent in the proper functioning of efficient markets. Efficiency is adversely affected if there is an imbalance in buyer's and seller's knowledge. Eggleston, Jensen, & Zeckhauser, (2002), asserted that readily available and wide dissemination of information can be a guide for the planting decisions of farmers, improve the flow of commodities from rural to urban areas, lower the risk of all transactions and facilitate the pricing decision at various points along the marketing chain. Thus, AMITs is aimed at improving the welfare of farmers through the improvement of the performance of the market which increases farmer's income.

The availability and reliability of information have often been seen by many economists and scholars as one of the basic contributors to the efficiency of the market (David-Benz, Andriandralambo, Soanjara, Chimirri, Rahelizatovo and Ravolala, 2016). It is important to note that the adoption of AMITs by farmers in the agricultural sector is low. This is especially the case in most developing countries like Ghana. Indeed, government of these countries try to address this concern by making some considerable amount of efforts to promote AMITs among maize farmers. A lot of policies on AMITs have been put forward to try to develop the

agricultural sector. For instance, a Ghana case is where the government in trying to promote the dissemination of agricultural marketing information to farmers, introduced the ICT4AD policy in 2003 (ICT4AD, 2003) but not efficiently executed (Fafchamps and Minten, 2012).

Information asymmetry is mostly cited as restraining the effectiveness of agricultural markets. As such AMITs, which is aimed at improving the performance of market through the distribution of information to various actors in the market has also been suggested by David-Benz *et al.*, (2016). Kirui and Njiraini (2013) asserted that an improvement in the participation of market by smallholder farmers in developing countries carries the potential of reducing poverty. There has been a number of initiatives to provide marketing information recently as the desire to improve the participation of smallholder maize farmers in the market (Fischer and Qaim, 2014; Okello, Ofwona-Adera, Mbatia, & Okello, 2010).

Marketing of produce has often posed problems to smallholder farmers. Farmers receive a highly disproportionate share of profit during the marketing of produce of which the inadequacy of market information and information asymmetry are major factors (Nkuba, 2016). The lack of information to smallholder farmers has been estimated to be a major contributing factor to the low prices received by most farmers. This subsequently reduce incentives to invest resources and time to farming thereby suppressing output and agricultural productivity. In an attempt to rectify this problem, the need arises that farmers receive reliable, accurate and affordable market information. According to Tanzania Horticultural Association (Tanzania Programme Annual Report, 2014), such information would provide some protection to smallholder farmers from middlemen who more often than not take advantage of the knowledge of farmers to exploit them.

Smallholder farmers provide a significant proportion of the nation's food basket; they need to be well integrated in a marketing information system that help them understand price changes, consumer demand and preferences as well as various accesses to markets (Babu, Mensah, & Kolavalli, 2007).

Communication technology plays an important role in spreading knowledge and creating awareness on emerging agricultural technologies among farmers, essentially because it is faster than personal contacts. Ogutu, Okello, & Otieno (2013) asserted that recent use of information communication technologies in developing agriculture has improved efforts to promote smallholder farmers access to agricultural information. It is of no doubt that the evolution of information communication technology has indeed affected all sphere of life of agriculture, and this has been of great importance especially in the developed world. As in the case of India, the use of electronics as a means of information exchange enhances the contribution of extension services in spreading agricultural marketing information to farmers especially smallholder farmers. Thus, AMITs could be used to support the conventional methods of agricultural extension in farming areas in Ghana (Sakyi-Boateng, 2012). Falola, & Adewumi (2012) indicated that the use of ICT, an example of AMITs, has been proven to reduce the cost of transportation and other risks that agricultural producers might possibly face in their farming and marketing activities. ICT provides solutions for smallholder farmers in the marketing of their goods, finding new buyers as well as managing sales (USAID, 2013).

The study, therefore, sought to assess the impact of AMITs on income of maize farmers.

## 1.2 Problem Statement

Farmer's access to agricultural marketing information has become a major problem when it comes to marketing their produce (Antwi & Seahlodi, 2011). Smallholder farmers had often sought to access vital information from traditional media such as friends, family, network of traders, and agricultural extension workers. Timeliness of the marketing information sourced are imperative to decision making but these could not be guaranteed by traditional sources. Farmers are visited by extension officers once in a while. It is usually on this occasion that they are able to access marketing information from them. Their colleague farmers may not also have adequate information on markets where farmers produce would be demanded more.

There is usually poor communication of marketing information by colleague farmers and extension officers in providing timely information (Curtois & Subervie, 2014). Most maize farmers usually become price takers accepting whatever price dictated by traders and middlemen as a result of inadequate marketing information. Okello *et al.*, (2010) argued that traders and middlemen have much information on both demand and supply conditions. This could result in farmers becoming marginalized by accepting a very small fraction of the marketing margin. Farmers who have low income save less, have low credit access and low discretionary income resulting in a vicious cycle.

Donor agencies, government and the private sector continue to contribute to dissemination of sustainable agricultural marketing information to improve the livelihoods of farmers in Ghana. Notably among them include the establishment of Agricultural Information Centers (AICs) in 2001 by MoFA and GIZ; the e-Agriculture under West Africa Agricultural Productivity Programme (WAAPP) in 2007 by Directorate of agricultural Extension services under MoFA

and Esoko Ltd, a private company was also started by a group of private individuals in 2004. The initiatives mentioned above were all aimed at making it easier for farmers to have access to information on farming activities. These stakeholders provide a number of support to farmers. For instance, agricultural information centers have been set up in the Atebubu yam market where farmers can visit for information on market prices of inputs and produce. The e-agriculture project staff also assist farmers with comprehensive and up-to-date information on market prices, farm management techniques and practices. It has to be emphasized that policy makers in the agricultural sector have not yet embraced fully the importance of these AMITs to the development of the sector (Bertot, Jaeger, & Grimes, 2010).

Although farmers' income is associated with the adoption of agricultural MIS in general (Kizito, Donovan, & Staatz, 2012), yet, not much attention has been given to the level of adoption of AMITs in the study area by stakeholders. The impact of AMITs on the income of smallholder farmers at the local level, especially in farming areas such as the Akwapim South Municipal has not been determined since 2001 when farmers in the area began to try it. The study raised two important questions that helped understand the levels of AMIT adoption among smallholder farmers, and in the context of Akwapim, how the adoption associated positively with income of smallholder farmers. Specifically, the research questions are:

1. What are the determinants of choice of Agricultural Marketing Information Tools in the Akwapim South Municipal?
2. How does the use of Agricultural Marketing Information Tools affect the income of farmers?

### **1.3 Objectives of the Study**

The main objective of the study was to assess the impact of AMITs on maize farmers' income in the Akwapim South Municipality (ASM) of Ghana. The specific objectives the study sought to address were to;

1. Identify the determinants of choice of Agricultural Marketing Information Tools in the ASM.
2. Determine the extent to which AMITs use affect the income of maize farmers.

### **1.4 Relevance of the Study**

The importance of small-scale farmers in developing countries has received enormous recognition and acknowledgement. There have been several schools of thoughts concerned with increasing the agricultural productivity of these smallholder farmers. Magingxa & Kamara (2003), Diao & Hazell (2004) and Dorward, Kydd, Morrison, & Urey, (2004) asserted that it is imperative to involve the majority of smallholder farmers if agricultural development is to be achieved. Other authors such as Al-Hassan, (2008) also established that smallholder-driven economy is impeded by the lack of access to marketing information. The advocates of smallholder farming strongly agree that access to effective marketing information could lead to improved incomes, food security and sustainable agricultural growth (Kizito *et al.*, 2012; Sokoya, Alabi, & Fagbola, 2014). Access to timely and accurate marketing information is a contributing factor to the listed outcomes. Dissemination of timely and accurate marketing is key for effective market participation of all actors. Thus, reliable information on market conditions enables an effective decision making and planning (Zhang & Xu, 2006).

The study therefore will bridge a major gap of knowledge as far as AMITs adoption in ASM is concerned. Farmers would have knowledge of how their farm incomes are impacted by AMITs use from the findings of the study. Through constraints analysis, the study will also provide information on the challenges to AMITs adoption.

The study would provide information on factors affecting farmers' adoption of AMITs, for policy makers and other stakeholders, who may want to introduce any AMIT project in the farming areas. These policy makers and stakeholders may not be aware of the factors affecting farmers decision to use AMITs in the study area.

### **1.5 Organization of the Study**

The study is organized into five chapters. One is devoted to the introduction to the study, statement of the research problem, study objectives, relevance of study and the organization of study. Chapter Two presents the review of literature pertinent to the current study. The methodology of the research is described in Chapter Three. Chapter Four presents the results and discusses them, and the summary, conclusions and recommendations are presented in Chapter Five.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter provides both theoretical and empirical literature that is important to the study. Studies on agricultural marketing information tools and systems, supply of agricultural marketing information services, AMIT services provision in Ghana, factors influencing the adoption of AMITs, the impact of agricultural marketing information and constraints to the adoption of agricultural marketing information tools by farmers are extensively reviewed.

#### 2.2 Agricultural Marketing Information Tools and the Information System

Agricultural Marketing Information System (AMIS) defined by Staatz, Kizito, Weber, & Dembele, (2011) is a group of associations that collect data on market conditions, processes and analyses the data to transform it into marketing information and disseminates it to all and sundry through information channels. Again, there are various products which market information system may contain. These include information on prices, market conditions and clients as indicated by Staatz *et al.*, (2011). Mahaliyanaarachchi (2003) revealed that marketing information includes information on prospective market channels, quality, existing markets and demand. Moreover, the stakeholders in the information system includes farmers, traders, government policy analyst and policymakers, development organizations, input providers, banks, market information system personnel and researchers who directly or indirectly express needs for Marketing Information System products.

According to Kizito (2011), market information services include a frequent collection of product prices from larger markets, sorting, storing, and finally disseminating the information to other beneficiaries through chosen channels. Again, Kizito (2011) also indicated that there are different ways of disseminating commodity prices through market information system across stakeholders. Proven methods of dissemination include televisions, radio, email, newspapers, internet, mobile phones, and other devices. Shepherd (1997) stated that the information that is commonly used by marketing systems can be grouped current and historic information. Currently, up-to-date information is used most effectively in bargaining between stakeholders according to (Shepherd, 1997).

Marketing information system is likely to be underprovided by the market since firms cannot control access and capture payments. Poole (2003), expressed that this may prompt low levels of information which is lopsided; producers will probably be poorly informed as compared to the traders about demands for their product. Much of the time, the private marketing information is transmitted through casual systems or informal networks and is more relevant, timely and point by point as compared to the public market information through Marketing Information System (Poole 2003).

However, Mahaliyanaarachchi (2003) reported that, in many developing countries, marketing information is seen as a public service, especially when various smallholder farmers are unable to pay for Marketing Information System (MIS) services. It is therefore provided by a government department and can take different forms extending from market analysis and estimate to showcase market price data. Market Information Tools (MITs) has a wide range of

uses and users (Ferris, Engoru, & Kaganzi, 2008). With spot information, is mostly and directly used as sales negotiation and keeping informed of market conditions. Also, marketing information that is collated over a period of time provides historic data that helps users to make choices or decisions on which crops to produce and when to harvest. With historical market information, it enables co-operative marketing agents to settle on decisions on where to market their produce. Mostly, data on prices is used by financial institutions and other stakeholders or organizations for monitoring long-term wellbeing of the economy and assessing the risk of lending to individual farmers. Also, historical and current data are used by government, researchers and policymakers to review shifting marketing patterns and to monitor food security conditions.

Tollens (2006) opined that the marketing information systems (MIS) suffered from inadequate financing, failure of officials to gather solid market data and refusal of traders to give information because of fear of tax. However, Marketing Information System (MIS) is one way of increasing market transparency in most developing countries. Also, with liberalized markets, market transparency plays a vital role for effective marketing decision making. It can be characterized as the level of information that value chain actors have about issues pertinent to their decision making (Tollens, 2006). According to Badiane, & Kherallah, (2012), numerous rural farmers were undermined, ignorant of the advancement of prices with market liberalization. In Sub Saharan Africa, Marketing Information System (MIS) was set up to adjust asymmetries created by economic liberalization.

### **2.3 Supply of Agricultural Marketing Information Services in Ghana**

Different kinds of AMITs include mobile phone calls, SMS, radio and television programs, e-mails and internet blog. Larger number of farmers who could not be reached by organizations, institutions and other business entities can now be reached through various available AMIT services provision.

In Ghana, radio and television are essential tools in information dissemination. For instance, about 25% of Ghanaians have access to and watch television from time to time (IMP, 2013). Demonstrations on new practices and improved varieties can be recorded and showed to farmers on the television by extension officers. Programs such as the Wienco weather report, educate farmers on weather changes and crop production.

According to Chhachhar, Hassan, Omar and Soomro, (2012) reliance of farmers on television for marketing information is very low. They further explained that most farmers are not inspired to seek agricultural information from television because such programs are not broadcasted at the appropriate time.

Mobile services are in use in the field of agriculture for sharing and obtaining information. In most developing part of the world, there are programs that provide farmers with research and marketing information via text messages. Among these AMIT components, the mobile phone is the most commonly used because it allows information exchange at a lower cost as compared to others (Houghton, 2009). The use of mobile phones has significantly been on the rise over the years. As network coverage spread out and prices drop, mobile phone usage intensifies. As of 2010, mobile phone subscription was over 3.8 billion and about 68% penetration rate in Africa. Mobile telecommunications offer a better support for rural agricultural development. Its use can

act as a channel to relay important information to smallholder farmers who cannot easily access information through current extension services (Furuholt, 2011).

The radio and internet communication technologies also contribute significantly to information diffusion in Ghana. Currently, there are about 286 FM stations and 100 internet service providers in Ghana (NCA, 2012). The use of the internet in the global market to acquire specific information in order to limit uncertainties in decision making is more widespread in developed countries. (Sekabira, 2012). Better information exchange and efficient decision making among farmers is enhanced by availability and usage of modern AMITs.

#### **2.4 AMITs Service Providers in Ghana**

Several interventions aimed at sustainable agricultural information dissemination to increase farmer performance have been introduced in Ghana, and this includes the establishment of AICs, E-commerce project, e- Agriculture under the WAAPP, Esoko and Farm radio. The examples include the following initiatives:

The West Africa Agricultural Productivity Program (WAAPP)

The WAAPP was initiated by The Economic Community of West African States (ECOWAS) and was proposed to last for ten years, which ended in 2017 and was funded by the world bank. The first phase which started in 2007 to 2012 involved three (3) African countries (Ghana, Mali and Senegal) and the second face was carried out in thirteen (13) West African countries. A review of the WAAPP I identified several successes achieved. However, it found out that there was the inadequacy of resource allocation for technology dissemination and adoption activities and this led to the inclusion of technology dissemination by the Directorate of Agricultural

Extension Services (DAES) in 2010 (MoFA, 2012). The objective of WAAPP is to establish and speed up the adoption of improved technologies in agriculture led to the creation of a common web portal that allows communication and information flow among farmers, researchers and agribusiness extension workers. Illiterate farmers in the rural areas access agricultural information through FM stations and the TV where agriculture-related programs are broadcasted in their local languages extensively. The WAAPP is currently using mobile phones as a channel for crucial information delivery to rural farmers.

#### The E-commerce Project

As part of a national plan to reinforce the marketing of agricultural produce, the Directorate of Agricultural Extension Services, MoFA introduced the E-commerce project in 2002, with the assistance of the International Institute of Communication and Development (IICD) (MoFA,2002). The project was phased in 2006. Computers were made available in district assembly offices to give farmers the opportunity to buy and sell goods and services online. The project was established to significantly provide a cost-effective communication to farmers and small-scale entrepreneurs and also to balance farmer-extension officer ratio in the country. It was to enable users of the online services to easily access current market information and consequently improve their negotiation position. (MoFA, 2002).

The district agricultural officer, a renowned farmer, a representative from a farmer group or an agricultural-based NGO operating in the area and two representatives each from the district assembly and the traditional authority, formed the team responsible for the management of the project. To ensure long-term sustainability, the project was carried out in partnership with the

district assemblies at the community level where the assemblies contributed financially towards the sustenance of the project.

#### mFarm Platform

The mFarm is a wireless mobile phone application and internet-based platform to send and receive data, for monitoring the activities of field agents and farmers to collect data on direct sales, monitoring of operations stocks with the use of mobile phone. The platform was developed by Image-AD Limited to assist IFDC in the implementation of their project. The launch took place in 2012 in Tamale (IFDC, 2012). The platform allows organization, association and identifiable groups to offer support to members scattered around the operational areas. The platform is made up of mobile Application. (Java and Android and web application).

The platform is specialized in production and planning, verification of adherence to production techniques and schedules, extension messages through text messages and interactive voice response services and estimation of production cost. The mFarm synchronizes with modules developed on the platform using APIs. It uses search and query facility to find the location of beneficiaries with ease.

Through the project "Linking Farmers to Markets (FTM)", the international Fertilizer Development centre (IFDC) is increasing farmers' incomes by developing linkages with traders to specifically deal with the issue of poor farmer-to-market linkages. The project uses mobile phones to support farmers with technical information. The Northern and Eastern regions have been mapped as areas for the mobile platform (IFDC, 2012).

## Farm radio

The radio has been spotted as one of the effective tools for agricultural information dissemination to supplement agricultural extension in Ghana. 20 radio stations in the Northern, Upper East and Upper West Regions are being supported by USAID under its “farm radio” program to promote best agricultural practices for farmers through radio programming. Resource persons from the Ministry of Food and Agriculture (MoFA) and some agricultural Research Institute are linked to these radio stations where they lead discussions relevant to agriculture. During such discussions, audience farmers participate by phone-ins to ask questions or take part in discussions.

## **2.5 Empirical Studies on Factors of AMITs Adoption**

AMITs adoption strengthens the effort of extension work in Ghana. Agricultural extension is supplied free of charge through face-to-face delivery of technical information to farmers (Asogwa, Ezihe and Ogebe, 2012). Radio, TV and mobile phone used as AMITs and the messages transmitted through them can be expensive to the farmers and therefore, those who are poor cannot afford it (Diirro, 2013). Most smallholder farmers are poor and may not adopt the use of AMITs regardless of its significance in productivity improvement (Sekabira, 2012). Farming activities is concentrated mostly in the rural areas where AMITs are not common. Dziwornu (2013) opines that farmers who are willing to adopt AMITs may not have access due to problems of proximity. For instance, Agricultural Information Centres (AICs) were established to provide agricultural information to farmers in Ghana. However, these centres were located in the District capitals making access to these facilities difficult for farmers living in

remote areas (Dziwornu, 2013). Simply introducing ICTs does not necessarily guarantee that farmers will automatically start using them.

Agricultural training and education have a direct impact on agricultural productivity and performance, but literature has it that most farmers only have access to primary education in Africa (Aneani, Anchirinah, Owusu-Ansah, & Asamoah, 2012). According to Baumüller (2012), for a user to get access to a technology, awareness of the existence of the technology, potential risk and ability to finance such technology are required. Farmers must be able to use the technology without much constraints. A study of maize adoption in Tanzania showed that more extension contacts was highly significant in influencing the adoption of improved seeds (Kaliba, Verkuijl, & Mwangi, 2000).

There is evidence that imperfect knowledge of the agricultural innovation as a barrier decrease with experience. Also, farmers may learn from their colleagues who are already using the new technology (Foster and Rosenzweig, 1995). Challenges that some farmers from rural communities' face are the delay or obstruction of mobile application due to language barrier and illiteracy. It was reported in Ghana (Frimpong, Asare, & Otoo-Arthur, 2016) and (Rashid, & Elder, 2009) that lesser extent of SMS usage by farmers was due to a higher rate of illiteracy.

A study conducted by Chi & Yamada (2002) in Japan discloses that farmers have a positive perception towards new technology in agriculture, but many factors may limit their adoption to these new technologies. According to them, age is one of these major limiting factors. Their findings show that most young and well-educated farmers adopt new technology in farming as compared to their old and conservative counterparts who believe in their own past experiences. These old farmers, they say are reluctant to accept new technology because they do not believe it ensures high yield as they are being told and as a result are unwilling to adopt them. According

to Falola and Adewumi (2012), the age of household head is negatively correlated with mobile usage, as one would expect younger farmers to be more familiar with mobile telephony, although it may be the households with older heads that are better able to afford them.

Several factors have been identified by researchers on the determinants or factors that influence the intensity of adoption of agricultural marketing information tools (AMITs). Fawole (2008) found out that among pineapple farmers in Nigeria, four demographic characteristics (age, sex, marital status, and education) had an influence on farmers' marketing source of information system. He also indicated that they are more likely to source and use marketing information system as farmers' education level improves. Radio and newspapers were the main tools used for assessing marketing information by the farmers.

Oyesola and Obabire (2011), also found out that farmers' main sources of information were radio, extension officers, television, newspapers, farmer organization, colleagues and relatives. Farmers were motivated to purchase and use the tools during marketing of harvested produce because of their relatively higher levels of education. They could appreciate the importance of these tools in marketing because they could understand the information that was provided.

Also, a study by Ali and Kumar (2011) in India, however, revealed that respondent's level of education, income, land size holding, and social category influenced access to AMITs use on farmers' decision-making ability. In the study, the farmers who used AMITs for marketing information had superior decision-making abilities throughout the agricultural supply chain. The findings of Senthilkumar, Chander, Pandian, & Kumar, (2013) also showed that farmers access and use of AMITs is significantly influenced by farmers' education, land holding, income and land size.

The research by Kiiza and Pederson (2012), showed that farmers' access to AMITs on marketing information is positively influenced by farmers' access to microfinance loans, membership to farmers' associations and government awareness campaigns. However, distance to the trading centres and sex negatively affected the likelihood of accessing information using AMITs. Female-headed households were less likely to access information using AMITs as compared to the male counterparts.

However, in 2014, in Kenya, Ogutu, Okello, & Otieno, (2014) later evaluated farmers' decision to participate in AMIT projects in three (3) districts namely; Kirinyaga, Migori and Bungoma. The study found out that among the three districts, Bungoma had the highest proportion of farmers participating in the AMIT projects and this was due to the presence of Kenya Agricultural Commodity Exchange (KACE) which is an AMIT provider in the region. They further argued that, the probability of participating in AMIT services is largely influenced by age, the number of crops grown, group membership prior to the project, land size owned and ownership of mobile phones.

According to the study conducted by Mahaliyanaarachchi (2003) in Sri-Lanka, it is indicated that there was a positive correlation between farm gate prices and market information system on existing markets, quality, quantity and wholesale price. This implies that a great positive relationship exists between marketing information system and farm gate prices. The author established that farmers can organize their production and marketing practices if they have day-to-day price information for making marketing decisions. The works of Naidoo and Rolls (2000) in Mauritius on the adoption of agricultural marketing information by smallholder farmers

suggested that the farmers managed market information system as a production resource. Mwombe, Mugivane, Adolwa, & Nderitu, (2014) also studied the use of AMITs, as a source of marketing information for farmers in Kenya. Their study revealed that age, gender, income and size of banana farm had an influence on the use of ICT tools.

Good access to information by extension contacts, group membership, number of years in farming, number of years in using market information tools (radios, phones, televisions) influenced food farmers' market information system and likelihood for selling at farm gate without a contract; according to Chogou, Lebailly, Adégbidi, & Gandonou, 2009) who worked on the topic 'impact of public marketing information system on farmers' food marketing decisions in Benin. They, however, argue that farmers often accessed reliable marketing information from social networks, but, is unlikely to be obtained from government supported market information systems. The study though reinforced the importance of social networks but never indicated the channels of information and their usefulness in accessing of market information systems.

A study on agricultural market information systems was conducted in Turkey by (Demiryurek, Erdem, Ceyhan, Atasever, & Uysal, 2008). The results indicated that the frequently accessed of an agricultural marketing information system by farmers enhanced their income. They were able to keep more European breeds and obtain more milk yield per cow.

There are some constraining factors affecting the adoption of AMITs. According to Barrett and Carter (2013), in many developing countries, in spite of agriculture market information system importance, market participation is constrained by lack of access to marketing information

system. Poor access to market information system in markets impedes participation by some farmers due to problems such as moral hazard and poor selection which increase transaction costs. (Omamo, 1998; Fafchamps and Hill, 2005; Shiferaw *et al.*, 2008). For most African countries, Makhura (2001) stated that several challenges face smallholder farmers in accessing marketing information tools in their market participation. These include illiteracy and related problems, poor infrastructure in rural and weak institutions, low availability of AMIT services, lack of access to agricultural education from extension contacts, time-consuming in using the AMITs and the high costs involved in production and marketing information. Dorward, Kydd, Morrison, & Poulton, (2005) suggested that some farm business or organization collapses or fails due to high transaction costs of market information tools such as mobile phones, internet/web-based platforms, and video, radio and television which abridge the exchange process and block market participants from investing in complementary services. Thus, attempts to improve smallholder farmers' access to agricultural marketing information system have been concentrated and encouraging. These interventions are progressively utilizing mobile phones, televisions, radios, internets as an example of ICT-based technologies as the channel for transferring information to farmers (Tollens, 2006; Okello *et al.*, 2010).

Some constraints to AMITs are identified to be market access and infrastructure, trouble in handling information generated, inability to read and understand the information received in other to know the mode of delivery of information. A survey by Ferris and Robbins (2004) in East Africa to develop market information showed that agricultural markets are portrayed by a long channel of transactions between farmers and consumers, lack of competition between traders, and poor access to proper market data.

Aker (2010) demonstrated that smallholder farmers are limited to market access largely because of the absence of information tools. Bibangambah (2002) also found out that lack of access to AMITs such as phones, radio and TV used to facilitate timely information of marketing of agricultural goods and services were major constraints to AMITs.

## CHAPTER THREE

### METHODOLOGY OF THE STUDY

#### 3.1 Introduction

This chapter of the study is made up of theoretical and conceptual frameworks, the methods of analysis and method of data collection. It ends with the scope and limitations of the study.

#### 3.2 Theoretical Framework

Farmers' adoption of agricultural innovation is a result of their individual decision-making processes, where marginal benefit of the technologies is expected to exceed marginal cost (Foster and Rosenzweig, 2010). Therefore, in deciding to adopt a technology, farmers seek to maximize their expected utility. The decision to adopt a new technology occurs when the expected utility of adoption  $U_a$  exceeds the expected utility of non-adoption  $U_n$ . The parameters of this decision are generally not observed, but are defined by a latent variable,  $U_i$ . This latent variable  $U_i$  is a function of a set of personal, (e.g., education and access to information) behavioral, (e.g., risk aversion and overconfidence in management) and social characteristics of the farmers.

$$\text{Mathematically, } U_i^* = \beta X_i + e_i \quad I = 1, 2, \dots, N \quad (3.1)$$

The parameter  $\beta$  is a vector that shows the effect of  $X_i$  factors on the likelihood of adoption of the technology or technologies and  $e_i$  is the error term of the equation.

Farmers decision to adopt a technology is of a binary nature (Baffoe-Asare, Danquah, & Annor-Frempong, 2013), hence qualitative response regression models can best be used to analyze such decisions. Probit and Logit regression models are preferred over the linear probability model when analyzing farmers adoption decisions. This is because the linear probability model is very

susceptible to heteroskedasticity and therefore not able to fit the predicted values between 0 and 1, which gives way to unrealistic values (Stock and Watson, 2007). The binary logit model can be used for analyzing the farmer's adoption decisions. It is specified by (Stock & Watson, 2007) as:

$$\Pr(Y = 1 / X_1, X_2, \dots, X_k) = \Phi(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k) \quad (3.2)$$

Where Y which is the dependent variable is binary and  $\Phi$  is the cumulative standard normal distribution function.  $X_1, X_2, \dots$ , are the regressors.  $\beta_0, \beta_1, \dots$ , are the coefficients to be estimated. The binary logit model however is appropriate for only two alternative choices.

Where the alternative choices of the farmers adoption decision are more than two, the multinomial logit model is preferred instead. For this study, farmers are presented with eight unordered agricultural marketing information tools: no tool used (0), mobile phone only (1), radio only (2), and TV only inorganic fertilizer (3), Phone and Radio (4), Phone and TV (5), Radio and TV (6), and Phone and Radio and TV (7). We estimate an unordered Multinomial Logit Model (MNL) to assess the determinants of farmers' choice of AMITs. The multinomial logit model has each farmer  $i$  faced with  $j$  alternatives from the population random draw,  $(x_i, y_i)$ . Even though each farmer receives some level of utility from each alternative, they would invariably choose the alternative that maximizes their utility. Wooldridge (2002) expresses the MNL as:

$$P(y = j|x) = \frac{\exp(x\beta_j)}{[1 + \sum_{h=1}^J \exp(x\beta_h)]}, j = 1, \dots, J \quad (3.3)$$

Where  $y$  denotes a random variable which takes on the values  $\{0, 1, \dots, J\}$  for  $J$ , a positive integer.  $X$  denotes a set of conditioning variables. For this study,  $y$  denotes the alternative tools and  $x$  contains the farmer characteristics. Since the probabilities must sum up to unity, we are able to determine  $P(y=0|x)$  once we know the probabilities for  $j=1, \dots, J$ . From the multinomial logit test, we assume that the Independence of Irrelevant Alternative (IIA) holds for equation 1. If a particular farmer derives maximum utility from a particular tool, the addition of one more alternative or otherwise would not affect that farmer's choice.

The effect of adoption of AMITs was measured based on the farmer's income. One of the problems in assessing the effect is finding comparable groups of treated and control groups (i.e. adopters and non-adopters of AMITs). Ravallion (2003) asserted matching econometrics provides a good tool to do that while estimating the average treatment effects. Hagos, Jayasinghe, Awulachew, Loulseged, & Deneke, (2008) also asserted that matching is a method widely used in estimating the average treatment effects of a binary treatment on a continuous scalar outcome and it used non-parametric regression procedure to construct the counterfactual based on the assumption of selection on observables. Food crop farmers adopting AMITs are treatment group and non-adopters are the control group. The propensity score matching aims to match the treated and control group farmers with similar observable characteristics in order to estimate the effect of adoption as the difference in the mean value of the outcome variable.

Following Hagos *et al.*, (2008), let  $Y_1$  be the total food crop income when a farmer  $i$  is subject to treatment ( $C=1$ ) and  $Y_0$  be the total food crop income when a farmer  $i$  is exposed to the control ( $C=0$ ). The observed outcome therefore becomes:

$$Y = CY_1 + (1-C)Y_0 \tag{3.4}$$

$Y_1$  is observed when  $C=1$ ; and  $Y_0$  is observed when  $C=0$ . The average effect of treatment on the treated (ATT) is to be identified and it is defined as:

$$ATT = E(Y_1 - Y_0 | C = 1) = E(Y_1 | C = 1) - E(Y_0 | C = 1) \quad (3.5)$$

Unlike the observed  $E(Y_1 | C = 1)$ ,  $E(Y_0 | C = 1)$ , cannot be observed since it is not found in the data. This problem can be solved by creating the counterfactual  $E(Y_0 | C = 1)$  by matching the treatment and the control farmers. Certain assumptions must be met for matching to be valid and the fundamental assumption underlying matching estimators is the Conditional Independence Assumption (CIA). Conditional Independence Assumption states that adoption decision is random conditional on observed covariates  $X$ ;

$$(Y_1, Y_0) \perp C | X \quad (3.6)$$

The assumption implies that the counterfactual outcome in the treated group is the same as the observed outcomes for control group;

$$E(Y_0 | X, C = 1) = E(Y_0 | X, C = 0) = E(Y_0 | X) \quad (3.7)$$

The assumption rules out of the selection into the programme based on unobservable gains from adopting. The Conditional Independence Assumption requires that the set of  $X$ 's should contain all the variables that jointly influence both the outcome of non-treatment and treatment. The average treatment effect, ATT can be computed under the CIA as follows:

$$ATT = E(Y_1 - Y_0 | X, C = 1) = E(Y_1 | X, C = 1) - E(Y_0 | C = 1) \quad (3.8)$$

Rosenbaum and Rubin (1983) argue that instead of matching along  $X$ , one can match along  $P(X)$ , a single index variable that summarizes covariates. This index is known as the propensity score and it is used to overcome the curse of dimensionality arising from too many dimensions of the covariates making matching of farmers based on observed covariates undesirable or not feasible.

The propensity score (response probability) is the conditional probability that farmer  $i$  adopts AMIT given covariates:

$$p(X) = \text{pr}(C=1) | X \quad (3.9)$$

Equation 10 can then be written as:

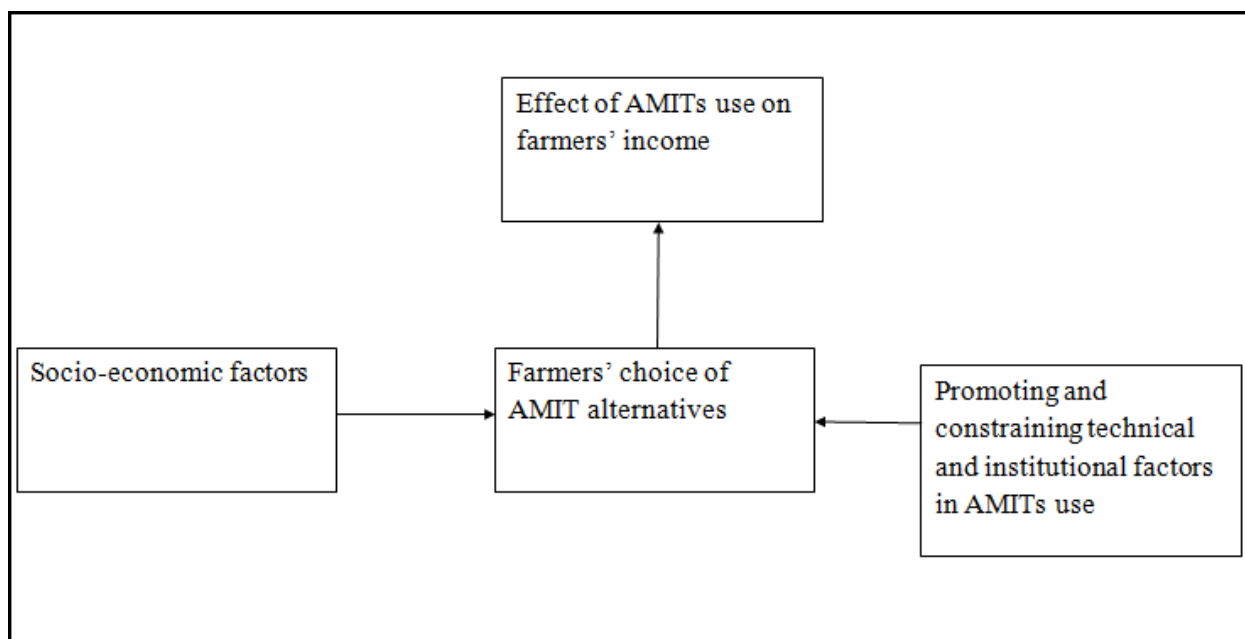
$$ATT = E(Y_1 | P(X), C=1) - E(Y_0 | P(X), C=1) \quad (3.10)$$

The propensity score is estimated by a simple binary regression model. According to Caliendo and Kopeinig (2005), for a binary treatment case, the probability of adoption versus non-adoption is to be estimated, the logit and probit models usually yield similar results. The binary probit regression model will be employed in this study. Hagos *et al.*, (2008) suggested that since the propensity score is a continuous variable, exact matches may rarely be attained and certain distances between the treated and untreated farmers should be accepted. They proposed that in order to solve this problem, the treated and non-treated farmers should be matched on the basis of their scores using either nearest neighbour, kernel and radius matching estimators. These three methods identify for each farmer the closest propensity score in the opposite intervention status and then estimates the technology adoption impact (in this case AMITs adoption) as the mean difference of farmers' income between each pair of matched farmers.

### 3.3 Conceptual Framework

The major objective of the research is to assess the impact of AMITs on maize farmers' income. Farm income has been linked to personal characteristics of AMIT adopters, characteristics of the AMITs themselves and the institutional environment that facilitates access and sustainable use (Figure 3.1). The assumption is that AMIT is a market good. The choice of a particular AMIT alternative in the Akwapim South district by maize farmers would come with some associated

cost and benefits to the farmers. Therefore, the farmers' decision to choose a particular AMITs alternative will depend on the farmers level of income. Some of the alternatives might be expensive to adopt. Farmers' would consider the intensity of use of AMITs after they have first adopted it. A farmer may want to go ahead and use a particular tool after becoming aware of any of the various tools. However, the number of tools the farmer may want to use is another huddle for the farmer.



**Figure 3.1: Conceptual Framework of the Study**

Source: Author's own conceptualization of the study, 2018

The AMITs adoption decision of farmers is influenced by socio-economic factors such as gender, age, farmers' educational level, marital status, household size. The institutional factors that affect AMITs adoption are the access to credit, extension contact and farmer-based organization among others. These factors affect the choice of tools for the farmer. There are some constraints associated with the use of the various tools that are highlighted for adopters of AMIT. Mobile phones for instance could be expensive for a farmer to buy, farmers may not be

able to use the internet, the telecommunication network is usually not reliable, high illiteracy level of farmers, low availability of AMIT services in the district and information generated by AMITs is difficult to access. Figure 3.1 therefore shows the important linkages needed to understand the impact of AMITs on maize farmers income.

### 3.4 Method of Analysis

#### 3.4.1 Constraints in the use AMITs

A list of constraints validated by farmers were tested and ranked according to order of importance using the Kendall's coefficient of concordance. These included; internet use is cumbersome; low availability of AMIT services in the district; network is bad (erratic) and therefore the use of AMITs is time-consuming; high illiteracy level of farmers; AMIT (mobile phone) use is expensive; and information generated by AMITs is difficult to access.

The Kendall's coefficient is specified as (Legendre 2005):

$$W = \frac{12S}{p^2(n^3 - n) - pT} \quad (3.11)$$

- n= Number of problems ranked
- S= sum of squared deviation
- T= correction factor for tied.
- p= the number of judges

W = 1, represent a perfect agreement, W = 0, represent no agreement and Intermediate values of 'W' indicate a greater or lesser degree of unanimity among the various responses.

Hypothesis and Significant Test for w (F-Test) is also carried out:

Ho: There is no agreement among the rankings of the constraints by the farmers.

H<sub>a</sub>: There is an agreement among the rankings of the constraints by the farmers.

Where; Ho and H<sub>a</sub> denote null and alternate hypothesis respectively.

### 3.4.2 Determinants of choice of Agricultural Marketing Information Tools in the ASM

The multinomial logit model was used to identify the determinants of choice of agricultural marketing information tools. Following Alem, Beyene, Kohlin, & Mehonnen, (2016), the empirical specification of the multinomial logit model is given as:

$$\begin{aligned}
 Y_{ji} = & \beta_0 + \beta_1 Gender_{ji} + \beta_2 Age_{ji} + \beta_3 Education_{ji} + \beta_4 FarmSize_{ji} \\
 & + \beta_5 AMITAwareness_{ji} + \beta_6 TransportCost_{ji} + \beta_7 FBO_{ji} + \beta_8 Extension_{ji} \\
 & + U_{ji}
 \end{aligned} \tag{3.12}$$

$Y_{ji}$  = AMIT alternatives

$\beta_1 - \beta_8$  = coefficients of explanatory variables

$\beta_0$  = constant term

$U_{ji}$  = error term

Description of variables:

The variables selected, description and how they were measured are presented in Table 3.1. The aprior expectations are also shown.

**Table 3.1 Description of regression variables, measurements and expected signs**

<b>Variables</b>	<b>Measurement</b>	<b>A priori expectation</b>
<i>Dependent</i>		
Alternative tools	Choice of AMITs (0=No tool used, 1= mobile phone, 2= Radio, 3= TV, 4= Phone and Radio, 5= Phone and TV, 6=Radio and TV, and 7= Phone and Radio and TV)	
<i>Independent</i>		
Gender	Dummy (1 if male and 0 otherwise)	+
Age	Age of farmer in years	-
Years of Schooling	Number of years of formal education	+
Farm size	Size in acres	+/-
AMIT Awareness	Dummy (1 if farmer has knowledge in AMIT and 0 otherwise)	+
Transport cost	Amount incurred in transporting goods to market in (GH ¢)	-
FBO Membership	Dummy (1 if farmer is a member of an FBO 0 otherwise)	+
Extension contact	Dummy (1 if received extension and 0 otherwise)	+

Source: Author's own conceptualization of the study, 2018

### 3.4.3 Determining the extent to which AMITs adoption affect income of maize farmers

The propensity scores matching procedure was employed to determine whether the use of AMITs affect the income of farmers. Following Barnard and Nix (1973), Net Farm Income is measured as Gross Revenue less Total Cost (Variable + Fixed Cost).

$$NFI = GR - TC(\text{Variable} + \text{Fixed cost}), \text{ where } GR = (P * Q)$$

*Where, GR = Gross revenue, TC = Total cost, P = Price,*

*Q = Quantity of maize produced, NFI = Net farm income*

The common support condition; sensitivity analysis; and the testing of the balance of propensity score and covariates were also determined.

### Hypothesis Testing of the Regression Analysis

The main hypothesis of the regression is presented. These include the main hypothesis of the regression analysis. The decision rule of the hypothesis is also given.

$$H_0 : \beta_i = 0$$

$$H_A : \beta_i \neq 0$$

Null hypothesis ( $H_0$ ): The explanatory variables individually have no significant effect on the choice of the various Agricultural Marketing Information Tools.

Alternative hypothesis ( $H_A$ ): The explanatory variables individually have significant effect on the choice of the various Agricultural Marketing Information Tools.

### **Validation of Hypothesis**

The z-test is employed to validate the main hypothesis of the regression analysis. For individual hypothesis, the z-statistic is computed as:

$$Z_{stat} = \frac{\beta_i}{SE(\beta_i)} \quad (3.13)$$

Where z is the test statistic, SE is standard error and  $\beta_i$  are the coefficients of the explanatory variables.

If the z-statistic is greater than the critical value or significant at 1%,5% or 10%, then we reject the null hypothesis. Otherwise, we do not reject the null hypothesis.

## **3.5 Method of Data Collection**

### **3.5.1 Sources of data**

The study employed primary data. This was obtained from the field survey using a well-structured questionnaire administered to farmers in the study area. It consisted of questions on the socio-demographic characteristics of the respondents, farm characteristics, and adoption of AMITs in accessing marketing information as well the constraints to the use of AMITs in accessing marketing information.

### **3.5.2 Sampling procedure for primary data collection**

The sample size table for determining sample size from a given population proposed by Krijcie and Morgan (1970) was employed to select the respondents in the study area, Akwapim South Municipal. According to the Ghana Statistical Service population census (2010), the district has about 5,213 people engaged in farming. Using the sample size table Krijcie and Morgan (1970)

the required sample for the study was between 357 and 361. However, the study sampled a total of 420 maize farmers to cater for non-response and inaccurate data.

The population for the study was all farmers cultivating maize in the Akwapim South Municipal. The study employed the multi-stage sampling technique which involved three stages. In the first stage, three communities (Aburi, Nsakyee and Pokrom) were purposively selected because they were predominantly maize farmers in the Akwapim South Municipal. The simple random sampling technique was then used to select the respondents in the communities yielding a sample size of 420.

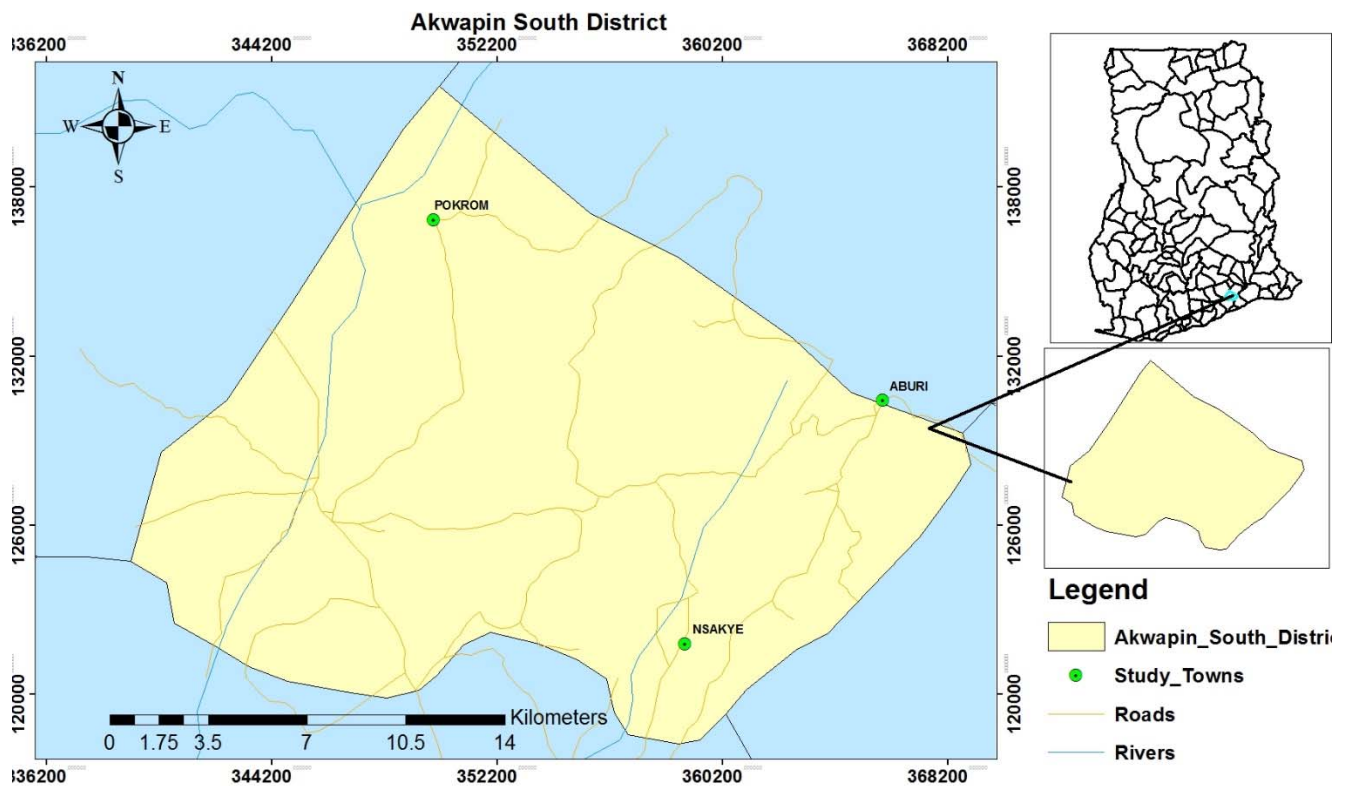
### **3.5.3 Description of the study area**

The study area was the Akwapim South Municipal in the Eastern region of Ghana. The district capital is Nsawam. The district was upgraded to a municipality in 2008. The municipality is located at the eastern corridor of the Eastern Region of Ghana which lies between latitudes and longitudes 5.45°N and 5.58°N and 0.0°W respectively. The municipality covers about 224.13 km<sup>2</sup> land area and shares borders with Nsawam-Adoagyiri Municipality to the West, Kpone-Katamanso District to the South-east, the Ga-East District to the south and Akwapim North Municipality to the North-east. The weather condition in the district is generally cold experiencing an annual temperature of 24°C averagely recorded between the months of March and April. The lowest temperature of 20°C, however, is recorded in the month of August. The municipality experiences a bimodal rainfall pattern with an average rainfall between 125cm and 200cm. The geology of the municipality is mainly sedimentary rocks. Agricultural products such as fruits (mainly pineapple, mangoes and citrus), food crops (including maize, cassava, plantain and vegetables) and livestock (including poultry, goats, pigs, cattle). The municipality has a population

of about 37,501 persons with males and females constituting about 49% and 51% respectively (GSS, 2010).

About 51.2% of the population, 12years and older own mobile phones. About 8.0% and the population 12years and older use internet facility. The proportion of household having access to desktop or laptop computers is 7.3% which is close the regional average of 7.5% (GSS, 2010).

Marketing activities in the area mainly involve agricultural produce.



**Figure 3.2: Map of Akwapim South**

Source: Department of Geography, University of Ghana (2018)

### **3.6 Scope and Limitation of the Study**

The study was carried out in the Akwapim South municipality of the Eastern region. Since effect of technology adoption is influenced by demographic, environmental and economic factors, the findings of the study may not fully represent farmers in other areas. Agricultural marketing technology adoption like AMITs, may not have only income effects but may involve other livelihood aspects of farmers. Due to this constraint, the study is limited to the impact of AMITs on maize farmers in the study area.

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSIONS**

#### **4.1 Introduction**

This chapter presents the results and discusses the study. First, the results on the socio-economic characteristics of the farmers sampled for the study are presented. Next, the results on the determinants of choice of Agricultural Marketing Information Tools is presented and discussed. Finally, the PSM results on the extent to which adoption of AMITs improved maize income of farmers is presented and discussed.

#### **4.2 Socio-economic Characteristics of Respondents**

Table 4.1 presents a distribution of gender, age, educational background, marital status, household size, membership of farmer-based organization, farming experience, farm size, extension contact and income of the respondents. There were more males than females of the sampled farmers. Males formed 52.4% while females formed 47.6%. The average age of the farmers was 49.7 years with a standard deviation of 20.3 years with standard deviation of 20.3. About 21.7% of the farmers had no formal education. The percentage of farmers who had basic education was 52.6% and 13.8% had secondary education. The percentage of farmers who had tertiary education was 11.9%.

The percentage of farmers who were married was 82.4% and those who were single represented 14.3%. About 2.6% were either divorced or separated and 0.7% of the farmers were widowed. The mean household size of the farmers was 4.7. The percentage of farmers who were members of an FBO was 32.9% while 67.1% were not members of an FBO. The average farm size of farmers in Akwapim South was 4.6 acres. The average farm experience of farmers was 18.8 years.

About 52.4% of the farmers had contact with extension officers while 47.6% did not have any contact with extension officers.

**Table 4.1: Socio-economic characteristics of respondents**

Variable	Category	Frequency	Percentage
Gender	Male	220	52.4
	Female	200	47.6
Age (years)	20-40	123	29.3
	41-60	213	50.7
	Above 60	84	20.0
	<b>Mean = 49.7</b>	<b>SD = 20.3</b>	
Educational Level	None	91	21.7
	Basic	221	52.6
	Secondary	58	13.8
	Tertiary	50	11.9
Marital Status	Married	346	82.4
	Single	60	14.3
	Divorced/Separated	11	2.6
	Widowed	3	0.7
Household Size (number of persons)	1-3	88	21.0
	4-6	272	64.8
	7-10	60	14.2
	<b>Mean =4.7</b>	<b>SD =3.2</b>	
FBO Membership	Yes	138	32.9
	No	282	67.1
Farm Size (acres)	Less than 5	240	57.1
	5-10	161	38.3
	11-15	12	2.9
	Above 15	7	1.7
	<b>Mean = 4.6</b>	<b>SD = 3.7</b>	
Farm Experience (years)	Below 10	110	26.2
	10-20	170	40.5
	21-30	60	14.3
	Above 30	80	19.0
	<b>Mean = 18.8</b>	<b>SD = 9.6</b>	
Extension Contact	Yes	220	52.4
	No	200	47.6

Source: Field survey, 2018

### 4.3 Various Marketing Information Tools Used by Farmers

The study identified three different types of AMIT mostly used by farmers. It was observed that some farmers were using more than one tool. About 24.29% of the farmers were not using any tool to access information. About 7.14% used only mobile phone, about 11.43% also used radio and 5.95% used television only to access marketing information. The percentage of farmers who used both mobile phone and radio was 6.67% while about 3.57% of farmers used phone and television to access information. The percentage of farmers who use radio and television was about 8.33 while about 32.62% used all the tools for accessing agricultural marketing information. Table 4.2 shows the frequency and percentage use of the different types of AMITs by farmers. The three most used tools are Phone and Radio and TV; Radio only; and Radio and TV. These tools are very common among farmers in the study area.

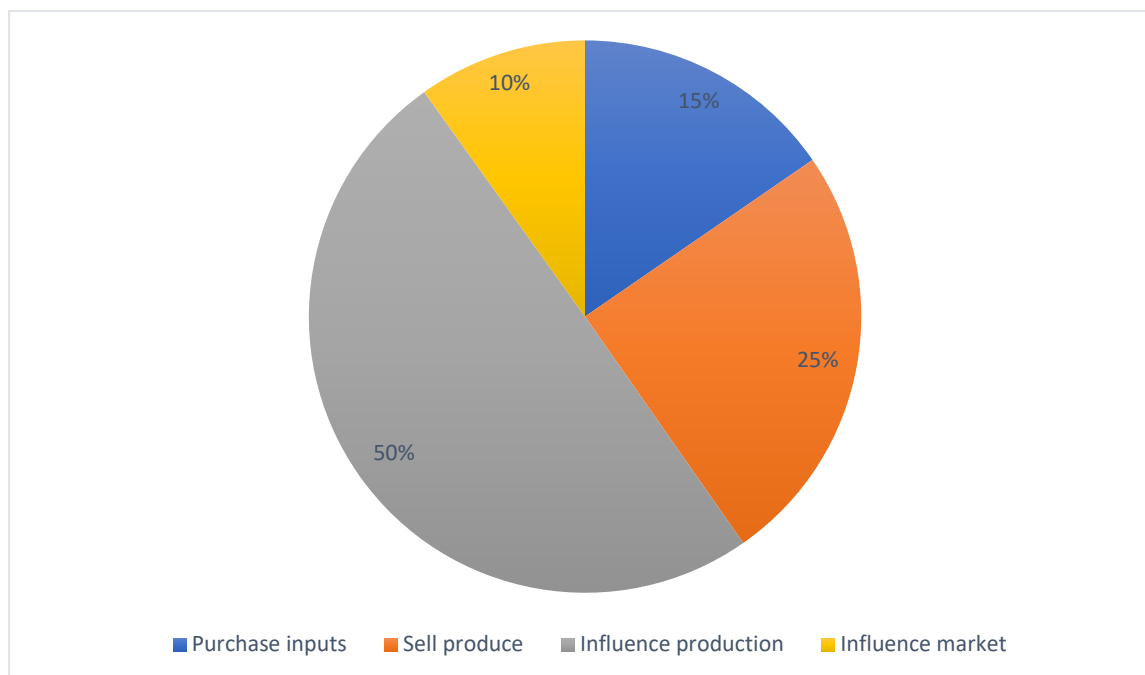
**Table 4.2: Farmers' usage of various AMIT**

Type of tools used	Frequency	Percent
No tool used	102	24.29
Mobile phone	30	7.14
Radio	48	11.43
TV	25	5.95
Phone and Radio	28	6.67
Phone and TV	15	3.57
Radio and TV	35	8.33
Phone and Radio and TV	137	32.62
Total	420	100

Source: Field survey, 2018

#### 4.4 Benefits of AMIT to farmers who use them

Farmers who had access to the various tools used them for accessing agricultural marketing information which was very useful in achieving a lot of purposes. This however influenced their income. About 15.4% of the farmers used the tools to purchase inputs timely. About 24.9% used the tools to sell their produce in a more demanding market. About 49.8% of farmers used the tools to influence production. Marketing information received was used to make informed decision on their production regarding what to produce and how much of it should be produced. About 9.9% of the farmers used the information to influence selected markets to sell their produce. Information received is used by farmers who use AMITs to select which market to sell produce to get a good price. Farmers who did not use AMITs cannot have such opportunity. They usually would sell in markets closer to them to reduce transportation cost. This might not necessarily impact positively on their farm income. Figure 4.3 presents the distribution of benefits of AMIT to farmers.



**Figure: 4.3: Benefits of AMITs to farmers who use them**

Source: Field survey, 2018

#### **4.5 Constraints Facing Farmers**

The use of AMITs in accessing marketing information just like any other technology is not devoid of barriers. The study sought, therefore, to find out about some of the constraints to the use of the AMITs in accessing marketing information by farmers and the result is presented in Table 4.3. The result indicates that the cumbersomeness in the use of internet poses the major constraint to the use of AMITs as about 61% and 28% of the farmers strongly agreed and agreed respectively with a mean score of 1.5. Also, the second most pressing constraint to the use of AMITs in accessing marketing information is the low availability of AMIT services in the district as 60% and 19% of the farmers agreed and strongly agreed with a mean score of 2.1. Again, the third constraint to the use of AMITs in accessing marketing information is farmers unable to read and understand the information received as about 32% and 25% strongly disagreed and disagreed respectively with a mean score of 3.5.

**Table 4.3: Constraints to the use of AMITs in accessing marketing information**

Constraints	1	2	3	4	5	Mean Score	Rank
Internet use is cumbersome.	258 (61.4)	119 (28.3)	38 (9.0)	5 (24.3)	0 (0.0)	1.5	1st
Low availability of AMIT services in the district.	78 (18.6)	252 (60.0)	67 (16.0)	21 (5.0)	2 (0.5)	2.1	2nd
Network is bad(erratic) and therefore the use of AMITs is time-consuming.	132 (31.4)	26 (6.2)	21 (5.0)	102 (24.3)	139 (33.1)	3.2	3rd
High illiteracy level of farmers.	52 (12.4)	76 (18.1)	55 (13.4)	103 (24.5)	134 (33.9)	3.5	4th
AMIT (mobile phone) use is expensive.	1 (0.2)	130 (31.0)	40 (9.5)	51 (12.1)	198 (47.1)	3.8	5th
Information generated by AMITs is difficult to access	18 (4.3)	114 (27.1)	81 (19.3)	176 (41.9)	114 (27.1)	4.2	6th

(Kendall's  $W^a = 0.480$ , Sig. = 0.000)

(1= Strongly Agree, 2=Agree, 3= Neutral, 4= Disagree, 5=Strongly disagree)

Source: Field survey, 2018

On the other hand, the difficulty in accessing the information generated, the expensive use of AMITs as well as the bad network making it time-consuming in using AMITs to access market information does not pose a barrier to use of AMITs in accessing marketing information by smallholder farmers in the Akwapim South district. In conclusion, the cumbersome nature of using AMITs, low availability of AMIT services in the district and network is bad(erratic) and therefore the use of AMITs is time-consuming are the main constraints faced by farmers in the use of AMITs in accessing marketing information (Table 4.3).

The Kendall's coefficient of concordance value of 0.480 which is significant suggests that a somewhat high agreement between the ranking of constraints by the farmers.

#### 4.6 Determinants of Choice of Agricultural Marketing Information Tools

Table 4.4 summarizes the regression results of determinants of choice of AMITs. The values in the parenthesis are the significant levels of the regressions. The coefficients, marginal effects and respective probability levels are estimated using the multinomial logit regression model. From the marginal effect (Table 4.5), extension contact was the only significant factor that affected farmers' decision not to use any tool. The significant level was 1% and the effect was negative. More extension contacts for farmers meant a decrease in probability of farmers not to use any tool. They can access almost all information needed for marketing their produce by themselves without having to use any AMITs. Therefore, they are not willing to use any other tool to access information.

The significant factors influencing farmers decision to choose mobile phone as a marketing information tool were gender, years of schooling and AMIT awareness. Gender influenced farmers choice of mobile phone at 1% significance level. The direction of effect was negative with a marginal effect of approximately 0.1174. The probability of farmers choice of mobile phone is increased by approximately 11.74% for female farmers. Male farmers are normally expected to adopt agricultural innovations because they have the resources as found in the work of Akudugu *et al.*, (2012), however this was not the case in this study. Years of schooling was negative in influencing farmers decision to choose mobile phones with a significant level of 5%. The probability of farmers decision to choose mobile phone is decreased if farmers had one more year increase in schooling. This however contradicts the assertions of Olagunju & Salimonu (2010), who studied the effect of adoption pattern of fertilizer technology on small scale farmers productivity in Boluwaduro. They found years of schooling to have a positive effect. The

awareness of AMITs increased farmers decision to use mobile phone by approximately 5.82% and at 10% significance level. Farmers who were aware of the tools were more likely to use mobile phone only.

**Table 4.4: Multinomial Logit estimates of choice of alternative tools**

Dependent variables	Phone	Radio	TV	Phone and Radio	Phone and TV	Radio and TV	Phone, Radio and TV
Gender	-4.02*** (0.00)	-4.26*** (0.00)	-4.55*** (0.00)	- 1.63** (0.02)	-3.47*** (0.01)	-2.70*** (0.00)	-1.77*** (0.00)
Age	0.02 (0.38)	0.02 (0.25)	0.05** (0.05)	0.01 (0.56)	-0.02 (0.55)	0.05** (0.02)	0.03** (0.03)
Years of Schooling	0.00 (0.94)	0.04 (0.41)	0.05 (0.38)	0.13** (0.02)	0.13* (0.06)	0.08* (0.08)	0.13*** (0.00)
Farm Size	-0.11 (0.31)	-0.10 (0.25)	-0.04 (0.67)	-0.02 (0.79)	0.13 (0.15)	-0.05 (0.58)	0.01 (0.93)
AMIT Awareness	1.52** (0.01)	0.93* (0.08)	0.99 (0.13)	0.71 (0.22)	1.66* (0.05)	0.80 (0.16)	0.62 (0.18)
Transport Cost	0.00 (0.94)	-0.04 (0.27)	-0.05 (0.39)	0.03 (0.43)	0.13*** (0.01)	0.03 (0.44)	0.03 (0.32)
FBO Membership	1.01* (0.09)	1.24** (0.02)	1.13* (0.08)	0.53 (0.39)	0.74 (0.35)	1.22** (0.03)	1.12** (0.02)
Extension Contact	18.49 (0.97)	17.85 (0.97)	35.50 (0.98)	17.85 (0.97)	18.41 (0.97)	18.81 (0.97)	18.17 (0.97)
Constant	-1.55 (0.38)	0.53 (0.73)	-18.37 (0.99)	- 3.11** (0.06)	-7.38*** (0.00)	-4.61*** (0.01)	-2.91** (0.02)
LR chi2(56)	428.93						
Prob> chi2	0.0000						
Pseudo R2	0.2806						
Log likelihood	-549.9718						

Notes: No tool use alternative is chosen as the base outcome

\*\*\*, \*\* & \* represent significant levels at 1%, 5% and 10% respectively

Source: Field survey, 2018

Abebe, Bijman, Pascucci, & Omta, (2013) who worked on adoption of improved potato varieties and the role of agricultural knowledge and innovation system in Ethiopia, also found the awareness of the innovation to positively influence adoption.

The choice of radio only was influenced by gender, years of schooling and transport cost. Female farmers were more likely to choose radio in accessing marketing information. The probability of farmers decision to choose radio only was increased by approximately 25.91% if farmer were female. Years of schooling was negative in influencing farmers decision to choose radio only with a significant level of 5%. Farmers were less likely to choose radio only if they were more educated. Transport cost negatively influenced farmers decision to choose radio only in accessing marketing information. The probability of farmers decision to choose radio only increased if their transport cost reduces. This was however against the assertions made by Aggarwal, Brian, Dahyeon, Patrick, Jonathan, & Alan, (2017) that adoption is positively affected by transport cost of farmers. They found out in their study that; transport cost positively influenced technology adoption in Tanzania.

Extension contact was the only significant factor that affected farmers' decision to choose TV only. The significance level was 1% and the effect was positive. More extension contacts for farmers meant an increase in probability of farmers to choose TV. They are aided by the extension officers in gaining more understanding of the programs shown on TV about marketing of agricultural produce. The only factor affecting farmers decision to choose phone and radio only was gender. The direction of effect was positive with marginal effect of 8.25% approximately and a significant level of 10%. Males were more likely to choose phone and radio alternative as a means of accessing marketing information.

Farmers choice of the radio and TV alternative was positively influenced by extension contact at 5% significance level and a marginal effect of 8.75% approximately. The extension agents help farmers' in gaining more understanding of the programs shown on TV and heard on radio about marketing of agricultural produce. This was also consistent with the findings of Williams (2015), who studied factors affecting farmers adoption of agricultural innovations in Delta State.

Phone, radio and TV was also influenced by gender, years of schooling and extension contact in farmers decision in obtaining agricultural information. Gender influenced the alternative positively at 1% significance level. Female farmers were more likely to choose this alternative to obtain information. Years of schooling was also positive in influencing farmers' choice. The probability of choosing the phone, radio and TV alternative is increased by approximately 1.45% if farmer had a one more year of formal education. The effect of extension contact was also positive with a marginal effect of approximately 12.64%. The farmers will choose this alternative if they had more extension contact. The farmers take advantage of all the three tools in accessing information once they have the extension agents to help them understand the information. Phone and TV alternative was not significantly influenced by any factor.

**Table 4.5: Marginal effects from the regression model**

Dependent variables	No tool use	Phone	Radio	TV	Phone and Radio	Phone and TV	Radio and TV	Phone, Radio and TV
Gender	0.00 (0.99)	- 0.12*** (0.00)	- 0.26*** (0.00)	-0.00 (0.99)	0.08* (0.07)	-0.01 (0.35)	-0.03 (0.53)	0.33*** (0.00)
Age	-0.0000 (0.99)	-0.01 (0.50)	-0.01 (0.56)	0.00 (0.99)	-0.00 (0.25)	-0.00 (0.22)	0.00 (0.14)	0.00 (0.45)
Years of Schooling	-0.00 (0.99)	-0.01** (0.02)	-0.01** (0.04)	-0.00 (0.99)	0.00 (0.52)	0.00 (0.67)	-0.00 (0.63)	0.01** (0.02)
Farm Size	0.00 (0.99)	-0.01 (0.32)	-0.01 (0.21)	-0.00 (0.99)	0.00 (0.93)	0.00 (0.19)	-0.00 (0.72)	0.02 (0.11)
AMIT Awareness	-0.00 (0.99)	0.06* (0.09)	0.02 (0.62)	0.00 (0.99)	-0.01 (0.87)	0.01 (0.36)	0.00 (0.92)	-0.08 (0.20)
Transport Cost	-0.00 (0.99)	-0.00 (0.60)	-0.01** (0.01)	-0.00 (0.99)	0.00 (0.67)	0.00 (0.22)	0.00 (0.67)	0.01 (0.22)
FBO Membership	-0.00 (0.99)	-0.00 (0.88)	0.02 (0.61)	0.00 (0.99)	-0.05 (0.17)	-0.00 (0.61)	0.02 (0.67)	0.02 (0.74)
Extension Contact	-0.34*** (0.00)	0.04 (0.15)	-0.00 (0.94)	0.09*** (0.00)	-0.00 (0.95)	0.00 (0.55)	0.09** (0.01)	0.13** (0.05)

Note: \*\*\*, \*\* & \* represent significant levels at 1%, 5% and 10% respectively.

Source: Field survey, 2018

#### 4.7 Propensity Score Matching (PSM) Estimation of Effect on Farmers' Income

The Nearest Neighbor Matching method was used to estimate the propensity scores of factors affecting farmers income. Gender had a negative effect on AMITs adoption at 1% significance level. Age had a positive effect with a significant level of 5%. Years of schooling had a positive effect at 1% significance level. Farm size also had a positive effect on adoption of AMITs, also at 10% significance level. AMITs awareness was also positive with a significant level of 1%. FBO membership had a positive effect on adoption of AMITs at 10% significant level. These variables were then used to estimate the propensity scores. Table 4.6 shows the propensity score matching estimates on effects of farmers income.

**Table 4.5: Propensity score Matching (PSM) estimation of effect of AMITs adoption on farmers' income**

Adopt	Coefficient	Standard error	p-value
Gender	-2.1953***	0.4553	0.000
Age	0.0238**	0.0106	0.025
Years of Schooling	0.0999***	0.0309	0.001
Farm Size	0.0834*	0.0480	0.082
AMIT Awareness	1.1455***	0.3481	0.001
Transport Cost	0.0181	0.0235	0.442
FBO Membership	0.6981*	0.3628	0.054
Constant	-0.3218	0.9726	0.741

\*\*\*, \*\*& \* represent significant levels at 1%, 5% &10% respectively

Source: Field survey, 2018

#### 4.7.1 Common Support Condition

The matching was done with respect to common support condition. Only observations in the common support region were matched (Table 4.7). Out of the 420 observations, 102 of the untreated were on support and 102 of the treated were on support. About 216 of the treated were off support and none of the untreated was off support. It can however be implied that not all farmers who adopted AMITs were matched with non -adopters.

**Table 4.7: Common support condition**

Treatment Assignment	Off support	On support	Total
Untreated	0	102	102
Treated	216	102	318
<b>Total</b>	<b>216</b>	<b>204</b>	<b>420</b>

Source: Field survey, 2018

#### 4.7.2 ATT estimation of effect of adoption on farmers income

From the results, adoption of AMITs show a positive effect on maize farmers income. The results indicate that farm income of farmers who adopted AMITs was on average of GH¢1046.09 while those who did not adopt AMITs had GH¢880.44 on the average (Table 4.8). The difference between the average income of adopters and non-adopters is GH¢244.37 after matching and was significant. This means that, adopters had more income than non- adopters by GH¢244.37 on average.

**Table 4.8: ATT Estimation of Effect of Adoption on Farmers income**

Variable	Sample size	Treated GH¢	Control GH¢	Difference GH¢	S. E	T-stat
Maize	Unmatched	880.44	801.71	78.73	56.79	1.39
Income per Acre	ATT	1046.09	801.71	244.37***	69.72	3.51

\*\*\*, \*\* & \* represent significant levels at 1%, 5% & 10% respectively

Source: Field survey, 2018

#### 4.8 Sensitivity analysis

The Rosenbaum's sensitivity analysis was employed to unearth hidden biases against the results of matching estimates, testing the robustness of the results is highly imperative. It is necessary for us to do a sensitivity analysis to check how sensitive the estimated ATT is. The results of the analysis (Appendix 3.4) show that the effect of adoption of AMITs is not changing through adopters and non-adopters if it is allowed to differ odds up to gamma value of 3. For the outcome variable estimated at various levels of critical value of gamma, the p-values are significant. We couldn't get the critical value gamma where ATT is questionable even if we have set gamma high up to 3. This shows that ATT estimates are insensitive to unobserved selection biases and are a pure effect of income due to AMITs adoption.

##### 4.8.1 Testing the balance of propensity score and covariates

This test was done to know whether there was a statistical significant difference in the mean values of covariates between AMIT adopters and non-adopters. When estimating treatment effect, the percentage of bias before matching is expected to reduce up to about 5% after matching which is the threshold. The joint significant test of the pseudo  $R^2$  are a good indicator of matching quality. An insignificant likelihood ratio test supports the assumption that both groups have the same distribution in covariates after matching (Table 4.9).

**Table 4.9: Chi square test for the joint significance of variables**

<b>Sample</b>	<b>Pseudo R2</b>	<b>LRchi2</b>	<b>P&gt;chi2</b>	<b>Mean Bias</b>
Unmatched	0.312	145.36	0.000	71.0
Matched	1.000	37.10	-	137.9

Source: Field survey, 2018

## CHAPTER FIVE

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Introduction

The concluding chapter presents a summary of the study findings. This summary is followed by conclusions from the findings. Policy recommendations conclude the chapter from the study.

The study basically sought to assess the impact of AMITs on maize farmers' income in the Akwapim South Municipality (ASM) of Ghana. The Multinomial Logit model was employed to identify the determinants of choice of AMITs. PSM was also used to estimate the impact of AMITs adoption on income of farmers. Primary data was used for the study.

#### 5.2 Summary of the Study

About 75.71% of maize farmers adopted AMITs use while about 24.29% of them were non-adopters of AMITs. The study revealed that more females adopted AMITs than males. Females who adopted formed approximately 37.4% of the total number of maize farmers. Males who also adopted formed 6.9% of the total number of maize farmers.

The highest ranked constraint facing the adoption of AMITs was the cumbersome nature of internet use. The next highest ranked was the low availability of AMIT services in the district. High illiteracy level of farmers was ranked as the third most important constraint. The fourth most important constraint was bad network which makes AMITs use time-consuming. The fifth most ranked constraint was the expensive use of mobile phone and the least ranked constraint was information generated by AMITs is difficult to access.

Extension contact was the only significant factor that affected farmers' decision not to use any tool. The significant level was 1% and the effect was negative. The significant factors

influencing farmers decision to choose mobile phone as a marketing information tool were gender, years of schooling and AMIT awareness. Gender influenced farmers choice of mobile phone at 1% significance level with a marginal effect of approximately 0.1174. Years of schooling was negative in influencing farmers decision to choose mobile phones with a significant level of 5%. The awareness of AMITs increased farmers decision to use mobile phone by approximately 5.82% and at 10% significance level.

The probability of farmers decision to choose radio only was increased by approximately 25.91% if farmer were female. Years of schooling was negative in influencing farmers decision to choose radio only with a significant level of 5%. Transport cost negatively influenced farmers decision to choose radio only in accessing marketing information. The probability of farmers decision to choose radio only increased if their transport cost reduces.

Extension contact was the only significant factor that affected farmers' decision to choose TV only. The significance level was 1% and the effect was positive. The only factor affecting farmers decision to choose phone and radio only was gender. The direction of effect was positive with marginal effect of 8.25% approximately and a significant level of 10%.

Farmers choice of the radio and TV alternative was positively influenced by extension contact at 5% significance level and a marginal effect of 8.75% approximately. Gender influenced the alternative positively at 1% significance level. Female farmers were more likely to choose this alternative to obtain information. Years of schooling was also positive in influencing farmers' choice. The probability of choosing the phone, radio and TV alternative is increased by approximately 1.45% if farmer had a one more year of formal education. The effect of extension contact was also positive with a marginal effect of approximately 12.64%. The farmers will

choose this alternative if they had more extension contact. Phone and TV alternative was not significantly influenced by any factor.

On the average, farmers who adopted AMITs had more income than their non-adopting counterparts. Farmers who adopted AMITs increased their income by approximately GH¢244.37 compared to those who did not adopt.

### **5.3 Conclusions of the Study**

Extension contact was an important factor affecting farmers decision not to adopt any of the tools. It can however be implied that maize farmers decision not to use any of the tools for accessing marketing information would depend on the number of extensions contacts they had. Gender, years of schooling and AMIT awareness were the only important factors affecting farmers decision to choose mobile phone. It can also be implied that maize farmers decision to choose mobile phone only would depend on their gender, years of schooling and AMIT awareness. Gender, years of schooling and transport cost were the only important factors that affected decision to choose radio only. It can be implied that maize farmers decision to choose radio only would depend on their gender, years of schooling and transport cost.

Extension contact was also the only important factor affecting farmers decision to choose TV. It is therefore implied that maize farmers decision to choose TV only would depend on extension contact. Gender was the only factor affecting farmers decision to choose mobile phone and radio. It is therefore implied that maize farmers decision to choose phone and radio would depend on gender. Extension contact was the only factor affecting farmers decision to choose radio and TV. It is implied that maize farmers decision to choose radio and TV would depend on extension

contact. Gender and years of schooling were the factors affecting farmers decision to choose phone and radio and TV. It can be implied that maize farmers decision to choose phone and radio and TV radio would depend on their gender and years of schooling.

Farmers who adopted the technology increased their income by approximately GH¢244.37. This can be implied that the effect of AMITs adoption on farmers income was positive.

#### **5.4 Recommendations of the Study**

Farmers should be encouraged by stakeholders (donor agencies, policy makers, etc) of agricultural marketing information systems to use AMITs. Awareness creation should be encouraged further to get more farmers to use the tools. Those farmers who have already adopted this marketing technology must be supported through the provision of resources so they can intensify the use of AMITs. Farmers should be encouraged more to use the various tools for marketing since it can greatly impact their income.

Policy makers should give more training to farmers on the use of Agricultural marketing information tools especially mobile phones to access marketing information. More marketing information companies should be encouraged to extend their services to smallholder farmers who are mostly in the rural areas. The district agricultural department could use farmer organization during provision of extension service and integrate the message on effective use of AMITs for marketing information sharing.

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**APPENDICES**

**Appendix 3.1- Sample size table**

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Source: Krejcie and Morgan (1970). Note: “N” is population size “S” is sample size.

**Appendix 3.2- Questionnaire for the study: THE IMPACT OF AGRICULTURAL MARKETING INFORMATION TOOLS (AMITs) ON INCOME OF MAIZE FARMERS IN THE AKWAPIM SOUTH MUNICIPALITY OF GHANA**

**UNIVERSITY OF GHANA, LEGON**

**DEPARTMENT OF AGRIBUSINESS**

**QUESTIONNAIRE FOR MAIZE FARMERS**

*Consent note: This survey is meant to elicit information from maize farmers to enable the researcher assess the factors affecting the adoption of agricultural marketing information tools on farmers income in the Akwapim South District. Your kind assistance would be greatly appreciated as your insight will provide the researcher with information on the determinants of choice of the various AMIT and its subsequent impact on farmers' income. I want to assure you that information provided will be treated with outmost confidentiality and your identity will not be disclosed to any third party.*

a. Questionnaire number/ID .....

b. Name of Community: ..... Community Code/ID [ ]

c. Date of Interview Day / /Month/ /2018/

e. Time interview started ..... Time interview ended .....

f. Enumerator's Name ..... Enumerator Code/ID [ ]

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**SECTION A: Personal and Household Characteristics**

- 1. Name.....
- 2. Mobile phone number:.....
- 3. Gender    1.Male [ ]    0.Female [ ]
- 4. Age (years): .....
- 5. Education level: 1. None [ ] 2. Non-formal [ ] 3.Basic [ ] 4.Secondary [ ] 5. Tertiary [ ]
- 6. Actual number of years of formal education.....years.
- 7.Marital Status: 1. Married [ ] 2. Single [ ] 3.Divorced/Separated [ ] 4. Widowed [ ]
- 8. Household size ..... Males..... Females.....
- 9. Adult members in the household (>18 years).....
- 10. Children in the household (<18 years).....
- 11. Ethnicity: 1. Ashanti [ ] 2. Akyem [ ] 3.Fante [ ] 4. Bono [ ] 5.Akuapem [ ]  
6. Kwahu [ ] 7. Other, specify.....
- 12. Religion: 1. Christianity [ ]    Islamic [ ]    Traditionalist [ ]    Atheist [ ]
- 13a. Are you a member of any farmer- based organization? 1. Yes [ ] 0. No [ ]
- 13b. If yes, how long have you been a member to this association?.....years.
- 14.If yes, what assistance do you get from the farmer -based Organization?  
.....  
.....  
.....  
.....

**SECTION B: Farm Characteristics of Respondents**

1. What is your total agricultural land? ..... acres

2. How many acres of maize did you cultivate last season? .....acres

3. How many years have you been farming? ..... years

4. How many years have you been cultivating maize?..... years

5. Did you receive any extension contacts for the 2017 cropping season?

1. Yes [ ]      0. No [ ]

6.If Yes, how many contacts did you have with an extension officer? .....times

7. How much do you spend on transportation cost in marketing your produce.....Ghs?

**8. FARM OUTPUT AND SALES IN 2017**

	Crop	Total Quantity obtained(bags)	Unit price/bag (Gh ¢)	Total output price(Gh ¢)	Quantity of output sold(bags)
<b>Cereals:</b>	Maize (major season)				
	Maize (minor season)				
	Rice				
	Other(specify):				

<b>Tubers:</b>	Crop	Total quantity obtained (number of tubers/bags)	Average unit price (Gh ¢)	Total output price (Gh ¢)	Quantity of output sold(bags)
	Yam				
	Cassava				
	Other (specify):				
<b>Legumes:</b>	Crop	Total Quantity obtained(bags)	Unit price/ bag (Gh ¢)	Total output price(Gh ¢)	Quantity of output sold(bags)
	Groundnut				
	Cowpea				
	Others (specify):				
<b>Cash crops:</b>	Crop	Total Quantity obtained(bags)	Unit price/ bag (Gh ¢)	Total output price(Gh ¢)	Quantity of output sold(bags)
	Cocoa				
	Oil palm				
	Citrus				
	Others (specify)				

<b>Livestock</b>		Quantity sold	Average unit price (Gh ¢)	Total output price(Gh ¢)	
	Goat				
	Sheep				
	Pigs				
	Chicken				
	Others (specify)				

**9. Other income source in 2016**

Source	Annual income
Agro-processing	
Rent (land, room, equipment)	
Salary/Wage income	
Trading/commerce	
Service (sewing, hairdressing, etc.)	
Remittances	
Pension	

**SECTION C: Agricultural Marketing Information Tools Adoption**

1. Do you have knowledge in the use of AMITs ?

1. Yes [ ]      0. No [ ]

2. Do you own any of the AMITs ?

1. Yes [ ]      0. No [ ]

3. Which ones do you own?

1. Mobile phone [ ]    2. Radio [ ]    3. Television [ ]

4. Are you aware of Agricultural Marketing Information Tools?

1. Yes [ ]                      0. No [ ] *{if No, skip to section D}*

5. If yes, complete the table

AMITs	Awareness of AMIT as a source of agricultural info.	Which of them do you use?	Most Used (Rank 1 <sup>st</sup> , 2 <sup>nd</sup> 3 <sup>rd</sup> ...)	Spending on AMITs (monthly) (Gh ¢)
	(1=yes 0=No)			
Mobile phone				
Radio				
Television				
Others				

6. How many years have you been using AMITs to access market information .....years

7. If any of the AMITs above is used to access market information, what is the source of information received?

1. Input dealers [ ]    2. Buyers [ ]    3. Extension agent [ ]    4. Other Farmers [ ]  
 5. Others, specify.....

8. If you use mobile phones, for SMSs and calls, what do you use MOST?

1. SMS [ ]    2. Calls [ ]

9. If SMS, are you able to personally read the messages?

1. Yes [ ]    0. No [ ]

10. Do you know of any agricultural programme that is broadcasted on radio or TV?

1. Yes [ ]    0. No [ ]

11. If Yes, which of the following programmes are normally broadcasted on radio or TV?

1. Weather information [ ]    2. Market information [ ]    3. Production information [ ]  
 4. Livestock information [ ]    5. Alternative livelihood activities [ ]  
 6. Other,..... *{Multiple response}*

**12. Use of AMITs and Usefulness**

Usage	1 = Yes, 0 = No	How often? 1 = Occasionally 2 = Regularly 3 = Always	How is the information useful? 1 = Not useful 2 = Quite useful 3 = Useful 4 = Very useful
Do you use information received to purchase inputs?			
Do you use information received to sell your produce?			
Does information received influence your production?			
Does the information received influence the			

market selected to sell produce?			
----------------------------------	--	--	--

**SECTION D: Perception on AMITs**

	1	2	3	4	5
<i>The use of AMITs</i>					
AMIT services are easy to use (user friendliness)					
The use of AMIT to access market information reduces transportation cost					
Mobile phone is the most effective tool in accessing market information					
The network is reliable all the time					
<i>Farm returns</i>					
The use of AMIT has increased your output					
The use of AMIT has reduced your cost of production					
The use of AMIT increases farm returns					
<i>Information</i>					
Information is received on time					
Information received is relevant					
Information is received frequently					
Information received is reliable					
I already have enough information in agriculture and do not need more					
<i>Cost</i>					

The use of AMIT is costly					
High cost of information received					
<b>(1= strongly Agree, 2=Agree, 3= Neutral, 4= Disagree, 5=strongly disagree)</b>					

**SECTION E: Constraints to the use of AMIT**

	1	2	3	4	5
Mobile phone use is expensive.					
Internet use is cumbersome.					
Network is bad and therefore the use of AMIT is time consuming.					
Able to read and understand information received.					
Low availability of AMIT services in the district					
Information generated by AMIT is difficult to access					
<b>(1= Strongly Agree, 2=Agree, 3= Neutral, 4= Disagree, 5=Strongly disagree)</b>					



TV							
	Gender	-4.549107	.8997871	-5.06	0.000	-6.312658	-2.785557
	Age_Respondent	.0418523	.0209617	2.00	0.046	.000768	.0829365
	Num_Years_Schooling	.0512268	.0582911	0.88	0.380	-.0630217	.1654753
	Total_Farm_Size_Maize_Production	-.0418468	.1004688	-0.42	0.677	-.2387621	.1550685
	AMIT_Awareness	.9988674	.6671443	1.50	0.134	-.3087115	2.306446
	Transport_Cost	-.0453301	.0537243	-0.84	0.399	-.1506277	.0599675
	FBO_Membership	1.13135	.6518391	1.74	0.083	-.1462316	2.408931
	B_Receive_Extension_contacts_201	35.50023	1459.595	0.02	0.981	-2825.252	2896.253
	_cons	-18.37328	1322.509	-0.01	0.989	-2610.443	2573.697
Phone_and_Radio							
	Gender	-1.633027	.6689247	-2.44	0.015	-2.944095	-.3219584
	Age_Respondent	.0110924	.019273	0.58	0.565	-.026682	.0488667
	Num_Years_Schooling	.1263224	.0534562	2.36	0.018	.0215501	.2310947
	Total_Farm_Size_Maize_Production	-.0202685	.079535	-0.25	0.799	-.1761543	.1356173
	AMIT_Awareness	.707782	.5790592	1.22	0.222	-.4271531	1.842717
	Transport_Cost	.0318052	.0399043	0.80	0.425	-.0464059	.1100162
	FBO_Membership	.5269659	.6150788	0.86	0.392	-.6785664	1.732498
	B_Receive_Extension_contacts_201	17.8481	617.5677	0.03	0.977	-1192.562	1228.258
	_cons	-3.113933	1.650426	-1.89	0.059	-6.348708	.1208424
Phone_and_TV							
	Gender	-3.466124	1.268799	-2.73	0.006	-5.952925	-.9793235
	Age_Respondent	-.0189653	.0315279	-0.60	0.547	-.0807589	.0428283
	Num_Years_Schooling	.1278582	.0687824	1.86	0.063	-.0069529	.2626693
	Total_Farm_Size_Maize_Production	.1250385	.087472	1.43	0.153	-.0464035	.2964805
	AMIT_Awareness	1.664345	.8518513	1.95	0.051	-.005253	3.333943
	Transport_Cost	.1290819	.0472576	2.73	0.006	.0364586	.2217051
	FBO_Membership	.7422118	.7953275	0.93	0.351	-.8166015	2.301025
	B_Receive_Extension_contacts_201	18.40505	617.5682	0.03	0.976	-1192.006	1228.816
	_cons	-7.376136	2.360977	-3.12	0.002	-12.00357	-2.748706

Radio_and_TV							
Gender	-2.695964	.6572039	-4.10	0.000	-3.98406	-1.407868	
Age_Respondent	.0452097	.0186077	2.43	0.015	.0087393	.0816801	
Num_Years_Schooling	.0888943	.0521766	1.70	0.088	-.0133699	.1911585	
Total_Farm_Size_Maize_Production	-.0457373	.0844862	-0.54	0.588	-.2113273	.1198526	
AMIT_Awareness	.8035978	.5676913	1.42	0.157	-.3090567	1.916252	
Transport_Cost	.0311963	.0406378	0.77	0.443	-.0484524	.1108449	
FBO_Membership	1.22466	.5753245	2.13	0.033	.0970444	2.352275	
B_Receive_Extension_contacts_201	18.81159	617.5677	0.03	0.976	-1191.599	1229.222	
_cons	-4.608694	1.670323	-2.76	0.006	-7.882467	-1.33492	
Phone_and_Radio_and_TV							
Gender	-1.765608	.5301855	-3.33	0.001	-2.804753	-.7264636	
Age_Respondent	.0309745	.0141963	2.18	0.029	.0031502	.0587988	
Num_Years_Schooling	.1302581	.0423384	3.08	0.002	.0472763	.2132399	
Total_Farm_Size_Maize_Production	.0055629	.060669	0.09	0.927	-.1133462	.124472	
AMIT_Awareness	.6119563	.4603788	1.33	0.184	-.2903695	1.514282	
Transport_Cost	.0309086	.031344	0.99	0.324	-.0305246	.0923418	
FBO_Membership	1.116355	.4584784	2.43	0.015	.2177542	2.014957	
B_Receive_Extension_contacts_201	18.17217	617.5676	0.03	0.977	-1192.238	1228.582	
_cons	-2.906097	1.21248	-2.40	0.017	-5.282514	-.5296803	

variable	dy/dx	Std. Err.	z	P> z	[	95% C.I.	]	X
Gender*	.0000983	.03179	0.00	0.998	-.062208	.062405		.52381
Age_Re~t	-1.05e-06	.00034	-0.00	0.998	-.000668	.000666		49.731
Num_Ye~g	-3.95e-06	.00128	-0.00	0.998	-.002509	.002501		6.67857
Total_~n	9.66e-07	.00031	0.00	0.998	-.000612	.000614		4.55357
AMIT_A~s*	-.0000284	.00918	-0.00	0.998	-.018018	.017961		.440476
Transp~t	-7.59e-07	.00025	-0.00	0.998	-.000482	.00048		26.5476
FBO_Me~p*	-.0000355	.01149	-0.00	0.998	-.022546	.022475		.328571
B_Re~201*	-.3412955	.05907	-5.78	0.000	-.457065	-.225525		.52381

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx,predict(pr outcome(1))
```

Marginal effects after mlogit

```
y = Pr(AMIT_Types==Phone) (predict, pr outcome(1))
    = .07263421
```

variable	dy/dx	Std. Err.	z	P> z	[ 95% C.I. ]	X
Gender*	-.1174315	.04	-2.94	0.003	-.195836 -.039027	.52381
Age_Re~t	-.0007221	.00108	-0.67	0.503	-.002837 .001393	49.731
Num_Ye~g	-.0072052	.00298	-2.42	0.015	-.013037 -.001374	6.67857
Total_~n	-.0059549	.00604	-0.99	0.324	-.017795 .005885	4.55357
AMIT_A~s*	.0582584	.03476	1.68	0.094	-.009871 .126388	.440476
Transp~t	-.0011987	.00229	-0.52	0.600	-.005678 .00328	26.5476
FBO_Me~p*	-.0043158	.02864	-0.15	0.880	-.060458 .051826	.328571
B_Re~201*	.0350097	.02448	1.43	0.153	-.012964 .082983	.52381

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx,predict(pr outcome(2))
```

Marginal effects after mlogit

```
y = Pr(AMIT_Types==Radio) (predict, pr outcome(2))
    = .13423228
```

variable	dy/dx	Std. Err.	z	P> z	[	95% C.I.	]	X
Gender*	-.259144	.05475	-4.73	0.000	-.366449	-.151839		.52381
Age_Re~t	-.0009329	.0016	-0.58	0.559	-.004061	.002195		49.731
Num_Ye~g	-.008353	.00411	-2.03	0.042	-.016408	-.000298		6.67857
Total_~n	-.0104482	.00841	-1.24	0.214	-.026936	.00604		4.55357
AMIT_A~s*	.0212426	.04285	0.50	0.620	-.062746	.105231		.440476
Transp~t	-.0084077	.00342	-2.46	0.014	-.015101	-.001714		26.5476
FBO_Me~p*	.0229176	.04445	0.52	0.606	-.064195	.11003		.328571
B_Re~201*	-.0027795	.03504	-0.08	0.937	-.071456	.065897		.52381

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx,predict(pr outcome(3))
```

Marginal effects after mlogit

```
y = Pr(AMIT_Types==TV) (predict, pr outcome(3))
    = .00002765
```

variable	dy/dx	Std. Err.	z	P> z	[	95% C.I.	]	X
Gender*	-.0000651	.04097	-0.00	0.999	-.080374	.080244		.52381
Age_Re~t	3.92e-07	.00025	0.00	0.999	-.000484	.000485		49.731
Num_Ye~g	-1.45e-06	.00092	-0.00	0.999	-.001796	.001793		6.67857
Total_~n	-4.55e-07	.00029	-0.00	0.999	-.000562	.000561		4.55357
AMIT_A~s*	6.43e-06	.00405	0.00	0.999	-.007936	.007948		.440476
Transp~t	-1.80e-06	.00114	-0.00	0.999	-.002229	.002225		26.5476
FBO_Me~p*	1.59e-06	.001	0.00	0.999	-.001955	.001958		.328571
B_Re~201*	.0941329	.0264	3.57	0.000	.042391	.145874		.52381

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx,predict(pr outcome(4))
```

Marginal effects after mlogit

```
y = Pr(AMIT_Types==Phone_and_Radio) (predict, pr outcome(4))
= .1148073
```

variable	dy/dx	Std. Err.	z	P> z	[ 95% C.I. ]	X
Gender*	.0825335	.04651	1.77	0.076	-.00862 .173687	.52381
Age_Re~t	-.0019016	.00165	-1.15	0.249	-.005134 .001331	49.731
Num_Ye~g	.0025843	.00405	0.64	0.523	-.005344 .010513	6.67857
Total_~n	.0005886	.00628	0.09	0.925	-.011727 .012904	4.55357
AMIT_A~s*	-.0068244	.04368	-0.16	0.876	-.092426 .078777	.440476
Transp~t	.0013621	.00315	0.43	0.666	-.004818 .007542	26.5476
FBO_Me~p*	-.0576677	.04216	-1.37	0.171	-.140307 .024972	.328571
B_Re~201*	-.0022353	.03515	-0.06	0.949	-.07113 .06666	.52381

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx,predict(pr outcome(5))
```

Marginal effects after mlogit

```
y = Pr(AMIT_Types==Phone_and_TV) (predict, pr outcome(5))
= .00787939
```

variable	dy/dx	Std. Err.	z	P> z	[ 95% C.I. ]	X
Gender*	-.0076853	.00818	-0.94	0.347	-.02371 .008339	.52381
Age_Re~t	-.0003673	.0003	-1.22	0.224	-.000959 .000225	49.731
Num_Ye~g	.0001895	.00045	0.42	0.672	-.000688 .001067	6.67857
Total_~n	.0011853	.0009	1.31	0.189	-.000584 .002955	4.55357
AMIT_A~s*	.0076392	.00829	0.92	0.357	-.008605 .023884	.440476
Transp~t	.00086	.00069	1.24	0.215	-.000499 .002219	26.5476
FBO_Me~p*	-.0024722	.0049	-0.50	0.614	-.012082 .007138	.328571
B_Re~201*	.0032247	.00536	0.60	0.547	-.007281 .013731	.52381

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx,predict(pr outcome(6))
```

Marginal effects after mlogit

```
y = Pr(AMIT_Types==Radio_and_TV) (predict, pr outcome(6))
    = .11939459
```

variable	dy/dx	Std. Err.	z	P> z	[	95% C.I.	]	X
Gender*	-.027538	.04387	-0.63	0.530	-.113521	.058445		.52381
Age_Re~t	.0020959	.0014	1.49	0.135	-.000655	.004847		49.731
Num_Ye~g	-.0017812	.00369	-0.48	0.630	-.009019	.005456		6.67857
Total_~n	-.0024287	.00675	-0.36	0.719	-.01566	.010802		4.55357
AMIT_A~s*	.0042338	.04091	0.10	0.918	-.075945	.084413		.440476
Transp~t	.0013438	.0031	0.43	0.665	-.004734	.007421		26.5476
FBO_Me~p*	.0183514	.04361	0.42	0.674	-.067132	.103835		.328571
B_Re~201*	.0875264	.03449	2.54	0.011	.019919	.155133		.52381

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx,predict(pr outcome(7))
```

Marginal effects after mlogit

```
y = Pr(AMIT_Types==Phone_and_Radio_and_TV) (predict, pr outcome(7))
    = .55098652
```

variable	dy/dx	Std. Err.	z	P> z	[	95% C.I.	]	X
Gender*	.3292321	.07368	4.47	0.000	.184823	.473641		.52381
Age_Re~t	.0018287	.00243	0.75	0.453	-.002943	.0066		49.731
Num_Ye~g	.014571	.00614	2.37	0.018	.002544	.026598		6.67857
Total_~n	.0170575	.01062	1.61	0.108	-.003759	.037874		4.55357
AMIT_A~s*	-.0845277	.06653	-1.27	0.204	-.214927	.045872		.440476
Transp~t	.0060431	.00497	1.21	0.224	-.003707	.015793		26.5476
FBO_Me~p*	.0232205	.0689	0.34	0.736	-.111821	.158262		.328571
B_Re~201*	.1264166	.0645	1.96	0.050	1.9e-06	.252831		.52381

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

### Appendix 3.4- Propensity Score Matching

```
. psmatch2 Adopt_AMIT Gender Age_Respondent Num_Years_Schooling Total_Farm_Size_Maize_Production AMIT_Awareness Transport_Cost FBO_Membership
> , outcome(Maize_Inc_Acre) logit neighbor(1) descending noreplace
```

```
Logistic regression      Number of obs   =      420
                        LR chi2(7)             =     145.19
                        Prob > chi2            =     0.0000
Log likelihood = -160.23252      Pseudo R2       =     0.3118
```

Adopt_AMIT	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
Gender	-2.195303	.4553531	-4.82	0.000	-3.087779	-1.302827
Age_Respondent	.0238694	.0106844	2.23	0.025	.0029283	.0448105
Num_Years_Schooling	.0999213	.030967	3.23	0.001	.0392272	.1606155
Total_Farm_Size_Maize_Production	.0834136	.0480274	1.74	0.082	-.0107184	.1775457
AMIT_Awareness	1.145565	.348116	3.29	0.001	.4632703	1.82786
Transport_Cost	.0181342	.0235794	0.77	0.442	-.0280806	.0643489
FBO_Membership	.6981163	.3628615	1.92	0.054	-.0130791	1.409312
_cons	-.3218711	.9726865	-0.33	0.741	-2.228302	1.584559

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Maize_Inc_Acre	Unmatched	880.448274	801.714751	78.7335234	56.7931998	1.39
	ATT	1046.09189	801.714751	244.377142	69.7213804	3.51

psmatch2: Treatment assignment	psmatch2: Common support		Total
	Off suppo	On suppor	
Untreated	0	102	102
Treated	216	102	318
Total	216	204	420

. rbounds Maize\_Inc\_Acre,gamma(1(0.01)3)

Rosenbaum bounds for Maize\_Inc\_Acre (N = 420 matched pairs)

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	0	0	838.962	838.962	789.968	889.782
1.01	0	0	836.6	841.056	787.504	892.167
1.02	0	0	834.45	843.168	785.233	894.592
1.03	0	0	832.37	845.2	782.983	896.788
1.04	0	0	830.282	847.2	780.658	899.268
1.05	0	0	828	849.657	778.288	901.437
1.06	0	0	826.182	851.6	776.389	903.917
1.07	0	0	824.361	853.926	774.42	906.15
1.08	0	0	822.033	855.888	772.348	908.284
1.09	0	0	820.055	858.097	770.535	910.281

1.1	0	0	817.95	860.41	768.763	912.41
1.11	0	0	816.103	862.333	766.621	914.45
1.12	0	0	814.296	864.182	764.588	916.445
1.13	0	0	812.052	866.4	762.533	918.277
1.14	0	0	809.823	868.282	760.658	920.298
1.15	0	0	807.838	870.225	758.694	922.545
1.16	0	0	806.199	872.236	756.65	924.516
1.17	0	0	804.395	874.341	754.7	926.548
1.18	0	0	802.464	876.468	752.808	928.7
1.19	0	0	800.62	878.249	750.916	930.798
1.2	0	0	798.825	880.344	749.04	932.7
1.21	0	0	797.045	882.7	746.9	934.588
1.22	0	0	795.199	884.582	745.168	936.437
1.23	0	0	793.338	886.5	743.575	938.7
1.24	0	0	791.5	888.609	741.909	940.446
1.25	0	0	789.65	890.155	740.073	942.433
1.26	0	0	787.699	892.078	738.165	944.14
1.27	0	0	785.958	894.15	736.7	946.278
1.28	0	0	784.1	895.705	734.95	948.2
1.29	0	0	782.366	897.64	733.438	950.083

1.3	0	0	780.451	899.523	731.483	951.7
1.31	0	0	778.598	901.31	729.883	953.45
1.32	0	0	777.121	903.155	728.11	955.314
1.33	0	0	775.522	904.788	726.32	957.044
1.34	0	0	773.907	906.759	724.45	958.7
1.35	0	0	772.266	908.399	722.746	960.383
1.36	0	0	770.758	909.988	721.205	961.95
1.37	0	0	769.46	911.487	719.317	963.633
1.38	0	0	768.053	913.338	717.525	965.4
1.39	0	0	766.399	914.819	715.889	967.381
1.4	0	0	764.642	916.4	714.24	969.289
1.41	0	0	762.939	917.7	712.713	970.633
1.42	0	0	761.525	919.275	710.97	972.428
1.43	0	0	760.002	920.95	709.663	974.148
1.44	0	0	758.494	922.788	708.245	975.814
1.45	0	0	756.955	924.45	706.668	977.45
1.46	0	0	755.355	925.958	705.091	978.958
1.47	0	0	753.9	927.471	703.055	980.522
1.48	0	0	752.398	929.025	701.705	981.889
1.49	0	0	750.888	930.81	700.42	983.433

1.5	0	0	749.4	932.303	698.95	984.941
1.51	0	0	747.7	933.805	697.455	986.27
1.52	0	0	746.25	935.246	695.713	987.577
1.53	0	0	744.922	936.7	694.194	989.04
1.54	0	0	743.698	938.578	692.583	990.577
1.55	0	0	742.466	939.965	691.2	992.29
1.56	0	0	741.043	941.365	689.7	993.75
1.57	0	0	739.642	942.91	688.2	995.41
1.58	0	0	738.155	944.2	686.9	996.788
1.59	0	0	737	945.964	685.26	998.251
1.6	0	0	735.723	947.384	684.074	999.715
1.61	0	0	734.354	948.95	682.616	1001.37
1.62	0	0	733.25	950.333	681.269	1002.95
1.63	0	0	731.58	951.631	679.81	1004.43
1.64	0	0	730.19	952.947	678.244	1006.03
1.65	0	0	729.074	954.36	677	1007.39
1.66	0	0	727.65	955.674	675.601	1008.85
1.67	0	0	726.3	957.05	674.407	1009.97
1.68	0	0	724.88	958.45	673.099	1011.25
1.69	0	0	723.549	959.698	671.775	1012.7

1.7	0	0	722.199	960.809	670.34	1014.17
1.71	0	0	721.033	962.028	669.207	1015.31
1.72	0	0	719.55	963.408	667.955	1016.69
1.73	0	0	718.2	964.785	666.689	1017.75
1.74	0	0	716.87	966.238	665.69	1019.2
1.75	0	0	715.505	967.714	664.373	1020.65
1.76	0	0	714.35	969.24	663.11	1022.04
1.77	0	0	713.157	970.238	661.87	1023.66
1.78	0	0	711.716	971.631	660.783	1025.21
1.79	0	0	710.492	972.868	659.65	1026.85
1.8	0	0	709.631	974.2	658.38	1028.43
1.81	0	0	708.467	975.539	657.101	1029.95
1.82	0	0	707.355	976.688	655.894	1031.35
1.83	0	0	706.15	977.987	654.511	1032.59
1.84	0	0	704.899	979.15	653.316	1034.07
1.85	0	0	703.274	980.275	651.936	1035.34
1.86	0	0	702.2	981.378	650.94	1037.01
1.87	0	0	701.2	982.503	649.6	1038.42
1.88	0	0	700.2	983.74	648.127	1039.98
1.89	0	0	698.995	984.868	646.745	1041.31
1.9	0	0	697.9	985.858	645.461	1042.69
1.91	0	0	696.7	986.983	644.38	1043.86
1.92	0	0	695.402	987.915	643.16	1044.97
1.93	0	0	694.194	989.04	641.909	1046.28
1.94	0	0	692.965	990.379	640.833	1047.69
1.95	0	0	691.913	991.58	639.903	1048.97
1.96	0	0	690.76	992.71	638.66	1050.16
1.97	0	0	689.58	993.844	637.621	1051.06
1.98	0	0	688.448	995.046	636.66	1052.45
1.99	0	0	687.485	996.144	635.525	1053.51

2	0	0	686.36	997.219	634.263	1054.91
2.01	0	0	685.19	998.4	633.091	1056.1
2.02	0	0	684.25	999.467	632.117	1057.43
2.03	0	0	683.151	1000.71	631.103	1058.53
2.04	0	0	682.055	1001.98	629.895	1059.81
2.05	0	0	681.1	1003.15	628.953	1060.97
2.06	0	0	679.95	1004.31	627.825	1062.15
2.07	0	0	678.8	1005.45	626.717	1063.22
2.08	0	0	677.85	1006.45	625.45	1064.54
2.09	0	0	676.7	1007.54	624.476	1065.75
2.1	0	0	675.766	1008.7	622.963	1066.95
2.11	0	0	674.772	1009.65	621.996	1067.87
2.12	0	0	673.73	1010.6	620.95	1069.16
2.13	0	0	672.88	1011.5	619.821	1070.19
2.14	0	0	671.838	1012.61	618.583	1071.36
2.15	0	0	670.754	1013.6	617.763	1072.52
2.16	0	0	669.855	1014.79	616.867	1073.45
2.17	0	0	668.951	1015.6	616.05	1074.69
2.18	0	0	668	1016.66	614.93	1075.73
2.19	0	0	666.98	1017.45	614.018	1076.83
2.2	0	0	666.255	1018.44	612.967	1077.84
2.21	0	0	665.45	1019.5	611.95	1078.98
2.22	0	0	664.4	1020.65	610.98	1080.12
2.23	0	0	663.41	1021.79	609.95	1081
2.24	0	0	662.575	1022.9	609.12	1082.2
2.25	0	0	661.591	1023.93	608.11	1083.38
2.26	0	0	660.783	1025.21	607.319	1084.23
2.27	0	0	659.894	1026.39	606.148	1085.22
2.28	0	0	659.05	1027.65	605.161	1086.28
2.29	0	0	658.173	1028.81	604.232	1087.59
2.3	0	0	657.101	1029.95	603.15	1088.72
2.31	0	0	656.2	1031	602.439	1089.71
2.32	0	0	655.15	1031.97	601.401	1090.6
2.33	0	0	654.078	1032.83	600.509	1091.85
2.34	0	0	653.325	1034.05	599.755	1093.17
2.35	0	0	652.473	1035.08	598.95	1094.16
2.36	0	0	651.465	1036.04	598.144	1095.2
2.37	0	0	650.65	1037.38	597.2	1096.36
2.38	0	0	649.603	1038.4	596.383	1097.5
2.39	0	0	648.41	1039.62	595.45	1098.6
2.4	0	0	647.409	1040.7	594.467	1099.86
2.41	0	0	646.575	1041.73	593.475	1101
2.42	0	0	645.514	1042.67	592.75	1102.26
2.43	0	0	644.635	1043.52	591.824	1103.41
2.44	0	0	643.814	1044.38	590.959	1104.38
2.45	0	0	642.799	1045.13	590.13	1105.38
2.46	0	0	641.95	1046.18	589.157	1106.53
2.47	0	0	641.169	1047.2	588.264	1107.65
2.48	0	0	640.444	1048.25	587.25	1108.66
2.49	0	0	639.649	1049.24	586.39	1109.74

2.5	0	0	638.744	1050.07	585.548	1110.91
2.51	0	0	637.88	1050.7	584.5	1111.89
2.52	0	0	637.245	1051.71	583.574	1112.67
2.53	0	0	636.527	1052.58	582.811	1113.49
2.54	0	0	635.7	1053.42	581.872	1114.29
2.55	0	0	634.69	1054.45	581.183	1115.19
2.56	0	0	633.65	1055.41	580.2	1116.17
2.57	0	0	632.95	1056.31	579.113	1117.2
2.58	0	0	632.21	1057.25	578.1	1118.09
2.59	0	0	631.5	1058.18	577.325	1118.79
2.6	0	0	630.657	1058.87	576.6	1119.63
2.61	0	0	629.86	1059.9	575.689	1120.53
2.62	0	0	629.183	1060.72	574.9	1121.59
2.63	0	0	628.275	1061.59	574.036	1122.67
2.64	0	0	627.403	1062.45	573.435	1123.76
2.65	0	0	626.697	1063.26	572.548	1124.9
2.66	0	0	625.72	1064.25	571.582	1125.83
2.67	0	0	624.917	1065.2	570.7	1126.9
2.68	0	0	624.055	1066.04	569.9	1127.73
2.69	0	0	622.965	1066.95	569.05	1128.73

2.7	0	0	622.215	1067.7	568.183	1129.58
2.71	0	0	621.626	1068.42	567.375	1130.6
2.72	0	0	620.699	1069.35	566.685	1131.57
2.73	0	0	619.999	1070.13	565.91	1132.25
2.74	0	0	619.025	1070.98	565.074	1133.15
2.75	0	0	618.334	1071.9	564.083	1134.1
2.76	0	0	617.656	1072.65	563.325	1134.94
2.77	0	0	616.95	1073.25	562.525	1135.74
2.78	0	0	616.341	1074.2	561.8	1136.47
2.79	0	0	615.694	1075.01	561.019	1137.26
2.8	0	0	614.842	1075.82	560.099	1138.18
2.81	0	0	614.157	1076.66	559.42	1139.01
2.82	0	0	613.381	1077.31	558.74	1139.98
2.83	0	0	612.603	1078.25	557.75	1140.74
2.84	0	0	611.95	1078.98	557	1141.51
2.85	0	0	611.203	1079.86	556.25	1142.26
2.86	0	0	610.4	1080.5	555.467	1143.05
2.87	0	0	609.78	1081.41	554.686	1143.79
2.88	0	0	609.2	1082.11	554.03	1144.7
2.89	0	0	608.4	1082.97	553.217	1145.4
2.9	0	0	607.813	1083.65	552.407	1146.39
2.91	0	0	607.2	1084.47	551.782	1147.42
2.92	0	0	606.425	1085.1	550.748	1148.06
2.93	0	0	605.7	1085.79	549.95	1149.04
2.94	0	0	604.883	1086.7	548.967	1149.78
2.95	0	0	604.215	1087.59	548.345	1150.45
2.96	0	0	603.41	1088.5	547.653	1151.42
2.97	0	0	602.825	1089.2	546.95	1152.2
2.98	0	0	602.28	1089.83	546.168	1153
2.99	0	0	601.5	1090.49	545.36	1153.79
3	0	0	600.728	1091.42	544.669	1154.99

\*  $\gamma$  - log odds of differential assignment due to unobserved factors

$\text{sig}^+$  - upper bound significance level

$\text{sig}^-$  - lower bound significance level

$\hat{t}^+$  - upper bound Hodges-Lehmann point estimate

$\hat{t}^-$  - lower bound Hodges-Lehmann point estimate

$\text{CI}^+$  - upper bound confidence interval ( $\alpha = .95$ )

$\text{CI}^-$  - lower bound confidence interval ( $\alpha = .95$ )