CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE
Faculty of Tropical AgriSciences
Department of Economics and Development

The Impact of Mobile Phone Technology on Agricultural Information Services Delivery in the Northern Region of Ghana

MASTER'S THESIS

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Author:
Emmanuel Quintin-Cofie

Supervisor:
Alexander Kandakov, Ph.D.

Declaration

I hereby declare that I have done this thesis entitled **"The Impact of Mobile Phone Technology on Agricultural Information Services Delivery in the Northern Region of Ghana"** independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague 26th April, 2019

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Emmanuel Quintin-Cofie

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Abstract

Information and Communication Technology (ICT) plays a key role in fostering agricultural information delivery to farmers hence improving productivity. The research therefore studied the factors that are likely to influence farmers decision to subscribe to mobile phone based weather and market information service. The study further examined the challenges and the perception of farmers using weather and market information services via mobile phone. The study was conducted in 4 communities namely; Yong, Tibale, Chalam and Bihinaa-Yili within the Savelugu-Nanton district in the Northern Region of Ghana. The communities and respondents were selected using purposive sampling. Respondents were enumerated using semi-structured questionnaires. Data collected was analyzed using Binary logit model, descriptive statistics, hypothesis testing and qualitative analysis. Findings from the study showed that gender of the farmer, income level and farmers membership in a FBO played a significant role in farmers' decision to subscribe to a mobile phone based weather and market information service. The study revealed that male farmers were more likely to subscribe to mobile extension servies. In addition, farmers who belonged to a FBO were more likely to adopt extension services via mobile phone. On the other hand, there was a lower probability for farmers with increasing income due to off-farm activities to subscribe to mobile agricultural information. In examining farmers perception, majority of farmers agreed and strongly agreed that information from mobile weather and market service providers was useful, reliable and satisfactory. The use of descriptive statistics coupled with the Kendall's Concordance Coefficient W non-parametric test statistics helped to identify and rank farmers sources of agricultural information as radio, agricultural extension agents, mobile extension services, TV and farmer to farmer interactions respectively. Farmers identified poor network coverage, cost of handling mobile phone, lack of electricity to charge phones, difficulty in reading SMS messages due to illiteracy, inaccurate weather forecast and inaccurate market prices as the main challenges impeding their access and use of mobile phone weather and market information.

Key words: Mobile Phone, Information Communication Technologies (ICTs), Northern Region of Ghana, Farmers' Club, Weather and Market Information.

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List of the abbreviations used in the thesis

ACP	African, Caribbean and Pacific
AMIS	Agricultural Market Information Services
CRED	Centre for Research on the Epidemiology of Disasters
CTA	Technical Centre for Agricultural and Rural Cooperation
DFID	Department for International Development
EBSCO	Elton B Stephens Company
EM-DAT	Emergency Events Database
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEPC	Ghana Export Promotion Council
GIPC	Ghana Import Promotion Council
GSMA	Global System Mobile Association
GSS	Ghana Statistical Service
IAALD	International Association of Agricultural Information
ICTs	Information and Communication Technologies
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPM	Integrated Pest Management
MOFA	Ministry of Food and Agriculture
ODI	Overseas Development Institute
OEC	The Observatory of Economic Complexity
OFDA	Office of Foreign Disaster Assistance
SMS	Short Message Service
SRID	Spatial Reference System Identifier
UNICEF	United Nations International Children's Emergency Fund
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
USAID	United States Agency for International Development
WBG	World Bank Group
WFP	World Food Programme
WHO	World Health Organization

1. Introduction and Literature Review

1.1 Introduction

Agriculture is a very essential sector within the economy of Ghana as it remains an important contributor to export earnings, a major source of raw materials for the manufacturing sector and the most important sector for jobs and livelihoods in rural areas (World Bank 2018). The abysmal growth performance of the sector in achieving developmental goals is of much concern. The devastating effect of climate change coupled with the poor use of improved technologies due to limited reach of extension systems has resulted in low crop yields (FAO 2016).

Small holder farming need information on how to reduce risks associated with their farming activities and rural livelihoods (MacNamara 2003; Ducombe 2012; Sife et al. 2010). The lack of access to mass media and other channels of communication has resulted in poor information flow in rural areas (Hellstrom 2010; Bon 2012). An improved agricultural information delivery is a key component in improving small scale agricultural productivity, access to remunerative markets, quality of products, higher yields and food security (Asaba et al. 2006). The lack of weather and market information can lead to low farm productivity, high production and marketing costs and low price offers for farm produce (Mittal 2012; Mawazo 2015; Courtois & Subervie 2013).

Ghana operates a conventional system of extension delivery using public extension agents who disseminate information on new technologies and practices to farmers. This system is faced with much constraints; lack of funds, understaffing, large operational area coverage, ageing staff, limited knowledge upgrade opportunities and few female staff (DFID 2001; Ali 2012; Etwire et al. 2017). Hence the role of ICTs in enhancing information delivery to farmers is necessitated (FAO 2017). In comparison to conventional extension approaches, ICT based extension services such as mobile phones are a more convenient way of delivering advanced and real time weather and market information to farmers (Ali 2012; Mawazo 2015; Etwire et al. 2017).

The rapid acceptance and use of mobile phone in Ghana is the best means to facilitate the flow of weather and market information to and from farmers hence the introduction of Esoko and Farmers Club mobile phone based extension services in Ghana. The main aim of this thesis is to analyse the factors that are likely to influence farmers decision to use mobile phone based weather and market information. In Ghana, mobile phone based extension is an emerging area as such much enquiry on its operations is necessitated.

1.2 Literature Review

1.2.1 General facts and figures about Ghana

1.2.1.1 Landscape

The Republic of Ghana as officially known, is a country which lies on the West Coast of Africa. It covers an area of 238,500 km^2 lying within latitude 4^o 44'N and 11^o 11'N; longitude 3 ^{o} 11' W and 1^o 11'E and shares borders with Togo to the east, la Cote d'Ivoire to the west, Burkina Faso to the north and the Gulf of Guinea to the South (Ghana Web 2018).

1.2.1.2 Demography and Ethnicity

Ghana was the first African country to gain its independence in 1957 and currently operates a democratic governance system. English is the official language in Ghana but there are many different languages spoken by respective ethnic groups. The main religions practiced in Ghana are Christianity, Islamic and traditional (World Fact Book 2018). The major ethnic groups in Ghana comprise the Akan (49.7%), Mole-Dagbani (14.2%) and Ewe (13.3%) with Mande and Ga-Dangme as the smallest (GSS 2014).

1.2.1.3 Population

Ghana's estimated national population size stands at 28,308,301 with a 2.3% growth rate per annum and a male population of 13,886,734 and female population of 14,421,567. The highest populated region being the Ashanti region with population of 5,406,209 followed by the Greater Accra region with population of 4,613,637 out of ten regions of Ghana (GSS 2016). The life expectancy at birth stands at 63 years (World Bank 2018).

1.2.1.4 Meteorology

Ghana has a tropical climate with an estimated annual temperature of 26 °C and annual rainfall pattern of 736.6mm/29''. The country also experiences two rainy seasons which spans from April to July and September to November except for the north. The harmattan which is mostly severe in the northern part of the country is also experienced (Ghana Web 2018). The dry season in Ghana is accompanied by higher temperatures with greatest variations in the north and rainfall patterns which decline from the southern to the northern part of the country (World Bank Group 2018).

1.2.1.5 Economic Outlook

Ghana's growth and development efforts has been stagnated by the huge infrastructure deficit in very important sectors of its economy (FAO 2016). Ghana is a lower middle-income country with GDP of 42.8 billion US dollars which grows annually at 3.7% with an inflation of 17.8% and fiscal deficit of 9.3%. The growth in the industrial sector, mainly petroleum and mining subsectors has led to the expansion of the economy by 9.3%. An improved growth of 15.6% in ICT also helped to revamp the services sector from 3.7% to 5.6%. The increase in gold and oil exports has put Ghana in a better position with its surplus of trade balance standing at 3.2% of its GDP but for a more sustainable economic growth there is the need to look beyond the petroleum and mining sectors (World Bank 2018). Majority of the Ghanaian populace are employed in the services sector (43.1%), followed by the agricultural sector (41.5%) and finally the industrial sector (15.4%). There is 67.7 % of working age populace fully employed with 9.1 unemployed. The rural populace of 70.4 % is employed compared to employment of 60.4% of the urban populace. The forestry, fishery and skilled agricultural labour force constitute the largest proportion of the employed work force (GSS 2016). Ghana is blessed with petroleum, gold, bauxite, manganese and diamond as its main natural reserves. Ghana has its major export products to be cocoa, cocoa paste, gold, crude petroleum, coconut, brazil nuts and cashew with its main import product as cars, cement, delivery trucks, refined petroleum and non-fillet frozen fish (OEC 2016). Ghana also trades on the world market with its main agricultural import commodities being; wheat, rice, chicken (frozen), milk and fish and on the other hand exports mainly; cocoa, horticultural products, fish and other sea foods (MOFA 2016).

The results of The Observatory of Economic Complexity (2016) reveals that Ghana's total earnings from exports to Switzerland, India, China, the United Arab Emirates and the Netherlands amounted to 16.5 billion US dollars. According to Ghana Country Commercial Guide (2017) Ghana is engaged in international trade with the United States, Belgium, China, India and Canada as its main import partners with importation volumes of 8.9%, 5.6%,18.4%, 4.7% and 4.7% respectively of the country's total imports. Ghana is rich in natural resources for food and agriculture (FAO 2016).

1.2.2 Agricultural Sector in Ghana

The Agricultural sector in Ghana is the most vital sector in providing jobs and improved livelihoods especially in rural areas as it currently provides employment for over 70 % of rural dwellers (World Bank 2018). The Ghana Living Standards Survey Round 6 (2014) shows that sector provides employment to about 50% of Ghanaians and 51.5% of households either owns or manage a farm.The Ghanaian household populace of 2,203,465 representing 25.8%, majority of who predominantly reside in rural areas are engaged in agricultural activities of which 1,690,026 (76.7%) are headed by males and 513,939 (23.3%) by females but of all the regions, the Northern region has its largest household populace of 294,672 representing 54.5% engaged in agricultural activities (GSS 2016).

According to the Ministry of Food and Agriculture (2016) the sector remains the beacon of hope for social and economic transformation of Ghana as such the need to improve productivity in livestock and food crops through the "Planting for Food and Jobs" program which is aimed at ensuring sustainable incomes and a high growth projection within the sector which is expected to go a long way to achieve the needed force to engineer this transformation. The World Bank (2018) reveals that the sector contributes 18.9% of the country's national GDP and continues to be a key contributor to export earnings. The sector also stands as the main source of raw materials to the manufacturing sector in Ghana. The facts and figures of the Ministry of Food and Agriculture (2016) shows that 13,600,000 hectares representing 56.94% of the total land area of 23,884,245 hectares are agricultural lands with 6,421,450 hectares representing 47.22% under cultivation. The sector is dominated by small-scale farming with many farmers operating farm land size of less than 2 hectares with hoe and cutlass. Intercropping and monoculture remain the main production systems adopted in small and large -scale respectively with focus on coconut, oil palm, rubber, rice, maize and pineapple production on commercial farms. Productivity within the crop sub-sector is keenly subjected to soil factors and rainfall patterns. The availability of vase agricultural lands, lower cost of labour, water resources, opportunity for value linkages and increasing demand for food are cardinal opportunities for agricultural commercialization in Ghana (Agric Outlook 2013).The sector is categorized into major sub-sectors namely the crop, cocoa, livestock, forestry and fisheries with each constituting 67.7%,8.8% ,6.2%,11.2%, 6.1% respectively of agricultural GDP (GSS 2016).

The Crop Sub-sector

This sub-sector dominates the other sub-sectors and its growth rate of 9.4% in contribution to agricultural GDP component was recorded as the highest compared to the other sub-sectors (MOFA 2017). The sub-sector produces 3 major crop produce. Firstly, industrial crops: cocoa, oil palm, coconut, coffee, cotton, kola, rubber, cashew, shea and soya bean. Secondly, starchy staples, cereals and legumes: cassava, cocoyam, yam, plantain, maize, rice, millet, sorghum, cowpea and groundnut. Thirdly, fruits and vegetables: pineapple, citrus, banana, pawpaw, mango, tomato, pepper, okro, egg Plant, onion, butternut squash and Asian vegetables (MOFA 2016). According to the Statistics, Research and Information Directorate of Ministry and Food Agriculture (2017) Annual productivity of major food crops totalled 33,277 MT and apart from milled rice and millet, all other major food crops recorded a significant growth in production leading to excesses. Pineapple, banana, pawpaw exports to Europe and citrus exports to Togo sums up to over 70,000 tonnes of fruit exports whilst chillies, okro, egg plant, guar beans, tinda, gourds, yard long beans and marrows accounts for over 20,000 tonnes of vegetables exports from Ghana annually (GEPC 2010).

Cocoa, beans, oil palm, pineapple, cotton, tomato, banana, citrus fruits, coconut, cashew and fresh vegetables stands out as the primary cash crops. Tomato is classified as the most productive vegetable in terms of productivity volumes and export earnings. Coconut is predominately cultivated by small holder farmers on 36,000 hectares and this accounts for 80% of annual productivity where as citrus and pineapple annual production stands at over 20,000 and 60,000 MT respectively (GIPC 2018). Coconut, Brazil nuts and cashew exports in 2016 accounted to 619 million dollars and cocoa beans on the other hand accounted for 2.21 billion dollars of export earnings (OEC 2016). The volume and value of four major non-traditional crop exports from Ghana for the duration from 2012 to 2016 (see Table 1& Table 2).

Table 1. Volume of four major non-traditional crop exports (Mt), 2012 to 2016

Crops	2012	2013	2014	2015	2016
Pineapple	41,212	40,095	33,634	43,461	27,148
Yam	25,079	5,230	36,826	28,296	24,105
Banana	60,425	8,656	56075	95,180	108,473
Cashew nuts	157,176	271,537	192,376	232,835	231,555
Shea nuts	108,976	37,518	59,909	134,651	78,268

Source: Statistics, Research and Information Directorate, MOFA 2016

Table 2. Value of four major non-traditional crop exports (US$'000), 2012 to 2016

Crops	2012	2013	2014	2015	2016
Pineapple	16,816	19,209	17,960	20,539	13,727
Yam	12,251	3,255	18,282	18,980	18,977
Banana	15,317	2,287	16,699	25,443	30,853
Cashew nuts	91,290	155,629	134,614	211,328	196,784
Shea nuts	26,338	8,063	25,046	33,572	19,165

Source: Statistics, Research and Information Directorate, MOFA 2016

1.2.2.1 The Challenges confronting the agricultural sector in Ghana

The sector in Ghana is confronted with many setbacks and these include; climate change, lack of irrigation schemes, limited access to credit facility by farmers, low levels of production and processing due to minimum mechanization, high post-harvest loses due to poor storage, low value addition and poor post-harvest handling methods coupled with ineffective extension delivery approaches which has resulted in poor adoption of improved technologies and limited access to markets (MOFA 2013).

Climate Change and its effects on agriculture in Ghana

Africa and the World (2018) there is a great potential in the agricultural sector in Africa that remains untapped. Agriculture in sub-Saharan Africa is the backbone to ensuring growth, poverty reduction and food security within the region but challenges confronting the sector has incapacitated the exploitation of these potentials (FAO 2009). Producing quality and quantity to feed the growing population in Africa remains a force to reckon with and this is of much concern since the region records the highest levels of hunger, malnutrition and food insecurity (World Bank 2011). Food produced by rainfed agriculture dominates poor communities in developing countries and more than 95% of farmers in sub-Saharan Africa rely on rainfed farming which is characterized by great uncertainty to productivity (Wani 2009). As mentioned by FAO (2009) climate change leading to extreme conditions of flood and drought is expected to decrease prospective crop yields by 50% within some countries in the region causing an estimated 5 to 10% loss in GDP. Climate change stands out to be considered as the major risk to world agriculture (Cline 2007). Climate change effect on agricultural productivity will have a more devastating effect on developing countries and for Ghana an estimated 5% to 15% loss with a much more devasting effect on its Northern parts (Nankani 2009). Ghana's agricultural sector is very much challenged with climate change especially within the Northern region where high temperatures and severe heat accompanied by frequent flooding and later drought occurrences have led to crop unproductivity (World Bank 2018).

Rainfall profile in Ghana

Majority of farmers in Ghana operate rainfed agriculture as such rainfall remains crucial to agricultural productivity in Ghana (MOFA 2017). For the period dating back from 2011 to 2017, Ghana has experienced inconsistent rainfall patterns which has adversely affected farmers planning and decision making hence a major setback to their farming activities (see Figure 1).

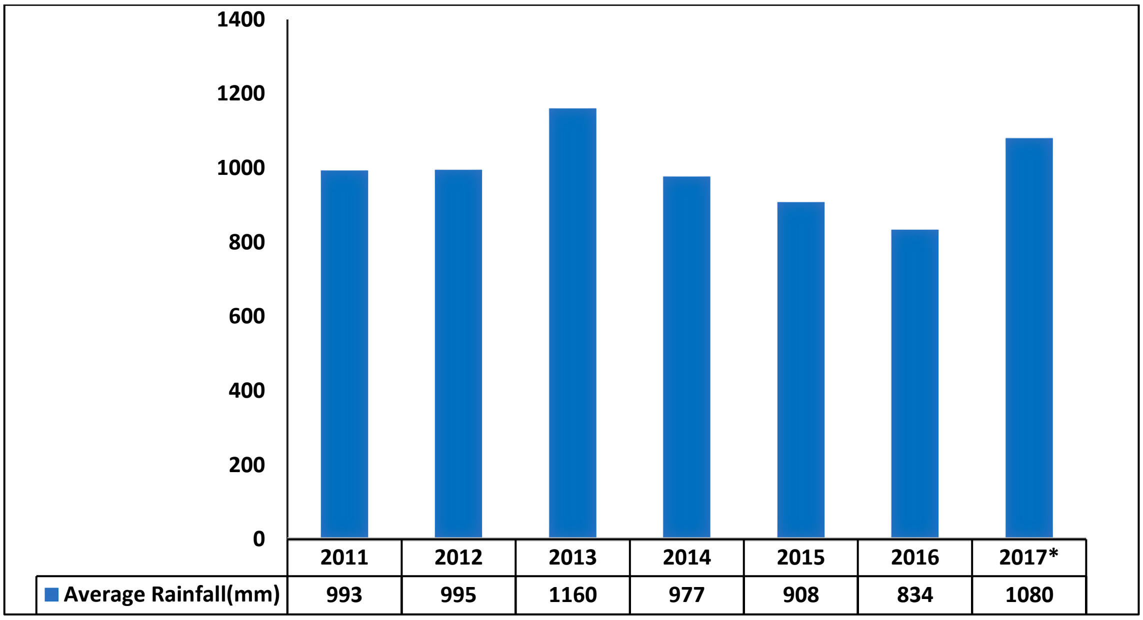

Figure 1: National average rainfall(mm) trend (Ghana 2011-2017)

*Provisional, Source: MOFA 2017

The farming seasons in Ghana are climate dependent (MOFA 2015). The forecast of the Ghana Meteorological Agency (2017) shows clearly the Upper West and the Northern regions recorded a drop in the amount of rainfall of 22.4% and 4.4% respectively. There was a low yield of major staple crops; maize, sorghum, millet, rice and groundnut produced within these regions as a result of no rains in the peak farming season as was expected (MOFA 2017). The Agricultural Sector Progress Report by MOFA (2016) identifies an irregular distribution and descending trend of rainfall from 1276mm in 2008 to 834mm in 2016 with a 60% drop in volumes of rainfall because of climate change.

Rainfall and temperature profile in the northern region of Ghana

The northern region of Ghana experiences a wet season and a dry season from May to November and from December to March respectively (World Bank Group 2018). The region records a very warm climate with a yearly average of 34 degrees centigrade. It records relatively higher humidity from July to September (World Data 2018). The monthly temperature and rainfall trend in the northern region is inconsistent (see Figure 2).

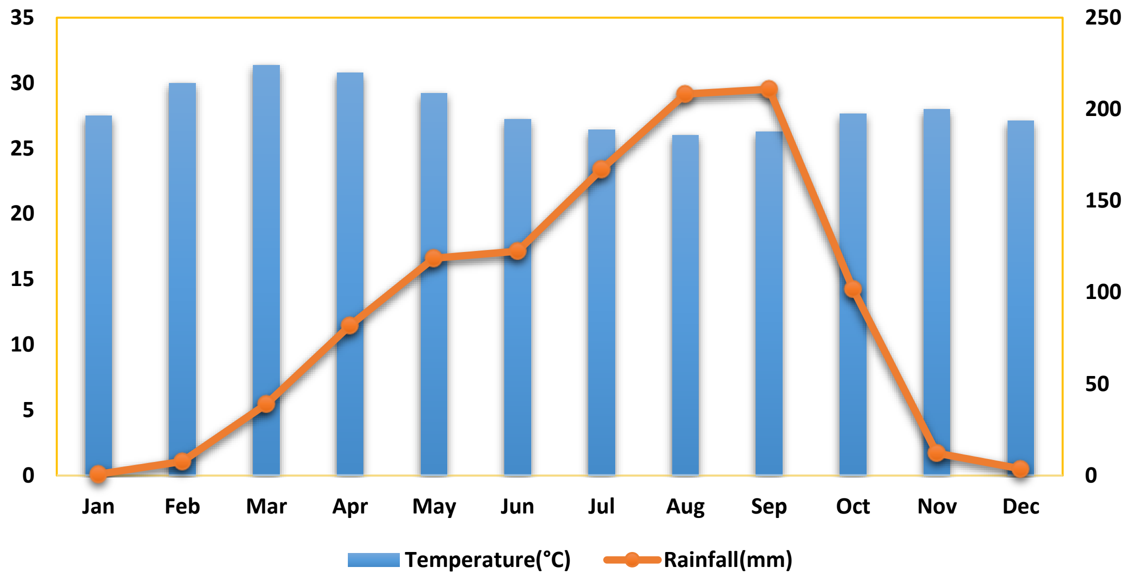

Figure 2: Average monthly temperature and rainfall within the northern region of Ghana (1901-2015)

Source: World Data 2018

Conditions of Flood and Drought in Ghana

The frequency and intensity of droughts and heavy rains has adversely influenced the lifestyle of African farmers (Giles 2007). Floods and droughts rank second and first respectively as the disasters the claim lives and affect majority of the populace in Ghana. Extreme temperatures and alternating rainfall cycles has resulted in this phenomenon which continues to be one of the most cardinal challenges confronting agricultural productivity in Ghana (Asumadu-Sarkodie et al. 2015). Crop failure due to droughts and floods is having wider impacts on the regional economy of Ghana (World Bank Group 2018). According to EM-DAT (2018) total economic loss as a result of flood and drought in Ghana amounted to US$ 120,300,000 (see Table 3).

Table 3. Climate related disasters in Ghana from 1990 to 2018

Disaster	No of events	Total death	Total affected	Total economic loss (US$)
Flood	21	479	4,889,990	120,200,000
Drought	3	-	12,512,000	100,000
Storm	1	20	12	-

Source: EM-DAT 2018

According to The International Disaster Database (2015) the greatest proportion of Ghana's economic loss can be attributed to flooding. The impacts of flood and drought has negatively influenced the socio-economic living standards of the people in the Northern region of Ghana. In 2007, the devastating effects of flooding on lives and properties experienced in the Northern region of the country amounted to 130 million US dollars with over 12,220 hectares of farmlands destroyed leading to the loss of foodstuff amounting to 13,895 MT (EPA 2012; Ahadzie & Proverbs 2011).

Devastating effects of flood and drought in the northern region of Ghana

The vulnerability of the region to floods and droughts is very high. Households within four selected communities in the region rated the effects of flood and drought as "most severe" with a 76% and 80% respectively (Lolig et al. 2014). The region declared a state of emergency owing to the destructive effect of floods which amounted to the loss of 13,895 metric tonnes of foodstuffs, 83 roads and 68 bridges within farming communities (Ahadzie & Proverbs 2011).

In the Northern region of Ghana nine out of thirteen districts experienced flooding which led to the destruction of livestock, farm roads, irrigation dams and farms. A total of 2330 hectares of crop varieties comprising of 957.3ha, 935ha, 293.4ha, 92ha and 52.4ha of rice, maize, sorghum, millet and groundnut respectively were destroyed (MOFA 2016).

The worst flooding conditions experienced in the Northern region of Ghana in 2007 occurred because of the spillage of the Bagre Dam in Burkina Faso coupled with intense rainfall patterns within the same time. The Ministry of Food and Agriculture of Ghana recorded an estimated loss in production of maize, sorghum, millet, groundnut, yam, cassava and rice totaling 144,000 MT as a result of the destruction of 70,500 hectares of agricultural lands by floods (Armah et al. 2010). The United Nations Office for the Coordination of Humanitarian Affairs (2007) reported the northern region was at the risk of malnutrition and food insecurity for over a year with about 50,000 people as victims after the floods.

According to Armah et al (2010) the devastating effects of floods within the northern region of Ghana predominantly affects crop farmers since they form the largest populace within the region. The destruction of farm lands, crops, livestock and seed stores leads to low food productivity which in turn results in hunger and malnutrition, rural-urban migration and lower household incomes as medium to long term effects (see Appendix 1).

1.2.3 The role of information services in confronting challenges facing crop farmers

Information gap and asymmetry on weather, farming practices and market trends makes farmers more susceptible to uncertainties associated with market and climate which reflects negatively on productivity and income levels (Mittal 2012). Climate change remains on the top list of factors engineering natural disaster occurrence which militate against majority engaged in agricultural activities. A clear, concise and reliable information delivery is therefore necessitated in the management of these natural disasters (World Bank Group 2018). The intensity and frequency of floods and droughts is having a major impact on the lives of farmers in Africa (World Bank 2011). Therefore, the ability of agriculture dependent communities to forecast, plan and prepare for these impending disasters depends on their adaptive capacity of using information and technology (Armah et al. 2010). Access to information is very crucial in dealing with the variability and extremity of Climate (FAO 2018). The adoption of coping strategies to manage the challenges confronting farmers by way of climate change is the reliance on information from extension services (Lolig et al. 2014). In complementing the role of information delivery via extension services, ICT has been identified to have the potential to disseminate information on farming practices, market trends, improved technologies and risk management techniques to farmers (Mittal & Tripathi 2009). ICT tools can be used to create awareness and deliver productive information to meet the needs of farmers (USAID 2013).

Agricultural information delivery via extension services

Agricultural extension service has been used as a major transformational tool to enhance rural livelihoods in most developing countries by way of information exchange between extension agents and farmers on agricultural practices, weather and market (Saravanan 2010; Annor-Frempong et al. 2006). One significant pillar behind formulated agricultural policies remain the feedback gathered from farmers through agricultural extension providers (DFID 2001). In Ghana, extension delivery service is carried out by the Directorate of Agriculture Extension Service under the Ministry of Food and Agriculture and its core mandate is delivering superior agricultural technologies and practices to farmers (Ali 2012; MOFA 2018). According to Mittal (2012) extension services are used extensively in disseminating innovative agricultural technologies, better farming practices and disastrous climate management techniques to farmers in India. Information delivery by extension officers contributed 71.8% as source of agricultural information to farmers in local communities in Tanzania. Though farmers have appraised extension as a vital source of information flow, its efficiency and effectiveness in meeting the demands of farmers remains a worry. This phenomenon is not different from the experiences in Ghana where funding and staffing remain key constraints to the operationalization of extension services (Lwoga et al. 2011; Adomi et al. 2003; Castella et al. 2006; Ali 2012).

Agricultural information delivery via ICTs

Information Communication Technology (ICT) has become a very vital developmental instrument we cannot do away with in our daily lives. The world has become a global village with easy access to information from one end to another through ICT tools ranging from landline phones, TV, radio, internet, mobile phones, satellites to a broader scope of ICT initiatives focussed on SMS, information kiosks, multipurpose community centres and village knowledge centres (GSS 2014; Mittal 2012; McNamara 2003). ICT's assist in educating, creating awareness and providing content-specific information to bridge the gap in accessing information. Studies in Asia and Africa gives a clear evidence of how ICT's can be used to cut down cost associated with information delivery to farmers (Mittal 2012; Gumah et al. 2016; Baumüller 2012). According to Yonazi et al (2012) ICT's can be deployed in the farming lifecycle of pre-cultivation, crop cultivation, harvesting, post-harvest and to a larger extent geographical information system for land-use planning and climate change adaptation. ICT has enormous potential of delivering advanced and real time information to farmers as such it has become very crucial to thoroughly access, formulate and roll out ICT initiatives that will keep farmers better informed (Fischer et al. 2009; Ali 2012; Mittal 2012). Around the world today, ICT's commonly radio, TV and more recently mobile-phone based information services is helping farmers minimise market and production risks via price and weather information provision respectively (Mawazo 2015; Shaham 2016; Etwire et al. 2017).

1.2.3 The role agricultural market information services in agriculture

Agricultural Market Information Services (AMIS) are systems designed to collect, analyse and disseminate information on the dynamics of prices on agricultural markets. AMIS promotes transparency in markets and ensures efficient allocation of resources (Mawazo 2014; Galtier et al. 2013). Agricultural Market Information Services have become a very vital tool in accessing and distributing data on market prices, following the food crisis experienced in 2007 and 2008. Efficient market information systems have the tendency of improving market efficiency, competitiveness and reducing the information gap that exists among farmers, traders and stakeholders. Through AMIS farmers become aware of market choices and opportunities as such gain power in bargaining of their produce (FAO 2017). According to David-Benz et al (2011) farmers' livelihood depends on AMIS since their decision on what to plant, when to plant, when to harvest, where to sell, to whom to see to and at what price to sell is primarily reliant on market information services.

ICT-based agricultural market information services

Research evidence show that the rural livelihoods are greatly enhanced by access to information on improved agricultural practices, market and weather (Saravanan 2010). Compared to conventional extension approaches, it has been shown that ICTs such as mobile phones are a more convenient way to deliver useful and up-to-date weather and market information. For extension providers, mobile phone-based services enable the delivery of content-specific information, extensive creation of awareness, and reduction in the cost of diffusing information manually. Besides, by relying only on conventional approaches, extension providers may not be able to sufficiently meet the increasing demand for information (Mittal 2012). There are several initiatives to connect small-scale farmers to markets and marketing information. Although there are several applications providing this service in sub-Saharan Africa, Esoko is well-known (Mawazo, 2015). The outstanding view remains that AMIS in developing countries can be beneficial for both farmers and traders (David-Benz et al. 2011). In recent years several researches have been carried out, in many cases to assess the impact of improved market information via mobile phone. A study in Niger and India revealed that mobile phones helped to reduce distortion in market prices in cowpea and fish farming respectively (Aker & Fafchamps 2014; Jensen 2007). Improved interrelationships between farmers and traders in Philippines and Tanzania was a result of transactions initiated over mobile phone (Molony 2008; Labonne & Chase 2009). In Uganda and Kenya farmers using mobile-phone based market information services were much more involved in marketing activities compared to farmers who did not have access to mobile information services (Ogutu et al. 2013; Muto & Yamano 2009). In recent times, Esoko has engaged farmers in different locations of Ghana in mobile phone based weather and market information pilot project. Esoko is a profit-oriented organization that collects and distributes information to farmers via mobile phone and website. Subscribers can access input and output prices, bids and offers, weather forecast, and tips on good agricultural practices at a fee ranging between US$35 to US$ 1500 per annum (Etwire et al. 2017).

In 2015, Esoko partnered with Vodafone Farmers' Club, an agricultural information service initiated by Vodafone Ghana. The pilot project was funded by Vodafone Ghana and the GSMA through the mNutrition initiative funded by UK aid from the UK government (DFID). GSMA mAgri programme provided consultancy throughout the project development cycle. Over 200,000 farmers had registered for project by December 2016. Farmers get advice on weather updates, market prices and free calls between Farmers' Club members with a Farmers' Club SIM. Farmers' Club has been free of charge since October 2016 for an extended trial period with consideration for future pricing of the service. After registration farmers get access to 3 agricultural tips a month on main crop cultivated and one nutritional tip as outbound dialed calls in a choice of ten local languages. Twelve 2 to 3 day weather forecasts and four market price SMS are sent monthly in English. Farmers can get advice from experts in 14 local languages free of charge via the Esoko inbound call centre (Palmer & Darabian 2017).

2. Objectives of the Thesis

2.1 Main objective

The main aim of thesis is to examine the impact of mobile phone technology on agricultural market and weather information delivery in the northern region of Ghana.

2.2 Specific objectives

The main objective of the thesis will be accomplished through more specific objectives:

i. To assess the factors that influence a farmer's decision to acquire mobile phone based weather and market information.

ii. To evaluate the perception of farmers using mobile phone based weather and market information services.

iii. To identify the challenges in using mobile phone based weather and market information services.

iv. To identify and rank agricultural information sources available to farmers.

The study sought to achieve its objectives by answering the following research questions

1.What are the factors that influence a farmer's decision to acquire mobile phone based weather and market information? This will be analysed using binary probit model.

2. How do farmers perceive the usefulness, reliability and satisfaction in using mobile phone based weather and market information services? This will be analysed using descriptive statistics and hypothesis testing;

Hypothesis:

H_0: ratings of usefulness of mobile phone based weather and market information are similar within a given category.

H_0: ratings of reliability of mobile phone based weather and market information are similar within a given category.

H_0: ratings of satisfaction of mobile phone based weather and market information are similar within a given category.

3. What are the challenges encountered by farmers using mobile phone based weather and market information? This will be analysed qualitatively.

4. What are the most preferred sources of weather and market information to farmers? This will be analysed using descriptive statistics.

3. Methods

3.1 Data sources

The study employed two types of data sources. The secondary data sources employed helped to get a broader insight and perspective of the topic under study which preceded the field survey. The primary data collection employed different techniques to obtain new data set.

3.1.1 Secondary data sources

The key sources engaged included scientific journals, reports, statistical databases, research papers and projects such as Journal of Agric Food Information, International Journal of Safety and Security Engineering, Journal of Disaster Research, Research Gate Journal, International Journal of Applied and Pure Science, Quarterly Journal of International Agriculture, Journal of Development Studies, American Economic Journal and Journal of Economic Perspectives. Thomson Reuters Web of Science, Science Direct, EBSCO, InCites, Scopus and Elsevier were very useful databases for relevant data access. In addition, researches, reports and statistical databases of FAO, UNICEF, World Bank, WFP, MOFA and the Ghana Statistical Service were employed. The use of key terminologies was the main search criteria adopted to solicit information.

3.1.2 Primary data sources

To get access to a more exact dataset, alternative sources of data collection methods were used. The methods employed to solicit primary data was Structured questionnaires and interviews with respondents coupled with observation of the study area which facilitated further understanding of the topic under study. In Appendix 3 is a picture representation showing the questionnaire survey carried out in the study area.

Structured questionnaire

Primary data was collected using the structured questionnaire as the major instrument and its design was influenced by the objectives of the study. It was considered as best fit instrument as it quickly, easily and efficiently helps to get responses from a larger number of respondents. Questionnaire was expressed in English language with questions format demanding single, multiple choice, scaling, ranking and open-ended responses (see Appendix 2). The structure of the questionnaire consists of:

i. **Socio-demographic characteristics of respondents**: age, gender, community, marital status, level of education, farm size, household size, income and employment.

ii. **Farmers choice of mobile-phone based agricultural information**: factors influencing farmers decision to acquire weather and market information.

iii. **Agricultural information services**: available sources of information for farmers, preference of information source.

iv. **Usage of mobile phone agricultural information**: rating of perception on usefulness, reliability and satisfaction.

v. **Challenges in using mobile phone extension services**: Open-ended response of constraints in usage by farmers.

Pre-tests of Questionnaire

The initially drafted questionnaire was pilot tested in the Savelugu-Nanton district of the Northern region with 10 farmers within the first day of field survey. Observation of the study area was also initiated. To ensure effectiveness of the questionnaire in obtaining information there was the need for amendments. The final version of the questionnaire was prepared for the field survey.

Observations

Observation was formally carried out in 4 communities namely; Yong, Tibale, Chalam and Bihinaa-Yili within the Savelugu-Nanton district. A better understanding of respondent’s activities and interactions with agricultural information delivery services was ascertained from feedback obtained from observations made.

3.2 Description of study area

The study was conducted in four communities within the Savelugu-Nanton district of the Northern region of region. The Savelugu- Nanton district is situated within the Northern region of Ghana. Savelugu is the district capital. It is bounded by Karaga to the East, Kumbungu to the West, West Mamprusi to the North and Tamale Metro to the South. It has 149 communities. The district covers an estimated total land area of 2022.6 sq.km with 400 to 800 feet altitude above sea level. The district has a population of 139,283 which comprises of 48.5 percent males and 51.5 percent females. The population density in the area is 68.9 persons per sq.km. The area experiences erratic rainfall patterns and high temperatures. The average annual rainfall and temperature recorded is 600mm and 34°C respectively. Agriculture accounts for 74.1 percent of employment and crop farming dominants the district with rice, yam, cassava, groundnut, maize, cowpea and sorghum as the main food crops cultivated (GSS 2014).

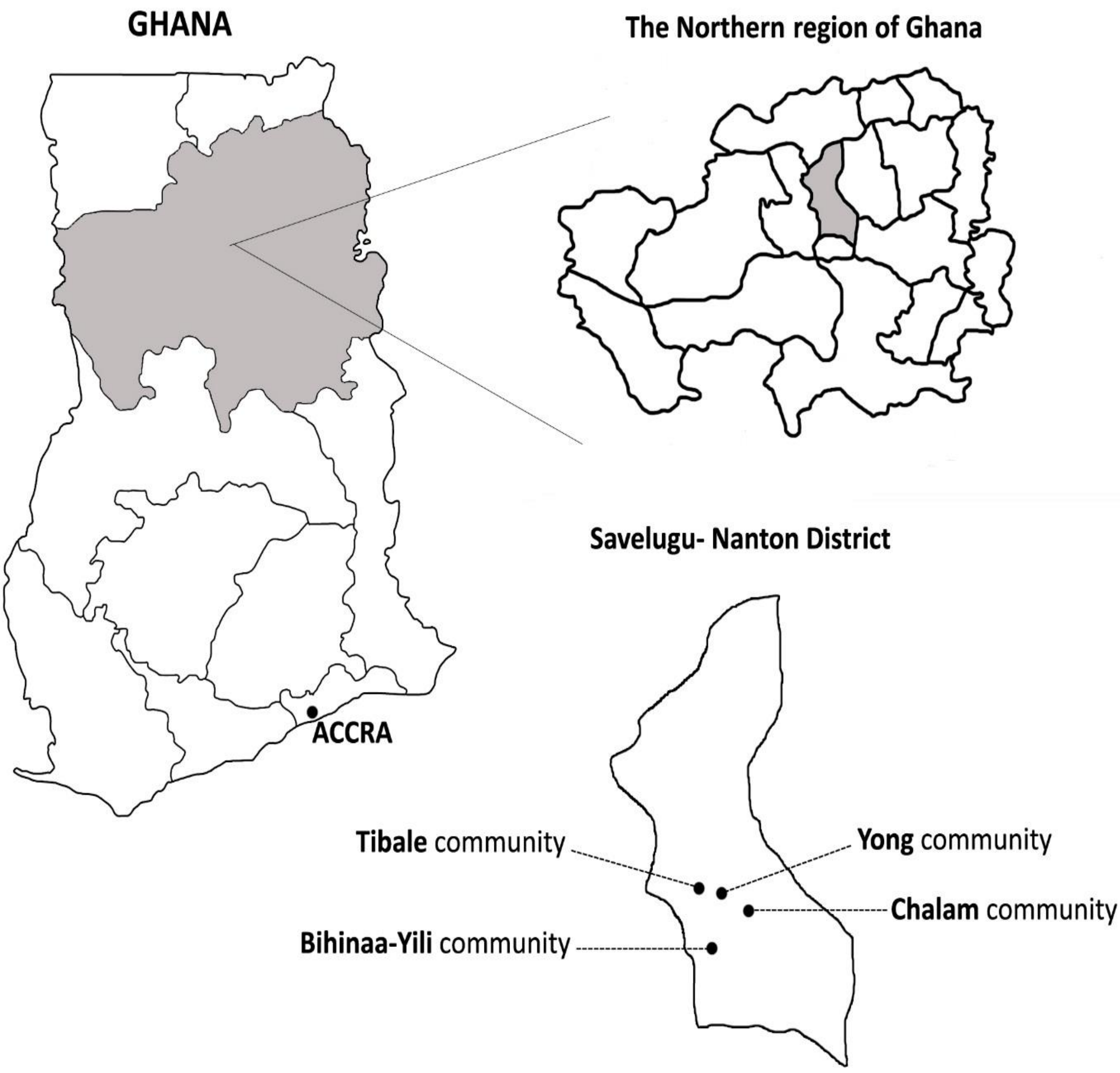

Figure 3: A map of the Northern Region of Ghana showing the study area

Source: Compiled by Author 2019

3.3 Target Group and Sample size

The focus was on farmers residing in communities within the Savelugu-Nanton district of the Northern region of Ghana. The sampling technique adopted was purposive sampling of the district specifically the Yong, Chalam, Bihinaa-Yili and Tibale communities where mobile phone weather and market information was available to farmers on the Esoko and Farmers Club pilot project. The respondents were purposively sampled from the communities. The Ghana Statistical Service 2010 population and housing census in the Northern region recorded an estimated crop farmers population of 117,631 9 (GSS 2012). A sample size calculation formula by (Survey Monkey 2018) was used to calculate the sample size.

$$\text{Sample Size} = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$

N = population size

e = Margin of error/confidence interval

z = z-score (number of standard deviations a given proportion is away from the mean)

p = standard of deviation

Using N =117,631, e = 9% (0.09), z = 1.96 (based on confidence level of 95%) and p = 50% (0.05)

$$\text{Sample Size} = \frac{\frac{(1.96)^2 \times 0.5(1-0.5)}{(0.09)^2}}{1 + \left(\frac{(1.96)^2 \times 0.5(1-0.5)}{(0.09)^2 117631}\right)} = 119$$

Respondents were selected using the below listed criteria;

i. Should be a food crop farmer

ii. Should belong to any of the four selected rural communities

iii. Should be able to communicate in English or local dialect Dagbani

iv. Should own a mobile phone

In order to ensure equity same number of respondents were surveyed in each of the four communities. In total, 120 respondents were surveyed within the study area (see Table 4)

Table 4. Sample distribution across communities

Name of District	Name of Community	Number selected per community
Savelugu- Nanton	Chalam	30
	Yong	30
	Bihinaa-Yili	30
	Tibale	30
Total	4	120

Source: Field Survey 2017

3.4 Time Frame

The preparation and writing of the thesis was accomplished in 3 main stages before final submission. The preparation stage which is the first, involved formulation of the objectives and research methodology to be used and this was based on extension literature reviewed on the study. The second stage of data collection was also achieved by surveying crop farmers in the Northern region of Ghana. The final stage involved cleaning and coding data, analysing data in SPSS software and interpreting outcome of data analysed.

Activity	April 2017 to July 2017	August 2017 to September 2017	October 2017 to December 2017	January 2018 to April 2018
Analysing secondary data				
Objectives formulation				
Research methodology formulation				
Designing questionnaire				
Questionnaire pre-tests				
Survey and data collection in Ghana				
Cleaning and coding data				
Analysing of data				
Interpretation of data				

Source: Author 2018

3.5 Data Analysis

The primary data obtained was analysed using three different analytical tools. In order to analyse the first objective, farmers decision to utilise mobile phone based weather and market information was modelled as a binary option where farmers were either willing to subscribe to Esoko and famers Club pilot project or not. A binary logit model is further estimated. The dichotomous nature of the dependent variable as spelt out in many econometric literatures was a key driving force in adopting the binary logit regression

(Berger 2017; Long & Freese 2014). Secondly, descriptive statistics and hypothesis testing was used to analyse the perception of farmers on the usefulness, reliability and satisfaction of using mobile phone based weather and market information services. The third objective was achieved by qualitatively analysing the challenges in the use of mobile phone based weather and market information. Finally, to identify and rank available agricultural information sources to farmers, descriptive statistics was employed.

3.5.1 Binary Logit Model

Binary logistic regression is useful when the dependent variable is dichotomous in nature. In such cases where Y is a dummy variable (value of 1 or otherwise 0) binary choice models fit best (Berger 2017; Dudek 2013). This study used the binary logit model to estimate the factors that inform farmers decision to subscribe to weather and market information provided by Esoko and Farmers club pilot project. The dependent variable (Y= Farmers decision to subscribe) is coded as a dummy and takes on a value of one (1) when farmers were willing to subscribe for weather and market information and zero (0) if farmers were not willing to subscribe for weather and market information services. The model sought to find out the relationship between the probability (P_i) that Y will be one (1) and the characteristics of respondents (Greene 2000).

An assumption of a normal binary choice model can be made inferring from Greene (2000) that;

$$P_i = P\ (Y_i = 1) = F\ (\beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_k X_{ki})$$

Where: (Y_i= 1) denotes that a farmer is willing to subscribe for weather and market information services, β_j is unknown parameters, F is the cumulative logistic distribution function and X_j is explanatory variables (characteristics likely to influence farmers decision of subscription).

Therefore, this equation is empirically estimated as;

$$\Pr(\text{Subscribe} = 1) = F(\beta_o + \beta_1 Gender + \beta_2 \text{Age} + \beta_3 \text{Education level} + \beta_4 \text{Farm size} + \beta_5 \text{Income} + \beta_6 \text{Member of FBO})$$

The logit model takes the form;

$$P_i = P(Y_i = 1) = \wedge(X_i^T \beta) = \frac{1}{1 + exp(Xi^T \beta)}$$

Where: $X_i^T\beta = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_k X_{ki}$ and F(.) = ^(.) is logistic cumulative frequency

The logit model employs odd ratios to explain effects on outcome as a result of changes in explanatory variables. The study defined odds as a ratio of two probabilities P_i and

1- P_i that is the ratio of the probability of farmers willingness to subscribe to that of farmers unwillingness to subscribe. This can be expressed in the equation;

$$\text{Odds} = \frac{Pi}{1 - Pi} = exp(Xi^T \beta)$$

Where exponential relationship gives an interpretation of odds ratio and β is estimated parameter. Hence for a unit change in each explanatory variable (X_j) the odds are expected to change by a factor of $exp(\beta j)$ holding all other variables constant. The explanatory variable, parameters are estimated by maximum likelihood method and odds by SPSS software package (Dudek 2013).

3.5.1.1 Explanation of Exogenous variables used in the model

The choice of the explanatory variables used in the model is based on literate reviewed about the study. The variables used in the model included socio demographic characteristics of farmers; age, gender, farming income, level of education, size of farm land and farmer based organization membership. A description of the explanatory variables used in the model is outlined in Table 5.

Gender

There is a strong link between gender and access to information. It is important to give attention to gender differences when assessing the opportunities and risks of adopting new technologies. Gender inequality remains a serious issue in ICT's use (FAO 2018). Gender is factored in the model to ascertain the divide that lies in assessing mobile phone based weather and market information services. Gender for the sake of this study is treated as a dummy, given a value of 1 for a male farmer and 0 for a female farmer.

Age

A study by GSS (2014) shows mobile phone ownership is prevalent among younger people. The older populace have concern and fear using technology due to lack of knowledge and perceived dangers. The lack of social interaction and communication coupled with the feelings of inadequacy compared to younger generations makes the older generation sceptic (Vaportzis et al. 2017). This implies the older generation are less likely to sign up for mobile phone based weather and market information services. Age is captured as a continuous variable and represented in years.

Farming Income

The lack of material means hinders efficient accessibility to information (Britz 2004). Low level of income is an additional barrier to possible adoption of ICT initiatives (FAO 2018). According to World Bank (2011) farmers whose income levels from farming activities are low are forced to give priority to other activities to get income. The adoption of modern practices is hindered by financial constraints (Darfour & Rossentrater 2016). There is a lesser likelihood for low income farmers to patronize mobile phone based weather and market information services. Farming income is categorised and represented in the model as a continuous variable.

Level of Education

Education was found to play an important role in influencing the use of ICT's in decision making. Illiteracy is a barrier to possible adoption of ICT initiatives (Mittal 2012; FAO 2018). A study by Lwoga et al (2011) reveals that strategies to improve knowledge base of rural farmers is essential to increase the adoption rate of information and technologies. It is factored in the model as a dummy with 1 representing formal education and 0 as no formal education.

Size of Farm Land

It was captured during the data collection as the number of acres of crop cultivated by the farmer. Farm size plays a critical role in adoption process of a new technology. Many authors have analysed farm size as one important determinant of technology adoption. Farm size can affect and in turn be affected by other factors influencing adoption. Large farm size may have positive effect on adoption of a certain technology and it may also reveal a negative impact on adoption of another technology (Lavison 2013; Mwangi & Kariuki 2015). Farmers with large farm size are likely to adopt a new technology unlike those with smaller farm size (Uaiene et al. 2009). It is factored in the model as a continuous variable.

FBO Membership

Farmer to farmer interactions has a greater impact in influencing farmers decision to subscribe to mobile phone based weather and market information services (Etwire et al. 2017). This variable is handled as a binary choice where farmers belonging to a farmer based group is given 1 and 0 if farmer is not a member of a FBO.

Table 5. Variables included in the estimation of the Binary logit model

Variable	**Type of Variable**	**Description**
	Dependent Variable	
Weather and Market information services	Binary variable (yes=1, no=0)	Farmers decision to subscribe to mobile phone based information
	Independent Variables	
Gender	Binary variable (male =1, female = 0)	Gender of farmer
Age	Continuous variable	Age of the farmer
Farming income	Continuous variable	Average annual income
Level of Education	Binary variable (formal =1, no formal= 0)	Level of formal education
Farm Size	Continuous variable	Size of farm land cultivated in acres
FBO member	Binary variable (yes =1, no = 0)	Farmer's membership in a farmer group

Source: Author 2019

3.5.2 Wilcoxon-Mann-Whitney Test and Kendall's Concordance Coefficient W

Farmers perception based on usefulness, reliability and satisfaction in using mobile phone based weather and market information of Esoko and Farmers Club Pilot project was measured on a 5-point Likert scale; strongly agree, agree, indifferent, disagree and strongly disagree. In order to examine whether perception vary among different categories of farmers in terms of gender, age, income level and educational level, their ratings on usefulness, reliability and satisfaction is subjected to a two independent sample Wilcoxon-Mann-Whitney non parametric test. A two-sided hypothesis test based on a 95% confidence interval is carried out to find out if there is similarity in the perception of farmers with respect to differences in gender, age, income level and educational level in the usefulness, reliability and satisfaction with using mobile phone based weather and market information services. The null hypothesis is formulated as follows;

H_0: ratings of usefulness of mobile phone based weather and market are similar within a given category.

H_0: ratings of reliability of mobile phone based weather and market are similar within a given category.

H_0: ratings of satisfaction of mobile phone based weather and market are similar within a given category.

Farmers preference of agricultural information sources was measured on ranked responses; most preferred, 2_{nd} choice, 3_{rd} choice, 4_{th} choice and least preferred. In order to examine the level of agreement in responses provide by farmers, the Kendall's Concordance Coefficient W analysis was run after farmers have been asked to rank their preferred source of agricultural information.

4. Results

4.1 Descriptive statistics results

This chapter entails the results of the Binary Logit Model, Wilcoxon-Mann-Whitney Test, Kendall's Concordance Coefficient W analysis, Hypothesis testing as well as socio-demographic characteristics and summary statistics of variables and respondents. It also contains descriptive statistics of sources of weather and market information for respondents as well as qualitative analysis of the challenges in using mobile phone based weather and market information services.

Socio-economic Characteristics of Respondents

In this section, the combined social and economic features of crop farmers for all the four communities in the study area is presented in Table 6. Specific issues discussed include the gender, age, income, marital status, household size and educational level of respondents.

The results in Table 6 shows that majority of the respondents constituting 75.8 % were males where as female farmers were 24.2%. Again, more farmers (30%) were in the age bracket of 31 to 40 years while 20.8% were in the age range between 41 to 50 years with only a few (9.2%) farmers above 61 years old. The oldest farmer was 65 years while the youngest aged farmer was 18 years old. In line with marital status many (84.2%) of respondents were found to be married where as the single respondents comprised 15.8%. Farmers who had some form of primary and secondary (formal) education were a little bit more (55%) than their colleague farmers (45%) with no formal education. Furthermore, lower income levels of between 100 to 500 Ghana cedi is recorded much (39.2%) among respondents. The income range of between 500 to 1000 Ghana cedi also had much appreciable number of farmers at 36.7% mean while farmers whose annual income was expected to be above 2000 Ghana cedi was at a lowest with 4.2%. The lower levels of income recorded was expected since respondents were predominantly into subsistence farming and produced only a few to sell. Farmers who recorded higher levels of income was due to off-farm income. Farmer household membership ranging between 11 to 20 was at the peak with 51.7%. The other respondents had members of household ranging between 1 to 10 and above 21at 35.8% and 12.5% respectively.

Table 6. Demographic Characteristics of farmers

Feature	Description	Frequency	Percentage (%)
Gender	Male	91	75.8
	Female	29	24.2
Age	Less than 20 years	5	4.2
	21 to 30 years	23	19.2
	31 to 40 years	36	30.0
	41 to 50 years	25	20.8
	51 to 60 years	20	16.7
	above 61 years	11	9.2
Marital Status	Married	101	84.2
	Single	19	15.8
Educational level	No formal education	54	45.0
	Formal education	66	55.0
Income level	100 to 500 Ghana cedi	47	39.2
	500 to 1000 Ghana cedi	44	36.7
	1000 to 1500 Ghana cedi	15	12.5
	1500 to 2000 Ghana cedi	9	7.5
	Above 2000 Ghana cedi	5	4.2
Household size	1 to 10	43	35.8
	11 to 20	62	51.7
	21 and above	15	12.5

Source: Field Survey 2017.

Orientation of farming activities of respondents

The results from the survey showed that land size cultivated by farmers was between 5 acres to 15 acres with mean acreage of 1.98. 89.2% forming majority of respondents cultivated farm size ranging between 11 acres to 14 acres. Farm households owning a farm size between 5 acres to 10acres was 6.7% mean while only 4.2% of farmers cultivated a farm area which was above 15 acres (see Figure 4). The survey revealed that farmers where engaged in other economic activities; teaching, trading, business, electrician, carpentry, masonry and civil servants as such could not make time to farm larger acres of land.

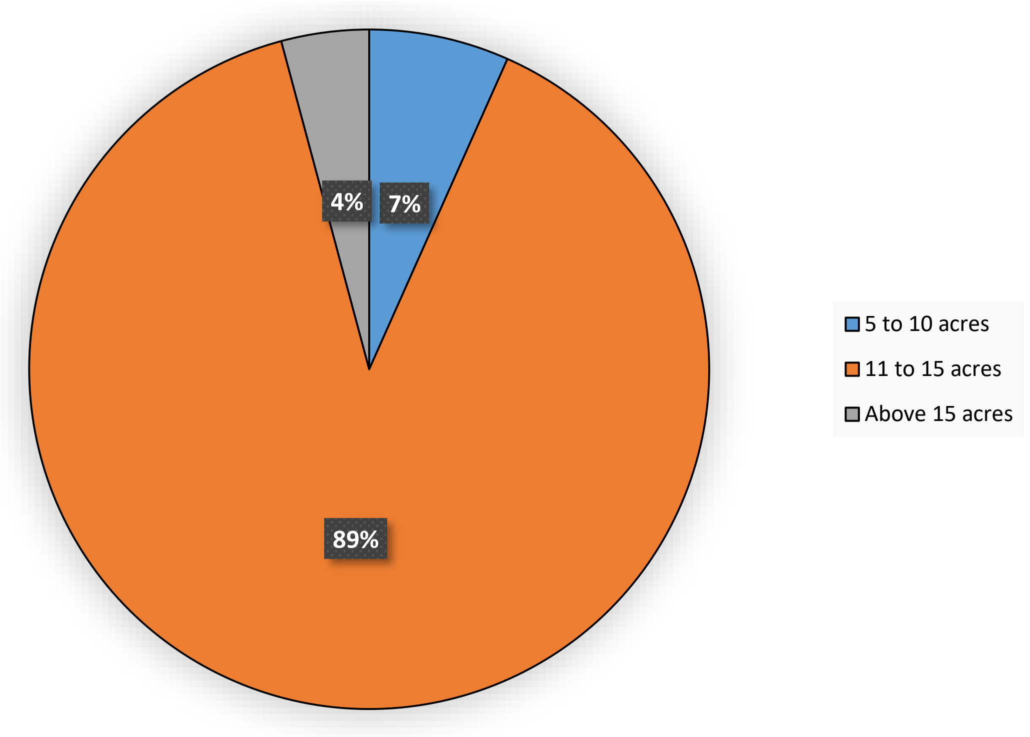

Figure 4: Farm size cultivated by farmers in the study area

It was also noted that the largest populace (93.8%) of respondents used traditional farming method (cutlass and hoe) in farming due to the subsistent nature of their farming activities. The remaining 6.2% used modern farming techniques applying tractors and combine harvesters in land preparation and harvesting respectively due to their farm size (see Figure 5). Additionally, farmers who used traditional farming methods were also engaged in rainfed agriculture as against farmers who used irrigation systems in their modern farming techniques.

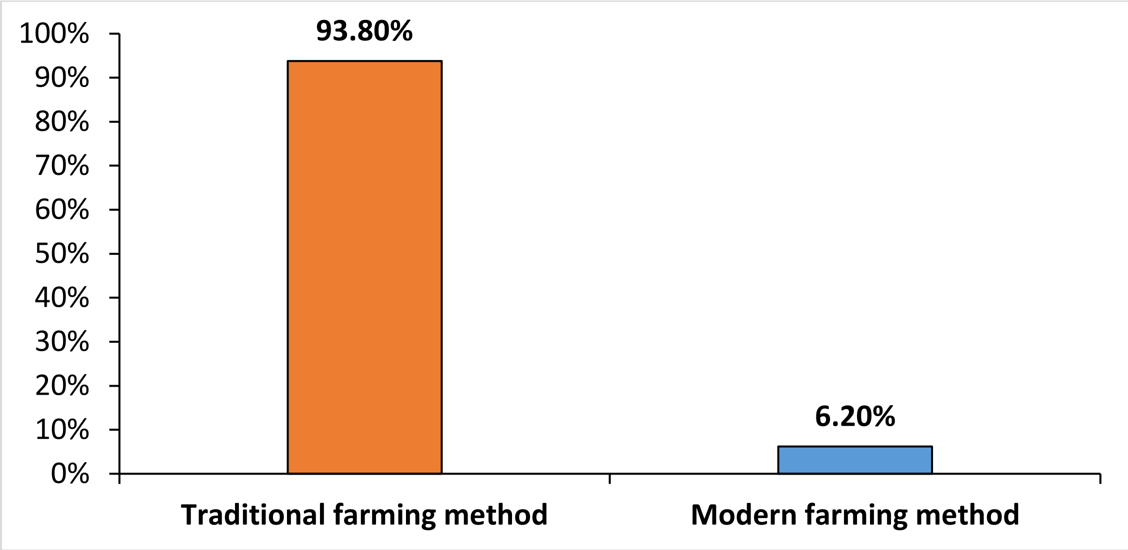

Figure 5: Farming method adopted by farmers in the study area

The respondents enumerated were crop farmers who cultivated mainly; millet, maize, rice, yam, sorghum, vegetable, groundnut, beans and soybeans (see Figure 6). Out of the total number of respondents surveyed, 89% mostly cultivated maize and groundnut. Also 38% cultivated soybeans while 34% cultivated rice. Yam was next on the list with 31% of farmers. Furthermore 28% and 17% of respondents farmed beans and vegetables respectively. The least farmed crops were millet at 7% and sorghum at 6%.

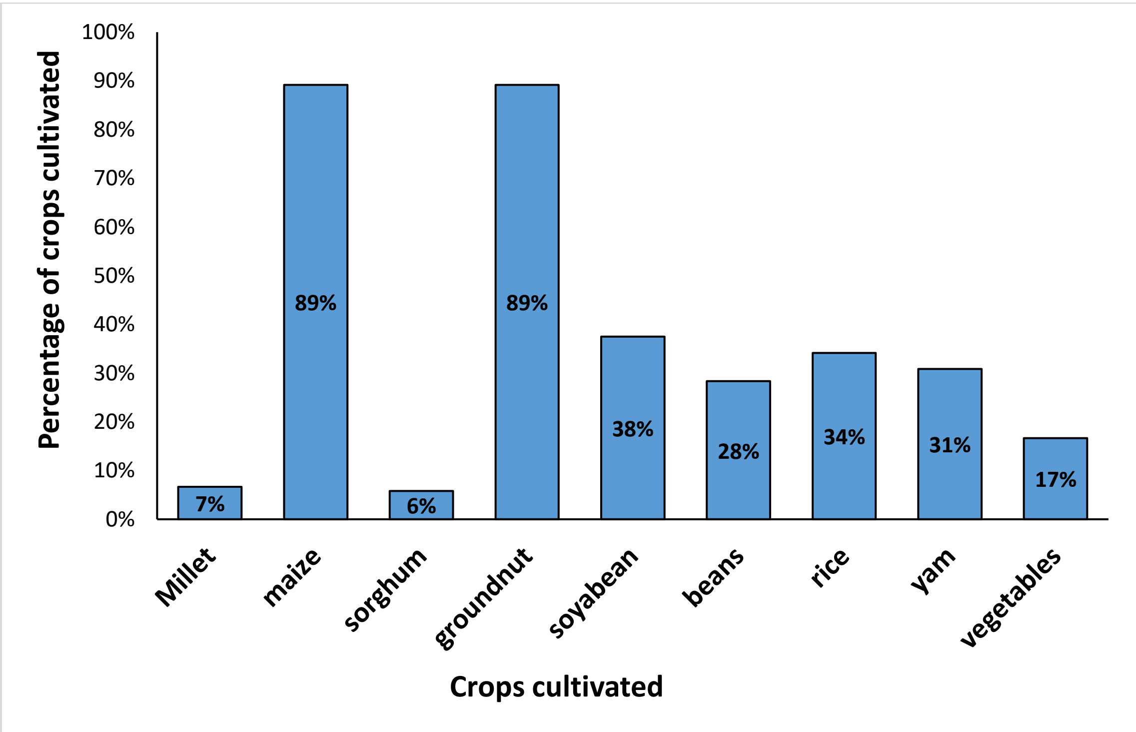

Figure 6: Main crops cultivated by farmers in the study area

Agricultural information sources available to farmers

Responses collected from respondents during the survey reveals that the main sources of information for their farming activities was solicited mainly from agricultural extension agents, radio, mobile phone based information services (Esoko and Farmers Club), TV and fellow farmers (see Figure 7). Farmers were given the opportunity to choose different options from which they sourced their information concurrently. Analysis of the data collected proved that 99% of the farmers making up the majority of the respondents did source their farming information from radio and agricultural extension agents. On the other hand, 81% of the respondents reported that they get essential information on the weather and market prices from Esoko and Farmers Club mobile phone based agricultural information services. 73% of farmers also sought information from television programs on agricultural practices. Additionally, 57% of farmers claimed to have sourced farming information from their colleague farmers.

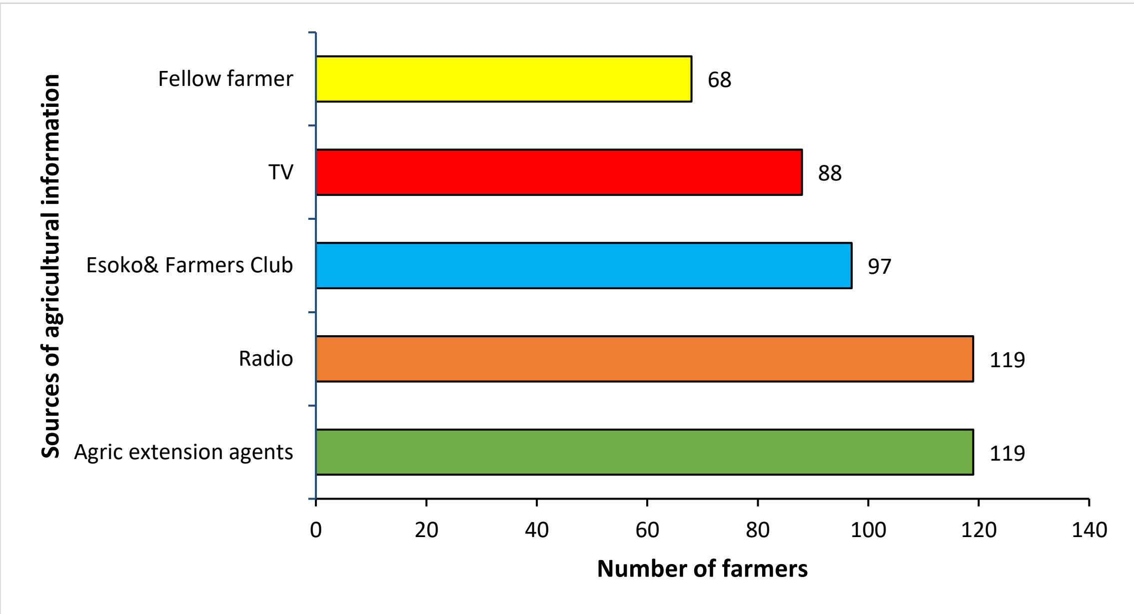

Figure 7: Main sources of agricultural information to farmers

In order to ascertain the preferential choice of agricultural information source as mentioned in objective 4 above, farmers were asked to rank their sources of farming information. The Kendall's Concordance Coefficient W non-parametric test statistics was used to analyse the ranked responses from farmers in order to be informed about the level of agreement in their responses provided (see Table 7). The results from Table 7 shows that farmers highly preferred radio as their source of farming information. This was expected since farmers were of the assertion that they usually carried their radios with them to the farm. Farmers also claimed that radio agricultural information was received in their local language and that many radio programs focused on farming activities was transmitted in the evening when they had returned from their farms. The second ranked choice was Agricultural extension agents which for farmers was vital because of demonstration practices carried out by extension agents during their visits but their concern had to do with the frequency of visits by agricultural extension agents. Mobile phone based agricultural information service was the next preferred choice of information for farmers as they reconciled with the quick response of getting information and the use of the mobile phone for mobile money transactions and networking. TV was ranked last but one because farmers were also interested in seeing the practicality of some information received on radio. Lastly, sourcing agricultural information from colleague farmers was the least preferred. Farmers believed that their colleagues sometimes lacked the needed information they need for their farming activities as such their last resought, should all other sources fail.

Table 7. Ranking of main sources of agricultural information to farmers

Source	**Mean Rank**	**Rank**
Radio	1.23	1st
Agric extension agent	2.61	2nd
Mobile phone based service	2.87	3rd
Television	3.73	4th
Farmer to farmer	4.57	5th
Kendal's W	**0.632**	

N= 75; Alpha (α) = 0.05; Chi^2 Statistic = 189.662; Asymp. Sig. = 0.000; df = 4

Perception of farmers on the usefulness of mobile phone based weather and market information services

The second objection was focussed on analysis of usefulness, reliability and satisfaction level of respondents using mobile phone based agricultural information services. Farmers had to choose only one option from a set of responses presented to them as follows; strongly agree, agree, indifferent, disagree and strongly disagree. The results in terms of perception on usefulness showed that a vast majority (87%) of the respondents strongly agreed where as 9% agreed but just a few (4%) were indifferent (see Figure 8). In the case of disagree and strongly disagree responses, no farmer was found in this category.

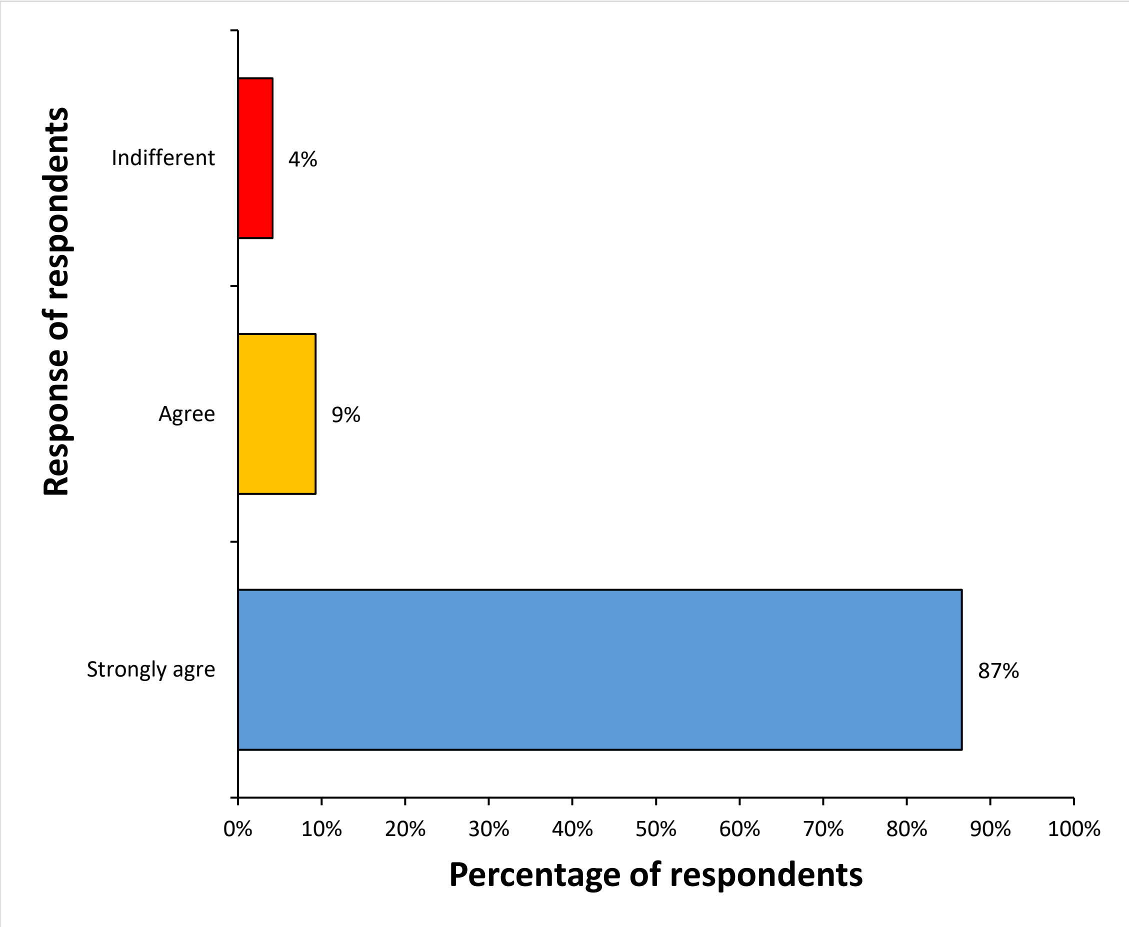

Figure 8: Usefulness of mobile phone based weather and market information service

Perception of farmers on the reliability of mobile phone based weather and market information services

Farmers were presented with 5 different options to choose from ranging from; strongly agree, agree, indifferent, disagree and strongly disagree on the reliability of agricultural information services received via mobile phone. Figure 9 shows the analysed results from farmers responses. Most (90%) of famers strongly agreed on the reliability of the services received from Esoko and Farmers Club. Respondents who opted for agree and indifferent were 6% and 4% respectively. On the other hand, the options disagree and strongly disagree was not selected by any respondent.

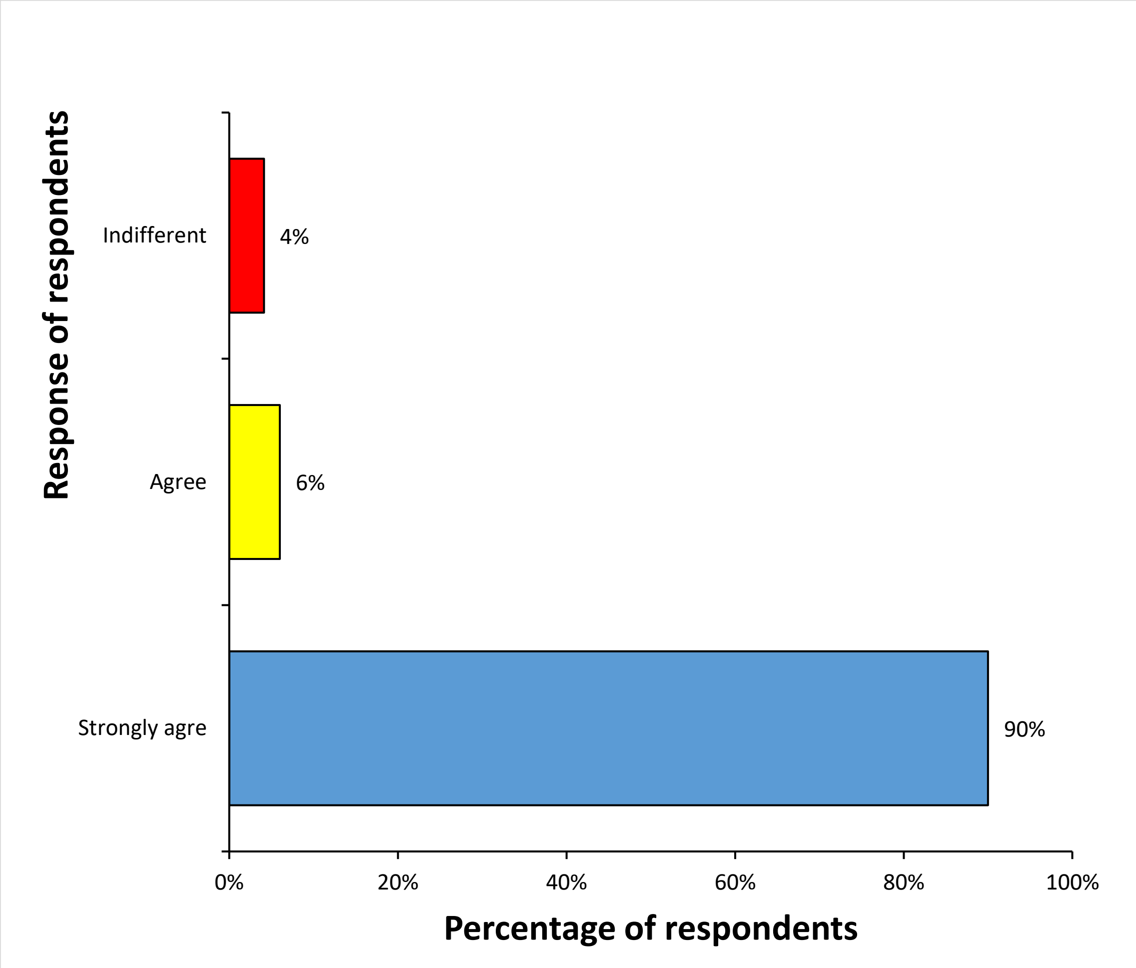

Figure 9: Reliability of mobile phone based weather and market information service

Perception of farmers on the satisfaction of services provided by mobile phone based weather and market information services

The alternatives; strongly agree, agree, indifferent, disagree and strongly disagree was presented to farmers so they can opt for one based on their level of satisfaction with services provided to them via their mobile phone on the weather condition and market prices. Figure 10 gives a clear picture of data analysed. Out of the total of 97 respondents enumerated, 88% representing a vast majority of respondents affirmed their rate of satisfaction with services received by opting for strongly agree. No respondent selected the option disagree and strongly disagree. For the option agree, 8% of respondents replied where as the option indifferent was the least responded to at 4%.

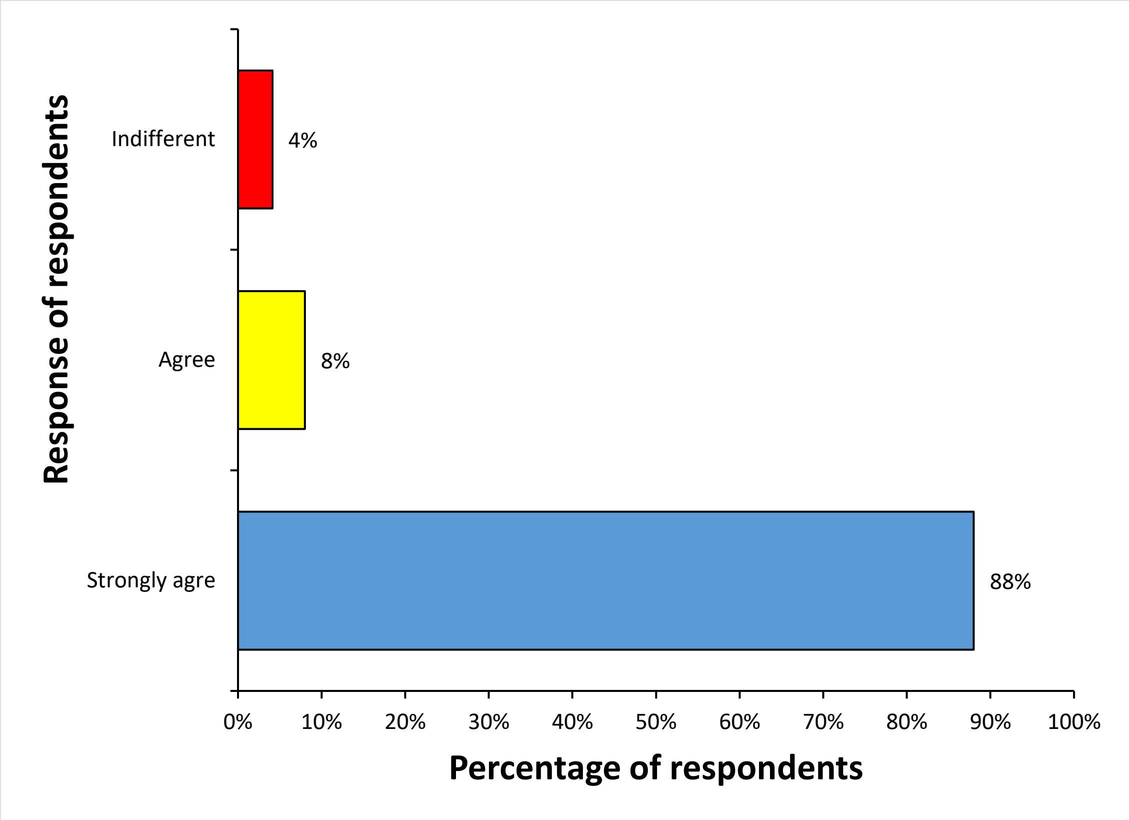

Figure 10: Satisfaction in using mobile phone based weather and market information service

Differences in perception among categories of farmers

In order to examine whether perception vary among different categories of farmers in terms of gender, age, income level and educational level, their ratings on usefulness, reliability and satisfaction was subjected to a Wilcoxon-Mann-Whitney Test (see Table 8). Farmers ratings are grouped based on gender (male and female), age (young and old), income level (poor and non poor) and educational level (formal education and no formal education). The categorization for gender included male (86) and female (11). Based on age, young (73) which included respondents below the age of 50 years and old (24) that is respondents above 51 years old. In relation to income level, those with annual income less than 500 Ghana cedi were treated as poor (35) and those with income level more than 500 Ghana cedi as not poor (62). The category for education included respondents with formal education (57) having completed primary, secondary or tertiary education and those with no formal education (40). Table 8 gives a summary of the two-sample Wilcoxon rank-sum (Mann–Whitney) test analysis upon which the null hypothesis is tested. The results of the Wilcoxon test on each category of gender, age, income level and educational level is subjected to analysis based on a 95% confidence interval to find evidence to either reject the null hypothesis or not to reject the null hypothesis. For the sake of the analysis, the null hypothesis was formulated as; perception on usefulness, reliability and user satisfaction of mobile phone based weather and market information services were similar across groups of gender, age, income level and educational level.

Table 8. Wilcoxon-Mann-Whitney Test

Category	Rank sum	Category	Rank sum	Category	Rank sum	Category	Rank sum
Perception on usefulness							
Gender		**Age**		**Income**		**Education**	
Male	4166	Old	1196	Poor	1717	Formal	2647
Female	587	Young	3557	Not poor	3036	No Formal	2106
z	-0.775	z	-0.237	z	-0.021	z	-1.519
p-value	**0.438**	p-value	**0.812**	p-value	**0.983**	p-value	**0.129**
Perception on reliability							
Gender		**Age**		**Income**		**Education**	
Male	4209.5	Old	1177	Poor	1720.5	Formal	2759
Female	543.5	Young	3576	Not poor	3032.5	No formal	1994
z	-0.107	z	-0.018	z	-0.087	z	-0.523
p-value	**0.914**	p-value	**0.986**	p-value	**0.931**	p-value	**0.601**
Perception on satisfaction							
Gender		**Age**		**Income**		**Education**	
Male	4220.5	Old	1153	Poor	1685.5	Formal	2750.5
Female	532.5	Young	3600	Not poor	3067.5	No formal	2002.5
z	-0.140	z	-0.365	z	-0.421	z	-0.591
p-value	**0.888**	p-value	**0.715**	p-value	**0.674**	p-value	**0.554**

Note: Wilcoxon-Mann-Whitney Test at Alpha (α) = 0.05

The results of the Wilcoxon-Mann-Whitney test is used to test proposed hypothesis based on a 5% significance level; if p-value is less than 0.05 ($p < 0.05$) we reject the null hypothesis that there is a similarity in perception within a given category. On the perception of usefulness, the p-values;0.438, 0.812, 0.983, 0.129 for the various categories of gender, age, income and education respectively are all greater than 0.05. The same is the case for perception on reliability where the p-values of 0.914, 0.986, 0.931 and 0.601 are all greater than 0.05. In relation to perception on satisfaction, the alpha value of 0.05 is less than all the p-values for the respective categories of gender (0.888), age (0.715), income (0.674) and education (0.554). The results imply that there is similarity in perception on usefulness, reliability and satisfaction within the various categories of gender, age, income and education since the null hypothesis was no rejected.

4.2 Binary logit model analytical results

The factors likely to influence farmers decision to subscribe to weather and market information services of Famers' club within the study area is presented in this section. Table 9 presents the results of the regression and the odds ratio estimated by the binary logit model. The results indicate that farmers gender, farmers membership in a farmer based organization and farmer's income were factors that influenced farmers decision to subscribe to Farmers' club mobile phone based weather and market information services. The estimated beta coefficient for farmers gender yielded a positive value which implies that male farmers were more likely to adopt Esoko and Farmers' club initiative on weather and market information. At a 1% significance level the estimated beta coefficient was said to be statistically significant. The value of Exp(B) representing the odds ratio shows that additional male respondents to the sample makes male respondent respondents 3662.166 times more likely to subscribe to Esoko and Farmers' club initiative compared to female respondents. The explanatory variable; member of farmer based organization (FBO) was also significant at 1% significance level with a positive coefficient value. This indicates a positive relationship between decision to subscribe and farmers membership in a farmer based organization. The odds ratio value gives an indication that a farmer belonging to a farmer based organization is 2420.731 times more likely to subscribe to Farmers' club compared to a farmer who is not a member of a farmer based organization. Also, the explanatory variable income was found to be significant at 5% significance level with a negative regression coefficient which suggests that with increasing farmers income there is a lesser likelihood for the farmer to subscribe to Esoko and Farmer' club weather and market information services. The odds ratio value can be interpreted as such; with a unit increase in farmers income, a farmer is 0.045 times less likely to subscribe to weather and market information services. The other explanatory variables; age and farm size were not significant and had negative coefficients. This means that with increasing age and farm size, farmers were less likely to subscribe to Esoko and Farmers' club weather and market information service. The effect of education variable on subscription to weather and market information service was not statistically significant. On the contrary, education as an explanatory variable had a positive coefficient which is to mean that farmers with formal education are more likely to subscribe to Farmers club weather and market information service.

Table 9. Results of Binary logit model and the Odds ratio

	Coefficient	Standard Error	p-value	Confidence Interval at 95%		Exp(B) Odds ratio
Gender	**8.206**	**2.818**	**0.004*** **	**14.625**	**917023.123**	**3662.166**
Age	-0.050	0.453	0.912	0.391	2.314	0.951
FBO member	**7.792**	**2.470**	**0.002*** **	**19.112**	**306611.737**	**2420.731**
Education	3.661	2.280	0.108	0.446	3391.446	38.884
Income	**-3.112**	**1.453**	**0.032** **	**0.003**	**0.768**	**0.045**
Farm size	-1.874	3.766	0.619	0.000	246.517	0.153
Constant	0.654	7.609	0.931			1.924

Nagelkerke R^2 = 0.874; Alpha (α) level of significance; 0.01 = ***, 0.05 = **, 0.1 = *

4.3 Qualitative Analysis results

The challenges of respondents who were exposed to mobile phone based weather and market information services was collected during the survey. Though majority of farmers strongly agreed that the weather and market information service via mobile phone was useful, reliable and satisfactory, they also had a few constraints. The data from respondents was coded and categorized. The key challenges confronting farmers using mobile phone based weather and market information services within the study area included; poor mobile network services and sometimes no network coverage as a result of farmers location, lack of electricity to charge mobile phone due to poor infrastructural development in the locality, difficulty in reading and understanding SMS messages especially for farmers with no formal education, high cost of buying airtime to make calls, challenge of feedback response, inaccurate weather information, in which case farmers reported that forecast for rainfall sometimes failed. Farmers were also disappointed sometimes as expected market prices received via mobile phone was different from the real price when they got to the market.

5. Discussion

The results of my study show a significant relationship between farmers gender and decision to subscribe to mobile phone based weather and market information such that male farmers were found to be more likely to subscribe to weather and market information via mobile phone compared to female farmers. A study by FAO (2018) also reveals that there is a strong link between access to information and gender stressing on the fact that men and women do not have the same access to information via ICTs. This is in line with a study conducted in Moldova where female farmers were found to be less likely to subscribe to weather forecast services compared to male farmers (Timoshenko 2018). In Nigeria, a study by Obisesan (2014) revealed that there is a significant and positive influence of gender on adoption of technology. Another study in Ethiopia and South Africa have shown that male headed households are more likely to adopt adaptation strategies to climate change since males have more access and control of resources (Deressa et al. 2010; Hassan & Nhemachena 2008). Several studies on the influence of gender on agricultural technology adoption have proven that men as household heads are main decision makers hence have more access and control and are more likely to adopt improved agricultural technologies compared to their female counterparts (Mignouna et al. 2011; Omonona et al. 2005; Lavison 2013). On the contrary, another study reported that female headed households are more likely to utilize adaptation strategies to climate change and variability since much of the agricultural work is done by women (Nhemachena & Hassan 2007).

Many research studies have come out with a significant and positive influence of social group on adoption of technologies. Information exchange is facilitated by involvement in social groups. Farmers within an organization learn from one another how to use new technologies and its benefits (Mignouna et al. 2011; Mwangi & Kariuki 2015). According to Uaiene et al (2009) adoption of agricultural innovations is largely influenced by farmers association with social networks. A study in Uganda revealed that farmers who belonged to community-based organizations were more likely to be involved in social learning about new technologies there by increasing their probability of using new technologies (Katungi & Akankwasa 2010). Member farmers are more likely to be early adopters of agricultural technologies than non-members. Findings from Congo, Burundi and Rwanda demonstrate that farmer groups can be, and are, an appropriate channel to enhance early adoption of agricultural technologies and improve farm level productivity (Herbert et al. 2015). Another study in Ghana also reported that the social and economic conditions, personal relationship and trust developed over time among farmers belonging to a community makes recommendation of new technologies more easily accepted. In this study, farmers likelihood of patronising agricultural weather and market information via mobile phone services was found to be influenced more by farmer to farmer interactions compared to agricultural extension agent services (Etwire et al. 2017).

The findings of this study indicate that with increasing farmers income, farmers were less likely to subscribe to mobile phone based weather and market information services. This is supported by the findings of Goodwin & Mishra (2004) whose research reported that farmers engagement in other activities to raise off-farm income undermines their adoption of new technologies by reducing the amount of household resources allocated to their farming activities. Timoshenko (2018) in her study in Moldova also had similar findings that with increasing farmers income the probability of using weather forecast services decreased mong farmers. My findings could be explained by the income level segregation from the descriptive statistics gathered which proved that only a few of the farmers enumerated had high income levels and farmers who had high income level were engaged in other income generating activities other than farming hence extra off-farm income. Study findings in rural Nepal reveals that farmers engaged in off-farm employment did not participate much in agricultural extension programs and technology adoption (Suvedi et al. 2017).

On the other hand, much more researchers have shown a positive impact of income on technology adoption. The adoption of modern practices is hindered by financial constraints (Darfour & Rossentrater 2016). This is supported by previous study in Nigeria and Malaysia that shows that farming income plays a key role when it comes to the application of agricultural technology by farmers (Bello et al. 2012; Jamsari et al. 2012). A significantly higher adoption rate was recorded among farmers with off-farm income compared with farmers without off-farm income in Uganda. In Uganda it was discovered that off-farm income intensified the adoption rate of new technologies by small holder farmers. Off-farm income provides farmers with liquid capital to be able to patronize services that improve on their agricultural productivity (Diiro 2013). A study in Ethiopia on the impact of income on adoption of agricultural technology reported that the more farmers have access and source of credit, the more likely they are to adopt agricultural technologies that could possibly increase crop yield (Hailu et al. 2014). Another research in Indonesia by Alam (2015) reveals that there was an increased level of technology adoption as household income increased since higher incomes was related to higher educational level.

The study results also indicates that farmers age and farm size were not statiscally significant and had negative coefficients signifying that with increasing age and larger farm size, there was a lesser likelihood of subscribing to mobile phone based weather and market information services. Many researchers have discovered age as a determining factor to adopting new technologies. A report by Deressa et al (2010) indicates that age has a positive influence on the choice of adaptation strategy used by farmers during extreme climatic events where as Hassan & Nhemachena (2008) have found no significant influence of age on extreme climate adaptative strategies. In line with the findings of my study, Mauceri et al (2005) found a negative relationship between age and technology adoption and explained that younger farmers are less risk conscious and are more willing to try new technologies compared to older farmers. Another study in Ethiopia proves that as farmers grow older, they become more conservative and reluctant in adopting new technologies hence prefer indigenous farming methods (Hailu et al. 2014). In Malaysia, Tanzania and Nigeria, the discontinuous use of new farming technologies was largely influenced by ageing farmers (Jamsari et al. 2012; Bello et al. 2012). On the other hand, other research findings are of the assertion that older farmers have gained knowledge and experience over time and are better able to evaluate technological information than younger farmers (Kariyasa & Dewi 2011; Mignouna et al. 2011).

In relation to farm size, my findings are inconsistent with that of other researchers who have claimed a positive and significant relationship between farm size and adoption of technology (Alam 2015; Nyanga 2012; Ayoola 2012). Gbetibouo (2009) discovered that large scale farmers are more likely to adapt strategies to mitigate against climate change and variability associated with farming activities.

According to Idrisa et al (2006) farmers with low level of formal education are less likely to understand and use improved practices in their farming activities. Education as an explanatory variable is not statiscally significant but has a positive coefficient denoting that farmers with formal education are more likely to engage in assessing weather and market information via mobile phone compared with farmers with no formal education. This is consistent with many research findings which argue that educated farmers are better able to interpret and use information hence facilitating adoption of ICTs in information delivery (FAO 2018; Mawazo 2015; Ayoola 2012; Namara et al. 2013; Mwangi & Kariuki 2015).

According to Ali (2012) in most developing countries, agricultural extension services remain the main source of agricultural information but in recent times ICT-based extension services have also become a potential source of providing agricultural information to farmers. This is not too different from my research findings because enumerated farmers identified and ranked Radio, Agricultural extension agents, Esoko and Farmers club mobile phone based service, Television and Farmer to farmer interactions respectively as their main sources of agricultural information. Also, farmers in India have relied on radio as their main traditional source of agricultural information assessing rainfall and market price information (Mittal 2012).

Mobile phone based weather and market information has helped to equip farmers with advanced and real time information to mitigate against climate change and enhanced profit for farmers. The usefulness of mobile-phone based agricultural information services has been acknowledged by farmers in India, Tanzania, Moldova and Ghana (Etwire et al. 2017; Angello 2015; Mittal 2012, Timoshenko 2018). The results of my study had similar findings.

Poor network coverage, high cost of usage, lack of electricity for charging phones, inability to comprehend SMS messages due to illiteracy and inaccuracy of information were among the challenges farmers encountered in using mobile phone based weather and market information service according to my study results. Hellstrom (2010) identified electricity issues, cost of ownership, language barrier and high illiteracy levels as major constraints that confront mobile agricultural service users in Kenya, Rwanda, Tanzania and Uganda. During a survey by Mittal & Mehar (2012) in India, they discovered that for farmers to fully utilize and benefit from mobile-phone information services there is the need to address poor infrastructure, electricity constraints, inefficiency in delivery, irrelevance of content and under developed capacity of farmers. Poor service provision, electricity fluctuations, higher cost of operation, high levels of informal education were factors that mitigated against the use of extension services via ICT's in Nigeria (Fawole & Olajide 2012).

5.1 Limitations of the study

The study encountered a few challenges which could have influenced the outcome of the research. These limitations were encountered during the survey and have been mentioned accordingly; Firstly, it was difficult getting access to farmers since majority of them had gone to their farms during the time of data collection. Secondly, the distance between the four communities surveyed was very far than estimated. This made data collection very difficult and time consuming. Thirdly, not all respondents enumerated within the purposively sampled 4 communities were users of the Esoko and Farmers Club mobile phone weather and market information pilot project as was expected as such the total number of respondents intended for the study could not be achieved. Lastly, data collection was very challenging since questionnaire was designed in English and majority of the respondents could not understand English hence the services of a translator was employed. This could have influenced the responses from farmers due to misinterpretation from translator.

6. Conclusions

Income of farmer, gender and farmer's membership in a farmer based organization were the key significant factors that informed farmers decision to acquire mobile phone based weather and market information service. The study proved that male farmers were more likely to subscribe to mobile phone based weather and market information services compared to female farmers. Also, farmers who belonged to a farmer based organization (FBO) were more likely to acquire mobile phone based agricultural services compared to farmers who did not belong to a FBO. On the other hand, farmers with lesser income level were more likely to subscribe to weather and market information from Esoko and Farmers' club compared to farmers with higher income levels.

Farmers age, income level and farm size had no statiscally significant influence on farmers subscription decision. Regarding the perception of farmers on the usefulness, reliability and satisfaction received from Esoko services, majority of the farmers strongly agreed. Farmers outlined and ranked respectively; radio, agricultural extension agents, Esoko and Farmers club mobile phone based agricultural services, television and farmer to farmer interactions as their main sources of farming information.

The study results also indicates that poor network coverage, cost of handling mobile phone, lack of electricity to charge phones, difficulty in reading SMS messages due to illiteracy, inaccurate weather forecast, market prices and poor feedback response were the main challenges that confronted mobile phone based weather and market information service users.

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8. Appendices

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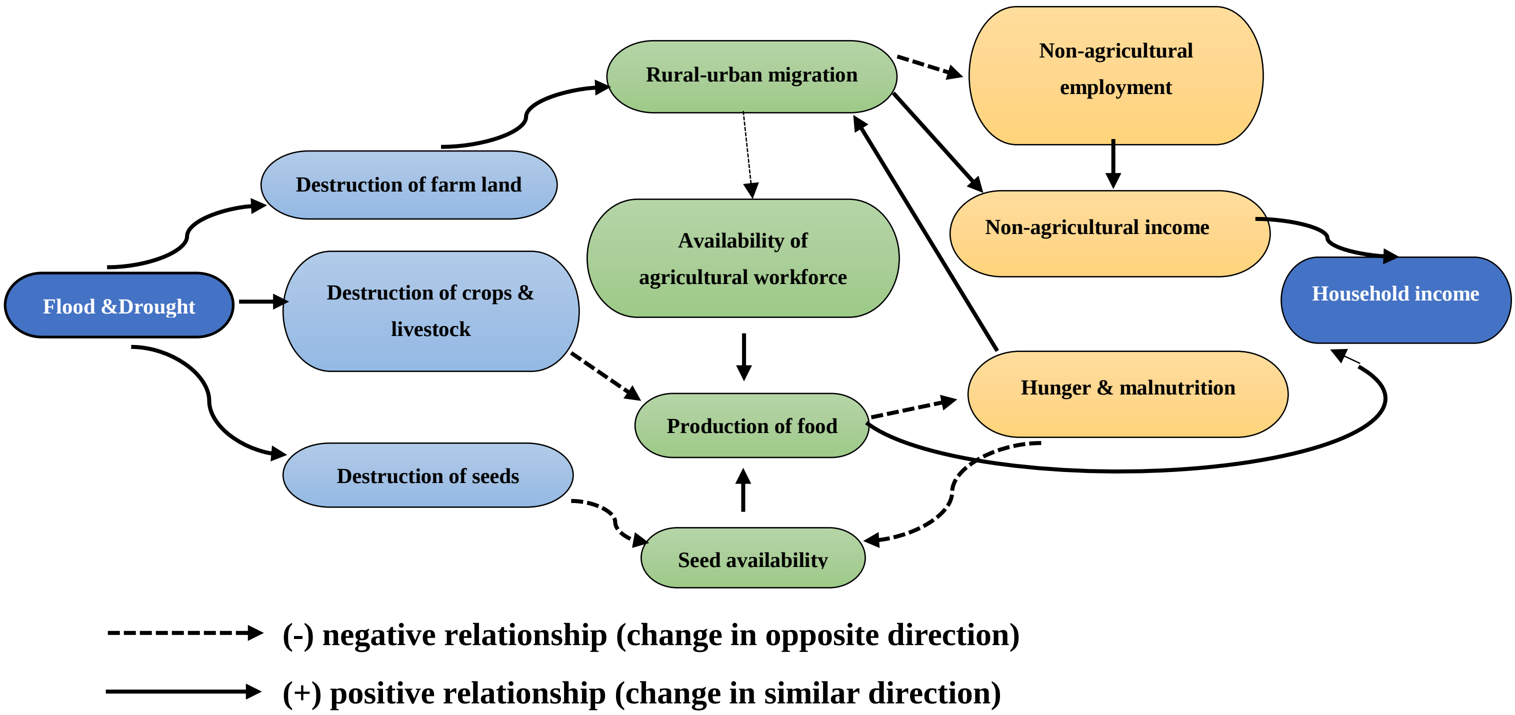
Appendix 1: A Cause-effect diagram depicting the consequences of flood and drought in the northern region of Ghana



(Source: Adapted from Armah et al. 2010**)**

Appendix 2: Questionnaire for crop farmers in English language

Czech University of Life Sciences, Faculty of Tropical Agrisciences

This questionnaires has been designed to execute a research purposely for academic work. The reseasrcher is **Emmanuel Quintin-Cofie** a student pursuing masters degree in International Development and Agricultural Economics at the Czech University of Life Scieces. The main objective of the research is to assess the Impact of Mobile phone Technology on Agricultural Information Services delivery in the Northern region of Ghana. All information provided will be used solely and exclusively for academic purpose and would be treated with the necessary confidentiality it deserves. Information provided would be used to make sound empirical analysis and also suggest policy recommendations that would help improve agricultural information services delivered to farmers and improve productivity as well as farmer's socio-economic well being and standard of living in the region. The entire interview will take nearly one hour of your time and you are kindly requested to provide honest and genuine responses within your possible best. Thank you.

Section 1: Socio-demographic Characteristics of Farmers

1. Name of Interviewer ………………………………………………………

2. Name of Respondent...…………………………………………………….

3. Name of District ………………………………………………………….

4. Name of Community………………………………………………………

5. Name of Respondent………………………………………………….

6. Age of Respondent………………………

[1] Less than 20 years [2] 21-30 years [3] 31- 40 years

[4] 41-50 years [5] 51-60 years [6] 61+ years

7. Sex of Respondent [1] Male [2] Female

8. Marital Status [1] Married [2] Single [3] Divorced [4] Widowed

9.Level of Education [1] No Formal Education [2] Primary/Basic [3] SHS/Technical/Vocational [4] Tertiary

10.Is farming your main source of income [1] Yes [2] No

11.Which other economic activities are you involved in………………………………

12. Level of income annually from farming [1] GH¢ 100.00 -500.00 GH¢ [2] GH¢500-GH¢1000.00 [3] GH¢1000.00- GH¢1500.00 [4] GH¢1500.00- GH¢2000.00 [5] Above GH¢2000.00

13. Are you the head of the Household? [1] Yes [2] No

14. Are you a member of a farmer based organization or group? [1] Yes [2] No

15. What is your household size? ……………………

16. Number of years in farming …………………………

17. What is your farm size ……………………………

18. Do you use modern farming methods [1] Yes [2] No

19. Do you use irrigation system on you farm [1] Yes [2] No

20 . What crops do you cultivate?

S/NO	Crops	Number of Acres
1	Millet	
2	Maize	
3	Sorghum	
4	Groundnut	
5	Soyabean	
6	Beans	
7	Sweetpotato	
8	vegetables	
9	Cowpea	
10	Rice	
11	Yam	

Section 2: Farmers access to agricultural information

21. What is your preferrred extension information on the crops you grow? You can choose more than one option. [1]Weather [2]Market [3]Pest and disease control [4]Fertilizer application [5]Other,specify…………………….

22. Do you get access to extension information services [1] Yes [2] No

23. If Yes,what kind of extension information do you receive?[1]Weather [2] Market [3] Pest and disease control [4]Fertilizer application [5]Other,specify……………….

24. If Yes, how often are you visited by Agric.Extension Agents?
[1]once a week [2] once a month [3] once every six months [4]once a year [5] cant remember [5] other, specify………………….

25.What methods of of information delivery are used by Agric Extension Agents? You can choose more than one option.
[1] Home and farm visits [2]Group meetings [3] Farmer based organizations [4] Posters [5] Radio [6]Mobile phone calls [7]Mobile phone SMS [8]Other,specify…………….

26. What are your major source(s) of agricultural information? You can choose more than one option
[1] Radio [2] Mobile phone [3]Television [4] Agric Extension Agents [5] Fellow farmers [6]Other,specify………………..

27. What is your most preferred source(s) of agricultural information? [1]Radio [2] Mobile phone information service[3]TV [4] Agric Extension Agents [5] Fellow farmers [6]Other,specify………………..

28. Give reason for your preferred source(s) of extension information in Question 27 above………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

Section 3: Mobile Agricultural Information Delivery

29. Do you own a mobile phone? [1] Yes [2] No (If response is Yes, move to question 29)

30.What do you use the mobile phone for? You can choose more than one option.

[1] Making calls [2] Receiving messages [3] Browsing the internet [4] Accessing agricultural information [5] Other,specify………………….

31. If used in accessing agricultural information,which source? You can choose more than one option . [1] NGO [2] Agric Extension Officers [3] Friends [4] Family [5] Internet [6] Esoko and Farmers Club mobile service [7] Other,specify……………

32. How often do you receive agricultural information via mobile phone? [1] Daily [2] weekly [3] monthly [4] As and when needed [5] Other, specify………………

33. In which form do you normally receive agricultural information via the mobile phone? [1] Calls [2] Messages [3] Internet [4] other,specify…………..

34. Do you apply the agrcultural information obtained via mobile phone [1] Yes [2] No

35. If Yes, how often do you apply the information obtained [1] Always [2] Sometimes [3] Seldomly [4] Other, specify…………………………

36. What is your most prefered form(s) of receiving agricultural information via phone? You can choose more than one option [1] Calls [2] Messages [3] Internet [4] Other,specify…………………..

37. Give reasons for your prefferred choice(s) in Question 35 above.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………….

38. Do you have accesss to Esoko and Farmers club mobile weather and market information [1] Yes [2] No. If yes answer question 38 to 42

39. Information provided is very useful. [1] Strongly agree [2] Agree [3] Not Sure [4] Disagree [5] Strongly disagree

40. Information provided is very relaible [1] Strongly agree [2] Agree [3] Not Sure [4] Disagree [5] Strongly disagree

41. Information provided is very satisfactory [1] Strongly agree [2] Agree [3] Not Sure [4] Disagree [5] Strongly disagree

42. Will you be willing to fully subscribe to the Esoko and Farmers club weateher and market information services after the pilot project [1] Yes [2] No

43. Will you be willing to pay for charges for services provided [1] Yes [2] No

Section 4: Constraints in using mobile phone based agricultural information services

44. What are some of the challenges you face when using mobile phone to access weather and maket information from Esoko and Farmers club project? Mention them ……………………………………………………………………..
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....
....

THE END

THANK YOU FOR YOUR TIME, PATIENCE AND PARTICIPATION.

Appendix 3: A photo coverage of researcher administering questionnaire to respondents within the study area