DEVELOPING AN AGRICULTURAL INFORMATION SYSTEM TO ENHANCE FOOD SECURITY IN SAMIA SUB-COUNTY, KENYA

BY

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DECLARATION

DECLARATION BY THE CANDIDATE:

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DEDICATION

This Thesis is dedicated to my late sister Consolata Mary Wafula. “You have always been the pillar of my strength”.

ABSTRACT

Small-scale agriculture provides livelihoods for over 70% of the Kenyan population. However, farmers face a number of challenges, including poor access to agricultural information. Information and Communication Technology (ICT) is yet to be fully utilized in the provision of real time access to information by farmers. The aim of this study was to develop a web-based information system to enhance food security in Samia Sub County. The objectives of the study were to: determine ways through which farmers access agricultural information in Samia Sub-County; determine opportunities that ICT-based agricultural information systems present to farmers in Samia Sub-County; identify factors that influence access and utilization of agricultural information by small-scale farmers in Samia Sub-County; and, model and build a prototype web-based agricultural information system that supports access to agricultural information by farmers in Samia Sub-County. The study was anchored on theMedia Richness Theory advanced by Daft and Langel (1986). The study employed a survey approach. The target population comprised of small scale farmers and technical staff in Samia. The sample comprised of agricultural officers and small scale farmers sampled purposively and location were stratified, participants chosen purposively from each stratum. This yielded a sample of 7 agricultural officers and 399 small scale farmers. Both the questionnaire and interview schedule were used to collect data. Data was analyzed using the cross case data analysis technique. It was established that farmers access agricultural information through radio, traditional sources and mobile phones. The farmers also indicated that access to agricultural information leads to increased farmer income, increased level of agricultural productivity, reduced costs of food and led to sustainable agricultural practices. Education level of farmers was the key factor influencing their access to and utilization of agricultural information. A prototype web-based agricultural system was designed and developed,on recommendation.Since majority of rural folks have access to mobile phones, agricultural officers should carry out sensitization seminars and workshops on how farmers can utilize their phones in accessing agricultural information. Besides, due emphasis has to be given towards strengthening rural education at different levels for both youth and adults.

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LIST OF ABBREVIATIONS AND ACRONYMS

AI	:	Artificial Insemination
AIS	:	Agricultural Information Systems
DSS	:	Decision Support Systems
ECA	:	Economic Commission for Africa
ERS	:	Economic Recovery Strategy
ESRI	:	Environmental Systems Research Institute
EU	:	European Union
FAO	:	Food and Agricultural Organization
FDD	:	Farm Driven Development
FMIS	:	Farm Management Information Systems
GIS	:	Geographical Information Systems
ICT	:	Information and Communication Technology
IDRC	:	International Development Research Centres
IDS	:	Internet Database Systems
IFS	:	International Food Standards
IICD	:	Institute for International Cooperation and Development
ILRI	:	International Livestock Research Institute
IT	:	Information Technology
ITU	:	International Telecommunication Union
IVRS	:	Interactive Voice Response Services
KACE	:	Kenya Agricultural Commodity Exchange

KFSSG	:	Kenya Food Security Steering Group
LDCs	:	Least Developed Countries
MDG	:	Millennium Development Goals
MIS	:	Management Information Systems
MRCs	:	Market Resource Centres
NAFIS	:	National Farmers Information Services
NEPAD	:	New Partnership for African Development
NGO	:	Non-Governmental Organization
PDAs	:	Personal Digital Assistance
SMS	:	Short Messaging Service
TRA	:	Theory of Reasoned Action
UNCTAD	:	United Nations Conference on Trade and Development
WAP	:	Wireless Application Protocol

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

According to World Food Summit (1996), food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. In this information age, technological innovations will play a very important role in pursuit of healthy lifestyle, especially as far as food security is concerned. One of these innovation is the internet. Hoffman (2010, p.152) observes that the Internet is "the most important innovation since the development of the printing press" and that it will "radically transform not just the way individuals go about conducting their business with each other, but also the very essence of what it means to be a human being in society".

According to Chowdhury (2011, p.12), Information and Communication Technologies (ICT) "store, process, share, display, protect, and manage information" (p. 12). ICT is one of the fastest growing industries in the world, and access to ICT can enable small farmers to participate in the global market, thus increasing food supply and access (Chowdhury, 2011, p.70). Lashgarara, Mirdamadi, Hosseini, and Chizari (2008) identify several ways in which ICT can be used to increase food security, including (a) increasing access to real-time market information, (b) fostering agricultural diversification, and (c) increasing the knowledge base of small agricultural businesses by improving access to global knowledge bases, including the world wide web (p. 70).

McLaren et al., (2009) opine that ICT can help eliminate the 'last mile' problem often found in rural areas, which refers to the expense and effort related to delivering connectivity to customers who are spread out geographically ("Last mile," 2011). Addressing this problem will be one of the means to achieving the goal of increasing access to knowledge and real-time market information suggested by Lashgarara et al., (2008). For example, geographic information systems (GIS) can be used to provide spatial mapping of food access (one of the important markers of food security), as well as more sophisticated analyses of food price and availability (McEntee&Agyeman, 2010). As noted by Hwang and Smith (2010), ICT and GIS can have a positive influence on food security when utilized within a web mapping framework. By using GIS and global navigation satellite systems (GNSS) and integrating with technologies that promote communication between farm implements, tractors, and computers, protocols have been developed that can trace food from the source to the market (Gebbers&Adamchuk, 2010).

Gebbers and Adamchuk (2010) believe that this merger of communication and GIS, and the management of the information gathered, will optimize production and help ensure that food supplies are correctly routed to meet current demands. Knowledge management systems (Brown &Duguid, 2002), specifically the utilization of databases populated by information gathered via GIS (Ostry& Morrison, 2009), web mapping frameworks (Hwang & Smith, 2010), and information gathered through precision agricultural systems (Gebbers&Adamchuk, 2010), combine information and communication technologies with geographic information and navigation systems. This combination of technologies allows information to be used effectively and to improve food security by cross-

referencing the information gathered by the various technologies with the hunger indices identified Masset(2011).

Letshela (1999) says that the greatest challenge facing the agricultural sector is the delivery of relevant information to farmers on time.Lwoga (2010) goes on to say Information and communication technologies (ICTs) are the effective means of sharing relevant information and knowledge and thus contributing to socio-economic growth among the farmers. This goal was at the heart of the Rome Declaration on World Food Security, and formed the basis of the first of the Millennium Development Goals.

Samia population still lacks enough food for their ever growing families, because methods used to access information on agriculture are still traditional. It has been argued that there is need for a new approach in understanding and finding solutions to the great challenge facing African agricultural development. In this regard, Jones (2006) suggested that technical innovation be accompanied by institutional change, where all stakeholders, including farmers, would be involved, he states that increases in agricultural production will come from application of new knowledge and innovations.

Researchers, civil society, government and private sector organizations have developed innovative technologies and best practices to modernize small-scale agriculture but most of these technologies do not get to the intended beneficiaries. The old extension service delivery system that was meant to pass on research outputs to farmers in Africa has proved inefficient, and most of these institutions have inadequate machinery and capacity to share and disseminate outputs widely to small-scale farmers and it has been pointed

out that the key to reversing this trend is to develop agriculture and industry through science, technology and innovation (ECA, 2005). ICTs interventions increase real time access to relevant information and knowledge which may lead to high agricultural production thus ensuring that there is food security, especially in the rural areas. Quick access to relevant information can enable small-scale farmers to make informed decisions regarding their agricultural activities. Though, developing countries such as Kenya are constrained in their ability to access agricultural information through ICTs for their agricultural growth, statistics show that the majority of the world's population (71.3%) does not have access to the internet (Internet World Stats, 2010).

It's argued that new discoveries and the application of technologies will drive agriculture, medicine, income growth and new materials in the 21st Century. Forecasts and predictions suggest that by 2020, emerging new technologies such as precision agriculture and sophisticated computer technologies will become possible in Africa (ECA, 2005). Juma and Yee Cheong (2005:15) defined new technologies as including new applications regardless of whether the technologies have been used in other parts of the world and include the use of emerging technologies such as information and communication technologies (ICTs) and biotechnology.

The United Nations Conference on Trade and Development (UNCTAD 2007:3) further emphasized this point and stated that technological advances in small-scale agricultural production and trade are often critical in initiating a catching-up process. According to the World Bank (2002 Strategy Paper on ICT cited in IICD, 2006), information and communication technologies are a key input for economic development and growth. ICTs

have been used in some of the large- scale farms and the commercial sector to tap opportunities and address some of the challenges facing farmers.

However, relatively little attention has been paid to their potential benefits to small-scale farmers. The focus by the International Development Research Centre (IDRC) on ICTs and small-scale agriculture is therefore timely, and it will contribute to the efforts of other players for effective global, regional and national partnerships. Jensen (2001) also pointed out that most local farmers cannot obtain up-to-date agricultural information thus affecting the manner in which Small-scale farmers, and other actors and rural areas, in Africa need space to contribute towards their own development. ICTs could help address some of the issues and challenges they face and enhance communication and delivery of critical knowledge, information and service.

It is worth noting that small farmers and producers living in less-accessible areas have been hardest hit by these challenges and as concluded by Kidane, Maetz and Dardel (2006), unless SSA countries create a condition for smallholder farmers to improve their labour productivity through technological change and enhanced capital assets, and invest in the development of labour-saving technologies, it is difficult to envisage a significant production increase through area expansion. There is, however, a need to create focal points of informal or formal interactions, in form of consortia, associations or networks. Some of the emerging ICT applications in small-scale agriculture in Africa include Geographic Information System (GIS), Decision Support Systems (DSS), management information system (MIS), distance learning, databases, land use planning, public access facilities, mobile applications, restructuring of extension and personal digital assistants

(PDAs)Munyua(2007). Precision farming is currently practiced by large-scale farms that can afford the high investment, skills and expertise required. These modern ICTs could play a major role in communicating knowledge and information to rural agricultural farmers, delivering education modules, accessing inputs, facilitating networking and strengthening partnerships, scaling up inter-linkages of development interventions and increasing agricultural productivity. Media such as the internet, web-based means, and mobile telephony, video, audio cassettes, CD-ROM, radio, fax and computer-mediated networks among others are being used in a number of initiatives in Africa to provide development solutions- eTransform Africa, EnockYonazi, Tim Kelly, Naomi Halewood and Colin Blackman (2012). Thus access to relevant and use of agricultural information by use of ICTs lends itself as one of the crucial factors that has an important bearing on food security of any area.

The study applies a media richness theory which takes into considerations the language of the locals and feedback is faster hence enabling them access the information required on agricultural activities in the sub county.

1.2 Farming in Kenya

Farming activities in Kenya are challenging, putting in mind that in rural Kenya, increasing numbers of environmental shocks (such as flooding and drought) and degradation of agricultural land are contributing to increasing pressures on small-holder farmers. Many need to intensify their food production even where productivity of land is already severely compromised (FAO, 2007).

1.2.1 Overview of SamiaSub County

The Samia speaking people as widely known by other tribes predominantly live in Samia Sub County (both in Kenya and Uganda) and speak kisamia, (African press international, 2008). SamiaSub County is in the larger Busia County in Western Kenya. It borders Uganda along Lake Victoria to the west, BunyalaSub County to the south, SiayaCounty to the south east and Busia Sub County to the north. It occupies an area of 264.2Km^2, witha population density of 334 persons per square kilometer (KNBS, 2010). The sub county has only one division, Funyula, seven locations and twenty nine sub locations.

Samia people are traditionally agriculturalists, they do grow different crops depending on the locations they live in. Close to Lake Victoria, the Samia are mainly fishermen, with their other main agricultural economic activity being growing of cassava, millet, sweet potatoes, beans, maize and cotton, but also horticulture crops such Sukuma week and tomatoes. They also keep a few livestock such as goats, sheep and cows (Kenya Food Security Steering Group KFSSG, 2012). Over the years, the government has been urged by leaders in the area to provide relief food to starving Samia Sub County residents, FranklineBwire (2012). If the area such as Samia with a lot of resource needs food as per the request of the sub county leaders then something is wrong and that needs research.

According to the area government officers, crops for farmers in the southern and northern parts of the district fail due to drought thus resulting poor harvest. At the same time erratic rainfall pattern in the area makes the situation quite unpleasant. Pests and diseases do not spare crops that try to resist the weather condition.

Figure 1.1: Farming activities in Samia Sub-County (ICT in Agricultural Development)

Farmers in the area should diversify their farming activities by planting drought resistant crops using the improved seeds to ensure food security. The farmers are encouraged to cultivate drought resistant crops that are certified and by taking advantage of the available agricultural experts to equip themselves with information that is vital for farming activities.

SamiaSub County Development Plan records Sub County Factsheet (2008 - 2012) lists the main crops as maize, sorghum, beans and finger millet. Thus situation where SamiaSub County finds itself asking for food from the government is unaccepted in the 21st century, with other resources available such as Lake Victoria.

1.2.2 Challenges the Farmers Experience

A number of factors contribute to localized poverty including declining soil fertility due to land degradation and failing markets particularly for agricultural inputs (i.e. seeds and fertilizer) among farmers in SamiaSub County. Furthermore a lack of alternative employment as well as few income generating activities exist. Meanwhile, high costs of production, increasing food prices, pests and diseases and reduced land holdings are occurring as well as increasing population pressure and continuous sub divisions of land (Place et al., 2013). For many farmers in the Sub County, these variables challenge their future survival.

Besides, increasing numbers of environmental shocks (such as flooding and drought) and stresses (such as degradation of agricultural land) are contributing to increasing pressures on smallholder farmers in the Sub County. Many need to intensify their food production even where productivity of land is already severely compromised (FAO, 2007). Some farmers have the capabilities, instead of relying wholly on subsistence agriculture to diversify their income sources while others have managed to maintain, or even improve their productivity levels; ensuring income and consumption needs are met. Social contacts, groups and networks are also recognised for their role in creating and improving household resilience in SamiaSub County (Place, 2013).

1.3 Statement of the Problem

Achieving food security is the greatest challenge of mankind (Raj, 2010). Information and Communication Technologies (ICT) as a tool of communication has a potential to contribute to achieving food security significantly. In the 21st century, speed, high

performance, and convenience of every activity have become a common demand for each and every sector and agriculture is no exception. But to majority, ICTs are seen us urban phenomena which have nothing to do with rural people(South African Social Attitudes Survey)As agriculture continue to be a major income earner for small scale farmers, how to obtain a reliable, timely and relevant information source for their agricultural activities becomes a very important aspect (Diekmann, Loibl, and Batte 2009 cited in Babu, Glendenning, Asenso-Okyere, and Govindarajan, 2012).

An agricultural information system would play a key role in disseminating knowledge, technologies and agricultural information, and in linking farmers with other actors in the economy. The information system might also be one of the critical change agents required in transforming subsistence farming to a modern and commercial agriculture that might also promote household food security, improve income and reduce poverty in an area such as Samia sub County. Access to reliable and timely agricultural information in Samia Sub County may help in ending perpetual food insecurity scenario in the sub county. This situation has hindered most farmers from keeping pace with changing technological advances in the Sub County.

Modern ICTs could play a major role in communicating information and knowledge to rural agricultural communities, delivering education modules, accessing inputs, planting methods, conducting business, facilitating networking and strengthening partnerships, scaling up inter-linkages of development interventions and increasing agricultural productivity. Inadequate agricultural information-research–extension–farmer linkages to facilitate demand-driven research and increased use of improved technologies continue to

constrain efforts to increase agricultural productivity in Samia Sub County as farmers continue to use outdated and ineffective technologies.

As Golan et al., (2014) notes, food safety is an important aspect of food security and can be better administered through information systems that manage food traceability and aid in making "informed decisions about agricultural productivity". This then begs the question, 'what kinds of agricultural information systems could be effectively implemented? This then brings to the fore the need to develop agricultural information systems that can link research and the farmers and hence enhance food security in the region.

1.4 Aim and Objectives of the Study

1.4.1 Aim

The aim of this study was to examine how farmers access agricultural information with a view to developing a web-based information system to support enhancement of food security in SamiaSub County.

1.4.2 Objectives of the Study

This study sought to achieve the following specific objectives:

1. To determine ways through which farmers access agricultural information in SamiaSubCounty.
2. To determine opportunities that ICT-based agricultural information systems present to farmers for enhancing food security in SamiaSub County.

3. To identify factors that influence access and utilization of agricultural information by small-scale farmers in SamiaSub County.
4. To model and build a prototype web-based agricultural information system that supports access to agricultural information by farmers in SamiaSub County.

1.5 Research Questions

This study was guided by the following questions:

1. Which are the approaches through which farmers' access agricultural information in SamiaSub County?
2. What are the opportunities that ICT-based agricultural information systems can present to farmers in SamiaSub County?
3. What factors influence access and utilization of agricultural information by small-scale farmers in SamiaSub County?
4. How can a prototype agricultural information system be designed, developed and used by farmers in SamiaSub County to access agricultural information? What should be incorporated in the design?

1.6 Scope of the Study

This research was carried out in the SamiaSub Countywithin the larger Busia County. The choice to work on small-scale agriculture in SamiaSub County was influenced by the major role the agricultural sector plays in poverty alleviation and ensuring food security in the Sub County. ICTs, small-scale agriculture and food security are a key focus under the new strategic plan of IDRC's Acacia Program and The Kenya Agricultural Information Network (KAINet, 2009). Samia was chosen for the study because of non-

accessibility to agricultural information on time and on demand by its farmers (Odame, 2002). The agricultural information system developed was limited to the core agricultural activities such as knowing planting time, types of seeds to plant, land preparation, storage, weeds and pest control and animal and fish keeping due to time constraints. Thus it was not to be a fully-fledged Sub County system which includes management information system, credits information system among others. This was to enable the researcher to focus on agricultural information service and develop an appropriate agricultural system to be utilized by farmers in accessing agricultural information. Whereas the researcher is aware that a system should ordinarily go through a full cycle from designing to development to full implementation, this study will be confined to the design phase only.

1.7 Assumptions

The study was guided by the assumption that lack of a web-based agricultural information system coupled with shortage of infrastructure such as power and strong telecommunication network have hindered farmers in Samia Sub County farmers from accessing agricultural information on time.

1.8 Significance of the Study

It is hoped that the developed multi-criteria web-based agricultural information system will benefit various stakeholders in agricultural sector in SamiaSub County as shown below.

a) **Farmers** in SamiaSub County will benefit a lot from the agricultural information system. Thesystem will enable them reach fellow farmers in the sub county and

agricultural officers in the sub county easily from their farms. They will also access information they want at the click of a button. But first and foremost, they will satisfy their information needs.

b) **Agricultural officers** will be able to offer agricultural information in an easy way and in amanner that will enhance food security in the sub county. They will also offer real time services to farmers.

c) **Sub County administration team** will have easy access to agricultural information on the food security in their areas ofadministration and thus make it easy for them to plan for sub county development.

d) **Students'** access to agricultural information will help them to embrace the technology inagriculture while still in school and likely to move into agriculture after school.

1.9 Definition of Operational Terms

Agricultural Information System (AIS): A system, in which agricultural information is generated, transformed, transferred, consolidated, received and fed back in such a manner that these processes function synergistically to underpin knowledge utilization by farmers.

Web-Based Agricultural Information System: An agricultural information system on the internet that allows farmers and potential users to query and obtain the desired agricultural information.

Information Communication Technology: An umbrella term that includes any

communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software applied in the development and execution of an agricultural system.

Farming: All agricultural activities targeted in the study such aslivestock keeping, fishing and crop planting.

Access: Being in a position to get agricultural information which should be (available on demand, relevant, ease to use and on real time) through a Web-based information system using direct access into UNIN servers, through ICTs as tool.

Mobile phone: This is an electronic device used for two-way radio telecommunications over a cellular network of base stations known as cell sites. A mobile phone can be carried anywhere anytime. It uses rechargeable, mobile phones also support additional services such as SMS, email, internet access gaming, Bluetooth, and camera.

External Variable: Controls which are beyond the farmers and the researcher for example, government ICT policy, power, hardware price and security.

Attitude: A cause of intention (Suki&Ramayah, 2010), for example, a farmer having a positive attitude towards using a developed agricultural information system.

Behavioral: Trends among farmers in making them accept ICT as a tool for them to access agricultural information.

The succeeding chapter presents a review of literature to the research problem.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents review of related literature on agricultural information systems and how farmers access their agricultural information. The review of literature provides a critique of the studies done by individual people, groups or organizations. The researcher was motivated by the desire to identify and evaluate opinions, knowledge and attitudes of various studies on access to agricultural information and development of agricultural information systems with regard to enhanced food security.

The sources of literature included books, journals, seminar papers, theses, periodicals, magazines, newspapers, commission reports and other relevant documents. Noteworthy is the fact that a lot of this literature was retrieved from the internet. The purpose of literature review is to provide a basis for the present study. Guided by the work done by other scholars, the study sought to examine how farmers access agricultural information with a view to developing a web-based information system to enhance food security in Samia Sub County. The chapter also presents the theoretical framework on which the study was grounded.

2.2 Theoretical Framework

This study was grounded on The Media Richness Theory advanced by Daft and Langel (1986). The theory essentially provides a framework that describes a communication medium's ability to reproduce information sent over it without any distortion. This theory makes two main assumptions. Firstly, that people always want to overcome equivocality and uncertainty.

Secondly, that a variety of media that is used would work better for some tasks than others.

Daft and Lengel (1986) presented a media richness hierarchy using four criteria arranged from the highest to the lowest levels of richness, to illustrate the capacity of media types to process various forms of communication. They introduced an approach considering information richness as a major factor in information processing and media selection by managers. They also defined information-richness as "the potential-carrying capacity of data", and stated that the medium used in communication determines the potential richness of the information processed, and thereby the effect(s) of a communication act. They further suggested that media differ in their potential capacity of transmitting the meaning of information in four information factors that can be ranked from "rich" to "lean".

The factors are:

(a) Interactivity or the availability to obtain instant feedback: rich media provide the opportunity for immediate feedback so that participants may adjust their messages "in response to signals of understanding or misunderstanding, questions, or interruptions. Synchronous media are richer than asynchronous media in this respect.

(b) Multiple cues: rich media allow transmission of a full range of multiple cues such as body language, voice tone, verbal, paralinguistic, intonation and inflection to not only the literal content of ideas, but also intensity and subtleties of meaning. These "surplus" cues are sometimes confusingly called "social" cues. Lean media put constraints on the range of cues that may be used in communication. Face to face meetings are rich media in this respect, while text is lean. Language variety or the use of natural language: These addresses the range of meaning that language symbols may convey.

    Numbers convey greater precision of meaning than natural language. Visual or graphic symbols carry a greater range of interpretations. Higher-variety languages are not only more

ambiguous, but may also be used to organize a large amount of information, given that a shared understanding of the language has been established. Rich media such as video conferencing allow the use of a high-variety language; lean media such as shared numeric databases restrict language use to low-variety language.

(c) Social-emotional cues or the personal focus of the medium: rich media permit communications to have "personal feelings and emotions infuse the communication. Some messages may be tailored to the frame of reference, needs, and current situation of the receiver." In this respect face to face meetings are richer than e-mail. A medium's potential richness can be thought of as the sum of scores on each of these information-richness factors. In other words "medium richness" is defined by the information-richness that a medium potentially transmits. "Potentially" is added because the actual richness of a medium is determined by how users use it. Face-to-face communication is viewed as the richest communication medium in the hierarchy followed by telephone, electronic mail, letter, note, memo, special report, and finally, flier and bulletins.

(d) The media richness theory (Daft, and Lengel, 1986) suggests that effective extension officers would make rational choices of communication medium(s) to a specific task or objective and to the degree of richness required by that task.

Agricultural information can be accessed in various forms, the same with the way it can be used. Sources that are information rich would make the information easier to access and to understand it; hence easier to use, this theory gives information feedback faster, farmers need.

Face to Face dialogue medium such as extension visits, field days, agricultural shows, trade fairs, refresher trainings, individual farm visit among others are information rich sources of agricultural

information. Therefore, they can be used to communicate complex information because they make it easier to understand.

According to this theory, information rich sources would provide extension service officers with more comprehensible information which would be easier for them to use hence easier to disseminate to clients. However, most of the information rich sources in developing countries are analogue or traditional and yet the world is moving towards digital communication mediums some of which are less information rich such as emails. This calls for a combination of all forms of mediums of communication; be they rich or poor as long as they equip the extension service officers with the right agricultural information that is varied and can adequately address the ever changing needs of their clients; the rural farmers, so they can attain food security.

2.3 The Concept of Agricultural Information

Having adequate and well-presented information will improve the efficiency of rural development, policies, projects and programmes. Agricultural information provision should be the basic component of rural development programmes. Oladele (2011) observed that lack of agricultural information is a key factor that has greatly limited agricultural advancement in developing countries. Thus, agricultural information interacts with, and influences, agricultural activities in a variety of ways. This tends to imply that agricultural information can help inform decision-making regarding land, labour, livestock, capital and management.

Interestingly, agricultural information is not static but, instead, needs replenishment through research and development. This is why Opara (2008) reports that agricultural activities can arguably be improved by relevant, reliable and useful information and knowledge. Mooko and Aina (2007) have reported in their research findings that agricultural information is an essential recipe for successful farming. One therefore sees that these same recipes can be used by famers in Samia Sub County to increase productivity.

However, information *per se* cannot increase productivity unless farmers are provided with the right type of information and at the right time, using the right channels and with all other necessary components in place, like telecommunication facilities, good roads, education and good agricultural policies. There appears to be other externalities that have to be in place so that information can make an impact. These significant externalities include such things as money, favourable socio-political stability, good governance, etc. (Radhankrishna, 2007). Invwieri (2007) opined that, rural people (farmers) who are mainly illiterate require access to appropriate information to be able to make decisions and participate fully in the national development processes, including agriculture.

2.3.1 Agricultural Information Generation Output and Types

Information generation is a process of creating, developing and communicating ideas which are abstract, concrete or visual. It is important to emphasize that the type of information generated revolve around scientific, commercial and legal information (Ballantyne, 2008; Demiryurek et al., 2009).

2.3.1.1 Scientific Information

Agriculture is generally interdisciplinary in nature. For agriculture to be fully developed, farmers need information from different disciplines. Scientific information is one of the innumerable examples which are generated from universities and research institutes. In India, for instance, Chandrasekan et al., (2010) and Rao, (2007), opine that agricultural information in India is mainly derived from universities and research institutes. It includes scientific information which deals with research and development works carried out in universities and research institutes. Scientific information is aimed at providing information on new crops varieties, their requirements and technical assistance during growing season. The characteristic of this information relates with climate, weather, drought and water stress periods, water sources, quality and availability.

In Turkey, Demiryurek*et al*., (2008) argue that agricultural research is usually carried out in research institutes and the objectives of such institutes are to provide farmers with information on best practices. Demiryurek (ibid.) further noted that as a result of information dissemination to dairy farmers in Turkey, functional cooperation between public and private information sources in the system is needed to motivate conventional dairy farmers to convert into modern dairy farming systems.

Emad-Kharasani (2009:17) in Iran seem to concur with Demiryurek*et al*. view that, "Nowadays, scientific and technical information is considered as a basis for material and intellectual sources in different societies and any society which is able to access more information automatically has more potentiality". Oladele (2006) hold the view that agricultural information is generated in universities and research institutions. This result

emanates from a research on multilingualism of farm broadcast and agricultural information access in Nigeria. Oladele, (2006) also pointed out that such information includes scientific and commercial information.

It is indicative that research and development has the ability to create a pool of scientific and technical information with a great wealth in modern societies. Therefore, research and development departments existing in the various universities in Kenya are a platform for creating material intellectual sources which can enhance Kenya's wealth.

Demiryurek, *et al.* (2008), Opara (2008) and Ekpenyong (2011) all provide further evidence that agricultural information is generated from universities and research institutes. They report that information generated from these institutions include, among others, information on pest and weed control, weather forecast, credit facilities, fertilizer and legislations on general agricultural practices.

Indeed farmers in Kenya, like their counterparts from Asia and other parts of Africa, need scientific and technical information because it is among the most important information needed for wealth creation and national development. This is corroborated by Ugboma (2010) in a study on access to agricultural information by fish farmers in the Niger Delta region of Nigeria, where it reveals that 98 percent of fish farmers studied prefer scientific information.

2.3.1.2 Commercial Information

Commercial information is another type of information generated by research institutes as well as the universities. This information deals with price control, price of fertilizers,

seeds prices and sale of agricultural products. Maru (2008) and Renwick (2010) in separate studies carried out in India and the Caribbean respectively reported that research institutes are behind the generation of commercial information that is related to markets. This type of information is related to production, productivity and profit enhancement. It therefore covers information on commodity price, food quality and safety as well as labeling information.

Maru (2008) asserts that agriculture is an interdisciplinary activity that requires information from different disciplines and that commercial information is a key to farmers who sell their produce. The fact that farmers require diverse information has been echoed by various researchers including those in Lesotho where Mokotjo and Kalusopa (2010:352) attested that "farmers need to have access to agricultural information in order to improve their agricultural production and that farmers need to have access to financial information for their actual performance as well as access to credit".

In a related development, Opara (2008) supports the fact that agricultural information is generally generated in universities and research institutes and that such information pertains to credit facilities, fertilizer and legislations on agriculture. The study was based on agricultural information sources used by farmers in Imo State, Nigeria.

Similarly, in Nigerian context, Ugwu and Kanu (2011) maintain that most of the agricultural information in Nigeria is generated from universities or commercial outlets as to where a farmer can find fertilizer, credit facilities, cost of inputs and its quality, transaction costs, labour supply and demand, distribution, selling options, agricultural

insurance, market price and quality requirements. The availability of commercial information enhances farmers' performances and without it, farmers will be skeptical as to what to produce, how to locate, potential market to sell their produce. To buttress the point that farmers in Africa need commercial information, Meyer and Boon (2003) buttress that South African farmer's wanted information on how to give loans and the repayment of such loans. It is therefore of significance that the agricultural information system enhances access to commercial agricultural information for farmers.

2.3.1.3 Legal Information

These are generally laws grouped under the heading of "agricultural laws", that relate to the production activities, as they are carried out in a commercial setting (Kaniki, 1995). There are numerous statutes in Kenya that subsidize, regulate or otherwise directly affect agricultural activity. These may deal not only with plants and animals but also with land use, environmental rules, and the use of food products.

Hence, with the increasing sophistication of farming process, issues of intellectual property, trade, finance, credit and generally commercial transaction, often arise. All legislations that affect agriculture such as land tenure, the production, distribution and sales of agricultural produce come under this category of legal information (Aina, 1995). This type of information often forms the domain of extension workers, policy makers and farmers.

From the foregoing, it is apparent that farmers in Samia Sub County and all over the country require diverse information, whether scientific, commercial, or legal as long as

that information hinges on the success of what they do. Consequently, any farmer who sells his produce will need commercial information, in the same way that he or she will need information about the weather, soil, buyers, loan facilities, et cetera. Therefore universities and other institutes which produce interdisciplinary information are very crucial to farmers in Africa who need different information to improve yields and production.

In a related development, Ozowa (2008) in a study contends that agricultural information is generated through research efforts from universities and is categorized as: (i) agricultural technology, (ii) agricultural credit and (iii) marketing. Ozowa's contribution is based on a study on information needs of small scale farmers in Nigeria. These findings confirm that farmers in many parts of Africa, and Kenya in particular, require technical information about pest control, new seedlings, use of machines and other equipment. Farmers all over the world require a range of information from the weather, loans, soil, seeds, farming mechanisms, control and management, harvesting, storage, marketing, sale, investments and repayment of loans (Opara, 2008).

An investigation of empirical literature reveals that agricultural information output is varied and extensive, hence, it needs to be generated, disseminated and be used by specific farmers based on their different needs Oladele, (2011); Ballantyne, (2009); and Ozowa, (2008). Some of the evidences from the review clearly show that not all information that is generated reaches the end user. Similarly, the research findings of Aina (1995) are still reminiscence of today's occurrences, where it was reported that sometimes the form of information generated for farmers is not used because of the

medium of communication, time allotted to air agricultural programmes, the language used in communicating information, and the attitude of the end user (farmers).

So far, the review shows a disconnection which may be one of the contributing factors why generated agricultural information has not been sufficiently used in Africa. A striking example is Nigeria, where most rural famers are illiterate and most of the information generated from universities and research institutes have not been stepped down to suit the end user.

2.4 Sources and Access to Agricultural Information

Any system producing or containing information intended for transmission is an information source. Information sources are distinguished by the form of representation; textual (books, journals, manuscripts), graphic (graphs, diagrams, plans, charts), and audio visual (sound recordings, motion pictures, slides). The characteristics of a good information source are relevance, timelessness, accuracy, accessibility, cost effectiveness, reliability, usability, exhaustiveness and aggregation level (Feather and Sturges, 2014). Oladele (2009) stresses that the efficiency of technologies generated and disseminated depend on effective communication which is the key process of information dissemination. Therefore, it is expected that the message from the client should be passed back to the source or researchers for the communication process to be complete.

Despite the attempts at technological innovation transfer, the wide gap between the levels of production which research contends is attainable and that which farmers achieve, suggests a missing link (Oladele, 2009). What is more, weak linkages between the farmer, extension workers, and researchers mean that the farmers are not included in the

planning of the innovation hence; they do not know where to get information, despite the fact that they are the end users. Agricultural information disseminated by different information sources needs to be determined. It is imperative therefore to identify the sources of agricultural information utilized by farmers. This was one of the objectives of this study.

Opara (2008) investigated the overall sources of agricultural information available to farmers in Imo State (Nigeria), as well as the farmers' preferred sources. The study reveals that 88.1% of the farmers' source of agricultural information was through extension agents. Similarly, Ozowa (2008) shows that among all the existing channels of communication, farmers in Nigeria ranked extension workers the highest in providing credible information and advice. The investigation was carried out on small farmers in Imo state, Nigeria.

Mokotjo and Kalusopa (2010) in their survey study found out that print sources are among the sources of information to farmers in Lesotho. Their study reveals that, though most of the farmers have acquired primary education, the agricultural information delivered to them is written in local languages. This enables them to utilize the information effectively.

It also demonstrates the high literacy level in Lesotho and indeed according to the literacy rate in Africa, Lesotho occupies the seventh position with a literacy rate of 84.80% (Aneki, 2012). However, only 13% out of 61.7% of the farmers in Lesotho are of the views that print media is one of the appropriate technologies to disseminate information.

However, Lwoga, Stilwell and Ngulube (2011) significantly differ from Mokotjo and Kalusopa (2010). For them, print materials have low usage due to their unavailability and illiteracy levels of most of the farmers in Tanzania.

The mass media also provides support for the growing involvement of farmers/producers and their organizations in the information dissemination arena. The rapid development of information technologies has profoundly changed the media landscape in African countries. Information and Communication Technology (ICT) is a term that combines computer and telecommunications technology in handling, acquiring, processing, storing and disseminating information (Chauhan, 2009; and Malhan, 2007). Information and Communication Technology is a general or an all-inclusive term that embraces all those technologies that are employed in collecting, storing, organizing and communicating information in various forms (Chisita, 2010).

ICT can become a key enabler of the agricultural-food sector by making dynamic and real time global level exchange of data as stated by Rao (2009, 492): "Effective deployment of ICT can lead to increase in agricultural competitiveness through cuts in production and transaction costs, raising production efficiencies and farm incomes, conserving natural resources, and by providing more information, choice and value to stakeholders". In using ICT successfully to support farmers and rural communities, the first step is to empower farming communities to define their own needs (Ballantyne, 2009:356). With wider access to and use of ICT, the potentials of opening up of communication as well as sharing information would be enhanced, so as to assist farmers, researchers, extension workers and policy makers. It will also narrow the information gap

that exists between the farmers and the researchers on the other hand because there will be a feedback (Ballantyne, 2009).

In the same view, Renwick (2010), points out that, most of the small island nations are above the 100% and some are over 200% mobile phone penetration mark. This implies that many people had more than one cell phone and over 100% of the farmers used cell phones to receive agricultural information. This indicates that ICT is a very useful tool in the dissemination of agricultural information to the farmers especially in rural areas where cell phones have been embraced by both literate and illiterate farmers. Therefore, ICT has become the most important tool that is crucial in processing and disseminating agricultural information.

In the same string of thought, Bolarin and Ayanlade (2010) maintain that mobile phones and computer systems are the most used and widely owned tools today by extension workers and their organizations in the North Central Zone of Nigeria. This is because, about 75% of the respondents surveyed by Bolarin and Ayanlade (2010) perceived themselves as frequent users of multimedia and other ICT tools.

Other sources of information for farmers that are equally important, but less recognized are the traditional sources. The traditional system is the form of information emanating from colleagues, during weddings, naming ceremonies, burials, agricultural shows and festivals and in some cases through town criers (Aina, 1995). Demiryurek et al., (2008) argues that Dairy farmers in Turkey use four categories of information all of which are

traditional sources of information relayed from family members. The four categories are: extension workers, posters and leaflets, family members, and the electronic media.

In the Caribbean, farmers rely heavily on traditional knowledge and informal meetings among themselves for farming (Renwick, 2010). Questions as to what to plant, what moon phase is best for sowing seeds and transplanting seedlings, and how often to rotate crops are answered through colleagues. This suggests that, one of the sources of information to farmers in the Caribbean is the traditional source which is transmitted through oral channels by colleagues.

Similarly, Opara (2008) reported that agricultural information in its broadest sense includes indigenous agricultural knowledge (IAK) which is transmitted orally from person to person. This is a very common practice among farmers in many countries and which is hugely relied on by old farmers as well as the illiterate and many others who favour oral dissemination of information. Oral tradition is an important method of disseminating agricultural information in many African cultures. This is because it recognizes existing traditional or indigenous channels of information dissemination.

Lwoga, et al., (2011) in their study on access and use of agricultural information and knowledge in Tanzania report that the major sources of information for farmers are predominantly local (neighbors', friends and family) which implies that their major sources of information are traditional. To emphasize the importance of traditional information in Africa, Aina (1995) points out that one of the sources of information of

farmers in Nigeria is traditional. That is, information is obtained not from official sources directly but through colleagues or family members.

Aina holds the view that, though the majority of the farmers in Africa are illiterate, it is possible to supply them with necessary information through the information gate-keepers for instance is popularly known in North Western Nigeria as *SARKIN NOMA* (Information gate keeper), who is a literate farmer among the farming community with a wealth of experience and vast land. The role of a *SARKIN NOMA* is to offer advice and information on a regular basis to other farmers for improvement. The contention by Ugboma (2010) buttresses the various studies cited, where in a study conducted on access to agricultural information by fish farmers in the Niger Delta Region of Nigeria, Ugboma observed that 63% of the respondents indicate that, their source of information is through traditional, as well as personal experience.

2.5 Factors affecting Access and Utilization of Agricultural Information

A number of empirical studies have been conducted by different people and organizations on the adoption of different agricultural technologies. There is however a limitation of empirical studies related to the factors influencing access to and utilization of agricultural information. Therefore, in this study factors that influence access and utilization of different agricultural information were reviewed. For simple presentation and ease of understanding, the variables were categorized as household's personal and demographic factors, socio-economic factors, psychological factors and institutional factors.

2.5.1 Household's Personal and Demographic Factors

Household's personal and demographic factors are among the most common household characteristics which are mostly associated with farmers' access and utilization of agricultural information behavior. From this category of factors, age, sex and education were reviewed in this study but there is a limitation of empirical study on other variables. Age is also one of demographic characteristics important to describe households and can provide a clue as to age structure of the sample and the population too.

Young farmers are keen to get knowledge and information than older farmers. Beside, older farmers are more risk averse and less likely to be flexible than younger farmers and thus have a lesser likelihood of information utilization and new technologies. With regard to age, different studies report different results. Haba (2004) opines that the willingness to pay for agricultural information delivery technologies such as print, radio, farmer-to-farmer, expert visit, and television has a correlation with age.

Haba argues that as age increased, the willingness to pay for these agricultural information delivery technologies decreased, meaning that older farmers were less willing to get information than younger ones. On the other hand, a study conducted by Katungi (2006), on social capital and information exchange in rural Uganda revealed that older men are less likely to engage in simultaneous receiving and providing of information, perhaps due to the low ability to communicate associated with old age.

A study conducted by Teklewold et al., (2006) on the adoption of poultry technology in DebreZeit, Ethiopia, indicated that farmers' decision on level of adoption of exotic

poultry breed were negatively influenced by age of the household head. Mulugeta, (1994) in a study on smallholder wheat technology adoption in South Eastern high lands of Ethiopia reported that age had a negative effect on the adoption of wheat technologies. Further, Kidane (2001) in astudy on factors influencing adoption of improved wheat and maize varieties in HawzienWereda of Tigray found that age is negatively related with farmers' adoption of improved wheat variety.

However, there are authors who reported a positive relationship between age and adoption. For instance, Asante-Mensah and Seepersad (1992) conducted a study on factors affecting adoption of recommended practices by cocoa farmers in Ghana and reported a positive relationship of age with adoption. Gender is another factor that limits access to and utilization of agricultural information. Due to the prevailing socio-cultural values and norms in some communities, males have freedom of mobility, participate in different meetings and trainings and consequently have greater access to information.

A study conducted by Katungi (2006) revealed that male-headed households tend to build and maintain larger network ties with relatives and friends than female-headed households. This is a clear justification of the nexus that exists between gender and access to agricultural information. Male-headed households are said to have better access to agricultural information than female headed households, which is attributed to negative influence of cultural norms and traditions (Habtemariam, 2004).

A study conducted by Pipy (2006) reveals that, there were significant difference between male and female farmers in poultry production the access and utilization of poultry

information. Yahaya (2011) reported similar results in previous studies that sourcing of agricultural information and utilization has a strong relationship with gender. Yahaya posits that women are less likely to participate because they have limited time to access or utilize available information due to pressure of household responsibilities.

Married women in particular are bypassed in the transfer of improved agricultural technologies with the assumption that they will get the information through their husbands. However, Saito and Weidemann, (2009) reported that for most of the women, relatives and friends were the source of information; nearly one-third had acquired their knowledge from the extension service, and only 1% had heard of the technologies from their husbands. Studies conducted by Ellis (2012) and Green and Ng'ong'Ola, (2013) indicated that female headed households had less access to improved technologies, credit, and land and extension service.

According to Habtemariam (2006), Policy makers and administrators typically still assume that men are the farmers and women play only "supportive role" as farmers' wives. This attitude by both planners and implementers has significant adverse effects on women's access to agricultural extension services. The low level of women's education and cultural barriers prevent them from the exposure to extension channels by their initiative. The male-dominated extension system also often restrains from contacting and working with women due to the strong taboos and value systems in the rural areas in some communities in Africa. Habtemariam's (1996) study shows that, there is a gender bias against women and among extension workers. Extension services in most countries in Africa are male-dominated and working mainly with male farmers, partly for cultural

reasons and partly because the extension system itself has traditionally relied on the use of contact farmers, whose criteria for selection tended to exclude female farmers.

Generally, extension services frequently fail to provide adequate information to women farmers through failing to recognize their specific needs. In addition to their productive tasks, they are frequently over burdened with household responsibilities which they cannot delegate, they are often less educated than men and have a limited access to resources such as credit. If an extension program deals effectively with these constraints, it can be easier for women farmers to get involved in agricultural activities and the subsequent access and utilization of agricultural information.

According to FAO (2002), "Rural women and girls usually have less access than men to information and new technologies. Without equal access to information, they are at a disadvantage in making informed choices about what to produce and when to sell their products". Agricultural extension as an educational and communication tool makes a vital contribution to agricultural production and rural development. It is thus important to provide women farmers in both male and female-headed households with efficient, effective and appropriate technology, training and information on agricultural issues.

2.5.2 Household's Socio-Economic Factors

Knowledge systems are dynamic, people adapt to changes in their environment and absorb and assimilate ideas from a variety of sources. However, access to knowledge is not spread evenly throughout a community or between communities. People may have

different objectives, interests, perceptions, beliefs and access to information and resources.

Knowledge is generated and transmitted through interactions within specific social and agro-ecological contexts. It is linked to access and control over power. Differences in social status can affect perceptions, access to knowledge and, crucially, the importance and credibility attached to what someone knows. Often, the knowledge possessed by the rural poor, in particular women, is overlooked and ignored (FAO, 2014). Therefore, access to information highly depends on the individual social and economic status.

Among different factors, annual farm income obtained from sale of crop and/or livestock are important income sources in the rural households. Off-farm activities are the other important activities through which rural households get additional income. Households' income position is one of the important factors determining access to and utilization of agricultural information and different improved technologies.

Almost all empirical studies reviewed show the effect of farm income on household's adoption decision to be positive and significant. For example, Kidane (2011); Degnet*et al* (2011) and Getahun (2004) reported positive influence of household's farm income on adoption of improved technologies. The income obtained from off-farm activities often helps farmers to purchase farm outputs. Review of some of the past empirical studies shows that, the influence of off-farm income on adoption varies from one study to the other. However, majority of the studies reported positive contribution of off-farm income to household's adoption of improved agricultural technologies.

2.5.3 Institutional Factors

In the context of this study, institutional factors included various formal and informal institutions, and organizations. These factors facilitating and enhancing the access and utilization of agricultural information such as credit, social participation, enhancing farmers' participation and joint planning, development of agents' support, visiting market place and different formal and informal social organizations.

Credit has strong and significant influence in determining the use of combined packages depending on the production type. It helps in alleviating current financial constraints enhancing the use of technology packages correspondingly. Survey results by Saito *et al.,* (2009) in Nigeria showed that a major reason for smallholders not using fertilizer was lack of cash, highlighting the importance of short-term credit. Different studies have shown that access to credit plays a significant role in enhancing the use of improved varieties (Tesfaye*et al.*, 2011). However, Jabbar and Alam (2013) found that access to credit was not significantly related to adoption of improved varieties.

In agricultural development, the importance of social capital (multidirectional social network) is perceived as a willingness and ability to work together. The very likely assumption on which the relationship between social capital and adoption is anchored is that neighboring agricultural households are, *de facto*, members of a social structure who exchange information about improved agricultural practices. Rogers (1995) concludes that: "The heart of the diffusion process consists of interpersonal network exchanges … between those individuals who have already adopted an innovation and those who are then influenced to do so".

Similarly, the findings of Habtemariam (2004) also indicated a positive relationship between social participation and adoption of all dairy practices. Therefore, social participation has a role in information exchange. Other reports indicate that, membership and leadership in community organization assumes that farmers who have some position in cooperatives are more likely to be aware of new practices as they are easily exposed to information.

To assure the need of farmers' agricultural information provision, the planning process should be bottom-top, based on the farmers' problem, aspirations, needs, resource, and environment. Market distance and frequency of market visiting is also another factor in the dissemination of agricultural information and utilization. A study conducted in Uganda indicates that the market serves as a forum for the exchange of goods and services and constitutes an important place where agricultural information is exchanged (Katungi, 2006).

Moreover, farmers located near the market will have a chance to get information from other farmers and input suppliers. The closer they are to the nearest market, the more likely it is that the farmer will receive valuable information (Abadi, 2009). Therefore, the frequency with which a farmer visits a market and distance from the market from where the farmer resides plays important role in the access to and utilization of agricultural information.

2.5.4. Psychological Factors

Psychological factors also play influential role in the access of agricultural information and technology utilization. In this study attitude towards improved farming, innovation proneness, production motivation and information seeking behavior were considered as important variables having influence on access and utilization of agricultural information.

Attitudes are usually defined as a disposition or tendency to respond positively or negatively towards a certain thing (idea, object, person, and situation). They encompass, or are closely related to, our opinions and beliefs and are based upon our experiences. Since attitudes often relate in some way to interaction with others, they represent an important link between cognitive and social psychology (Kearsley, 2008).

In this study, attitude towards improved farming is defined as the degree of positive or negative opinion of respondent farmers towards improved farming. Positive attitude towards improved farming is one of the factors the can speed up the farm change process. Attitude formation is also a prerequisite for behavioral change to occur. A study conducted in Adami Tulu District in Uganda by Ebrahim (2006) reported that attitude towards change was statistically significant in relation with dairy adoption. Innovation proneness in this study was operationally defined as the receptivity of the individual to new ideas related to different agricultural information.

A study conducted in Dire Dawa administrative council, eastern Ethiopia, Asres (2005) reported that innovation proneness was statistically significant relationship with access to productive role information and utilization of accessible development information of

women. Information seeking behavior was also one of the hypothesized variables that influence access and utilization of agricultural information. This variable is reflecting the degree at which the respondent was eager to get information from various sources on different agricultural activities. Information seeking behavior was assumed to have positive relationship with the access and utilization of agricultural information. From the previous study DeribeKaske (2007), found that there was a significant and positive relationship between information seeking behavior and knowledge of dairy farming. This indicates that as respondents' information seeking behavior increases, their utilization of accessible information also increases.

2.6 Modeling and Building Web-Based Agricultural Information Systems

According to Gokhe (2010), information and communication technologies (ICTs) are the expanding assembly of technologies which are used to aid communication. The discovery of personal computers, the Internet and mobile telephone over the last two decades has provided a much wider choice in collection, storage, processing, transmission and presentation of information in multiple formats to meet the diverse requirement and skills of people.

Perspectives from Braund*et al.* (2006) indicate that ICTs is believed to bring about social and economic progress by creating an enabling environment. Most activities in the modern world are believed to depend on ICTs on one use or another. The importances of ICTs reach even those who do not have first-hand access to them.

Through ICTs, for example, an agricultural extension officer or farmer can acquire new technologies, rainfall forecasts, commodity prices, etc and use that information to advice

farmers in rural villages. The benefits of ICTs in agricultural developmental processes was long known and access to ICTs was even made one of the targets of the Millennium Development Goal No. 8 (MDG 8), which emphasized the benefits of new technologies, especially ICTs in the fight against poverty.

With 10 percent increase in high-speed internet connections, economic growth increases by 1.3 percent, observed the recent World Bank report on Information and Communication for Development (World Bank, 2009). The world bank goes on to state that with connectivity of Internet or mobile phones increasingly brings farming information, financial services, and health services to remote areas, and helps to change people's lives in unprecedented ways. The innovations in computer technologies have affected everybody's daily life including farmers themselves since computers support and assist almost every single human activity (Odame, 2002).

According to Turban (2005), traditional decision support systems (DSS) focus majorly on computerized support for making decisions with respect to agricultural problems. Other good examples are computer aided software engineering (CASE) and computer aided design (CAD). Yao et al. (2001) argues that the introduction of Web technology, one may reconsider the existing methods and re-design or modify existing systems to meet new agricultural challenges which lead to food insecurity.

The Web is used both as a universal interface and as the underlying infrastructure for Intelligent Web Information Systems development. There has been an emerging and fast growing interest in computerized support systems in many other domains such as

information retrieval support systems, research support systems (Yao, 2003), teaching and learning support systems (Fan, 2003), computerized medical support systems (Stalidis et al. 2001), knowledge management support systems (Ginsburg &Kambil, 1999), and many more. The recent development of the Web generates further momentum to the design, develop and implementation of support systems (Yao, 2005).

The social systems networks in Africa also aid in the sharing of knowledge. The availability of a few mobile phones to start with can quickly spread a message from an authentic source to clan members, solidarity association members, and other members of the community. Mobile telephony in combination with radio enables messages to be given to a large number of listeners. The use of knowledge management web portals with pertinent production and farming information has even been tried in some communities in Asia and Africa with some challenges which are not insurmountable. Evidences also suggest that the technology is being effectively used in some countries in Africa with remarkable success on agricultural information, weather forecasts, transport information, information on storage facilities and information related to crop and livestock diseases and general advice related to agriculture (Gakuru et al., 2009).

Use of ICTs in extension provides for several key benefits in relation to traditional media, ICT projects also come with a range of challenges including: technological dependence; lack of accessible telecommunication infrastructure in many rural and remote areas; capital cost of technologies, high cost of on-going access and support; inherent need for capacity building; often difficulty in integrating with existing media, and local

communication methods and traditions; and, often lack of involvement of all stakeholders in planning, especially women and youth (Richardson, 2009).

Many types of Web-based Support System (WSS) have been studied recently by researchers (Yao &Lingras 2003). It is argued that the time to treat Web-based support systems as a new and separate sub-area such as agriculture of Web intelligence is coming based on the observations of existing studies. Recently, two workshops aimed to exchange research on the topics of WSS were held in Halifax, Canada and Beijing, China in 2003 and 2004 respectively. Many papers published in the proceedings and other venues cover a variety of Web-based support systems, including decision support, research support, and retrieval support, teaching and learning support, data mining support, agricultural support and business support systems (Bai et al., 2004).

2.6.1 ICT-Based Extension Services

Agricultural information is an important factor that interacts with other production factors thus productivity of these other factors, such as land, labor, capital and managerial ability, can arguably be improved by relevant, reliable and useful information. Information supplied by extension, research, education and agricultural organizations helps farmers make better decisions in enhancing food security (Demiryurek, 2008). Therefore, there is a need to understand the functioning of a particular agricultural information system in order to manage and improve it.

According to Maningas (2000), information within the hands of the farmers means empowerment through control over their resources and decision-making processes which in turn enhance food security. It is noted that being with an effective and efficient

delivery system of essential information and technology services facilitates the farmers' with a critical role in decision-making towards improved agricultural production, processing (Leeuwis, 2004). Information is very important for agricultural development because improving the income and ensuring food security of farming communities depends crucially upon raising agricultural productivity. Achieving sustainable agricultural development is less based on material inputs (e.g., seeds and fertilizer) than on the people involved in their use (Leeuwis, 2004). For achieving this there is a need to focus on human resources for increased knowledge and information sharing about agricultural production, as well as on appropriate communication methodologies, channels and tools (Leeuwis, 2004).

New agricultural technologies are generated by research institutes, universities, private companies, and by the farmers themselves. Agricultural information and knowledge delivery services such as extension, consultancy, business development and agricultural information services are expected to disseminate new technologies amongst farmers (Hafkin, 2002).

The role of research and advisory services is to give highly accurate, specific and unbiased technical and management information and advice in direct response to the needs of their clients. The adoption of new agricultural technologies by farmers is often very slow and research is not focusing on the actual needs of farmers. In many countries food security has been attributed, among other factors, to poor linkages between Research-Extension-Farmers and to ineffective technology delivery systems, including poor information packaging, inadequate communication systems and poor methodologies

(FAO, 2005). Therefore, the agricultural information systems which integrate farmers, agricultural educators, researchers, extensionists and farmers should be developed for agriculture sector (Odame, 2002).

2.7 Designing of Information System in Agriculture

Agriculture information distribution system is a system that was developed by P Krishan Reddy and R Ankaiah in India, it was developed to cover farmers' crops in a cost – effective manner. It enables farmers to obtain agricultural information in a manner that is personalized to that farmer and timely. The system makes use of computer networks between the farmer and the agriculture experts where information is sent between the farmer and the experts. Farmers sends queries and are able to obtain information/ answers they need.

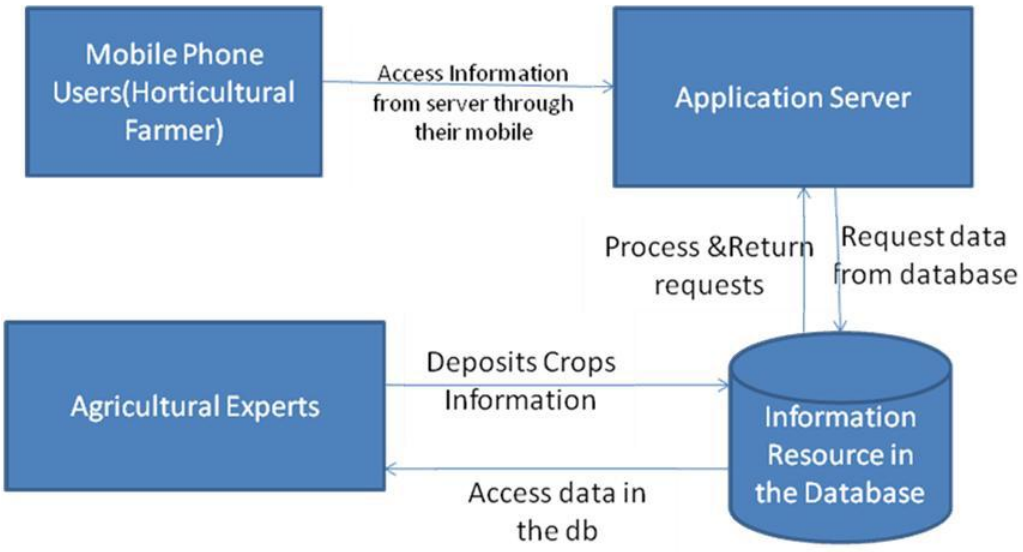


Figure 2.1: AgriculturalDirectory Use Case (Agile Modeling)

Shows how the different actors interact in the agricultural directory module. The different actors in the system include the farmers and system administrator. Famers have access to

a front end database that shows the names of farms and what products are produced plus the contact information. The other actor are the system administrator this actors have rights to modify, delete and update records.

2.8 Future of ICT in Agriculture

The role of ICT which includes the use of computers, internet, geographical information systems, mobile phones, as well as traditional media such as radio or TV to enhance food security and support rural livelihoods is increasingly recognized. Developing codes of good farming practice, and production systems as well as European standards of sustainable agricultural production systems require implementation of more elaborate management strategies. These have to respect specific ecological conditions, demands from the rural regions and those from the value-added chains. On top of that, these strategies have to be simple, but flexible enough to be adapted easily to changing economic or environmental conditions and they need proof of their compliance.

Beyond that, the demand for information about the production processes is growing, both from the perspective of the value-added chains (traceability) as well as from regional stakeholders in order to fulfill multifunctional objectives by farming. According to (Barrentes, 2005), a number of specific policy areas need to be addressed by ICT policies seeking to promote agricultural development. These pertain to food security and end-user competencies, levels of access and development of ICT in agriculture, knowledge management and information system generation, research and development, the price of technology and the cohesion between government departments' directly affecting ICT

initiatives. ICT face a number of unique barriers in rural communities that will have to be overcome in order to enhance food security.

Kenny et al, (2000) observe geography plays a very strong part in the determination of agricultural information system development communications costs and functionality. In rural communities, where a sparse population implies that potential users live in area of low demand density, communications costs will be higher and services will be less well developed. Different studies showed that even if subsidized, agricultural information systems in place may be beyond the reach of many potential beneficiaries, especially in rural communities in which poverty tends to be most prevalent.

The introduction of advanced ICT technologies into agriculture will also be a significant progress in all efforts for measurements oriented payments within agro-environmental programs and related efforts to enforce environmentally sound systems in land use within the EU. This also includes the Best Management Practice according to the cross compliance scheme. Crop products going into the food chain must show their certified provenance through a recognized management strategy and subsidy payments to farmers are now linked to respect of the environment through compliance to standards. To this end, an integration of information systems is needed to advise managers of formal advice, recommended guidelines and implications resulting from different scenarios at the point of decision making during the crop cycle. This can be achieved by integrating real-time modeling (a crop growth and development model linked to sensors within the growing canopy), with expert systems that have been configured with the guidelines from a

recommended management strategy as well as legal guidance (such as health and safety and environmental protection).

This will directly help the farmers to make better decisions. Expert knowledge in the form of models and expert systems can be published and made available in a machine readable form on the internet or made available as web-services to be dynamically bound into the end-user software. As the relevant farm data is already in the proposed information system, or may be automatically integrated using standardized services, documentation in the form of instructions to operators, certification of crop province and cross compliance of adopted standards can be generated more easily than with current systems.

The Future-Farm project attempted to address the balance of technological opportunities combined with environmental and socioeconomic needs with the key role of information management. Intensive use of information and knowledge will be a substantial activity of all commercial EU farms in future. Although most people can see the benefits of using a more precise approach to manage crops with additional information, the tools provided by precision farming and other information technologies have not yet moved into mainstream agricultural management. The increased complexity of the systems inhibits easy adoption and makes calculations as to the financial benefits uncertain. These issues can be resolved by improving the decision making process though better Management Information Systems, improved data interchange standards and clear management methods.

Therefore, most of the African governments cannot afford to remain behind in this information revolution which in one way or the other affects food security. They have to make information systems development a top government strategy and create environments that enable information systems to flourish. Challenges such as poor connectivity, lack of electricity, illiteracy, lack of local content and affordability, have to be overcome through the development of national information infrastructure, capacity building and political goodwill.

2.9 Conclusion

This chapter has presented a review of literature relevant to the research problem that this study sought to address. From this literature, it is clear that there is a paucity of literature on access to agriculture information systems that can enhance food security. The few studies that have been conducted on access toagricultural information do not seem to bring to the fore how systems can be adoptedin facilitating access to agricultural information to enhance food security. Besides, studies carried out on access to agricultural information have majorly addressed situations in developed states. Very few, if any studies have been conducted in developing nations and particularly in nations that are at the inception stages of devolved governments. This study comes in handy to fill this void. It’s important for more research to be done on the importance of accessing Agricultural information by farmers in rural areas and especially those with small acres of land.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter captured the stages that the study followed towards its completion. It discusses the decisions on how the research was carried out and how respondents were approached as well as when, where and how the research was completed. The chapter therefore elaborates the way research was designed, data collection instruments and procedures, data analysis and ethical issues that were considered.

3.2 Research Design

This study adopted the survey approach. Qualitative case study methodology provides tools for researchers to study complex phenomena within their contexts. If the approach is applied correctly, it becomes a valuable method to develop theory, evaluate programs, and develop interventions (Creswell, 2003). Agricultural information system is an emerging technology due to continued adoption of web-based technologies in the country. Research was exploratory in nature so as to enable the researcher to ask questions and clarify on issues in depth; as such multiple methods of data collection were used to enable the researcher get the real picture on the ground.

The study applied one of agile methodologies known as Feature Driven Development (FDD) model for system development as advanced by Jeff DeLuca and Peter Coad in (1999), Palmer and Felsing (2002), and Sensors (2011). Other agile methodologies include scrum, extreme programming, crystal, Dynamic Systems Development Methods

and Lean Software Development. FDD was chosen because it describes specific, short phases of tasks which are to be accomplished separately per feature and also it is a client-centric, architecture-centric, and pragmatic software process.

3.3. Study Area

The study was conducted in the seven locations namely Bwiri, Agenga, Nanguba, Nangosia, Namboboto, Nambuku and Odiado of Funyula division, Samia Sub County, in Busia County. The sub county has a population of about 124,952.Samia Sub County was chosen for this study partly because of its poor performance in farming(Kenya National Bureau of Statistics data, 2010). Despite farming being the main economic activity, it was identified as a sector that was performing poorly in the sub county. The formidable problem facing farming in the sub county was the need to improve farming practices through accessing reliable and timely agricultural information. Farmers in the area face many problems that range from very high transport costs, high transactional costs, low agricultural productivity, low levels of irrigation, erratic rainfall, vulnerability to high seasonal and inter-annual fluctuations, high rates of evapo-transpiration and very slow adoption of technology. The dominant mode of communication was conventional and this called for the need to explore the potential of a web-based information management system in Samia Kenya (ITU, 2010b).

3.4. Study Population

The sample population was taken from target population which comprised the agricultural officers and farmers. The population of Samia Sub County is 124,952 people. The target population comprised of small scale farmers and technical staff (1 Sub County

Agricultural Officer and 21 agricultural officers serving in locations) working in the agricultural sector who are ever in contact with farmers providing information on how to improve their agricultural activities.

3.4.1. Sampling Technique and Sample Size

In this study, a sample of 30% of the agricultural officers serving in the study locations was computed. This yielded a sample of 7 agricultural officers who were randomly selected, one from each of the locations in the Sub County. The Sub County Agricultural Officer of SamiaSub County was purposively sampled.

The sample size of small scale farmers was computed by the use of the formula indicated by Reid andBoore (1991) (since the population is greater than 10,000).

The formula is as follows:

$n = N / [1+N (e)^2]$

Where: n- Sample

N- Population size

e- Accepted level of error taking alpha as 0.05

Therefore:

$n=124,952/ (1+124,952x.05^2)$

n= 399

The sampling was enhanced by the presence of a list of small scale farmers in the seven locations obtained from the Sub County Agricultural Office. With the help of the agricultural officers serving in the respective locations, these small scale farmers were

identified and interviewed. Table 3.1 presents a summary of the sample size of the small scale farmers.

Table 3.1: Sample Size of Small Scale Farmers

Locations	**Population**	**Sample**
Bwiri	14,564	14,564/124,952 x 399=47
Agenga	18,943	18,943/124,952 x 399=60
Nanguba	16,789	16,789/124,952 x 399=53
Nangosia	16,894	16,894/124,952 x 399=54
Namboboto	19,897	189,897/124,952 x 399=64
Nambuku	21,432	21,432/124,952 x 399=68
Odiado	16,433	16,433/124,952 x 399=53
Total	**124,952**	**399**

Therefore, a total of 407 respondents were sampled in this study. Table 3.2 provides a summary of the sample size of the study.

Table 3.2: Sample Size

Respondents	**Target Population**	**Sample**
Sub County Agricultural Officer	1	1
Small scale farmers	124,953	399
Agricultural Officers	21	7
Total	**124,975**	**407**

3.5 Data Collection

Data for this study were collected using a questionnaire, interview schedule guide and content analysis.

3.5.1 Questionnaire

The farmers' questionnaire (FQ) consisted of a number of both open-ended and closed-ended questions. The questionnaire enabled the researcher to collect data within a shorter time since most of the information was easily described in writing. A questionnaire has the ability to source data associated with the nature of the research, it is found to be convenient, cost effective and highly dependable (Kothari, 2004).

The questionnaire item solicited data on sources of agricultural information, access and utilization of agricultural information, and factors that influence access and utilization of agricultural information in the respective sections (Appendix 1).

3.5.2 Interview Schedule Guide

Formal interviews were conducted with the selected participants of the study, to gather detailed data of the phenomenon under study. Semi-structured interviews place an emphasis on relatively open questions, although there were also some closed questions.

Wengraf (2001) opines that semi-structured interviews cover a great range of interview strategies, mixing both the features of fully structured and unstructured ones. This instrument was chosen because it allowed the researcher to prepare guiding questions before hand. It helped the researcher to get prepared in time and thus made him

competent during interviews and at the same time giving respondents freedom to express their views in their own ways. This enabled the researcher to have reliable and comparable data for the study. This tool was administered to the agricultural officers (Appendix 2 and 3).

3.6 Quality Control

3.6.1 Validity

Trochim (2005) defines validity of an instrument or scale as the success of the scale in measuring what it sets out to measure so that differences in individual's scores canbe taken as representing true differences in the variable under study. The usual procedure in assessing content validity of a measure is to use professionals or experts in particular field which is highly subjective (Mugenda&Mugenda, 2003). The validity of the instrument was verified with the help of supervisors.

For each item in the interview, respondents were required to indicate if they measured what they were supposed to measure or not. This content validity of the instrument was determined through piloting, where the responses of the participants were cross-checked against the research objectives. For research instrument to be considered valid, the content selected and included in the interview must also be relevant to the variable being investigated (Kerlinger, 1986).

3.6.2 Reliability

To ensure that theinstrument triggered off the same responses each time they were administered, a reliability coefficient was calculated. Reliability of the research

instruments were tested by administering the 20 questionnaire items once to the farmers in two randomly selected locations in Busia County that were not included in the main study. Using split half method, the reliability coefficient was computed. The instrument was divided into two sets, using the odd– numbered items for one set and the even – numbered items for the other set. Each set was treated separately and scored accordingly.

The correlation coefficients obtained between the two sets of data were adjusted by using Spearman–Brown Prophesy formula. The instruments were considered reliable since they yielded a reliable alpha coefficient of over 0.75 and were therefore accepted. This figure is usually considered desirable for consistency levels (Fraenkel&Wallen, 2000).

The reliability evidence for the interview items were determined by the use of inter-rater method used to determine inter-rater reliability. Here, a different rater alongside the researcher was trained in the same rating skills in order to assess the farmers and agricultural officers' responses using the same instruments. The two raters were in agreement in the data collected, and were therefore regarded as reliable. For the determination of internal consistency/ homogeneity, the interview instruments measuring a single construct gave highly correlated results.

3.6.3 Accuracy

The researcher tried to minimize effects of random errors so as to increase its accuracy. The researcher ensured that during the interviews, all issues were articulated well, any clarification sought, and the interview questions well organized to ease the process and facilitate collection of accurate data as much as possible.

3.7 Data Analysis

Data collected were analyzed using the cross case data analysis technique. The comparison is done against predefined categories to deduce similarities and differences, or in another strategy, classify the data by their data source (Eisenhardt, 1989). The researcher selected pairs of cases listing the similarities and differences which led to deeper understanding of the problem that was under investigation. The researcher derived insights from the questionnaire, document analysis and interviews separately. The finding becomes stronger when a pattern from one data source is corroborated by evidence from other source,Eisenhardt (1989)

3.8 System Design and Development

This consists of four activities:

i. Conceptualising the overall development process

ii. Design of the procedures to gather and processdata and disseminate information

iii. Deciding on the institutional setting, the principles that will guide the system, and the human and financial resources to use

iv. Creating a work plan showing how the system will be developed, (Figure 3.1)

Advantages of usingUML (Addison-Wesley, 2000)

1) The UML can be used to model just about any type of application, running on any type and combination of hardware, operating system, programming language, and network, in UML.

2) UML can be used for modeling middleware and this is effective for modeling large, complex software systems

3) Built upon the Microsoft Operating Framework (MOF) metamodel for object oriented modeling.

4) UMLProfiles (that is, subsets of UML tailored for specific purposes) help to model Transactional, Real-time, and Fault-Tolerant systems in a natural way.

5) This has an ability to generate test scripts apart from stub code when integrated with integrated development network.

6) The reverse engineering support, UML regenerate design level artifacts in accordance with the changes you made to the structure of class relationship

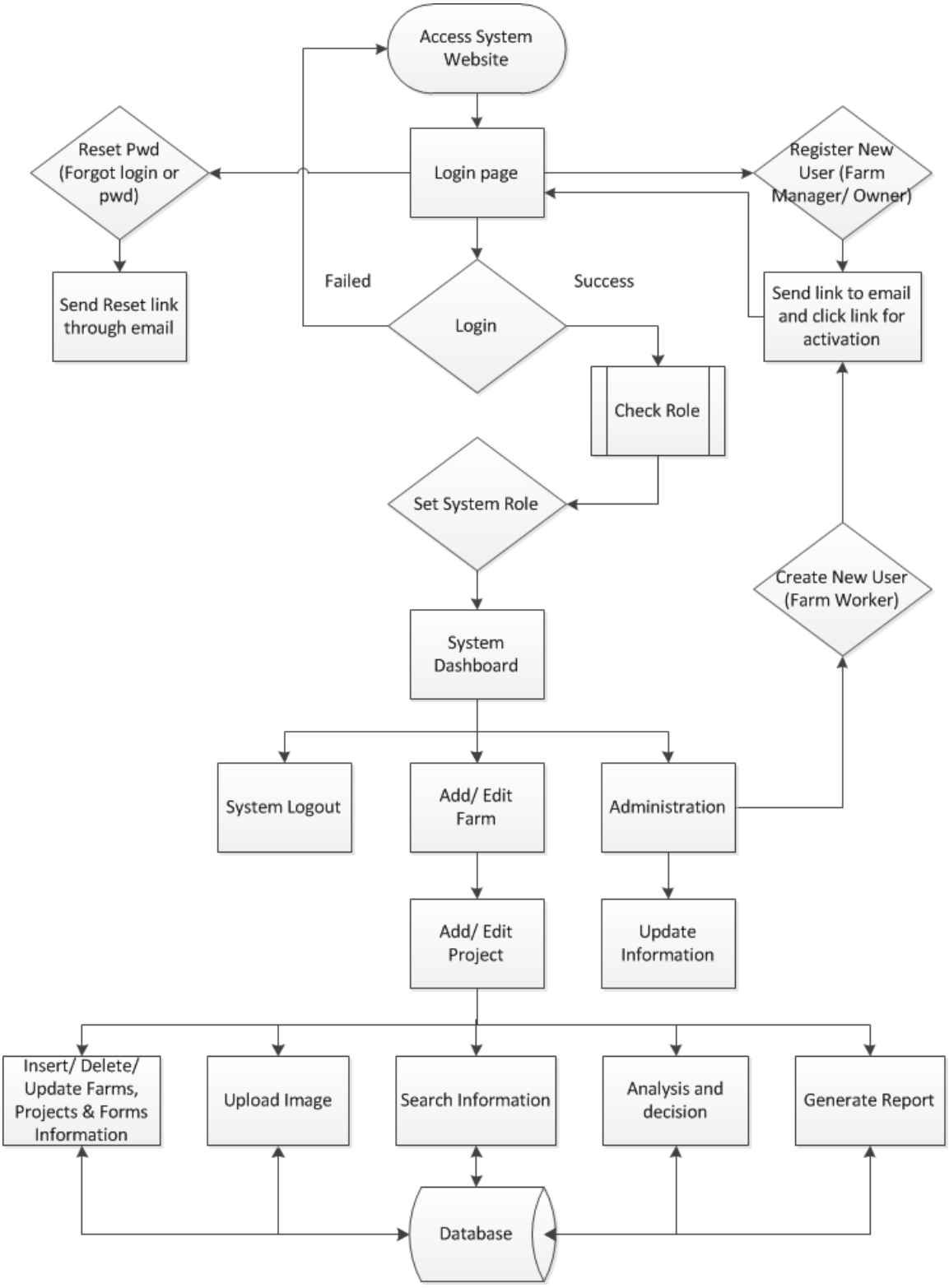


Figure 3.1UML Agricultural Information System Flow Design (Stockoverflow.com)

3.8.1System Development

Development Process

1. Identify and List Stakeholders

The persons, entities, or systems that participate in this system.

2. Identify and List Actors

Descriptions of the ROLES with which the stakeholders interact with the system.

3. Identify and List Use Cases

Description of a complete interaction that an Actor makes with the system, from start to finish.

4. Identify and List Scenarios

Description of the sequence of steps needed to complete a Use Case.

5. Identify and List Steps

Detailed description of the steps needed to complete a Scenario.

6. Identify and List Classes/Objects

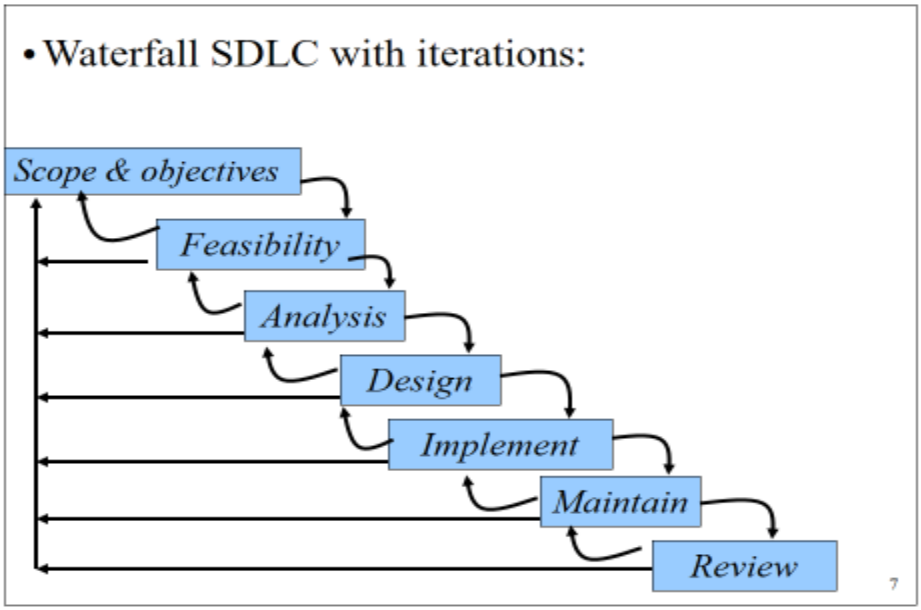
Detailed description(s) and/or models of the design and implementation of the methods and properties needed to complete a step. Can be organized into Interface, Controller, and Entity Classes, often using UML diagramming notation.

7. Manage Work Products

The collection of artifacts that are produced and delivered to the client or other project stakeholders during project development

3.8.1.1 The Waterfall Model

This model is a sequential design process, used in software development processes, in which progress is seen as flowing steadily downwards (like a waterfall) through the phases of Conception, Initiation, Analysis, Design, Construction, Testing, Production/Implementation and Maintenance since solutions are figured out from the start and a functional breakdown of detailed list of features is created, (Wysocki, 2010).



The reason why this model is preferred is that:

- Time spent early in the software production cycle can lead to greater economy at later stages. To take an extreme example, if a program design turns out to be impossible to implement, it is easier to fix the design at the design stage than to realize months later, when program components are being integrated, that all the work done so far has to be scrapped because of a broken design.
- The waterfall model provides a structured approach; the model itself progresses linearly through discrete, easily understandable and explainable phases and thus is

easy to understand; it also provides easily identifiable milestones in the development process.

- Phase 1-The project started with a high-level walkthrough of the scope of the system and its context. Next, detailed domain walkthroughs are held for each modeling area by domain owners. The researcher and key stakeholders of SamiaSub County agricultural activities will assess farming information which will be broken further into sub-functions in the following phase.
- Phase 2-The knowledge that was gathered during the initial modeling is used to identify a list of features. This is done by functionally decomposing the domain into subject areas. Subject areas each contain business activities. In this the developer will decompose farming activities and related services into activities land cultivations, pest control, seed type, rainfall amount etc.
- Phase3-After the feature list had been completed; here we produce the development plan. Based on features dependencies are written down. This is the time for developer to assess the decomposed activities critically to look for similarities in the features and their complexities in design.
- Phase 4- A design packages are produced for each feature. For agricultural information system features like a login system for access to register can be assigned. How the features were grouped in phase three will ease the design.
- The logical design of the system and database are mapped out in this phase.
- Phase 5- Build by feature, after a successful design inspection as per feature activity to produce a completed client-valued function (feature) is being

produced. Codes are developed and the units tested. A review of the whole functional system one done will enable to pinpoint faults and allow corrections.

3.8.2 Programming Technology is PHP Language and MySQL Database

PHP& MYSQL were preferred since PHP is a server side scripting language that creates dynamic pages with customized features while MYSQL is efficient in database management(eukhost.com).

Advantages of Using PHP

PHP provides a user-friendly and interactive website or web application and also enables visitors to freely interact while producing a very flexible and dynamic content. PHP is also very easy to learn and use as compared to the other programming languages. The PHP syntax can easily be parsed. Hence its application in the development of agricultural information systems is preferred (Inmotion Hosting).

- PHP can easily be incorporated into a code generated by WYSIWYG editors
- PHP can reduce the cost while increasing the efficiency of the websites or web applications.
- With PHP, one does not have to rewrite every line of HTML in a programming language.

Advantages of Using MySQL

It’s secure since it includes solid data security layers that protect sensitive data from unauthorized personnel/users. Rights can be set to allow some or all privileges to individuals; MySQL is suitable since it is inexpensive, fast in the sense of speed. MySQL

designers made the decision to offer fewer features than the other major database competitors, such as Sybase and Oracle. MySQL still offers all of the features required by most database developers. MySQL is scalable and can handle almost vast amount of data, up to as much as 50 million rows or more and the default file size limit is about 4 GB but you can increase this number to a theoretical limit of 8 TB of data. It manages memory very well, MySQL supports Novell Cluster Services. MySQL on an alternate server takes over and customers won't know that anything happened, MYSQL runs on many operating systems, including Novell NetWare, Windows OP operating systems, Linux, many varieties of UNIX (Sun, Solaris, AIX, and DEC, UNIX), OS/2, FreeBSD and also supports several development interfaces including the JDBC, ODBC, and scripting (PHP and Perl), thus enabling you create database solutions that run not only in your NetWare environment, but across all major platforms such as Linux, UNIX, and windows.

3.9 Ethical Protocol

A Research Permit was sought from the National Commission for Science, Innovation and technology (NACOSTI). A copy of this letter was used to seek permission to carry out the study within the Sub-County. Respondents were assured that information obtained were for research purpose only. The researcher maintained honesty and openness by interviewing people who were self-confident and not afraid to express their views. Besides, in order to attain honesty and in order to be careful not to ask questions in such a way that led respondents into providing confirmation of researcher's own views rather than eliciting theirs, the researcher was conscious of the interviewee's probable

wish to please the researcher, to defer to the researchers expertise and to seek the researcher's approval.

3.10 Conclusion

This chapter has presented the research methodology that was adopted in this study. The chapter describes how sampling of the respondents was conducted, how data was collected and analysed. It also describes the process model adopted for systems design and development as well as the technologies used in its development. The next chapter presents data, analyses and discussion.

CHAPTER FOUR

PRESENTATION OF DATA, ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter covers the presentation, analysis and discussion of the data collected. Information gathered through questionnaire and interviews with key informants and respondents is integrated to give an overall view of the situation under study. To determine ways through which farmers access agricultural information in Samia Sub-County; to determine opportunities that ICT-based agricultural information systems present to farmers in Samia Sub-County; to identify factors that influence access and utilization of agricultural information by small-scale farmers in SamiaSub County; and, to model and build a prototype web-based agricultural information system that supports access to agricultural information by farmers in Samia sub county.

A total of 399 questionnaires were administered to small scale farmers in the seven locations of Samia Sub County. Of these questionnaires, 350 were filled well and returned. This yielded a response rate of 87.7% which was way above a rate of 65% which Creswell (2012) considers appropriate for analysis.

4.2 Demographic Characteristics

4.2.1 Gender of Respondents

A majority (211; 60.3%) of the respondents were male. This could be attributed to the fact that land in Samia Sub County is still largely owned by men, who are the heads of households, as opposed to women (Omoit, 2013). Figure 4.1 summarizes this information.

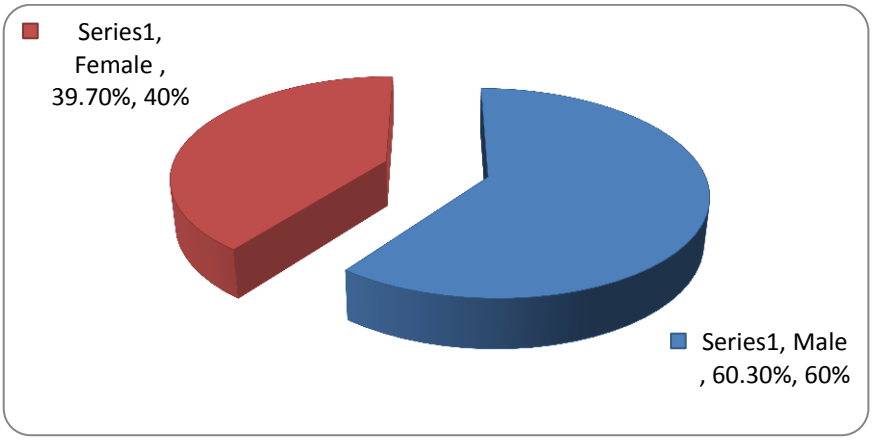


Figure 4.1: Gender of respondents

4.2.2 Educational Level of Respondents

The level of education of the respondents was considered significant in matters agricultural information access and use among farmers. This is because comprehending ICT based agricultural information goes hand in hand with the level of education. Table 4.1 presents a summary of the educational level of the respondents.

Table 4.1: Education Level of Respondents

Education level	Frequency	Percentage
University	67	19.1
Tertiary	99	28.3
Secondary or equivalent	100	28.6
Primary	84	24.0
Total	**350**	**100**

It can be observed that slightly more than 56% respondents had either attained tertiary or secondary education or the equivalent of secondary education. Besides, slighty more than 19% of the respondents had attained university education. This was indicative of the fact that a majority of the respondents were literate and were therefore able to comprehend the items in the questionnaire.

4.2.3 Size of the Farms

The sizes of farms owned by the respondents were established. Talking of matters food security requires that the size of farms be considered because they are usually in tandem with the yield and hence informs food security. This information was summarized in table 4.2.

Table 4.2: Size of the Farms

Farm size (Acres)	Frequency	Percentage
1-5	127	36.3
6-10	113	32.3
11-15	90	25.7
16-20	10	2.9
Over 20	10	2.9
Total	**350**	**100**

4.2.4 Age of Respondents

Being a factor that determines the way people access and utilize ICT based information, age was found an important component of the respondents' demographic characteristics. The respondents age was classified in cohorts of 10 years as illustrated in Table 4.3.

Table 4.3: Age of Respondents

Age (Years)	Frequency	Percentage
20-30	56	16.0
31-40	146	41.7
41-50	98	28.0
Over 50	50	14.3
Total	**350**	**100**

It can be observed from the Table 4.3 that the majority of the respondents were aged between 31 and 50. This age cohort was found appropriate since individuals who fall in this category are usually described as technologically savvy and therefore were in a position to comprehend the ICT component of agricultural information.

4.2.5 Household Heads

It was also significant to find out who the household heads were in the respective locations since these were majorly the respondents in this study. Besides, this information would indicate who the owners of the farms were and therefore the researcher would be in a position to gauge the responses in line with the objectives that the study sought to achieve. Figure 4.2 summarizes this information.

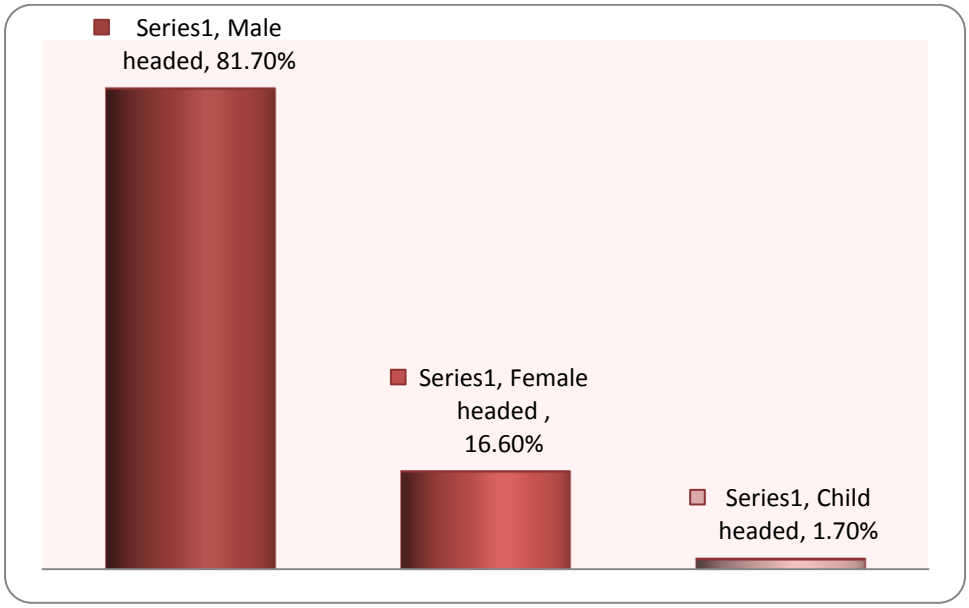


Figure 4.2: Household Heads

As can be seen in Figure 4.2, majority (286; 81.7%) of the households were headed by males. Majority of the males were actually the owners of the farms and therefore constituted a bulk of the respondents for this study. In cases where women were household heads, they were either single parents or widowed. Children headed families that were completed orphaned though such families were very few.

4.2.6 Farming Activities

The respondents were also required to indicate the farming activities that they engaged in. this was important because it would inform the extent to which the farmers required agricultural information. This information is summarized in Table 4.4.

Table 4.4: Farming Activities

Farming activity	Frequency	Percentage
Livestock husbandry	65	18.6
Crop husbandry	213	60.9
Livestock and crop husbandry	72	20.6
Total	**350**	**100**

Majority of the farmers in the study area were practicing crop husbandry as opposed to livestock husbandry. This was attributed to the many challenges one would have to endure in managing livestock or crops and livestock combined than those of managing crop growing alone.

4.3 Ways through which Farmers Access Agricultural Information

This was the first objective of this study. Data for this objective were sourced from both farmers and the Sub County Agricultural Officer. Farmers were asked to indicate ways through which they obtain agricultural information that informs their cultivation, planting, harvesting and the final marketing of their products. Eight sources through which farmers access agricultural information were identified by the farmer respondents albeit at varying frequencies. Table 4.5 presents a summary of this finding.

Table 4.5: Sources of Agricultural Information

Source of agricultural information	Frequency	Percentage
Mobile phones	122	34.9
Print media	21	6.0
Agricultural extension officers	76	21.7
Traditional sources (via colleagues, veteran farmers, ceremonies & agricultural shows)	167	47.7
Electronic media (internet)	15	4.3
Radio	239	68.3
Leaflets and newsletters	23	6.6
Posters	31	8.9

Percentages do not add up to 100% because of multiple responses

It can be noted from Table 4.5 that majority of the farmer accessed agricultural information through radio (68.3%) followed by traditional sources (47.7%) and mobile phones (34.9%). Of significance in this finding is the proportion of farmers who rely on traditional sources to obtain agricultural information and yet these sources do not in any way constitute ICT based information. Apart from agricultural information sourced from agricultural shows which are only organized once a year, information sourced from other traditional ways may not be authentic or scientific and hence unreliable. This perhaps explains why Samia Sub County is slowly creeping into a food insecure region.

Of concern in this finding also is the low proportion of farmers who receive agricultural information from agricultural extension officers. Ordinarily, agricultural extension officers should be on the fore front of ensuring that as many farmers as possible obtain reliable agricultural information.

This is in contrast with studies carried out in other parts of Africa which report that majority of small scale farmers obtain agricultural information from agricultural extension officers. For instance, Opara (2008) investigated the overall sources of agricultural information available to farmers in Imo State (Nigeria), as well as the farmers' preferred sources. The study reveals that 88.1% of the farmers' source of agricultural information was through extension agents. Similarly, Ozowa (2008) shows that among all the existing channels of communication, farmers in Nigeria ranked extension workers the highest in providing credible information and advice. The investigation was carried out on small farmers in Imo state, Nigeria.

The disparity with the scenario in SamiaSub County could be attributed to a number of factors such as the state of roads, availability of vehicles to transport the agricultural officers considering that Samia is vast in coverage and the adequacy in terms of capacity of the agricultural officers.

When asked to indicate how the he disseminates agricultural information to the farmers, the Sub County Agricultural Officers indicated as follows:

> …majorly I hold talk shows in radio stations whose wavelengths get to this region…at least majority of the small scale farmers own radios…I also use the agricultural officers in the various locations to meet farmers in their respective localities and disseminate required information….

In the same string of analysis, the researcher sought to establish the extent to which the farmers access agricultural information. A four-point likert scale was used to categorize the responses. The likert scale constituted the following items: 1-No Access; 2-Low

Access; 3-Medium Access; and 4-High Access. The results of this analysis are presented in Figure 4.3.

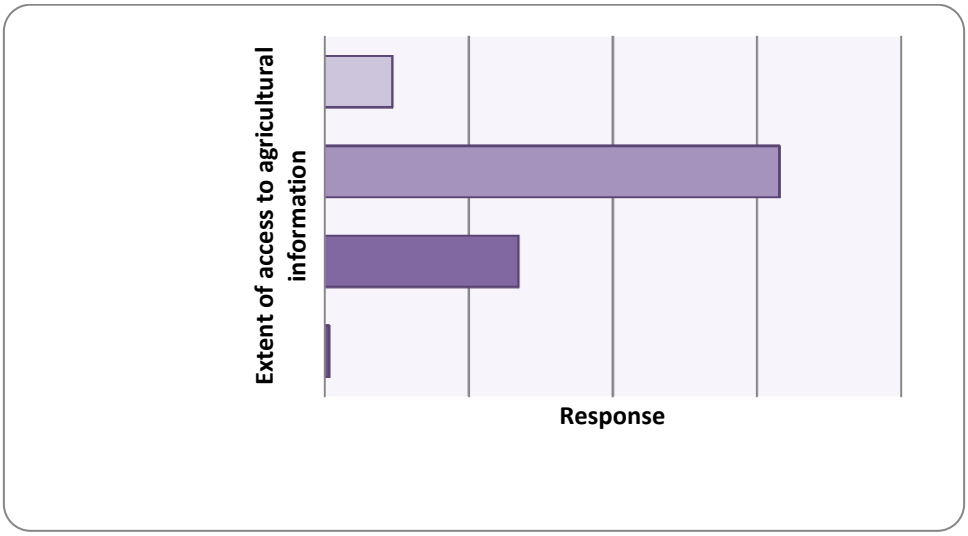


Figure 4.3: Extent of Access to Agricultural Information

From Figure 4.3, it can be observed that majority (221; 63.1%) of the respondents indicated that their extent of access to agricultural information was medium. They were followed by those whose access to agricultural information was low (94; 26.9%). Those whose access to agricultural information was high accounted for only 9.4% (33) while a negligible proportion (0.6%; 2) indicated that they had no access to agricultural information. Clearly, dissemination of agricultural information among farmers in Samia Sub County is still wanting.

Maru (2008) notes that having adequate and well-presented scientific, legal and commercial agricultural information will improve the efficiency of rural development, policies, projects and programmes. Agricultural information provision should be the basic component of rural development programmes. Oladele (2011) observed that lack of

agricultural information is a key factor that has greatly limited agricultural advancement in developing countries. Thus, agricultural information interacts with, and influences, agricultural activities in a variety of ways. This tends to imply that agricultural information can help inform decision-making regarding land, labour, livestock, capital and management.

The researcher also sought to find out the extent of utilization of agricultural information by small scale farmers in Samia Sub County. A four-point likert scale with the following items was used to categorize the responses: 1-No Utilization; 2-Low Utilization; 3-Medium Utilization; 4-High Utilization. Table 4.6 summarizes the analysis.

Table 4.6: Extent of Utilization of Agricultural Information

Extent of utilization	**Frequency**	**Percentage**
No utilization	2	0.6
Low utilization	98	28.0
Medium utilization	237	67.7
High utilization	33	9.4
Total	**350**	**100.0**

Like the findings of access to agricultural information, those who reported to be utilizing the information averagely were almost the same proportion of the farmers who indicated that they were accessing agricultural information averagely. Access and utilization of agricultural information need to go hand in hand otherwise the objective of disseminating such information may never be achieved.

While agreeing with the need to not only access but utilize agricultural information as well, Ballantyne (2009: 356) opines that "Effective deployment of ICT-based agricultural information can lead to increase in agricultural competitiveness through cuts in production and transaction costs, raising production efficiencies and farm incomes, conserving natural resources, and by providing more information, choice and value to stakeholders". In using ICT-based agricultural information successfully to support farmers and rural communities, the first step is to empower farming communities to define their own needs. With wider access to and use of ICT-based agricultural information, the potentials of opening up of communication as well as sharing information would be enhanced, so as to assist farmers, researchers, extension workers and policy makers. It will also narrow the information gap that exists between the farmers and the researchers on the other hand because there will be a feedback.

4.4 Opportunities that ICT-Based Agricultural Information System Presents to Farmers

This was the second objective of this study. As a way of establishing the opportunities that agricultural information presents to the farmers, the respondents were required to indicate the benefits that they derive in the use of agricultural information.

Five benefits of agricultural information were identified by the farmers albeit at varying frequencies. A summary of these benefits are presented in Figure 4.4.

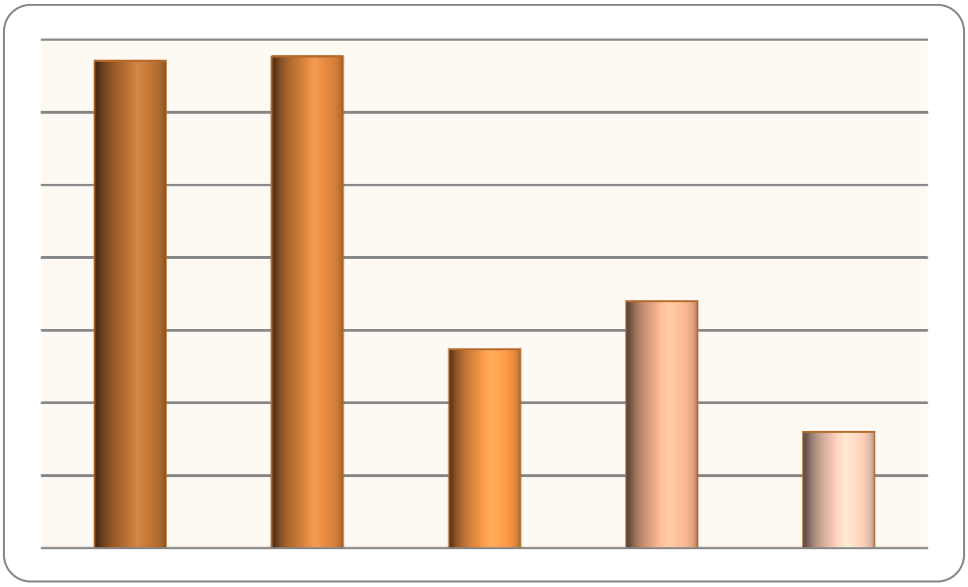


Figure 4.4: Benefits of Accessing Agricultural Information

From Figure 4.4, it can be observed that majority (237; 67.7%) of the farmers indicated that access to agricultural information leads to increased farmer income. Similarly, a significant proportion of the respondents (235; 67.1%) reported that access to agricultural information leads to increased level of agricultural productivity. Respondents who indicated that access to agricultural information leads to reduced costs of food accounted for 34% (119) of the respondents while those who believed that access to agricultural information would lead to sustainable agricultural practices and increased alternative farming methods accounted for 27.4% (96) and 16% (56) respectively.

The respondents were also asked to indicate the state of food security in the region in an attempt to establish how significant agricultural information would be in addressing the situation. This was done using a six-point likert scale as follows: 1-Extremely Poor; 2-

Fair; 3-Good; 4-Very Good; 5-Excellent; 6-Don't Know. The results of the responses are summarized in Table 4.7.

Table 4.7: Farmers' responses on the State of food security in Samia Sub County

State of food security	Frequency	Percentage
Extremely poor	21	6.0
Fair	287	82.0
Good	24	6.9
Very Good	00	0.0
Excellent	00	0.0
Don't know	18	5.1
Total	**350**	**100.0**

From Table 4.7, it can be observed that majority of the respondents indicated that the food security situation in Samia sub county is only fair, none of the responses indicated that the food security situation was very good or excellent. This is a serious situation as far as food availability in the sub county is concerned.

Knowing the situation of food security on the ground now led the researcher to interrogate responses of farmers on whether agricultural information would be of significance and if it would help avert the current food security scenario in the region. An overwhelming proportion of 93.4% were affirmative as indicated in Figure 4.5.

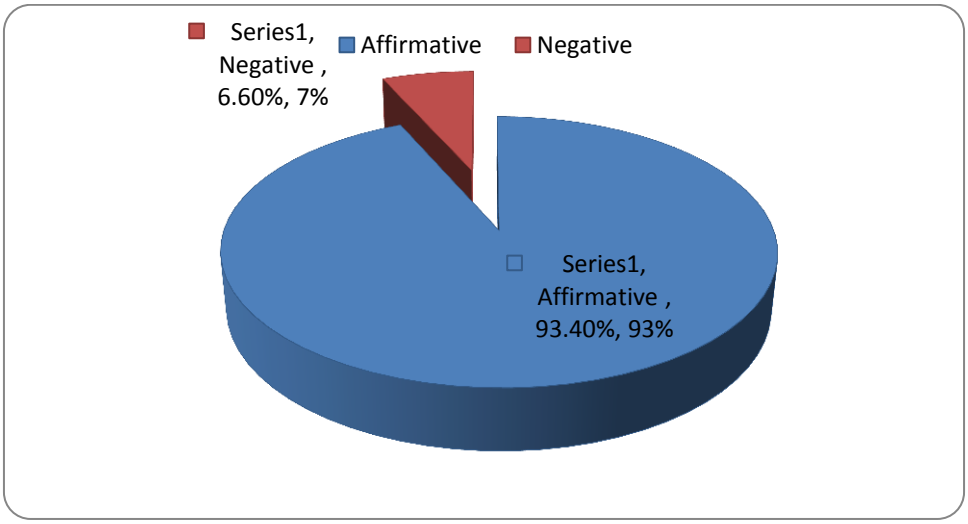


Figure 4.5: Farmers Response on Significance of Agricultural Information to Food Security

It is clear from Figure 4.5 that majority of the farmers agreed that agricultural information was significant and that it would present a key opportunity in ensuring that the district is food secure. The agricultural officers were also asked during the interviews to indicate whether agricultural information can play a role in overcoming the current farming challenges in the sub county. All (8) the agricultural officers did indicate that agricultural information was of great importance in alleviating food security challenges in the sub county. A key response from the agricultural officers is quoted thus:

> …one of our major duties as agricultural officers is to sensitize the farmers in this region on the importance of agricultural information to farming, particularly in enhancing productivity…once every farmer in this region will get to appoint of appreciating, accessing and utilizing agricultural information, food insecurity will be a thing of the past….

The benefits of ICTs in agricultural developmental processes was long known and access to ICTs was even made one of the targets of the Millennium Development Goal No. 8 (MDG 8), which emphasized the benefits of new technologies, especially ICTs in the fight against poverty. The World Bank Report (2009) further buttresses this finding by indicating that With 10 percent increase in high-speed internet connections, economic growth increases by 1.3 percent and that the connectivity of Internet or mobile phones increasingly brings farming information, financial services, and health services to remote areas, and helps to change people's lives in unprecedented ways. Supplementing this claim, Odame (2002) opines that the innovations in computer technologies have affected everybody's daily life including farmers themselves since computers support and assist almost every single human activity.

4.5 Factors that Influence Access to and Utilization of Agricultural Information

The third objective of this study involved identifying factors that influence farmers' access to and utilization of agricultural information. This was done by asking respondents to indicate the extent to which some factors which were provided influenced their access to and utilization of agricultural information using a five-point likert scale (1-Very Low; 2-Low; 3-Medium; 4-High; 5-Very High). Table 4.8 summarizes the results.

Table 4.8: Factors Influencing Access to and Utilization of Agricultural Information

Factor	1	2	3	4	5	Mean
Gender	15	43	114	100	78	**3.523**
Education level	2	7	21	228	92	**4.146**
Age	78	65	89	62	56	**2.866**
Income level	12	11	15	198	114	**4.117**
Distance from SubCounty Agricultural Office	76	81	75	63	55	**2.829**
Attitude towards agricultural information	14	12	22	166	136	**4.137**
Agricultural policies	76	79	54	78	63	**2.922**
Telecommunication facilities	06	09	16	219	100	**4.137**
Socio-political stability	56	34	51	109	100	**3.454**
		Aggregate mean				**3.570**

From Table 4.8, it can be observed that education level of farmers was ranked the highest in factors influencing access to and utilization of agricultural information (mean, 4.146). One of the respondents presented an explanation for this case as follows:

> …you know, without adequate education, one cannot comprehend an agricultural system that presents agricultural information…education is critical in the way farmers access information and utilize it especially in this error of advance technology….

Education level as a factor was followed by attitude towards agricultural information (mean, 4.146), availability of telecommunication facilities (4.137) and farmers income level (mean, 4.117) in that order. Respondents were of the opinion that distance from the nearest agricultural office and agricultural policies

in place have the least impact on the way farmers access and utilize agricultural information (mean, 2.829 and 2.922 respectively).

An aggregate mean of 3.570 is indicative of the fact that the mentioned factors influence farmers' access to and utilization of agricultural information to a high extent. Generally, households' personal and demographic factors (educational level and gender), socio-economic factors (income level) and psychological factors (attitude) were found to have the largest influence on farmers' access to and utilization of agricultural information.

In buttressing the findings of this study, a report by FAO (2014) indicates that differences in social status can affect perceptions, access to knowledge and, crucially, the importance and credibility attached to what someone knows. Often, the knowledge possessed by the rural poor, in particular women, is overlooked and ignored. Therefore, access to information highly depends on the individual social and economic status. Further Ebrahim (2006), in a study on the correlation between attitude and utilization of agricultural information opines that positive attitude towards improved farming is one of the factors the can speed up the farm change process. The author further indicates that attitude formation is also a prerequisite for behavioral change to occur including changes in agricultural practices such as the use of agricultural information derived from an agricultural information system.

4.6 Information Required by Farmers in the Sub County to be provided by Developed Information Agricultural System

Table 4.9: Agricultural InformationRequired by Farmers

Agricultural information required	Frequency	Percentage
New crops	122	34.9
Types of seeds and its availability	167	47.7
Fertilizer type and availability	76	21.7
Land irrigation	21	6.0
pesticide type and availability	23	6.6
When to plant and how	239	68.3
Agricultural loans	15	4.3
Market for farms products	31	8.9

Percentages do not add up to 100% because of multiple responses

The investigator asked to the respondent the areas of information which they required the system to provide. As evident from above table, majority of the farmers needinformation on when to plant and how (68.3%),seeds and its availability (47.7%) andnew crops availability (34.9%) followed by fertilizer types availability (21.7%).Others information required by farmers include market for their farms products (8.9%),pesticide type and its availability (6.6%), irrigation (6.0) and agricultural loans (4.3%)The results to some extent agrees with the finding of Metitei and Devi (2009) andAchugube&Anie (2011) that farmers required information on how to do planting, new crops , seeds & fertilizers availability

4.7 Challenges Faced and Solutions Proposed

The Samia people faced a lot of challenges in accessing the needed agricultural information. First, majority of the farmers because of low literacy level they could not read the information distributed via farmers journal because they are written in English or Kiswahili.Inadequate basic infrastructure (electricity and telecommunication), majority of the farmers don't have power in their homes, therefore they don't own televisions and also network is a problem in Samia because they board Uganda hence mostly their network tend to take Uganda network which also communicates in Kiganda. Lack of enough extension officers to handle the farmers, language barriers as majority of agricultural officers tend to prefer talking to farmers mostly in English hence farmers don't apprehend what they mean. Roads inSamia are often impassable during the rainy season, making it difficult for timely delivery of print information resources needed for day-to-day decision making and distance from agricultural offices in Funyula where all staff are stationed no one wants to visit the office for information because of the distance (Table 4.8).

The solution to these challenges are having an agricultural information system that shall provide agricultural information to farmers in their villages by a click of a baton in their own language and able to interpret for them information. The system should be web based. Also have passable roads, have reliable network and have electricity in farmers' homes. Having enough extension officers on the ground who are able to understand the needs of Samia people and ready to work with them.

4.8 Conclusion

This chapter has presented data for this study, its analysis and subsequent discussion. The analysis and discussion have been presented basing on the objectives that the study sought to achieve. Basing on the findings of the study, there was need for this study to fill in the glaring gaps in literature on issues pertaining to development of agricultural information systems to enable access to agricultural information to enhance food security. The subsequent chapter presents the design and development of the web-based agricultural information system.

CHAPTER FIVE

DESIGN AND DEVELOPMENT OF WEB-BASED AGRICULTURAL INFORMATION SYSTEM

5.1 Introduction

This chapter delved into the description of the design of the web-based agricultural information system that needs to be implemented at the sub-county to enhance food security.

5.2Requirements Identified

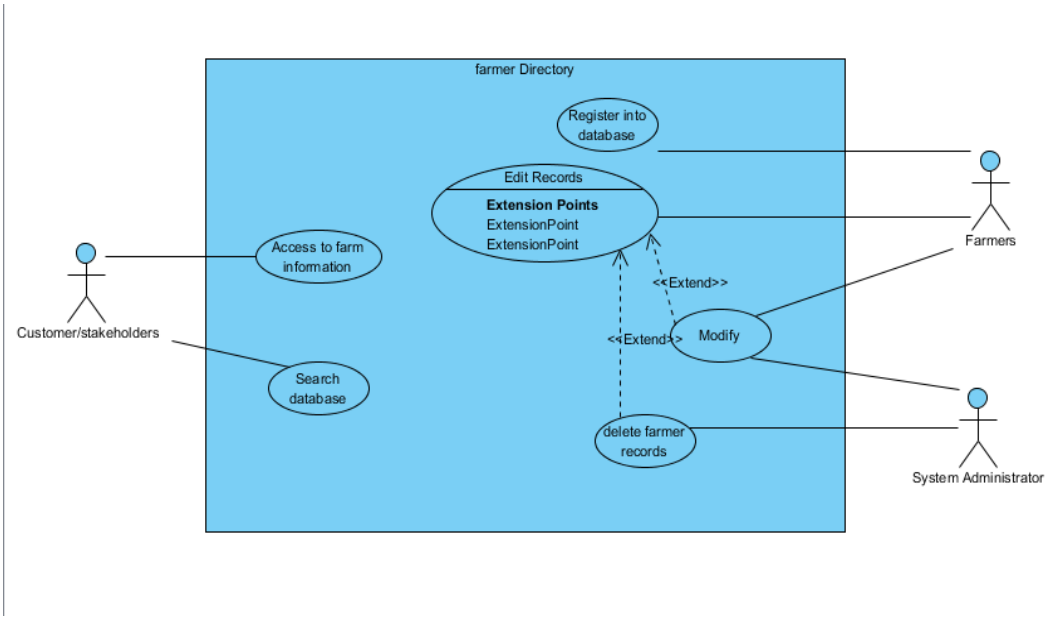


Figure 5.1 Farmer Directory Use case

The figure above shows how the different actors interact in the famer directory module. The different actors in the system include the farmers, system administrator, and the

general public. The general public have access to a front end database that shows the names of farms and what products are produced plus other information. The other actors are the system administrator and the farmers, farmer have rights for modifying personal information on his/her farm. These actors have rights to modify, delete and update records.

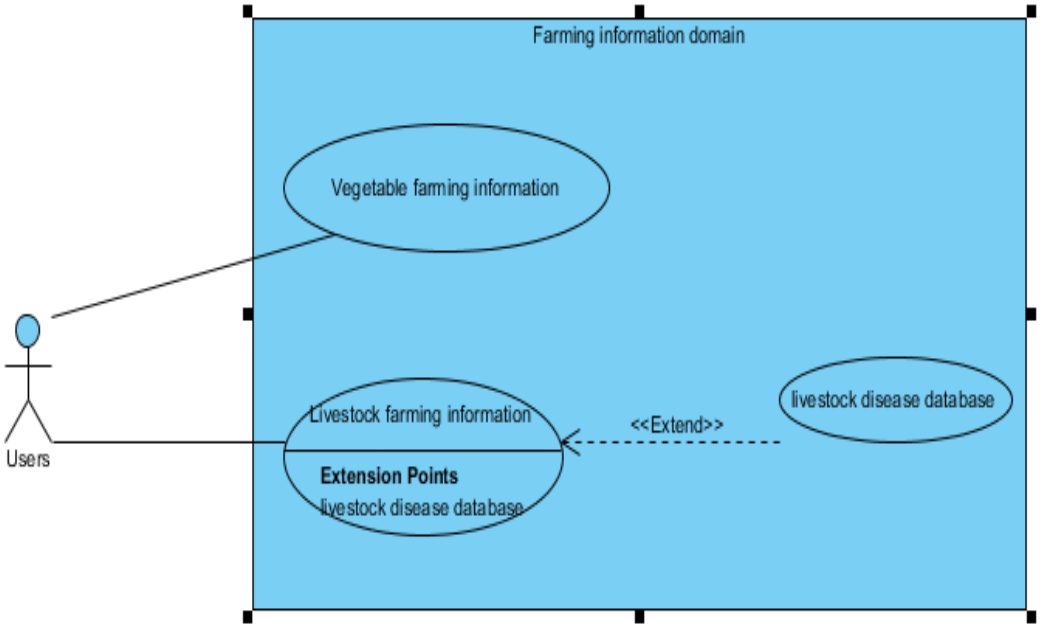


Figure 5.2: Crops and Livestock Farming Use Case

5.3 Design of the Prototype Web-Based Agricultural System

The fourth objective of this study involved the modeling and building of a prototype web-based agricultural information system to support access to agricultural information by farmers in Samia Sub-County. To model up a prototype web-based AIS that would enable farmers and rural areas carrying out various activities, among other things, information support is also vital. A majority of the rural farmers are not accessing most

of the required agricultural information. Therefore, application of ICT-based agriculture information support systems is very important for the dissemination of agricultural information and technological knowhow by rural farming community of Samia Sub County.

For positive improvements of information systems in agriculture, it is highly recommended to establish communication between farmers, coordinators, agricultural experts, research centers, and community by information technology. The information must be based on farmers' needs, internet used as a mode to transfer the advanced agricultural information to the farming community. Farmers can be illiterate and speak a local language and they are not expected to use the system directly. These conditions therefore should be considered when implementing better information systems for agriculture for Samia Sub County which is a rural community.

The analysis of the agricultural information systems may provide the identification of the basic components and networks of the system. It can be applied to any specific farming systems in order to analyze how the information system works. This approach is also useful to define the possible defaults and to improve the information management. In addition, the information exchange through networks among the system components is critically important for the successful technology generation and information transfers. The information system analysis indicates that more interactive information sources are needed. This may stimulate conventional farmers to convert to the modern approaches of farming. These changes could have been stimulated by more active experts working with selected local leaders if they had developed and improved relationships with public,

especially extension and research, and private information sources. The complexity of the agricultural information system leads to an underestimation among end-users. Lack of knowledge of agricultural information may weaken the support for public information funding as a major priority in agriculture. An increase in funding for public information should allow for an increase in the accessibility of public information to farmers.

For easy access and effective utilization of agricultural information in this digital age, there is need for establishment of information centers within Samia Sub County. Such information centers would be able to provide the rural farmers the desired agricultural information in a format that would be comprehensible to them, taking into consideration, the prevailing high illiteracy rate, cultural differences with the rest of Kenyans and limited technology. For effective dissemination of agricultural information in rural communities by extension staff, research institutes and other responsible persons, there is need for construction of good access roads that would lead to all the remote rural communities in the SubCounty.

Figure 5.3: Registration System of AIS

5.3.1 The Agricultural System Design Model

This section provides description of the Systems Design and model purpose and scope.

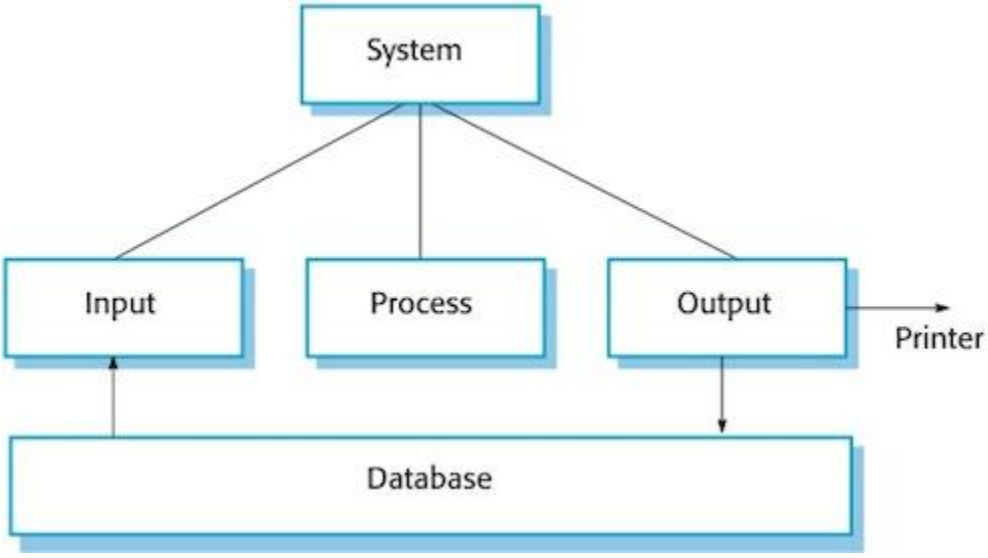


Figure 5.4: System interface (Ian Sommerville, 2008)

5.3.1.1 Inputs Design

In an information system, input is the raw data that is processed to produce output. During the input design, as developerI considered the input devices such as PC, MICR, OMR and many others.

The quality of system input determines the quality of system output. The designed input forms and screens have following properties: −

- It serve specific purpose effectively such as storing, recording, and retrieving the information.
- It ensures proper completion with accuracy.
- It is easy to fill and straightforward.
- It focus on user's attention, consistency, and simplicity.

- All these objectives were obtained using the knowledge of basic design principles regarding −
    - What are the inputs needed for the system?
    - How end users responded to different elements of forms and screens.

Objectives for Input Design

The objectives of input design are −

- To design data entry and input procedures
- To reduce input volume
- To design source documents for data capture or devise other data capture methods
- To design input data records, data entry screens and user interface screens.
- To use validation checks and develop effective input controls.

5.3.1.2 Interface Detailed Design

The interface provides enough detailed information about the interface requirements to correctly format, transmit, and/or receive data across the interface. Include the following information in the detailed design for each interface (as appropriate):

- The data format requirements; if there is a need to reformat data before they are transmitted or after incoming data is received, tools and/or methods for the reformat process are defined
- Specifications for hand-shaking protocols between the two systems; include the content and format of the information to be included in the hand-shake

messages, the timing for exchanging these messages, and the steps to be taken when errors are identified

- Format(s) for error reports exchanged between the systems; addresses the disposition of error reports; for example, retained in a file, sent to a printer, flag/alarm sent to the operator.
- Graphical representation of the connectivity between systems, showing the direction of data flow
- Query and response descriptions if a formal Interface Control Document (ICD) exists for a given interface, the information can be copied, or the ICD can be referenced in this section.

- **Different Types of Modeled Screens- Information from table 4.9**

The use interface screens were designed and developed in adobe Dreamweaver cc

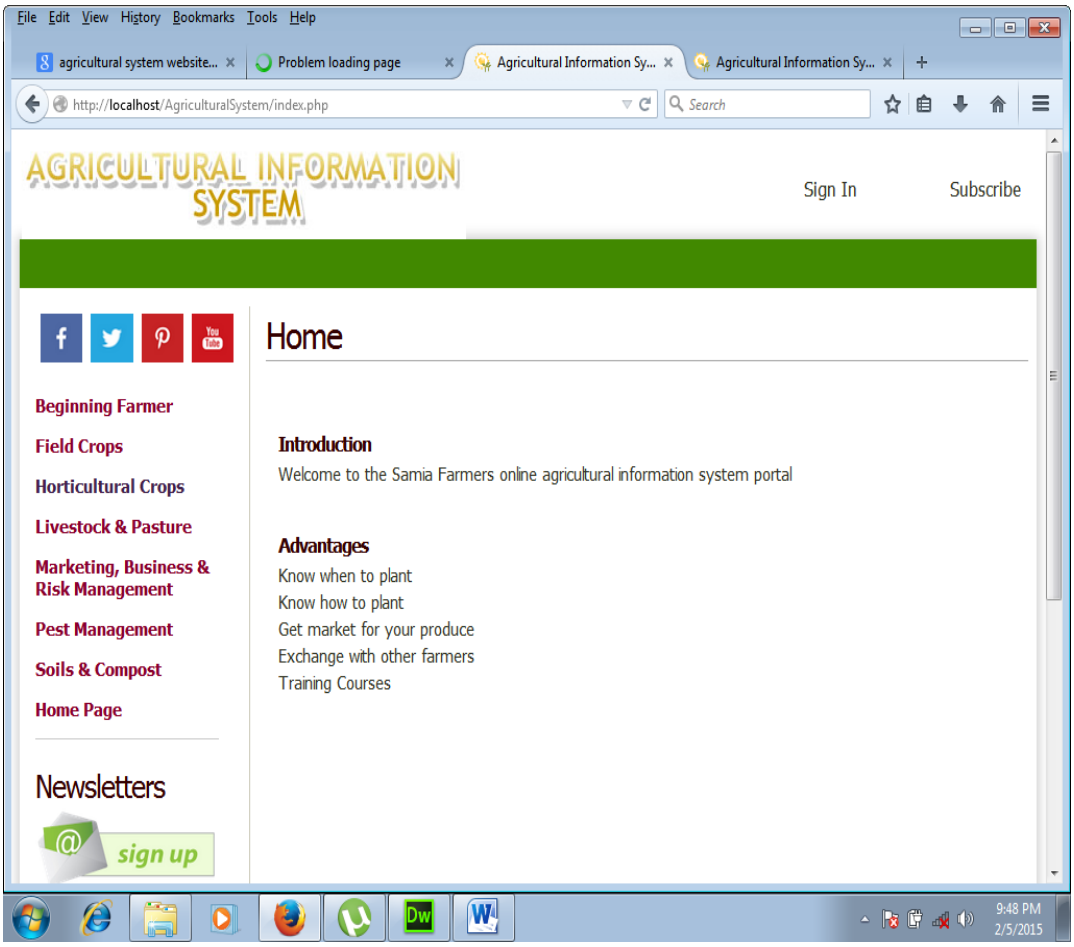


Figure 5.5: Agricultural Information System –Home Screen

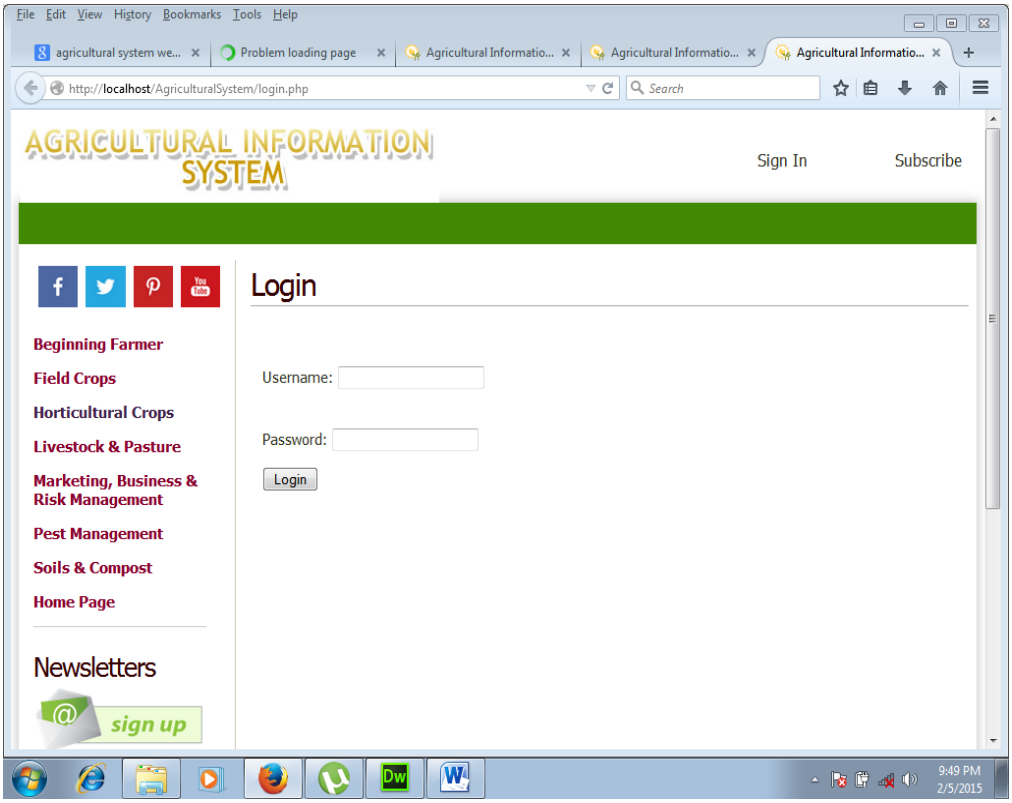


Figure 5.6: Agricultural Information System –Login Screen

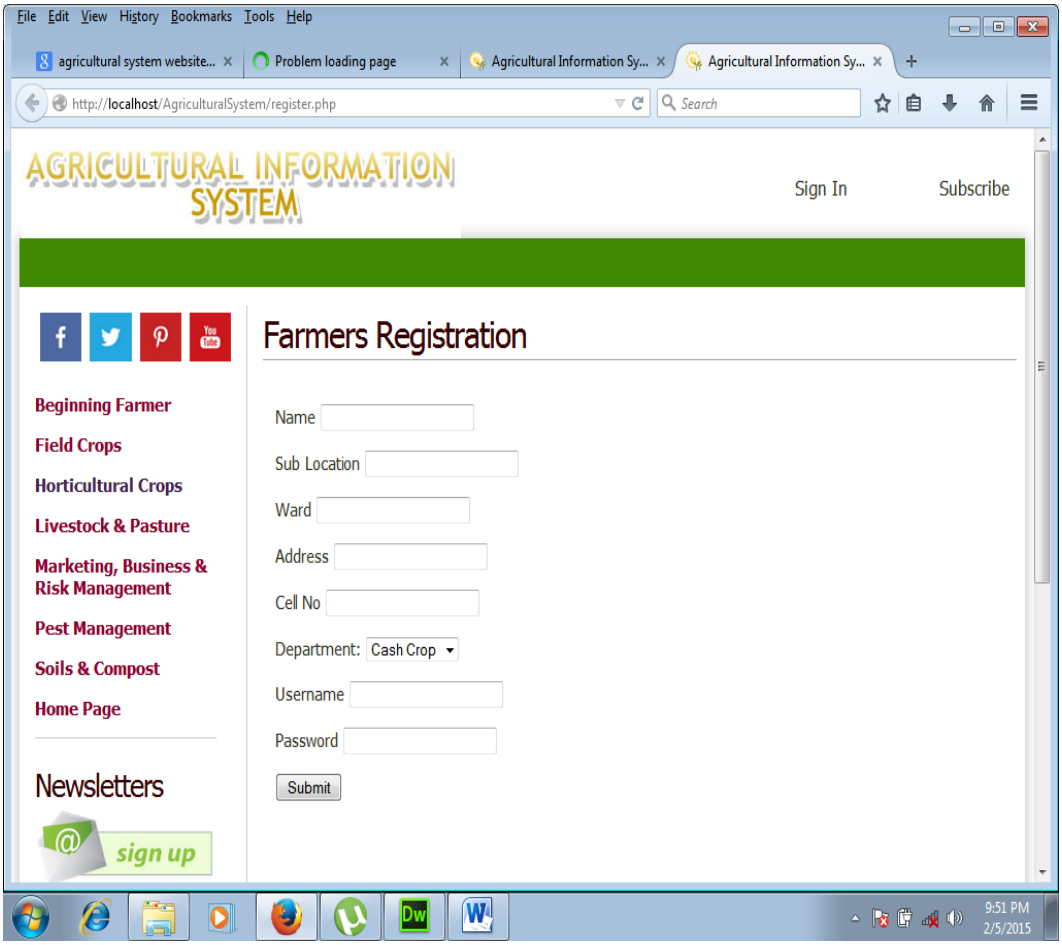


Figure 5.7: Agricultural Information System –Farmers Registration Screen

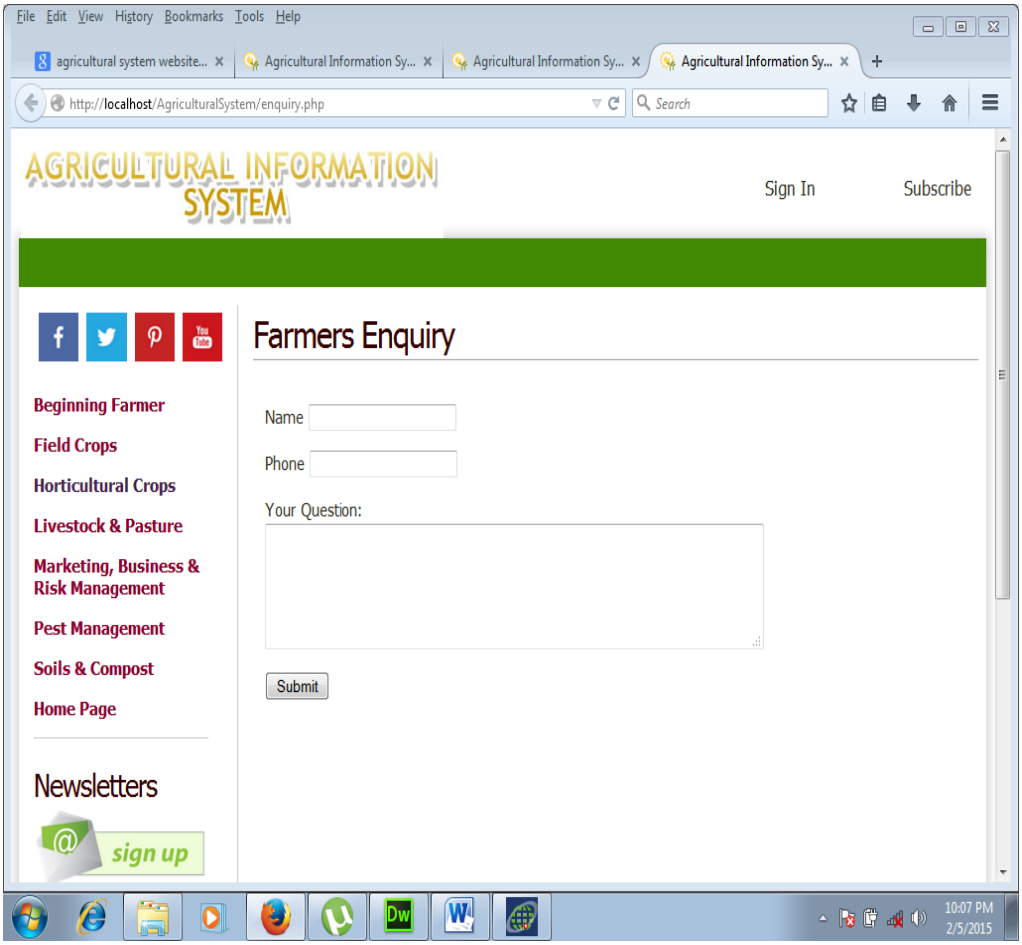


Figure 5.8: Agricultural Information System –Farmers Enquiry Screen

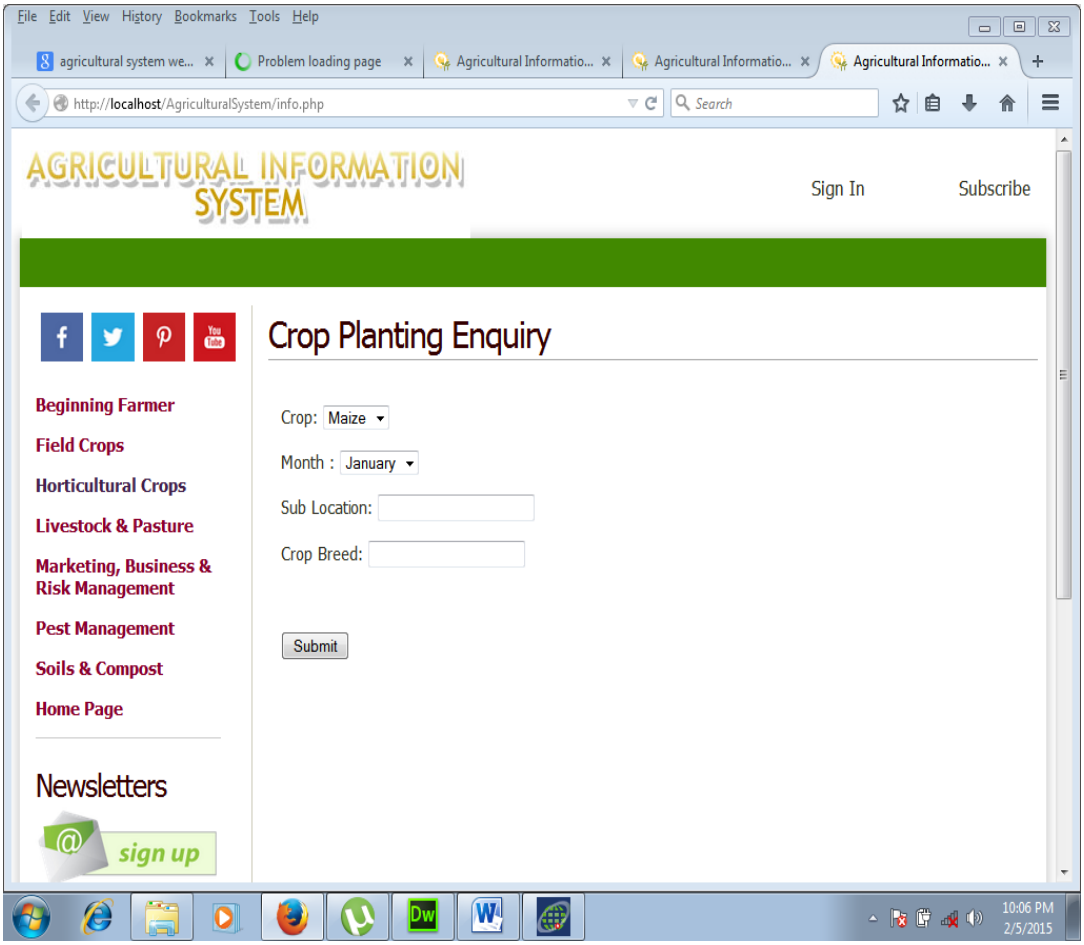


Figure 5.9: Agricultural Information System –Crop Planting Enquiry Screen

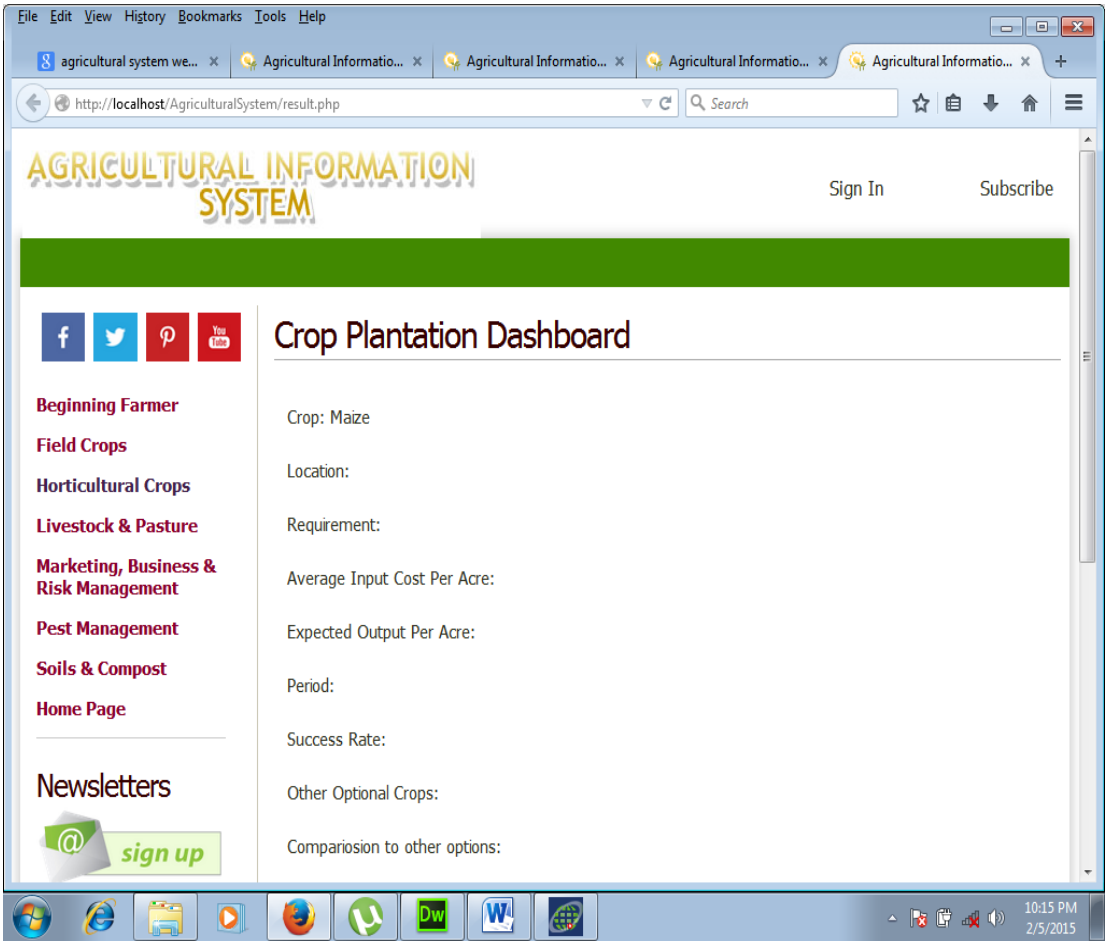


Figure 5.10: Agricultural Information System –Crop Dashboard Screen

5.3.1.3 Agricultural Database Design

Designing Database for agricultural information system I had to identify main entities, attributes, relationships and constrains. Mainly use entities are given listed.

- Crops specialization
- Animal specialization
- Production
- Product usage
- Company description
- Disease description
- Weeds
- Intercropping
- Intercrop fertilizers
- Soil
- Fertilizers

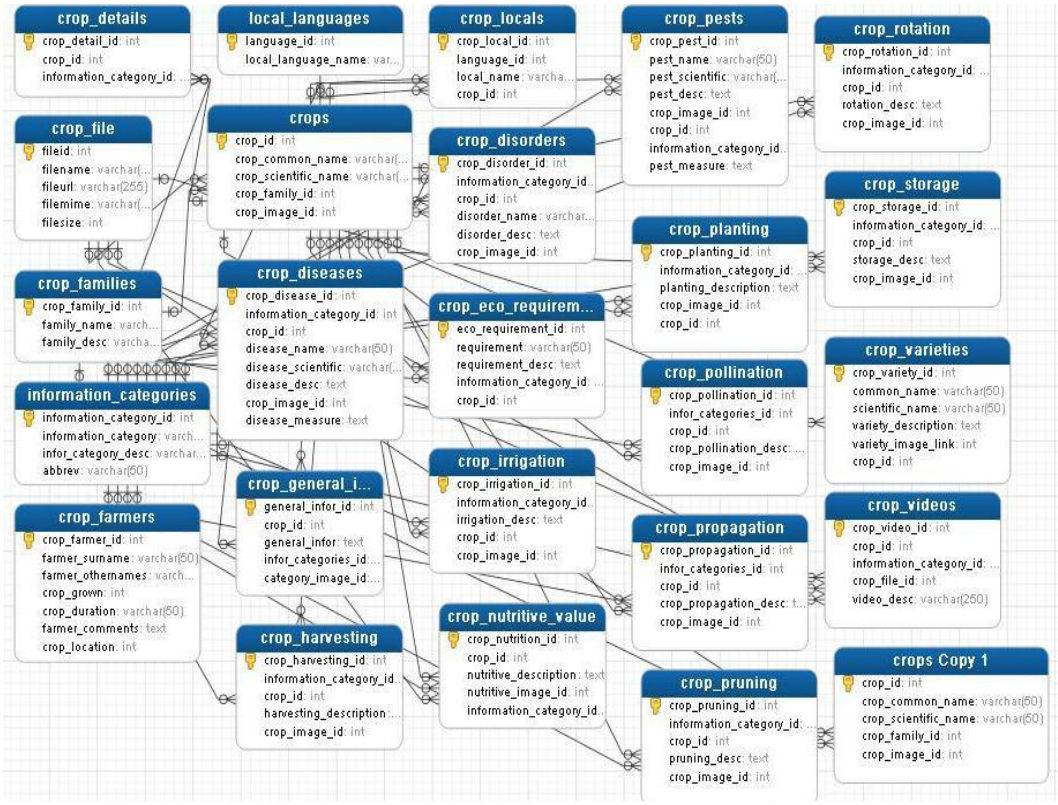


Figure 5.11: Agricultural Information System Database Design

The designed database provide various functions that allow management of a database and its data which is classified into four main functional groups:

1. Data definition – Creation, modification and removal of definitions that define the organization of the data.
2. Update – Insertion, modification, and deletion of the actual data.
3. Retrieval – Providing information in a form directly usable and processing by other applications. The retrieved data may be made available in a form basically the same as it is stored in the database or in a new form obtained by altering or combining existing data from the database.

4. Administration – Registering and monitoring users, enforcing data security, monitoring performance, maintaining data integrity, dealing with concurrency control, and recovering information that has been corrupted by some event such as an unexpected system failure.

5.3.1.4 System Integrity Controls Modeling

The data transmitted among the stakeholders within agricultural information system architecture must be secured in such a way that information cannot be intercepted and modified. Sensitive systems use information for which the loss, misuse, modification of, or unauthorized access to that information could affect the conduct of State programs, or the privacy to which individuals are entitled. Developing of sensitive systems standards enlisted the development of the following minimum specifications levels of control:

- Internal security to restrict access of vital data items to only those access types required by users
- Audit procedures to meet control, reporting, and retention period requirements for operational and management reports
- Application audit trails to dynamically audit retrieval access to designated vital data
- Standard Tables to be used or requested for validating all data fields
- Verification processes for additions, deletions, or updates of critical data in the system

- To have the ability to identify all audit information by user identification, network terminal identification, date, time, and data accessed or changed and authorized by whom.

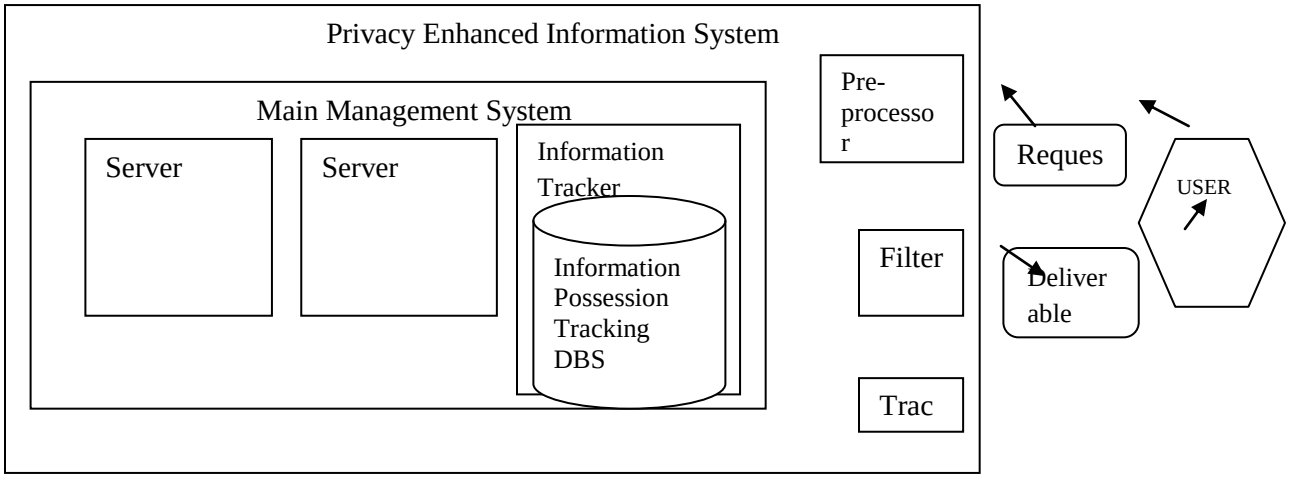


Figure 5.12: Architecture of Agricultural Information System Privacy Supporting System

5.3.1.5 System Modelling

System modelling helps the analyst to understand the functionality of the system and models are used to communicate with customers.

Different models present the system from different perspectives

- External perspective showing the system's context or environment;
- Behavioural perspective showing the behaviour of the system;
- Structural perspective showing the system or data architecture.

Model types

1. Data processing model showing how the data is processed at different stages.

2. Composition model showing how entities are composed of other entities.
3. Architectural model showing principal sub-systems.
4. Classification model showing how entities have common characteristics.
5. Stimulus/response model showing the system's reaction to events.

Context models

1. Context models are used to illustrate the operational context of a system — they show what lies outside the system boundaries.
2. Social and organisational concerns may affect the decision on where to position system boundaries.
3. Architectural models show the system and its relationship with other systems.

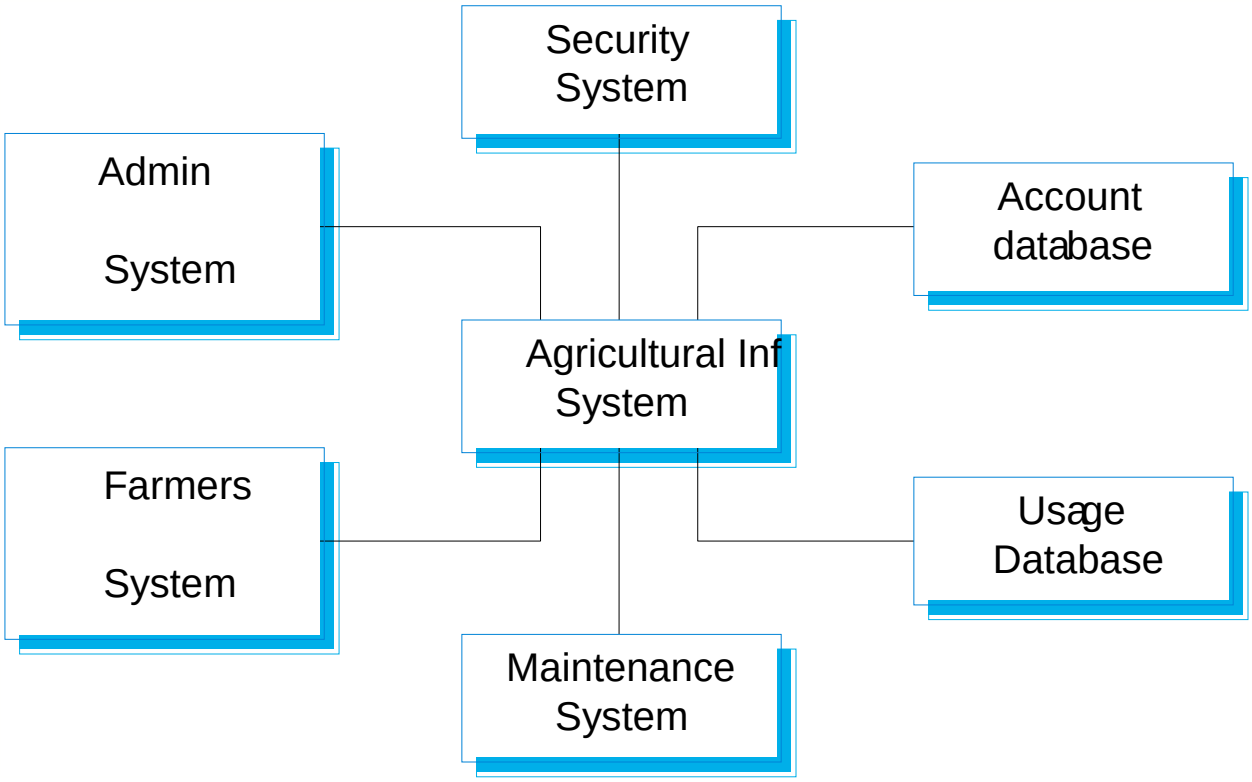


Figure 5.13: Architectural Model Showing Principal Agricultural Information Sub-Systems

5.3.1.6 Sample Source Code

<!DOCTYPE html>

<html lang=”en”><head>

<meta http-equiv=”Content-Type” content=”text/html; charset=windows-1252”>

<title>Agricultural Information System</title>

<meta name=”description” content=”This resource list contains sources of business planning templates and further resources for agricultural enterprises. These resources include Internet and print resources as well as training courses and workshops.”>

<meta name=”copyright” content=”Copyright 2015”>

<meta name=”viewport” content=”width=device-width, initial-scale=1”>

<!—COLORBOX FOR SHOPPING CART →

<link media=”screen” rel=”stylesheet” href=”assets/colorbox.css”>

<script type=”text/javascript” src=”assets/jquery.js”></script>

<script type=”text/javascript” src=”assets/jquery_002.js”></script>

<!—RATING SYSTEM →

<link href=”assets/ratings.css” rel=”stylesheet” type=”text/css”>

<script src=”assets/ratings.js” type=”text/javascript”></script>

</head>

<body><div style=”display: none;” id=”cboxOverlay”> <div style=”padding-bottom: 42px; padding-right: 42px; display: none;” class=”” id=”colorbox”> <div style=”float: left;” id=”cboxBottomLeft”> <div style=”float: left;” id=”cboxBottomCenter”> <div style=”float: left;”

</script>

<!—end footer→

<!—End of skin_wrapper→

</body></html>

CHAPTER SIX

SUMMARY OF RESEARCH FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This study sought to develop an agricultural information system to enhance food security in Samia Sub County.

1. To determine ways through which farmers access agricultural information in Samia sub county.
2. To determine opportunities that ICT-based agricultural information systems present to farmers in Samia Sub County.
3. To identify factors that influence access and utilization of agricultural information by small-scale farmers in Samia Sub County.
4. To model and build a prototype web-based agricultural information system that supports access to agricultural information by farmers in Samia Sub County.

6.2 Summary of Research Findings

6.2.1 Ways through which Access Agricultural Information

It was established that majority of the farmers access agricultural information through radio (68.3%) followed by traditional sources (47.7%) and mobile phones (34.9%). Of significance in this finding is the proportion of farmers who rely on traditional sources to obtain agricultural information and yet these sources do not in any way constitute ICT based information. Apart from agricultural information sourced from agricultural shows which are only organized once a year, information sourced from other traditional ways

may not be authentic or scientific and hence unreliable. This perhaps explains why SamiaSub County is slowly creeping into a food insecure region, Table 4.5.

6.2.2 Opportunities that ICT-based Agricultural Information Systems Present to Farmers

Majority (237; 67.7%) of the farmers indicated that access to agricultural information leads to increased farmer income. Similarly, a significant proportion of the respondents (235; 67.1%) reported that access to agricultural information leads to increased level of agricultural productivity. Respondents who indicated that access to agricultural information leads to reduced costs of food accounted for 34% (119) of the respondents while those who believed that access to agricultural information would lead to sustainable agricultural practices and increased alternative farming methods accounted for 27.4% (96) and 16% (56) respectively, Figure 4.4.

6.2.3 Factors that influence Access to and Utilization of Agricultural Information

Education level of farmers was ranked the highest in factors influencing access to and utilization of agricultural information (mean, 4.146). Education level as a factor was followed by attitude towards agricultural information (mean, 4.137), availability of telecommunication facilities (4.137) and farmers income level (mean, 4.117) in that order. Respondents were of the opinion that distance from the nearest agricultural office and agricultural policies in place have the least impact on the way farmers access and utilize agricultural information (mean, 2.829 and 2.922 respectively).

An aggregate mean of 3.570 is indicative of the fact that the mentioned factors influence farmers' access to and utilization of agricultural information to a high extent. Generally,

households' personal and demographic factors (educational level and gender), socio-economic factors (income level) and psychological factors (attitude) were found to have the largest influence on farmers' access to and utilization of agricultural information, Table 4.8.

6.2.4 A Prototype Web-based Agricultural Information System that Supports Access to Agricultural Information by Farmers

A prototype web-based agricultural system that supports access to agricultural information system was developed constituting an interface detailed design, an agricultural database design and a system integrity control model. A sample source code illustrating how the system can be used to disseminate agricultural information and information required by farmers has also been presented.Table 4.9.

6.3 Conclusion

Increased usage of web-based and related technologies is opening up opportunities to those who are ready to undertake them. Samia sub county population is growing every year and adopting new farming technology would assist much the Sub County in food security and in the county and for the much needed certification of its population.

The study examined in detail how farmers obtain agriculture information in Samia Sub County and how information obtained would assist in developing a web-based farming information system for the Sub County. Questionnaire, interview schedule guide and document analysis chosen as methods of data collection assisted the researcher to get in depth data from respondents.

Cross case data analysis guided the researcher in designing customized farmers information system. This was guided by FDD chosen for development of the farming information system. The well-developed system will complement the current systems of accessing information by farmers and assist the Sub County attain food security by offering real time information to small scale and large scale farmers alike.

6.4 Recommendations

Based on the findings of this study, the following recommendations are made:

- Study findings indicated that a larger proportion of the farmers rely on radios to receive agricultural information. Since majority of rural folks have access to mobile phones, agricultural officers should carry out sensitization seminars and workshops on how farmers can utilize their phones in accessing agricultural information.
- Enhancing participation of farmers in various areas of human resource development is the best option for empowering farm operators for better utilization of scientific agricultural information and technologies. It is recommended that extension services should strengthen human recourse development through well organized, training, field day, demonstration and visits.
- From the findings of the study it was found that education level has a significant and positive relationship with access and utilization of agricultural information. This result shows that education level of farmers has a role to increase the ability to obtain, process and use of agriculture related information and use technologies

in a better way. Therefore, due emphasis has to be given towards strengthening rural education at different levels for youth and adults.

6.5 Suggestions for Further Research

Whereas the concept of food in security is a global phenomenon, this study was confined to SamiaSub County which is ideally a very small geographical area. Further research could be carried to enhance further studies on food security in the sub county. Besides, this study concentrated on the development of an agricultural information system geared towards enabling access to reliable and timely agricultural information to enhancing food security. To complement the findings of this study, further research could be carried out to establish the relationship between information and knowledge management tools and food security, once the suggested system has taken effect.

REFERENCES

Aker, J.C. (2010). Dial ‘A’ for Agriculture: Using Information and Communication Technologies for Agricultural Extension in Developing Countries. Center for Global Development, Washington, DC.

Alavi, Maryam, and Leidner, D. Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. MIS Quarterly, 25(1), March, 2001, 107-136.

Andrew W. S. (1997), Market Information Services: Theory and Practice.

Bals, C., Smolnik, S., and Riempp, G. Assessing User Acceptance of a Knowledge Management System in a Global Bank: Process Analysis and Concept Development. In 40th Annual Hawaii International Conference on System Sciences (HICSS 2007), 2007, 203c.

Batchelor, C.H., and Cain, J.D. (1999) Application of belief networks to water management studies. Agricultural Water Management 40, 51-57.

Boucneau, G., van Meirvenne, M., Thas, O, and Hofman, G. (1998) Integrating properties of soil map delineations into ordinary kriging. European Journal of Soil Science 49: 213-229.

Cain, J. D. (2001) Planning improvements in natural resources management.Guidelines for using Bayesian networks to support the planning and management of development programmes in the water sector and beyond. Centre for Ecology and Hydrology, Wallingford. ISBN: 0903741009.

Cain, J.D., Batchelor, C.H, and Waughray, D.K.N. (1999) Belief networks: a framework for the participatory development of natural resource management rategies. Environment, Development and Sustainability 1: 123-133.

Cain, J.D., Jinapala, K., Makin, L.W., Somaratna, P.G., Ariyaratna, B.R., and Perera, L.R. (2003) Participatory decision support for agricultural management.A case study from Sri Lanka. Agricultural Systems 76: 457-482.

Dent, J.B. (1995) Theory and practice in FSR: considering the role of modeling. Journal for Farming Systems Research-Extension 5 (1), 31-44.

Deraman, A. B., and Bahar, A. K. S. (2000).Bringing the Farming Community into the Internet: A Case Study.Informing Science, 3(4) 207-214.

Deutsch, C.V., and Journel, A.G. (1992). GSLIB: Geostatistical software library and user‟s guide Oxford University Press.

Devereux, S. (2006). Distinguishing between chronic and transitory food insecurity in emergency needs assessments. SENAC.WFP. Rome.

ESRI. (2001). Using ArcGIS Geostatistical Analyst. Environmental Systems Research Institute (ESRI) Press. Redlands, California.

Fawcett, R., Smith, J., Broetz, K., and Nkowani, K. (1998). Agroforestry Options for Ghana— Land Use Planning with Integrated Bio-physical and Multiple Objective Models (Final Report). Institute of Ecology and Resource Management, University of Edinburgh, UK.

Fischer, R.A., D. Byerlee and G.O. EDMEADES (2012). Can Technology Deliver On The Yield Challenge To 2050? Expert Meeting on "How to feed the World in 2050", Food and Agriculture Organization of the United Nations and Economic and Social Development Department, Rome.

Franzel, S., and Scherr, S.J. (Eds.). (2002). Trees on the Farm: Adopting the Adoption Potential of Agro-forestry Practices in Africa. CABI Publishing in association with the International Centre for Research in Agro-forestry.

Goovaerts, P. (1994). Comparison of CoIK, IK and MIK performances for modeling conditional probabilities of categorical variables.In R. Dimitrakopoulos (Ed.), Geostatistics for the next century pp 18-29.Kluwer Academic Publishers, Dordrecht.

Jenny Aker (2008). The Impact of Cell Phones on Grain Markets in Niger University of California, Berkley

Jensen, F.V. (1996). An introduction to Bayesian Networks. UCL Press, London.

Journel, A. (1983). Non-parametric estimation of spatial distributions. Journal of the International Association of Mathematical Geology 15: 445-468.

KNBS (2010). 2009 Kenya Population and Housing Census Volume II: *Population and Housing Distribution by Socio-Economic Characteristics.*

Labonne L. and Chase R.S. (2011). "The Power of Information: The Impact of Mobile Phones on Farmers' Welfare in the Philippines." Policy Research Working Paper No. 4996. Washington, DC: World Bank.

Loucks, D.P. (2000). Sustainable water resources management. Water International 25(1): 3-10.

Marwick, A. D. (2001). Knowledge management technology. IBM Systems Journal, 40(4), 814-840.

McCown, R.L., Cox, P.G., Keating, B.A., Hammer, G.L., Carberry, P.S., Probert, M.E., and Freebairn, D.M. (1994). The development of strategies for improved agricultural system and land use management. In: Goldsworth, P., Perning de Vries, F.W.T. (Eds.), Opportunities, Use, and Transfer of Systems Research Methods in Agriculture to Developing Countries. Kluwer Academic Publisher in co-operation with ISNAR and ICASA, The Netherlands, pp. 81-96.

McKinney, D.C, Ximing, and Cai X. (2002). Linking GIS and water resources management models: an object- oriented method. Environmental Modeling & Software 17(5): 413-425.

Minten, B. Reardon T. and Chen, K (2011). "The Quiet Revolution of 'Traditional' Agricultural Value Chains in Asia: Evidence from Staple Food Supply to Four Megacities." Mimeo, International Food Policy Research Institute, Washington DC.

Mittal, S. (2012).Modern ICT for Agricultural Development and Risk Management in Smallholder Agriculture in India.Working Paper No. 3. Socioeconomics, CIMMYT, Mexico.

Munyua, H. (2007). ICTs and small-scale agriculture in Africa: a scoping study. Final Report.International Development Research Centre (IDRC), Ottawa.

Ochola, W.O., Kerkides, P., and Argyrokastritis, I. (2002a). Water quality: an indicator for sustainable land management? In Tsakiris, G. (Ed.).Water Resources Management in the Era of Transition. Proceedings of 5 th International Conference of European Water Resources Association (EWRA), pp 54-64.

Ochola, W.O., Kerkides, P., and Argyrokastritis, I. (2002b). Water resource hazard management system: Assessing sustainable practices at the farm and catchment scales. Irrigation and Drainage 51(3): 243-255.

Robert Jensen (August2007) The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector

Rybaczuk, K.Y. (2001). GIS as an aid to environmental management and community participation in the Negril Watershed, Jamaica. Computers, Environment and Urban Systems 25: 141-165.

Smith, C.S., and McDonald G.T. (1998).Assessing the sustainability of agriculture at the planning stage. Journal of Environmental Management 52: 15-37.

Smith, C.S., McDonald, G.T., and Thwaites, R.N. (2000). TIM: Assessing the sustainability of agricultural land management. Journal of Environmental Management 60: 267-288.

Starasts, A. M. (2004). Battling the Knowledge factor: A Study of Farmers' Information Seeking Learning and Knowledge Process with an online environment in Queensland.Unpublished Ph.D Thesis.

Stein, A., and Ettema, C. (2003).An overview of spatial sampling procedures and experimental design of spatial studies of ecosystem comparisons. Agriculture, Ecosystems and Environment 94: 31-47.

Straudenrausch, H., and Flügel, W.A. (2001).Development of an integrated water resources management system in southern African catchments. Phys. Chem. Earth (B) 26(7-8): 561-564.

UNESCO. Working Group M.IV. (1999). Sustainability Criteria for Water Resource Systems. Cambridge, UK: Cambridge University Press.

Varis, O. (1997). Bayesian decision analysis for environmental and resource management. Environmental Modeling and Software 12, 177-185.

Vesel: Village e-Science for Life, Web-based Knowledge Management. [Online].Available.

Wadswoth, R., and Treveek, J. (1999).Geographical information systems for ecology. London: Longman.

APPENDICES

Appendix 1: Questionnaire for Farmers (FQ)

Dear Respondent,

I am a masters student in Moi University undertaking a study titled, '**Developing an Agricultural Information System to enhance Food Security in Samia Sub County, Kenya'.** You have been identified as one of the respondents for this study. Kindly provide honest responses to the items in this questionnaire. Your responses will be used strictly for purposes of this study and will be treated with utmost confidentiality. Please do not write your name anywhere on this questionnaire.

Thank you.

Tick or cycle appropriately

Section A: Demographic Characteristics

1. Gender

   Male ( ) Female ( )

2. Highest education level

   University ( )

   Tertiary ( )

   Secondary or equivalent ( )

   Primary ( )

3. Age

   20-30 years ( )

   31-40 years ( )

   41-50 years ( )

Over 50 years ( )

4. Location ……..
5. Who is the household head

   Male-headed ( )

   Female-headed ( )

   Child-headed ( )

   Others ( ) ……..
6. Which farming activity do you engage in?

   Livestock husbandry ( )

   Crop husbandry ( )

   Livestock and crop husbandry ( )

Section B: Access to and Utilization of Agricultural Information

7. How does your household access agricultural information for cultivating, planting, harvesting and selling the farm products? (Multiple responses are allowed)

   Through mobile phones ( )

   Through radio ( )

   Through leaflets and newsletters ( )

   Through posters ( )

   Through internet ( )

   Others ( ) Specify ……

8. How would you describe your household's access to agricultural information?

   No access ( )

   Low access ( )

   Medium access ( )

   High access ( )

9. How would you describe your household's utilization of agricultural information?

   No utilization ( )

   Low utilization ( )

   Medium utilization ( )

   High utilization ( )

10. What do you think are your household's hindrances to access to agricultural information…….

    ……

    ……

    ……

Section C: Opportunities that ICT-based Agricultural Information presents to Farmers

11. In your opinion, what do you think are the benefits of accessing agricultural information as a farmer in this location?

    ……

    ……

    ……

12. What is your description of food security in this location?

    Extremely poor ( )

    Fair ( )

    Good ( )

    Very Good ( )

    Excellent ( )

    Don't know ( )

13. Do you think access to agricultural information has a bearing on food security in this location?

    Yes ( ) No ( )

    Please explain……

    ……

    ……

    .....

Section D: Factors that Influence Access to and Utilization of Agricultural Information

14. Using the key provided, indicate by ticking, how the following factors influence your ability to access and utilize ICT-based agricultural information.

    1-Very Low; 2-Low; 3-Medium; 4-High; 5-Very High

Factor	**1**	**2**	**3**	**4**	**5**
Gender					
Education level					
Age					
Income level					
Attitude towards agricultural information					
Distance from Sub County Agricultural Office					
State of feeder roads					
Agricultural policies					
Telecommunication facilities					
Socio-political stability					

Please explain your response in qn. 14 above

……

……

……

15. In your opinion, what do you think should be done to facilitate access to and utilization of ICT-based agricultural information in your location?

……

……

Thank you for your cooperation

Appendix 2: Interview Schedule Guide for the Sub County Agricultural Officer

Interview Date----------Interview Time----------

1. How long have you been in this Sub County?
2. How do you disseminate agricultural information to farmers in this Sub County?
3. What is the approximate population of farmers in the Sub County?
4. Are all farmers satisfied with how they obtain information on their current farming activities in the Sub County? If no why?
5. What is your understanding of agricultural information system?
6. In your opinion, what do you think are the factors that influence access and utilization of agricultural information among farmers in this Sub County?
7. How would you describe the state of food security in this Sub County?
8. One of the objectives of this study is to develop web based agricultural information system, what is your opinion on this? What features do you expect of such a system?
9. Would an agricultural information system play a role in overcoming the current challenges facing farming in the Sub County?
10. What would you say about the current and future trends in farming technology?
11. Are you involved in projects, programmes schemes or groups providing advice, assistance or training in agriculture? If yes, what kind of agricultural information do you disseminate to the farmers?

Appendix 3: Interview Schedule Guide for the Agricultural Officers

Interview Date---------- **Interview Time----------**

1. How long have you been in this area/location?
2. What is the population of the location? How many are farmers?
3. Are farmers satisfied with how they obtain information on their current farming activities in the district? If no why?
4. What is your view/understanding of agricultural information system?
5. One of the objectives of this study is to develop web based agricultural information system, what is your opinion on this? What features do you expect of such system?
6. Would an agricultural information system play a role in overcoming the current challenges facing farming and development in the Sub County?
7. What would you say about the current and future trends in farming technology?
8. Are you involved in projects, programmes schemes or groups providing advice, assistance or training in agriculture? If yes, what kind of agricultural information do you disseminate to the farmers?

Appendix 4: Coding

<!DOCTYPE html>

<html lang=”en”><head>

<meta http-equiv=”Content-Type” content=”text/html; charset=windows-1252”>

<title>Agricultural Information System</title>

<meta name=”description” content=”This resource list contains sources of business planning templates and further resources for agricultural enterprises. These resources include Internet and print resources as well as training courses and workshops.”>

<meta name=”copyright” content=”Copyright 2015”>

<meta name=”viewport” content=”width=device-width, initial-scale=1”>

<link rel=”stylesheet” href=”assets/styles.css” type=”text/css”>

<link rel=”shortcut icon” type=”image/x-icon” href=” /favicon.ico”>

<!—COLORBOX FOR SHOPPING CART →

<link media=”screen” rel=”stylesheet” href=”assets/colorbox.css”>

<script type=”text/javascript” src=”assets/jquery.js”></script>

<script type=”text/javascript” src=”assets/jquery_002.js”></script>

<!—RATING SYSTEM →

<link href=”assets/ratings.css” rel=”stylesheet” type=”text/css”>

<script src=”assets/ratings.js” type=”text/javascript”></script>

</head>

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id=”cboxCurrent”> <div class=””
id=”cboxPrevious”> <div class=””
id=”cboxClose”> <div style=”float: left;”
id=”cboxMiddleRight”> <div style=”float: left;”
id=”cboxBottomLeft”> <div style=”float: left;”
id=”cboxBottomCenter”> <div style=”float: left;”
id=”cboxBottomRight”> <div style=”position:absolute;
width:9999px; visibility:hidden; display:none”>

<!—Start of skin_wrapper→

<!—START USERBAR CODE →

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title=”www.ncat.org”>

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height=”37”><tbody><tr><td style=”padding-left:20px”><div
style=”cursor:pointer;position:relative;” onclick=”location.href=’/members.php’;”
title=”Sign In”>Sign In </td><td><div style=”cursor:pointer”
onclick=”location.href=’/subscribe.php’;”
title=”Subscribe”>Subscribe </td></tr></tbody></table>

<!—END USERBAR CODE →

<!—begin top nav→

<input id=”show-menu” role=”button” type=”checkbox”>

<ul id=”menu” class=”nav”>

Home

Contact

Funding ￬

<ul class=”navnav_hidden”>

Events

Breaking News

Multimedia ￬

<ul class=”navnav_hidden”>

Webinars

Videos

Tutorials

Podcasts

Publications

Databases

Español

About

Text Only

Donate

<form method=”get” action=”https://search.ncat.org/texis/search/”>

<input name=”dropXSL” value=”” type=”hidden”>

<input name=”pr” value=”ATTRA2014” type=”hidden”>

<input name=”prox” value=”page” type=”hidden”>

<input name=”rorder” value=”500” type=”hidden”>

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<input name=”rlead” value=”500” type=”hidden”>

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<!—begin left nav→

<table>

<tbody><tr>

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<td style=”padding:3px”><imgsrc=”assets/icon_twitter.png” alt=”Follow Us on Twitter” height=”auto” width=”100%”></td>

<td style=”padding:3px” align=”right”><imgsrc=”assets/icon_pinterest.png” alt=”Follow us on Pinterst” height=”auto” width=”100%”></td>

<td style=”padding:3px”><imgsrc=”assets/icon_youtube.png” alt=”Visit the ATTRA Youtube Channel” height=”auto” width=”100%”></td>

</tr>

</tbody></table>

Beginning Farmer

Field Crops

Horticultural Crops

Livestock & Pasture

Marketing, Business & Risk Management

Pest Management

Soils & Compost

Home Page

<hr style=”border-color:#ccc; border-style:solid; border-width: 1px 0 0; clear: both; margin: 0 0 20px; height: 0” align=”left” width=”90%”>

<h2>Newsletters</h2>

<img src=”assets/newsletter_signupbutton_off.png” alt=”Newsletter sign up button” name=”sign_up_button” id=”sign_up_button” border=”0” height=”auto” width=”90%”>

· Privacy Policy

· Newsletter Archives

<hr style=”border-color:#ccc; border-style:solid; border-width: 1px 0 0; clear: both; margin: 0 0 20px; height: 0” align=”left” width=”90%”>

<h2> </h2>

 <!—end left nav→

<!—start main content→

<!—startindex→

<h1 class=”header”>Home</h1>

<hr>

<table>

<tbody><tr>

<td style=”padding:10px”>

<h3>Introduction</h3>

Welcome to the Samia Farmers online agricultural information system portal

</td>

</tr>

<tr>

<td colspan=”3” style=”padding:10px”>

<h3>Advantages</h3>

Know when to plant

Know how to plant

Get market for your produce

Exchange with other farmers

Training Courses

</td>

</tr>

<tr>

<td colspan=”3” style=”padding:10px”>

</td></tr>

</tbody></table>

<!—end main content→

<!—

SESSION DATA:

Array

(

```
)
→
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                <!—begin footer→
<div id=”footer”>
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href=”https:///terms.html”>Terms of Service</a> | <a
href=”https:///sitemap/sitemap.html”>Site Map</a> | <a
href=”https:///management/comments.php”>Comments</a> | <a
href=”https:///privacy.html”>Privacy Policy</a> | <a
href=”http://www.facebook.com/pages/ATTRA-Sustainable-
Agriculture/134541719898890?v=wall”><img src=”assets/facebook_sm.gif” alt=”Find
us on Facebook” style=”margin:0 2px -3px 0” border=”0” height=”16”
width=”16”>Facebook</a> |</p>
        <p>Copyright © 2015. All Rights Reserved.</p>
        </blockquote>
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document.write(unescape(“%3Cscript src=’” + gaJsHost + “google-analytics.com/ga.js’
type=’text/javascript’%3E%3C/script%3E”));
</script><script src=”assets/ga.js” type=”text/javascript”></script>
<script type=”text/javascript”>
try {
varpageTracker = _gat._getTracker(“UA-7797226-1”);
pageTracker._trackPageview();
   } catch(err) {}
```

```
</script>
</div><!—end footer→
</div>
</div>
<!—End of skin_wrapper→

</body></html>
```

Appendix 5: User Manual

Table of contents

This is a comprehensive web based system for farmers. Farmers will be able to obtain agricultural information that informs their cultivation, planting, harvesting and the final marketing of their products.

Getting Started

System requirements

Recommended system configuration includes:

- Windows Vista, Windows 7, Windows 8 or Windows 10, Windows xp, Linux
- 512MB of RAM
- 30MB of free disk space

1024x768 screen resolution or higher

Overview of the User Interfaces

1. Setup

- Sub locations
- Wards
- Crop Departments

2. Farmers registration

3. Crops

4. Farmers enquiries

5. Knowledge Base

6. Marketing

7. Reports

8. Change Password

9. User Management

10. About

Quick Start Guide

Launching the application

To launch the application, open the web browser and type in the url of the website in the address bar then press enter.

Login in using your username and password.

On successful login you will be taken to the home page.

System Setup

From here you will be able to setup the system for use by farmers.

This section is only accessible to administrators.

Sub Locations

To add new sub location Click on New Record

Fill in the fields appropriately then click Save

To update existing record, Click on the details besides record you want to update.

The details will be populated on the form on the right

Make the necessary changes then click Save.

To delete an item, Click on the details besides record you want to delete.

Click on Delete Record, then confirm deletion by selecting Ok on the popup window that appears.

Wards

To add new ward Click on New Record

Fill in the fields appropriately then click Save

To update existing record, Click on the details besides record you want to update.

The details will be populated on the form on the right

Make the necessary changes then click Save.

To delete an item, Click on the details besides record you want to delete.

Click on Delete Record, then confirm deletion by selecting Ok on the popup window that appears.

Crop Departments

To add new department Click on New Record

Fill in the fields appropriately then click Save

To update existing record, Click on the details besides record you want to update.

The details will be populated on the form on the right

Make the necessary changes then click Save.

To delete an item, Click on the details besides record you want to delete.

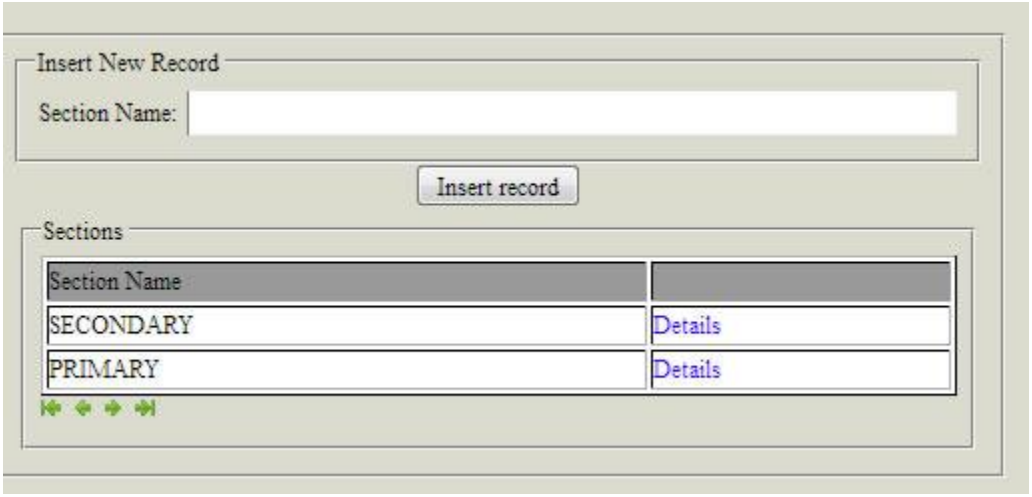
Click on Delete Record, then confirm deletion by selecting Ok on the popup window that appears.

Launching the application

To launch the application, open the web browser and type in the url of the website in the address bar then press enter.

Login in using your username and password.

On successful login you will be taken to the home page.

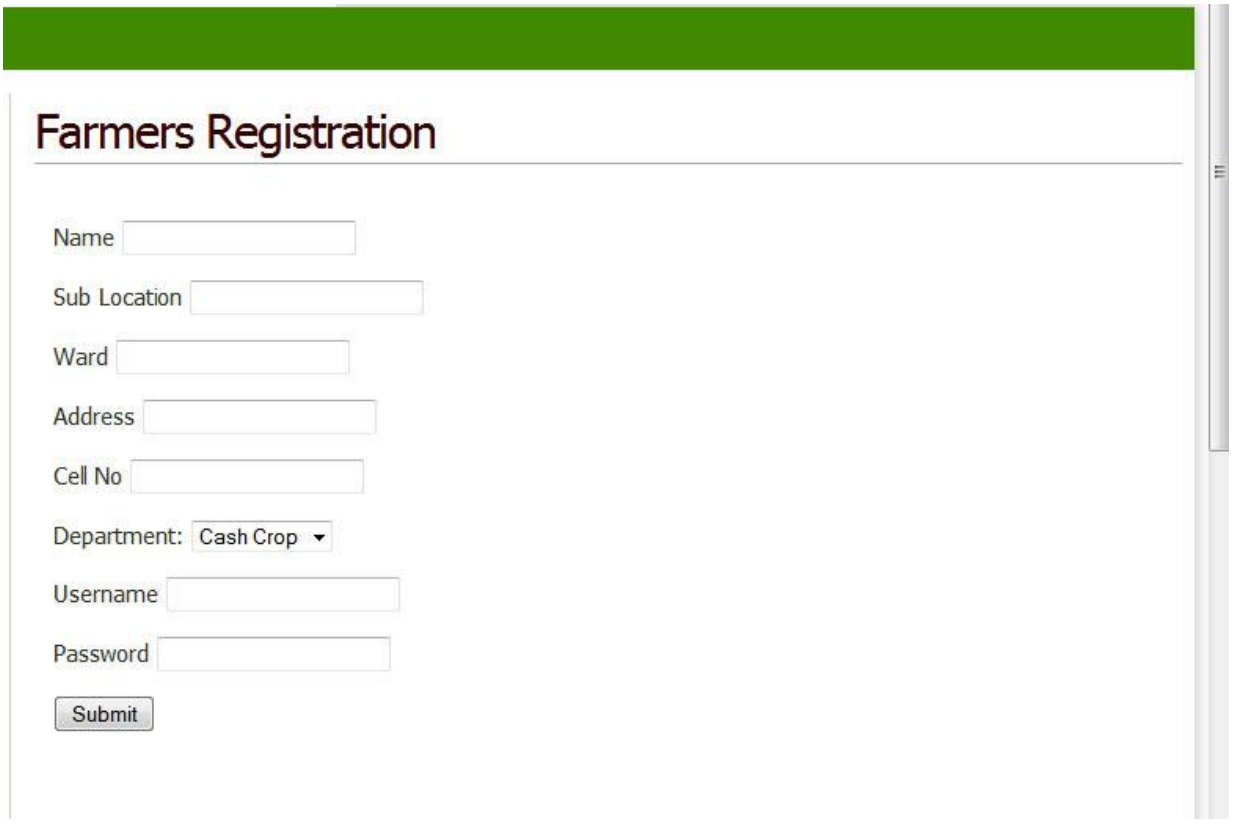


Farmers Registration

New farmers can register through this link.

Just click on Register Farmer and a form will appear

Fill your details in the form then click Register.



Crops

Administrators can use this section to add and update crop details.

Details here include crop name, planting season, requirements, etc.

Farmers Enquiries

Farmers use this screen to post questions on crop management.

Just put in your name, phone number and your question then submit.

Knowledge Base

This contain a list of questions with answers.

Before you ask any question, you can go through the knowledge base to see if your question is in the list.

Any relevant question that is asked by farmers will be available in this section.

Marketing

All marketing information and queries are accessible through this link

Just select you crop of interest and see the market details available

Reports

Reports on farming trends, marketing and farmers are all available here

Change Password

Use this screen to change your password regularly

Put in a new password and click Save.

User Management

System admin uses this to manage users and farmers.

Verify new farmers

Reset User Passwords

Remove Users

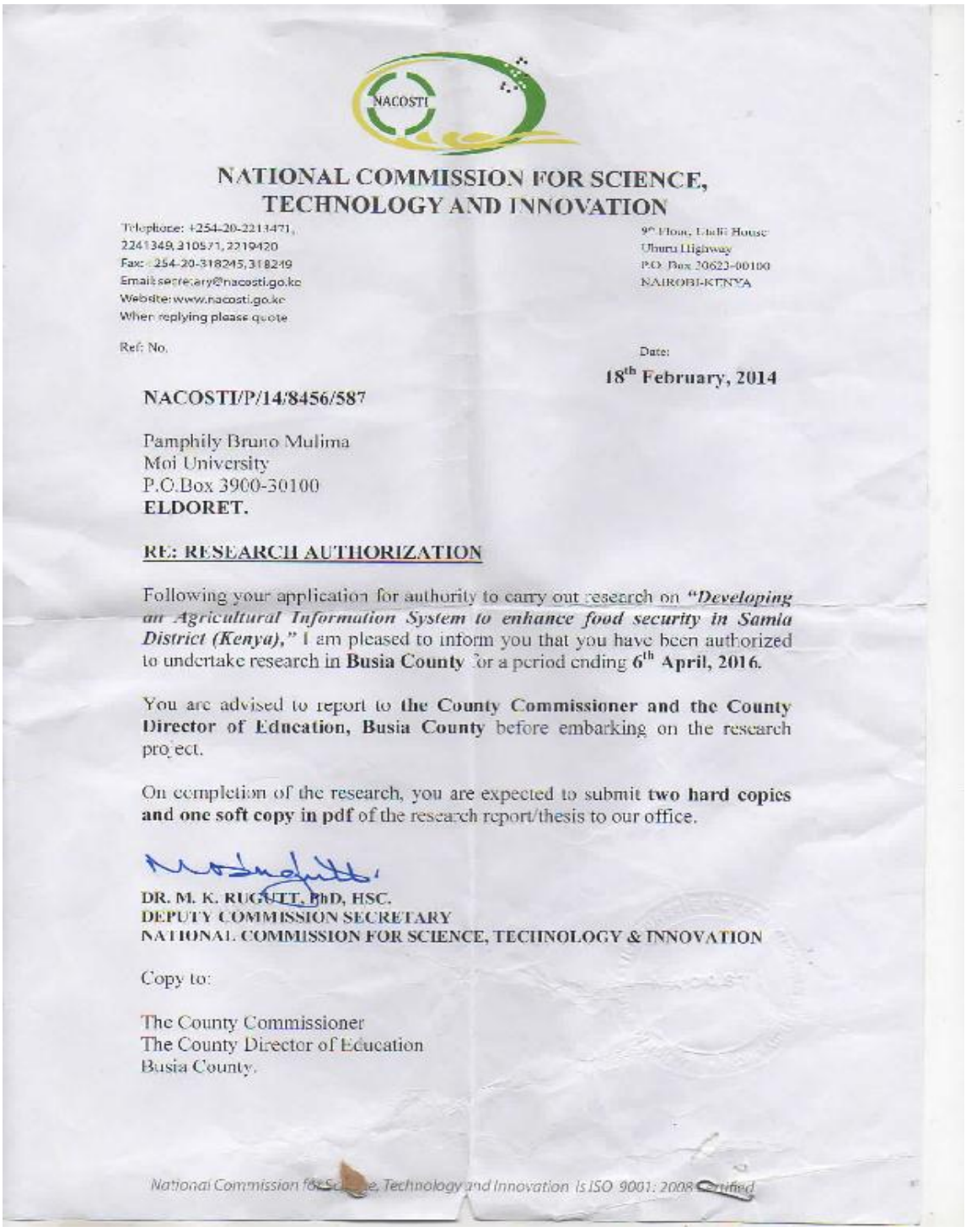
About

Agricultural Information System

Version 1.0

2015.

Appendix 6: Research Permit



NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349,310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 20622-00100
NAIROBI-KENYA

Ref: No.

Date:
18th February, 2014

NACOSTI/P/14/8456/587

Pamphily Bruno Mulima
Moi University
P.O.Box 3900-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Developing an Agricultural Information System to enhance food security in Samia District (Kenya),"*** I am pleased to inform you that you have been authorized to undertake research in **Busia County** for a period ending **6th April, 2016.**

You are advised to report to **the County Commissioner and the County Director of Education, Busia County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. M. K. RUGUTT, PhD, HSC.
DEPUTY COMMISSION SECRETARY
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Copy to:

The County Commissioner
The County Director of Education
Busia County.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

THIS IS TO CERTIFY THAT:
MR. PAMPHILY BRUNO MULIMA
of MOI UNIVERSITY, 0-400300
eldoret,has been permitted to conduct
research in *Busia County*
on the topic: *DEVELOPING AN AGRICULTURAL INFORMATION SYSTEN TO ENHANCE FOOD SECURITY IN SAMIA DISTRICT (KENYA)*
for the period ending:
6th April,2014

Permit No : NACOSTI/P/14/8456/587
Date Of Issue : 18th February,2014
Fee Recieved :khs1000.00

Applicant's Signature

Secretary
National Commission for Science, Technology & Innovation