# AN EVALUATION OF AGRICULTURAL KNOWLEDGE AND INFORMATION SYSTEMS IN ADOPTION: The case of grain amaranth production in Lugari, Kakamega County, Kenya

By

Wekulo Saidi Fwamba

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## DECLARATION

I declare that this Dissertation is my original work and has not been submitted to any other institution of higher learning for examination.

| **Name** | **Signature** | **Date** |
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| Wekulo S. Fwamba<br>**(REG; A56/73047/2012)** | ………………… | …..………. |

**SUPERVISORS' RECOMMENDATIONS**

This Dissertation has been submitted for examination with our approval as the University of Nairobi supervisors.

| **Name** | **Signature** | **Date** |
| --- | --- | --- |
| 1. Dr. Fred I. Mugivane | ………… | …..…………… |
| 2. Prof. P.N. Nyaga | …………… | ……………….. |

## DEDICATION

This dissertation is dedicated to my entire family members ( my wife Mrs. Asha Fwamba, my daughter Rukia Fwamba, my three sons – Asman Fwamba, Rashid Fwamba and Ramadhan Fwamba ) for their immense moral support and tireless efforts in encouraging me during my study.

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**List of Abbreviations**

| | |
|---|---|
| AKIS | Agricultural Knowledge and Information Systems |
| ARD | Agricultural Research and Development |
| ASDS | Agricultural Sector Development Strategy |
| CBO | Community Based Organization |
| CRWRC | Christian Reformed World Relief Committee |
| GDP | Gross Domestic Product |
| FAO | Food Agricultural Organization |
| FBO | Faith Based Organization |
| FSD | Farming Systems Development |
| KARI | Kenya Agricultural Research Institute |
| KAPAP | Kenya Agricultural Productivity and Agribusiness Programme |
| KASAL | Kenya Arid and Semi – Arid Lands |
| NARS | National Agriculture Research Systems |
| NGO | Non- Governmental organization |
| RATIN | Regional Agriculture Trade Intelligence Network |
| SMP | Soil Management Project. |

| | |
|---|---|
| SPSS | Statistical Package for Social Science |
| TOT | Transfer of Technology |
| REA | Rural Electrification Act |

# ABSTRACT

The access to agricultural information by smallholders for improved agricultural production has increased the application of agricultural knowledge and information systems (AKIS). The purpose of this study was to establish the factors that affect the use of AKIS tools by smallholder grain amaranth farmers in Lugari, Kakamega County, Kenya. The AKIS tools in this study included radio, mobile, extension agents, researchers and farmer to farmer. Using purposive sampling, the study selected 5 villages with 131 respondents to respond to questionnaires for data collection. Descriptive analysis was done by SPSS software while quantitative analysis was done by STATA software.

The results indicate that majority of the respondents own radio (84.7%), are able to access radio (87.8%) and are able to use radio for grain amaranth information (40.5%). 84% of respondents own mobile, 90.8% are able to access and only 64.1% use it for grain amaranth information. 78.6% of respondents are able to access extension agents but only 15.3% use them for grain amaranth production. Researchers are only accessed by 15.3% of respondents. Farmer-farmer communication is very effective as they access each other at 71.8% and use each other's information at 93.9%. The findings suggest that farmer-farmer (interpersonal) communication, FM Radio stations and cellular phones are important AKIS tools in improving small scale agriculture in rural areas**.** The use of AKIS tools and socio-economic factors has significant effect in the adoption of grain amaranth production by smallholder grain amaranth farmers.

The study recommends that the government strengthens the use of AKIS tools by restructuring research-extension-farmer linkages and making it affordable for farmer to buy mobiles and airtime for information sourcing. Deployment of technical extension staff should be based on their professional training and prevailing enterprises within the localities.

# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background

Agriculture is high on the global agenda because of volatile food prices and climatic factors. Billions of people remain hungry and malnourished (Ruel, 2011). In Kenya aagriculture has continued to be the backbone of the national economy contributing directly 24% of Gross Domestic Product (GDP) and 65% of the export earnings. In addition, the sector provides the livelihood of over 80% of the Kenyan population and their food security. The strengthening of the agricultural sector is a prerequisite condition for achieving economic recovery and growth (GoK, 2008).

Agricultural information is therefore a critical ingredient for both the sectorial development and national economy. GoK,(2009 ), states that since independence to date, Kenya has accumulated a significant amount of agricultural data and information through development projects and other methods, relative to other countries in sub-Saharan Africa, but consolidated information on the agricultural communication issues in the sector is not well documented. This is partly because there are no systematic procedures for information collection, analysis, storage and dissemination and partly because each development agency collects own data with little or no coordination with the rest.

According to Rege (2007), the available data is often outdated and is characterised by poor timeliness and unknown reliability. The sector is further challenged by constrained financial, human and technical capacities to generate, manage and disseminate accurate agricultural information. The recent formulation of the national Information Communication Technology (ICT) policy implies that most of the information structures being implemented in ICT are either sect oral or *ad hoc* in nature, without a national leverage.

The grain amaranth (*Amaranthus* spp.) is native to the New World. Pre-Columbian civilizations grew thousands of hectares of this pseudo-cereal. Some indigenous populations are said to have used grain amaranth, along with maize and beans, as an integral part of their cropping schemes. The Aztecs relied on amaranth seeds (or "grain") as an important staple. The most studied nutritional aspect concerning the food value of grain amaranth is the identification of the limiting amino acids of the protein component. The crude protein content of selected light-seeded grain amaranths has been reported to range from 12.5 to 17.6. Amaranth grain is reported to have high levels of lysine, a nutritionally critical amino acid, ranging from 0.73 to 0.84% of the total protein content. The limiting amino acid is usually reported to be leucine although some reports indicate that threonine actually may be the amino acid which is more biologically limiting than leucine (GoK, 2006).

In Kenya Amaranth (Amaranthus spp.) is known in local language as *Terere* (Kikuyu), *muchicha* (Kiswahili, Ngiriama), *Lidodo*, (Luyha), *alike*, (Luo), just but to mention a few (GoK, 2009). Amaranthus is among neglected/orphan/traditional crops (others include cassava, sorghum, finger millet). This has led to food insecurity (GoK, 2006). Grain amaranth as shown in figure 1 below, can bear a lot of grain for seed and healthy leaves for vegetable if managed well.

Figure 1: A farmer in his Grain amaranth plantation in Lugari Sub-County
Source: GoK, (2006)

This study which was carried out in Lugari, Kakamega county, tried to analyse how information transformation in Agricultural Knowledge and Information System (AKIS) impacts on adoption of Grain Amaranth by small scale farmers.

## 1.2 Previous studies on grain amaranth production

According to Kauffman and Weber (2006), of National Academy Sciences, utilization of amaranth germ plasm to promote more efficient production of the crop. The selection of appropriate amaranth genetic resources can reduce the need for purchased inputs. Need to broaden the food base by the utilization of underdeveloped food materials.

Study carried out by Twesige (2010) in Iganga, Uganda shows that grain amaranth has resistance to drought, pests and diseases. It uses only a third of the water required by other grains. It has a high nutritional value having 75% of the nutrients required by the body. The grain has a high medicinal value and has proved to be successful in the treatment, management and prevention of various diseases.

Study carried out by Mwangi et al (2011) in Yatta, Machakos, states that amaranth is high in protein and contains 8 essential amino-acids. The supply of high quality raw material (amaranth grain) has been a major problem. A kilogramme of amaranth grain sells at Ksh 50 in Nairobi. Farmers say an acre of land can produce about 16,000 kilogrammes of amaranth. The dream of striking it rich by growing the crop is driving a rapid change from tending traditional crops.

### 1.2.1 Gaps in previous studies

Previous studies dwelt on medicinal value, nutritional value, pest and disease resistance and drought tolerance of grain amaranth without exploring ways on adoption for production of the same crop. This has led to few farmers undertaking the crop as a business. With introduction of agricultural knowledge and information communication systems (AKIS), more farmers should access information on grain amaranth and adopt its production.

Marketing and prevailing market prices information access has not been addressed by previous studies. This brings about low adoption of grain amaranth by smallholder farmers. Farmers require information on enterprises in order to make decisions based on gross margin analysis.

Value addition for both utilization and marketing for grain amaranth production has not been given appropriate attention. This led to grain amaranth production at subsistence level other than being taken as a business enterprise.

## 1.3 Problem Statement

### 1.3.1 Introduction to the problem

Lack of information access for crop diversification is a major challenge to small scale farmers in this country. Dependence on maize, dairy cows and bananas as food and as income earners has let to poor livelihoods. With changing weather patterns, high input prices and erratic market prices, maize farming is becoming untenable as a commercial crop (GoK, 2008).

Grain amaranth adoption is often constrained by lack of grain amaranth information access and lack of appropriate technology or access to technology, inputs, services and credit, and by farmers' inability to bear risks. In addition, farmers' information and skills gap constrains the adoption of available technologies and management practices or reduces their technical efficiency when adopted. To address these challenges, building innovation capacity, enhancing use of knowledge and creating social and economic change is very important (Rajalahti, 2009).

Grain amaranth farmers therefore face great challenge of accessing information and knowledge on new varieties and where to market the crop produce. The extension agents are not adequately equipped with communication tools that can enable them disseminate research findings to farmers (Kiplang'at and Ocholla, 2005).

This study therefore sought to determine factors influencing use of Agricultural Knowledge and Information System tools for the adoption of grain amaranth production in Lugari Sub-County. Knowledge of these factors will assist in determining why grain amaranth farmers have limited access to Agricultural Knowledge and Information System tools and new information on grain amaranth production. The study further seeks to determine the strategies to be put in place to address full use of AKIS tools.

## 1.4 Objectives

### 1.4.1 Overall objective

To assess factors inhibiting/enhancing small holder farmers use of agricultural knowledge and information systems tools and access to knowledge and information**.**

### 1.4.2 Specific objectives

- To identify Agricultural Knowledge and Information System tools used to get information on Grain amaranth production by small scale farmers in Lugari, Kakamega County.
- To assess whether use of Agricultural Knowledge and Information System tools has significant influence on adoption of Grain Amaranth production in Lugari, Kakamega County.
- To determine socio-economic factors that influence farmers' use of Agricultural Knowledge and Information System tools in Grain Amaranth production and marketing in Lugari, Kakamega County.

## 1.5 Hypotheses

1) There is no significant difference between the agricultural knowledge and information systems (AKIS) tools used by farmers as sources of knowledge and information and the adoption of grain amaranth production.

2) There is no relationship between AKIS tools users and non-users in grain amaranth adoption.

3) There is no relationship between socio-economic factors in AKIS tools use and grain amaranth adoption.

## 1.6 Justification of the Study

The decision to focus on small scale grain amaranth farmers was influenced by the role of grain amaranth nutrition value and high income for smallholder farmers under very low input regimes. Farmers in Kakamega County as well as the whole of the other three counties in the former Western Province rely on maize as their major crop. Crop diversification spreads the risks in farming. To speed up technology adoption, requires understanding and improvement of information flow through modern Agricultural Knowledge and Information System tools. According to Lio and Liu (2005), rural telephone helps farmers to receive better prices for their crops and leads to significant increase in earnings. The study investigated how Agricultural Knowledge and Information System tools help determine farm produce and farm input prices through mechanism of information flow. The study aimed at informing both public and private extension providers, software developers and policy makers on the available Agricultural Knowledge and Information System tools used in grain amaranth production and the factors that affect their use.

## 1.7 The Scope of the study

The study covered grain amaranth small holder farmers in Lugari Sub location, Lugari Sub-County of Kakamega County. The study investigated socio-economic factors affecting AKIS tools use, knowledge and information sources and different AKIS tools used i.e. Mobile phones, radios, researchers and extension agents

## 1.8 Limitations of the study

One sub location out the 10 sub locations growing grain amaranth was studied due to logistic limitation. There are many factors other than Agricultural Knowledge and Information System contributing to adoption to grain Amaranth production in Lugari, Kakamega County which would not be covered because of limited resources. The study was limited to Agricultural Knowledge and Information Systems such as mobile phones, radios, researchers and extension agents that are available to rural farmers.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 Grain Amaranth background

The grain amaranths (*Amaranthus* spp.) are native to the New World. Pre-Columbian civilizations grew thousands of hectares of this pseudo-cereal. Some indigenous populations are said to have used grain amaranth, along with maize and beans, as an integral part of their cropping schemes. The Aztecs relied on amaranth seeds (or "grain") as an important staple.

The word "amaranth" in Greek means "everlasting" And in fact, the crop has endured. To assure a small annual supply for this specialty crop, traditional farmers have continued to grow small plots of the grain each year. Furthermore, the distinctly beautiful appearance of amaranth has helped to prevent the crop from slipping into obscurity. The enchanting beauty of the vividly colored leaves stems and seed heads in an amaranth field is a sight which evokes emotions that other crops cannot stir (Kauffman, and Weber, 2006).

**Figure 2: Grain amaranth as a dooryard crop in Peru**

Source: Kauffman, and Weber. (2006).

According to Putnam, *et al* (2004), amaranth, is an ancient crop originating in the Americas, and can be used as a high-protein grain or as a leafy vegetable, and has potential as a forage crop. Grain amaranth species have been important in different parts of the world and at different times for several thousand years. The largest acreage grown was during the height of the Aztec civilization in Mexico in the 1400's. The past two centuries grain amaranth has been grown in scattered locations, including Mexico, Central America, India, Nepal, China, and Eastern Africa. Research on amaranth by U.S. agronomists began in the 1970's, so optimum production guidelines and uniform, adapted varieties have not yet been fully developed.

**Utilization:**

Grain amaranth has been used for food by humans in a number of ways. The most common usage is to grind the grain into a flour for use in breads, noodles, pancakes, cereals, granola, cookies, or other flour-based products. The grain can be popped like popcorn or flaked like oatmeal. More than 40 products containing amaranth are currently on the market in the U.S.A.

**Nutritive value:**

One of the reasons there has been recent interest in amaranth is because of its useful nutritional qualities. The grain has 12 to 17% protein, and is high in lysine, an essential amino acid in which cereal crops are low. Amaranth grown at Arlington, WI in 1978 had protein levels of 16.6 to 17.5%. The grain is high in fiber and low in saturated fats, factors which contribute to its use by the health food market. Recent studies have linked amaranth to reduction in cholesterol in laboratory animals.

**Forage;**

Little is known about the production and utilization of amaranth as forage. The leaves, stem and head are high in protein (15-24% on a dry matter basis). A Minnesota study (1 year) on amaranth forage indicated a yield potential of 4-5 tons/acre dry matter, with crude protein of the whole plant at 19% (late vegetative stage) to 11-12% (maturity) on a dry basis. A relative of grain amaranth, redroot pigweed, (Amaranthus retroflexus), has been shown to have 24% crude protein and 79% in vitro digestible dry matter. Pigweeds are known nitrate accumulators, and amaranth responds similarly. Vegetable amaranths, which are closely related, produced 30 to 60 tons of silage (80% moisture) on plots in Iowa. In areas where corn silage yields are low due to moisture limitations, grain amaranth may become a suitable silage alternative after further research.

**Growth Habits:**

The two species of grain amaranth commonly grown in the U.S. are Amaranthus Cruentus and Amaranthus Hypochondriacus. Grain amaranths are related to redroot pigweed, but are different species with different characteristics and have not become weeds in fields where they have been grown. The grain amaranths have large colorful seed heads and can produce over 1000 pounds of grain per acre in the upper Midwest, though a portion of this grain yield may be lost in harvesting.

Grain amaranth plants are about five to seven feet tall when mature, and are dicots (broadleaf) plants with thick, tough stems similar to sunflower. The tiny, lens-shaped seeds are one millimeter in diameter and usually white to cream-colored, while the seeds of the pigweed are dark-colored and lighter in weight (Putnam, et al, 2004).

In Kenya, Grain amaranth was gazetted by the Ministry of Agriculture in legal notice No. 287 of 19/7/91. The most rapidly maturing grain type in Kenya is the "Nepal" morphological group of Amaranthus Hypochondriacus, which mature within 60 days of planting. The Amaranthus Hypochondriacus "Mercado" morphological group also perform although it grows taller and takes a few days longer to mature.  Amaranthus Caudatus produce high-quality grain, although the researchers feel it takes too many days to reach maturity. Amaranthus Cruentus prove to be of little use. Excessive moisture depresses yields of all accessions. This research program has shown that grain amaranth has the potential to be adapted for food use under Kenyan agricultural conditions (Guptaa & Thimbaa 2009).

Figure 3: Grain amaranth on a demonstration site in Machakos

Source: MoA (2009)

According to Mwangi, *et al* (2011) INCAS a limited liability company has been processing fortified food for the last 5 years. They process maize, wheat flour fortified with amaranth plus pure amaranth uji flour and distribute them in supermarkets countrywide. The main emphasis is the processing of whole grain using a state-of- the-art technology to make high quality products for health and vitality. INCAS is producing a range of healthy products including maize, wheat and pure amaranth flours. Most of their products are fortified with amaranth grain. Amaranth is high in protein and contains 8 essential amino-acids. Also rich in minerals and vitamins, antioxidants and rare oils like squalene. This makes amaranth a perfect natural health food and INCAS is using the grain to produce healthy products but the supply of high quality raw material (amaranth grain) has been a major problem. The amount produced locally is low and the quality poor. INCAS has been forced to import grain from India to supplement the little amount available in the country. Therefore in 2010, INCAS approached KASAL and formed a public-private partnership with the aim of improving quality and production of amaranth grain in the country. In this partnership, KASAL provides improved amaranth varieties, good quality seed, research on diseases and pests, good agronomic practices through field demonstrations and technical backstopping while INCAS provides a guaranteed market and price for the farmers. Demonstrations were carried out in Yatta, Machakos and Kitui districts during the long rains in 2010 and good results are streaming in. Esther Kingoo in Yatta district, Ndalani division, Mamba village planted approximately ¼ acre of amaranth and has harvested 250 kg valued at KES 12,500 with an estimated cost of about KES 5,000. This underlines the potential of this drought tolerant crop and the ability it has not only to improve nutrition in the dry areas of Eastern Kenya but also to address the poverty problem. This project is therefore addressing the aspirations of Vision 2030 and Millennium Development Goal Number 1 on food security and eradication of poverty and enhancement of nutritional status of communities

## 2.2 Role of AKIS in Agriculture

Table 1, below presents a list of functional steps in agricultural knowledge and information systems as proposed by various authors.

Table 1: Knowledge and Information function systems as proposed by various scholars

| Nagel 1980, 23 | Lionberger 1986, 117 | Röling& Engel 1991, 125 | Blum 1991, 324 | Eponou 1993, 18 |
|---|---|---|---|---|
| Need identification | Innovation | Anticipation | Problem identification | Diagnose farmers' problems |
| Generation of innovative knowledge | Validation | Generation | Review scientific & indigenous knowledge | Design a research program |
| Operationalization of knowledge | Dissemination | Transformation | Basic Research & Development | Generate technologies |
| Dissemination of knowledge | Information | Transmission | Adaptive Research & Development | Consolidate technologies |
| Utilization of knowledge | Persuasion | Storage | Sustainability assessment | Disseminate information and knowledge |
| Evaluation of experiences | Reinforcement | Retrieval | Optimal means of Communication | Approve and release technologies |
| | | Integration | Adoption | Multiply improved genetic material and duplicate technology packages |
| | | Diffusion | | Deliver technologies |
| | | Utilization | | Evaluate technologies |

Source: FOA (2000)

At a first glance, it appears that the suggested functions differ considerably. However, a closer look reveals that many functions are similar and differences are a result of divergent terminology for basically one and the same function. For a better comparability, corresponding or similar functions are presented in the same row of the table. The functions cover the spectrum from problem or need identification to the adoption and evaluation of an innovation.

The direction of activities within an agricultural knowledge system is determined by the actual needs of its sub-systems (or “connected entities“- Havelock; or “actors“ Engel nomenclature) and to a certain degree by the outside surrounding (macro-) system of institutions and policy framework. Regardless of the concrete manifestations of these interests, Nagel (2006) assumes that the basic determinants are the knowledge needs of farmers. Aware of deficiencies in practice he adds: “serving the needs of farmers is a postulate to which at least lip service is paid by everyone involved. “

Two levels of decision making are involved in need identification. On the first level, the actual farmers‘level, the problem of distinguishing between individual farmer‘s problems and problems that concern a larger number of farmers arises. It is a problem of prioritization. Which of the many farmers‘problems should be researched? On the second level, the institutional and policy level, matters may be quite removed from actual field problems. What counts here are the national policy goals, the needs of institutions and the availability of funds. However, policy formulation often leaves considerable room for interpretation. Therefore, which of the actual farmers‘problems become investigated, also depends, to a considerable extent, on the personal preferences and prejudices of researchers and Extensionists (Nagel, 2006).

From the above discussions, it is clear that availability of agricultural information on an innovation leads to high adoption rate hence increased farm productivity.

Agricultural Knowledge and Information System tools such as ICTs play key a role in agricultural production. WSIS (2006). ICTs include any communication devices or applications encompassing cellular phones, computer and internet hardware and software, satellite and Geographical information system, as well as various services associated with them, such as video conferencing (Techtarget, 2010). According to (Wambugu and Kiome 2001), Agricultural Knowledge and Information System improves flow of agricultural information to farmers and knowledge acquisition. In their marketing and technology research, they recommend organizations such as Kenya Agriculture Commodity Exchange (KACE), to inform farmers about distance market prices through rural telecentres.

According to Munyua *et al*, (2008), Frequent Modulated (FM) Radio stations, internet, e-mail, websites and web-based applications are becoming increasingly important in small-scale agriculture for purposes of sharing and disseminating agricultural information. Television was the major ICT used in extension delivery in Nigeria, while Radio was the most important ICT followed by Television and Video in Kenya (Ovwigho *et al*, 2009). Farooq (2007), stated that important sources of agricultural information for the respondents were fellow farmers and print media (100%), private sector (95%), Television (80.83%), extension field staff (67.5%), Radio (75%) while none mentioned NGOs

A DatAgro project in Chile takes advantage of the high penetration rate of mobile phones to allow rural farming cooperatives to define the types of information most critical to their livelihoods and receive it via text messages (Gantt and Cagley, 2010). Ilahiane, (2007), indicated that mobile phones had revolutionized the way in which farmers' access, exchange and manipulate information. For example, a network of community workers in Uganda uses a suite of mobile applications to give farming advice (Gantt and Cagley, 2010).

Röling, (2005), states that the main problem in Agricultural Knowledge and information systems ( AKIS ) is information transformation within its system units ( Research, Extension and farmers ).The long process of information transformation from researchers through extension agents to farmers makes it difficult to translate into increased farm productivity . Röling, (2005) lists knowledge transformations within an agricultural knowledge system at the following points:

From information on local farming systems to research problems, from research problems to research findings, from technologies to tentative solutions to problems (technologies), from technologies to prototype recommendations for testing in farmers‘ fields, from recommendations to observations of farmers behaviour (male, female, children), from technical recommendations to information affecting service (inputs and marketing) behaviour, from adapted recommendations to information dissemination by extension, and from extension information to farmers‘ knowledge.

The long process of information transformation illustrates the imminent high risk of things going wrong before the information reaches the small scale farmers for utilization for increased farm productivity. Farm productivity depends on new technologies or innovations adopted by the farmers. A way to reduce this risk is to ensure a proper documentation and retrieval of results at all steps. Röling, (2005) speaks in this context of the storage and retrieval function of an AKIS. Rather than a separate function, this could be seen as an ongoing continuous function required in combination with the other functions. Considering the huge amounts of information that need to be processed by an agricultural knowledge system it becomes evident that good documentation structures need to be developed. Access to findings (retrieval) is equally important. It is crucial that any member in the system can find the information he/she requires quickly. Of particular importance is a common language for all groups. To ensure that members of different sub-systems understand each other, it may be necessary that crucial documents are developed jointly (e.g. research documentation, extension materials, farmer leaflets, etc.). The information transformation problem in AKIS involves: information documentation, information storage, information retrieval, and common language to all groups in the system

According to Oparanya, (2009), the number of mobile subscribers in Kenya increased from 9.3 million in 2007 to 12.9 million in 2008. It had been projected to reach 19.9 million subscribers by 2010 (CCK, 2010). Kenya reached 28 million mobile subscribers in the first quarter of the year 2012 (CCK, 2012). As regards internet and e-mail services middle-class residents have internet access either through their fixed lines or through wireless internet services.

According to CCK, (2011), in the 4th quarter of 2010/2011, the total number of mobile subscriptions stood at 25.27 million, a 0.23 percent increase compared to the previous quarter. The total number of main fixed line (fixed terrestrial lines and fixed wireless) subscriptions declined by 15.4 percent from 442,950 lines in March 2011 to 374,942 lines in June 2011. Fixed terrestrial lines declined by 17.4 percent during the period while fixed wireless declined by 11.2 percent. The decline in the fixed lines may be attributed to increased vandalism and the increasing uptake of the mobile telephony which tends to substitute fixed line.

Overall tele-density increased to 65.15 percent from 65.12 percent in March 2011, with mobile Services accounting for 64.2 percent. Minutes of Use (MoU) per subscriber per month for mobile during the period stood at 82.4 from 80.2 recorded during the previous period, an increase of 2.7 Percentage points. The number of SMS per subscriber per month declined by 4.3 percent to 8.5 SMS compared to 8.8 SMS during the previous period. The increase in the MoU and the decline in the SMS are both attributed to affordable calling rates offered by operators.

The total number of internet subscriptions rose to 4.25 million from 3.84 million recorded in the previous period, registering 10.9 percent increase. Mobile data/internet subscriptions continued to dominate the total internet subscriptions and accounted for 98 percent of the total internet subscriptions. In addition, the estimated number of internet users rose by 13.6 percent from 11.03 million in the last period to 12.53 million during the period under review. The increase in the Internet subscriptions and users may be attributed to reduced Internet charges during the period under review. Kenya reached 28 million mobile subscribers in the first quarter of the year 2012 (CCK, 2012).

### 2.3 Socio-economic factors influencing use of AKIS tools

According to Wejnert, (2006), socioeconomic characteristics of the farmer; education level, economic wellbeing, socio-demographic variables affect use of an innovation. Ndiema, (2002), states that formal education is significant in as far as adoption of practices is concerned. These, among other diffusion studies suggest strongly that the level of education is associated with adoption of technology. It is clear that literate farmers will get access to written materials faster and thereby facilitate their awareness of information.

Ovwigho et al, (2009), found that major constraint to use of Agricultural Knowledge and Information System tools is high cost of telephone service, limited access to computer and rural poverty. Use of a particular type of ICT will depend more on economic variables than on socio-demographic variables like gender, marital status and education level (Wejnert, 2006). (Bruce, (2003) defines information literacy as “the ability to access, evaluate, organize and use information in order to learn, problem-solve, make decisions in formal and informal learning contexts, at work, at home and in educational settings”.

Lio and Liu, (2005), indicate that there is a positive and significant relationship between Agricultural Knowledge and Information System adoption and agricultural productivity .They found out that certain socio-economic characteristic such as higher level of education and skills are prerequisites for effective development of agricultural productivity by new Agricultural Knowledge and Information System.

## 2.4 Theoretical perspectives

### 2.4.1 Two Step Flow Theory

The two-step flow of communication hypothesis was first introduced by Paul Lazarsfeld, Bernard Berelson, and Hazel Gaudet in *The People's Choice,* a 1944 study focused on the process of decision-making during a Presidential election campaign. These researchers expected to find empirical support for the direct influence of media messages on voting intentions. They were surprised to discover, however, that informal, personal contacts were mentioned far more frequently than exposure to radio or newspaper as sources of influence on voting behavior. Armed with this data, Katz and Lazarsfeld developed the two-step flow theory of mass communication.

This theory asserts that information from the media moves in two distinct stages as shown in figure 4 below. First, individuals (opinion leaders) who pay close attention to the mass media and its messages receive the information. Opinion leaders pass on their own interpretations in addition to the actual media content. The term 'personal influence' was coined to refer to the process intervening between the media's direct message and the audience's ultimate reaction to that message. Opinion leaders are quite influential in getting people to change their attitudes and behaviors and are quite similar to those they influence. The two-step flow theory has improved our understanding of how the mass media influence decision making. The theory refined the ability to predict the influence of media messages on audience behavior, and it helped explain why certain media campaigns may have failed to alter audience attitudes and behavior. The two-step flow theory gave way to the multi-step flow theory of mass communication or diffusion of innovation theory.

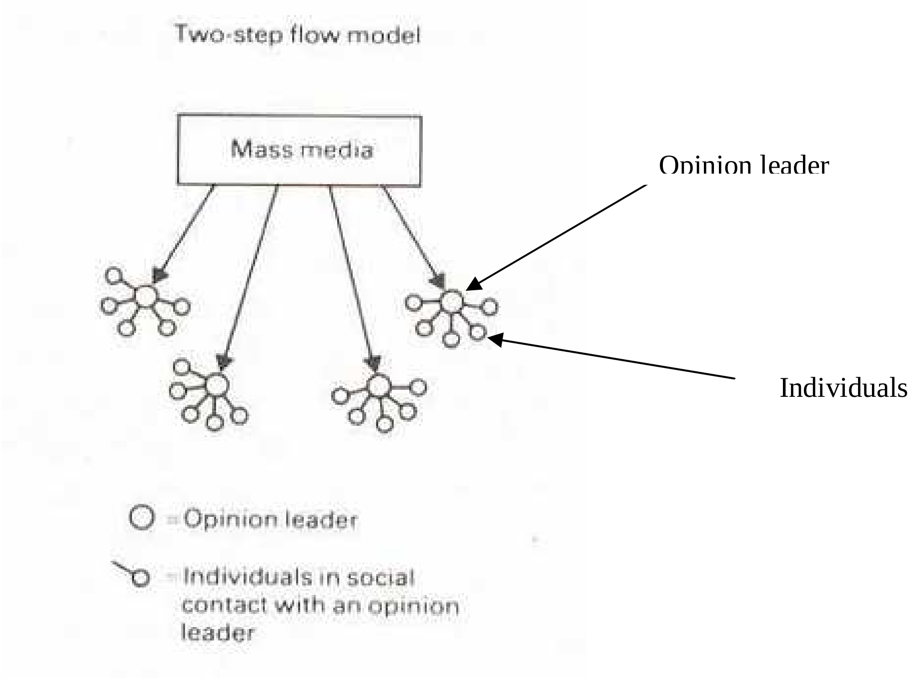



Figure 4: The Two-Step Flow Theory

Source: Katz & Lazarsfeld (1955)

### 2.4.2 Multi-step Flow Theory

Mass Media can reach Information Receivers through Opinion Receivers/ Seekers and Opinion Leaders using Step 1a, Step 1b, Step 2 and Step 3 as shown in figure 5 below. Multi-step Flow Theory shows the Innovation diffusion through the Channels of Communication within the Social System over time **DIFFUSION PROCESS:** The process by which the acceptance of an innovation is spread by communication to members of social system over time.

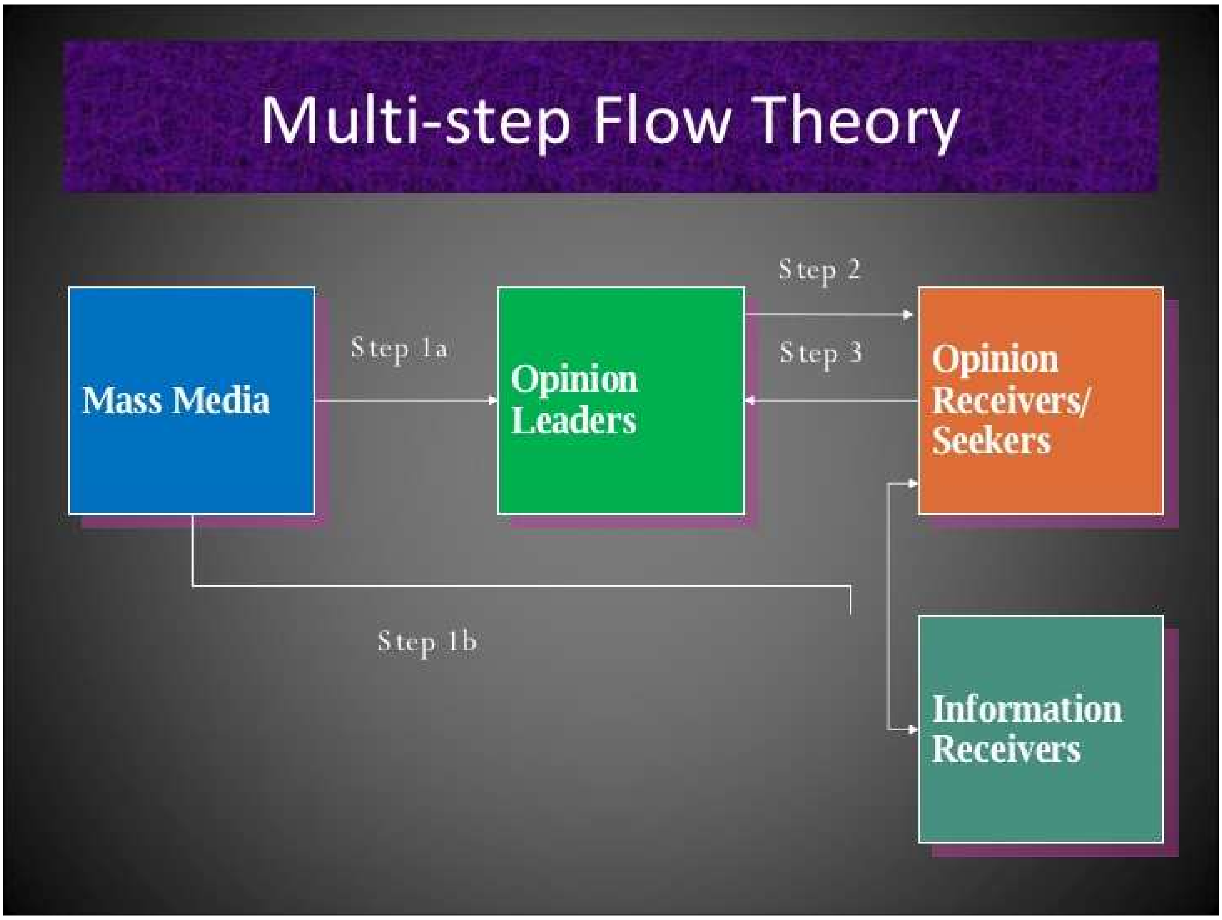



Figure 5: Multi-Step Flow Theory

Source:  Source: Katz & Lazarsfeld (1955)

### 2.4.3 Transfer of Technology Concept

As the systems approach to agricultural Research & Development evolves to accommodate participatory approaches, the underlying TOT linear model is stretched to its limit. This is evident when institutions try to adopt newer methods and find that the underlying TOT model blocks the way.


Figure 6: A one-way flow of agricultural knowledge and information

Source: FAO, (2000

The TOT model as shown in figure 6, is being eclipsed by newer models which acknowledge the overlapping of researchers, outreach workers and farmers. Rather than focusing on the technology itself, the new systems recognise that information and knowledge provide a common denominator among farmers, extension workers and researchers. In the late 1980s, researchers at Wageningen Agricultural University in the Netherlands proposed the "agricultural knowledge and information systems" (AKIS) model (FAO, 2000)

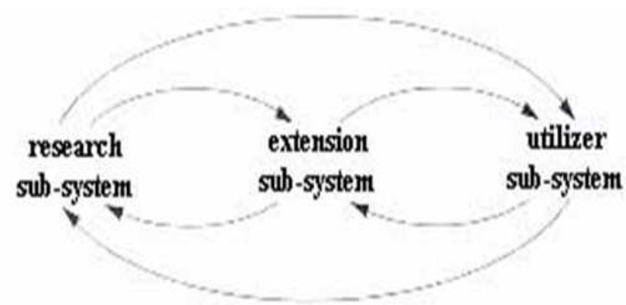



Figure 7: A two-way flow of agricultural knowledge and information

Source: FAO, (2000)

The model as shown in figure 7, describes the two-way flow of information and knowledge among the research, dissemination and utilizer sub-systems. These sub-systems play equally important roles in the system.

The utilizer sub-system is a source of information and knowledge that feeds into the other two. For the utilizer sub-system to be on a more equal footing with the other two, the sub-system must have a demand capacity. After all, the best extension systems in the world develop where farmers are organized and able to lobby for the technical assistance which they consider priority (Roling, 2005). It is the demand capacity of farmers that dictates the quality and effectiveness of the extension support. The opposite process, whereby extension systems conceivably strengthen farmers' production systems through technology, is more a myth of the TOT model than an observable reality.

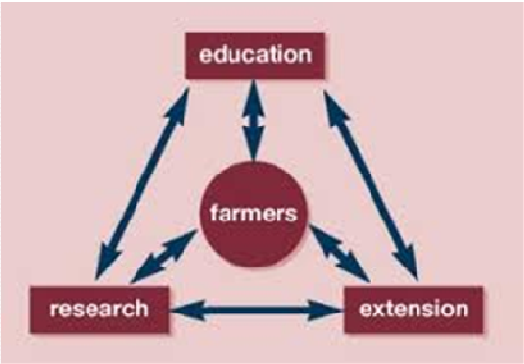



Figure 8: A two-way transfer of technology (TOT) with farmers at the center

Adapted from: FAO/World Bank (2000) AKIS

In the AKIS, the two-way exchange of information is crucial for effective generation and transfer of relevant technology. Figure 8, shows the two-way flow of information with farmers at the centre. Farmers can get information from extension agents, researchers or gain education from from other information sources. As a consequence, the role of the dissemination sub-system (the extension organization) has been reformulated from a one-way TOT persuasive channel into a two-way channel for requests and answers which facilitates the learning process for both farmers and researchers. But the change from disseminating to facilitating requires staff with fundamentally different attitudes, skills and knowledge. From the point of view of the

Agricultural Knowledge and Information System, and of participatory research, the facilitator can be described as a broker of information demands and supplies (FAO, 2000).

### 2.4.4 Innovation- Diffusion Theory

Rogers and Shoemaker, (2005) define an innovation as an idea, practice or object perceived as new by an individual. It matters little, so far as human behaviour is concerned, whether or not an idea is ’objectively‘ new as measured by the lapse of time since its first use or discovery. It is the perceived or subjective newness of the idea for the individual that determines her reaction to it. If the idea seems new to the individual, it is an innovation.”

In this context social change is understood as a process including three sequential stages: invention, diffusion and consequences (Rogers and Shoemaker 2005). Technical change in agriculture is consequently understood as the result of the adoption of technical innovations by farmers. Scientific research is seen as the source of such innovations.

Christoplos and Nitsch, (2004) review the diffusion model and describe adopter categories, adoption process and characteristics of innovation as the three main elements namely earlier adopters, take off and late adopters as shown in figure 9.

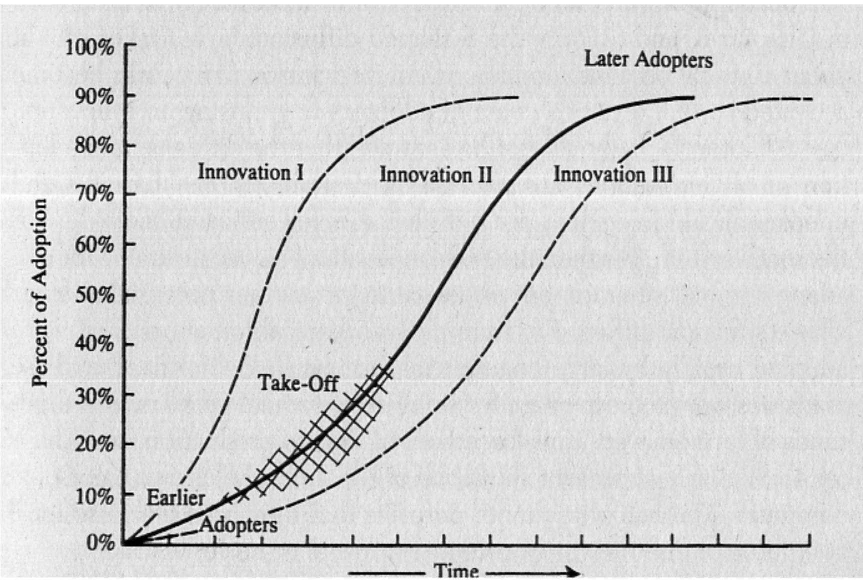



Figure 9: Diffusion with adopter categories

Source: Christoplos and Niitsch, (2004)

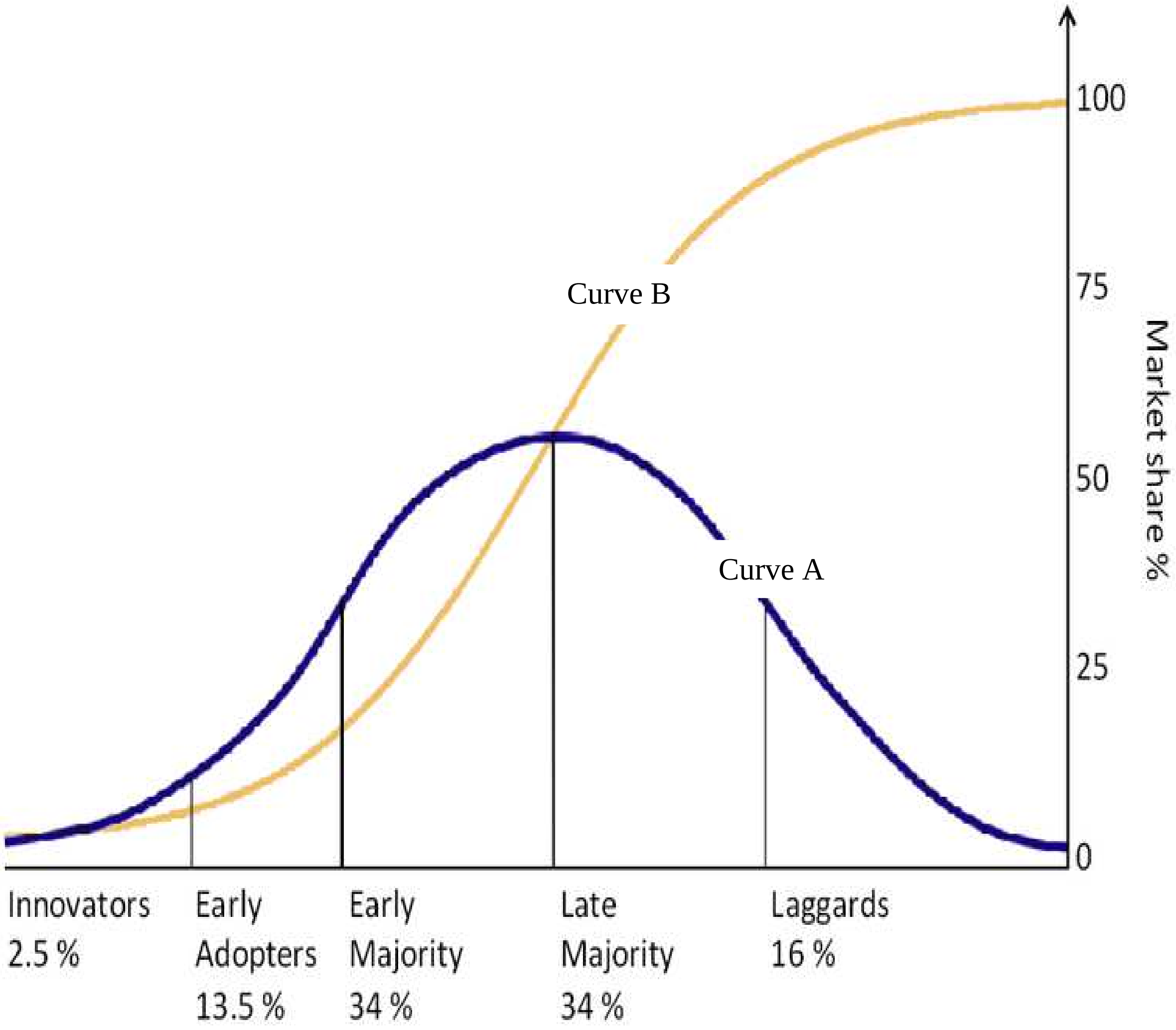



Figure 10: Diffusion with rate of adoption
Source: Rogers, (2005)

The above figure (figure 10) illustrates innovation-diffusion process. The diffusion of innovations according to Rogers, (2005) shows that with successive groups of consumers adopting the new technology (Curve A), its market share (Curve B) will eventually reach the saturation level

The Adopter categories classify farmers according to the rate of adoption of a new technology or practice. The first adopters are called innovators. They are followed by early adapters, early majority, late majority and laggards. The categories are associated with certain characteristics. Innovators are presumed to be venturesome, the late majority skeptical and laggards traditional. Early adopters are expected to have more education, higher social status and larger and more specialized farms. They are further considered as less dogmatic, less fatalistic, more rational and achievement oriented, and to hold a more favourable attitude toward credit, change, risk, education and science. Furthermore, they participate more in farmer organizations, are more cosmopolitan, have more contacts with outsiders, are aware of new recommendations and exert influence on local opinion. Late adopters on the other hand are characterized as being negative to change, risk and science, and as having little contact with extension services. Several extension methods, in particular the training and visit system (T&V) are implicitly based on the diffusion model, recommend choosing contact farmers in the categories of innovators and early adopters which are sometimes titled as progressive, outstanding or model farmers.

The adoption process describes the stages an individual goes through from the first exposure to an innovation to actually adopting it. The model distinguishes five stages: Awareness stage, interest stage, evaluation stage, trial stage and adoption stage.

### 2.4.5 Induced Innovation Theory

“Farmers are induced, by shifts in relative prices, to search for technical alternatives that save the increasingly scarce factor of production (FAO, 2000)” “. The induced innovation theory, however, does not consider technical change as entirely of an induced character. All actors such as farmers, scientists and planners etc. play active roles in responding to exogenous (supply) and endogenous (demand) factors and taking part in the general progress of science and technology. Consequently, the model defines technical change as "... any change in production coefficients resulting from the purposeful resource-using activity directed to the development of new knowledge embodied in designs, materials and organizations"(FAO, 2000).

The induced innovation school points at the importance of the economically scarce factor for directing innovation processes. It makes clear that innovation processes have to be seen in their specific social and economic context. Innovations have to be economically feasible and reward the user with an economic advantage. Economics have to be seen as a cornerstone of development and innovation processes. However, the tradition also has its limitations. In subsistence agriculture, many decisions cannot be determined in monetary terms. Hence, farmers do not always behave according to economic rationality and environmental factors all too often remain unconsidered.

### 2.4.6 Networks Model Theory

A third, recent school of thought, (Engel, 1995) labels "the network tradition". Analyzing innovation processes in larger industries, (Moss-Kanter, 1989) looks at types of co-operations between companies. Pooling, allying and linking (PAL) between companies, is recognized as an important strategy to generate innovation and improve competitiveness. This can also be observed in agriculture, where networking is becoming very popular in recent years. Many organizations are active around the globe trying to exchange information and cooperate in various fields. Engel, (1995), describes the essence of the network tradition as follows:

“It concentrates upon all social interactions relevant to agricultural innovation at a particular point in time within a specific social, economic and ecological context. It assumes that in any given situation a multiplicity of social actors develop and manage interactive relationships in order to improve their practices and develop new ones. The reason that these actors engage in such relationships is perceived interdependence: each is perceived as holding some of the keys to the others‘projects. “

Networks, thus, build on the different specialized skills that result from the division of labour in agriculture and surrounding sectors. A concept on how these network relations function is proposed by (Gremmen, 1993), with his ’interplay model‘: practices evolve autonomously in interaction of different social actors. Each can be seen as a competent performance, constraint only by its own defining and rules that emerge by experience. These rules are subject to continued revision by social interaction of the participants in a practice. Knowing as an activity rather than knowledge is crucial. “The central claim of the interplay model is that improvement is primarily an internal achievement of practices themselves. External influences can speed up or slow down the indigenous improvements of a practice“ (Gremmen, 1993). Open inter-action between practices must be seen as an external influence on practices. These influences are generally not directed only one-way. In this sense innovation in practices is a result of interaction in practices and not to be seen as a discovery process of only one practice such as science. “Science is often, and mistakenly, seen as the ideal way of advancing knowledge“. In the contrary different practices such as science and technology may be seen as “enmeshed in a symbiotic relationship ... science as one context of inventive activity“(Gremmen, 1993, 116 and 140).

### 2.4.7 General systems theory

According to Walonick (1993), the General Systems Theory was proposed by Ludwig von Bertalanffy, a Hungarian biologist who was interested in the interconnectedness that exists between humanity & the physical environment in 1928. A system's input is defined as the movement of information or matter-energy from the environment into the system. Output is the movement of information or matter-energy from the system to the environment. Both input and output involve crossing the boundaries that define the system. The information content of a "piece of information" is proportional to the amount of information that can be inferred from the information - ***The whole is more than the sum of its parts "Aristotle."***

Walonick model stresses that the role of decision is to move a system towards equilibrium. Communication and transaction provide the vehicle for a system to achieve equilibrium. "Culture is communicated, learned patterns and society is a collectively of people having a common body and process of culture. A subculture can be defined only relative to the current focus of attention. When society is viewed as a system, culture is seen as a pattern in the system. Social analysis is the study of "communicated, learned patterns common to relatively large groups of people (Bertalanffy, 1928)

This General systems Theory illustrates how diffusion of innovation in a given social set up is affected by barriers such as culture, education level, mode of communication and the benefits of the new technology. The agricultural knowledge and communication systems (AKIS) used for adoption of grain amaranth can be affected by these factors as illustrated by General Systems Theory. The aim of the study was to0 assess how these factors impact on the adoption of grain amaranth by smallholder farmers.

## 2.5 Conceptual Framework

Conceptual framework is graphical or narrative representation of the main dimensions to be studied and presumed relationship among them. To analyse Agricultural Knowledge and Information System impact on farm productivity the study adopted the awareness-knowledge-adoption-productivity (AKAP) framework. The framework visualizes Research and Extension as achieving their ultimate economic impact by providing information and educational or training services to induce the following sequence: farmer awareness; farmer knowledge, through testing and experimenting; farmer adoption of technology or practices; and changes in farmers' productivity. It assumes that changes in farmer behaviour will be reflected in information transformation, quantities of goods produced, the quantities of inputs used, and in their prices. These, in turn, can be measured as "economic surplus," which is the added value of goods produced from a given set of inputs made possible by the extension activities. While this sequence has a natural ordering, it is clear that real resources in the form of skills and activities by both extension staff and farmers are required to move along the sequence. Whereas awareness is not knowledge, knowledge requires awareness, experience, observation, and the critical ability to evaluate data and evidence.

The study viewed information and knowledge as leading to adoption, hence increased productivity (FAO 2000). The study also assessed the socio-economic factors affecting the use of AKIS tools for adoption of grain amaranth. The use of mobile, radio, extension agents and researchers by smallholder grain amaranth farmers was evaluated and rated.

By appealing to holism, as a multifaceted experience, the use of information covers the user's behaviour, connecting (to the information source), searching for information, information skills, utilizing information, information literacy, information needs, context, reactions and effects, as well as results (of learning). Both information and knowledge are representations of reality, but information is located outside one's mind (e.g., text in a book), and knowledge is located inside one's mind (e.g., a memory of the aforementioned text). In other words, knowledge is what a person knows, whereas information can be either raw material for knowledge, or externalized knowledge (Kari, 2010).

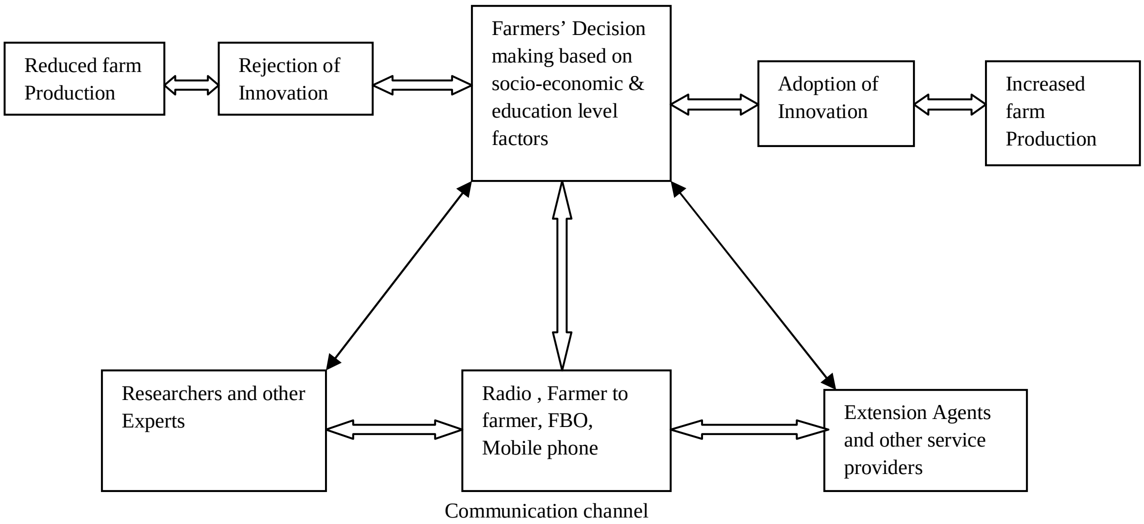



Figure 11: Conceptual Framework on Agricultural Knowledge and Information Systems

Source: Own conceptualization

From the study, farmer to farmer communication and communication between the farmers and faith based organizations (FBOs) are effective in influencing grain amaranth farmers make decision in growing grain amaranth. Farmers use radios in getting information on innovations. Farmers use mobiles conducting extension agents and researchers to get information on grain amaranth. Innovation originates from researchers, extension agents and other service providers. The technology or information is transferred to the farmer, through communication channel (ICT), who in turn makes a decision on to whether use the information or not. The outcome could be adoption of improved farming methods or increased income from the information obtained or rejection of the innovation. The farmer may decide to continue using the information/technology or discontinue, and gives feedback to the source using appropriate ICT channel

# CHAPTER THREE

## 3.0 STUDY METHOD

### 3.1 Study Area

The study was carried out in Lugari Sub-County, Kakamega County of former Western Province. The Sub-County has administratively 3 Divisions namely: Lugari, Matete and Likuyani. It has 10 locations and 28 Sub-locations. The Sub-County has an area of 669 $km^2$, population of 292,151, 59,476 households and population density of 399 people per $km^2$ (GoK, 2011). The Sub-County is bordered to the North by Trans-Nzoia,Bungoma to the West, Kakamega North to the South and Uasin Gishu to the East respectively.). It lies in the geographical coordinates of Longitude 0025'N – 0055'N and Latitude 340 40'E – 35010'E. Soils are predominantly clay loam.  Lugari is the grain basket of Kakamega county with annual maize harvest of about 2 million bags. The main cash crops include sugar cane and coffee (*coffee Arabica)*. The common food crops include maize (*zea may),* common beans (*phaseolus vulgarii*), potatoes (*solanum, tuberosum).* Vegetables include kales (*brassica spp*), cabbage (*Brassica,spp*) (GoK, 2011).

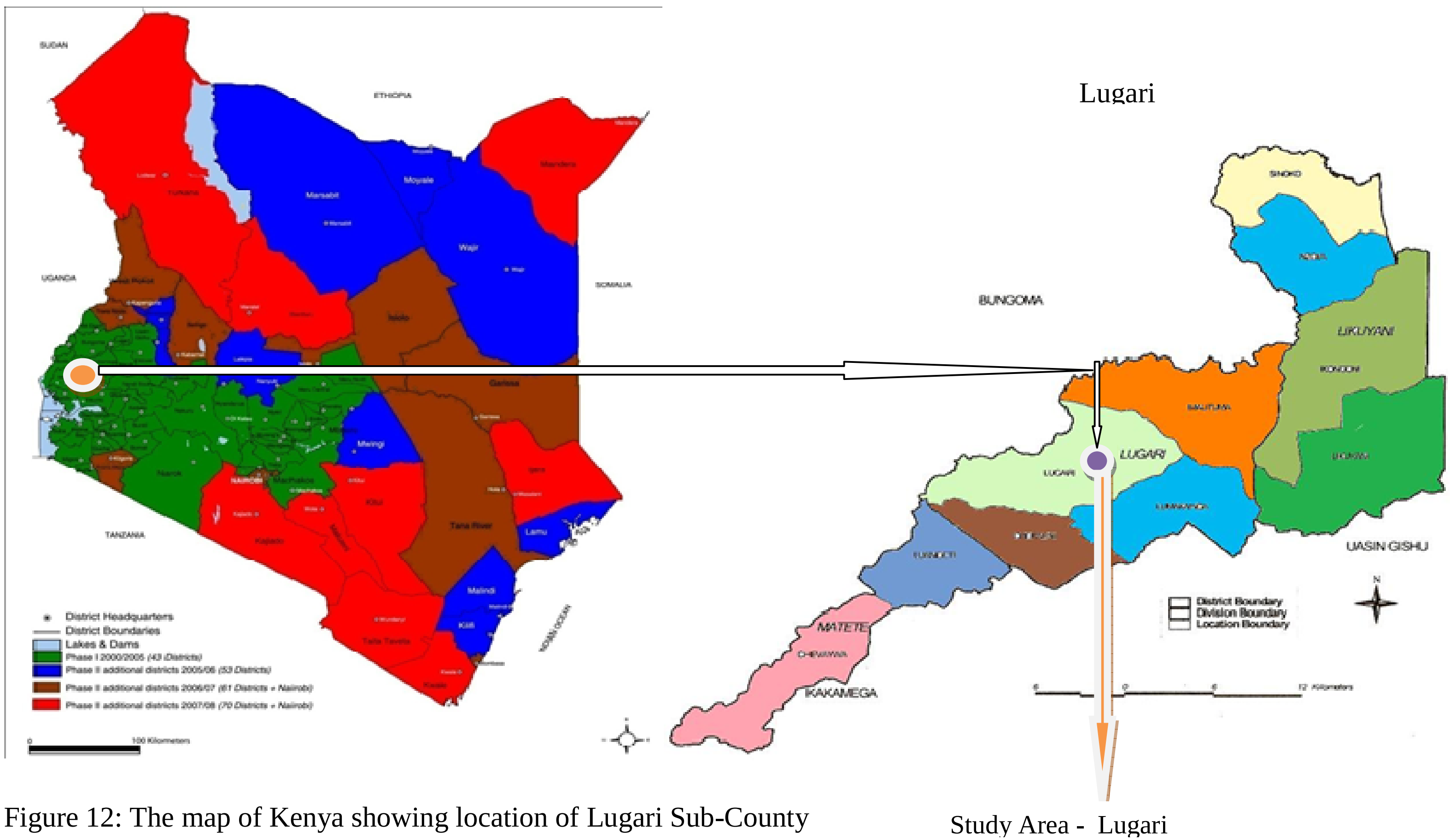



Figure 12: The map of Kenya showing location of Lugari Sub-County

Source: GOK (2008)

## 3.2 Study Design

Survey design was used for the study across the population. Individual grain amaranth farmers and groups were interviewed using questionnaires about the use of AKIS tools such as mobile phones, radios, researchers and extension agents and the factors inhibiting their use. The study also established whether adoption of grain amaranth was due to use of AKIS tools such as mobile phones, radios, researchers, farmer to farmer and extension agents.

## 3.3 Sampling Procedure

### 3.3.1 Sampling method

Individual small scale farmers involved in Grain Amaranth production were chosen for the study. in Lugari sub-location of Lugari Sub County. The sub-location has a total of nine (9) villages with a total of 353 grain amaranth farmers (GoK, 2012) as shown in the table below:

Table 2: Grain amaranth farmers in Lugari Sub-Location

| **No** | **Village** | **No of farmers** |
|---|---|---|
| 1 | Maji Mazuri | 52 |
| 2 | Lugari Center | 39 |
| 3 | Mufutu | 35 |
| 4 | Sirende | 34 |
| 5 | Kiwanja Ndege | 35 |
| 6 | Lugari station | 38 |
| 7 | Mufunje | 42 |
| 8 | Lumama | 39 |
| 9 | Murram | 39 |
| | **Total** | **353** |

Source: GoK, (2012)

Purposive sampling was used to select five villages with a total of 200 grain amaranth smallholder farmers. These five villages had formed cereal banking group for marketing of grains in the five villages (GoK, 2012). This cereal banking group had organized the grain amaranth farmers in the five villages for the purpose of marketing the grain. These five villages with 200 grain amaranth farmers formed sampling frame. The unit of analysis was individual small-scale Grain Amaranth farmer

### 3.3.2 Sample size

According to Fishers et al., (1991), the required sample size (n), can be calculated using the formula: $n = \frac{Z^2 \alpha/2 \, p \, Q}{L^2}$,

Where:
Q = 1-p
$Z\alpha/2$ = Confidence level at 95% (standard value of 1.96)
p = Estimated prevalence at 50 %( Proportion)
L = Level of precision at 5% (standard value of 0.05).

$$n = \frac{1.96^2 \times 0.5 \times (1-0.5)}{(0.05)^2} = 384.16$$

Using a finite study population of 200 from the five villages, correction factor is used. The actual sample size is calculated as follows:

$$n = \frac{1}{1/n + 1/N}$$ which is the reciprocal of 1/n + 1/N

Where:
n is the actual sample size
N is the study population = 200

Therefore actual sample size (n) = $\frac{1}{(1/384) + (1/200)} = 131$

Therefore my study sample size was 131 grain amaranth smallholder farmers in Lugari Sub-location.

Table 3: sampled number of farmers from five villages

| No | Village | No of farmers | No of farmers sampled per village |
|---|---|---|---|
| 1 | Maji Mazuri | 52 | 52/200x131= 34.06= 34 |
| 2 | Lugari Center | 39 | 39/200x131= 25.55=26 |
| 3 | Mufutu | 35 | 35/200x131= 22.93=23 |
| 4 | Kiwanja Ndege | 35 | 35/200x131= 22.93=23 |
| 5 | Murram | 39 | 39/200x131= 25.55=25 |
| | **Total** | **200** | **131** |

Source: Author's field survey data 2012

**Systematic Sampling**

Systematic sampling was used to get the sample from the sampling frame of 200. Thus, the simplest fraction is 131/200x100 (65.5%), leading to 1 farmer sampled in every 2 farmers. Therefore 1 name was picked out of every 2nd name on the list. Thus alternately was every other name, then the immediate next name The first to be pick was either number 1 or number 2 on the list depending on the tossing of a coin where head =1 and tail =2.

**Using Systematic Sampling (Sampling Fraction) per village from table 3 above:**

- Village 1 – Maji Mazuri – 34/52=17/26=1/1.5=1/2 i.e. one smallholder grain amaranth farmer was picked out of every two in the population of 52 smallholder grain amaranth farmers.
- Village 2 – Lugari Centre – 26/39=2/3=1/1.5=1/2 i.e. e one smallholder grain amaranth farmer was selected out of every two in the population of 39 smallholder grain amaranth farmers.

- Village 3 – Mufutu – 23/35=1/1.5=1/2 i.e. one smallholder grain amaranth farmer was selected out every two in the population of 35 smallholder grain amaranth farmers.
- Village 4 - 23/35=1/1.5=1/2 i.e. one smallholder grain amaranth farmer was selected out every two in the population of 35 smallholder grain amaranth farmers.
- Village 5 - 25/39=1/1.6=1/2 i.e. e one smallholder grain amaranth farmer was selected out of every two in the population of 39 smallholder grain amaranth farmers.

## 3.4 Data gathering methods

Smallholder grain amaranth farmers' discussions were used to collect primary data through field interviews using questionnaires. Secondary data was collected from published and unpublished materials which included reports from government of Kenya (GoK) departments, non-governmental organizations (NGOs) faith based organizations (FBOs) and private sector.

Enumerators were people who understood the Lugari farming community. Five enumerators underwent training that enabled them to administer the questionnaires to respondents (figure 15 below).

Figure 13: Training of enumerators by Mr. Fwamba in DAO'S office

Pilot testing was carried out in Sirende village for 25 smallholder grain amaranth farmers. The pilot participants were representative of the target area AKIS awareness. The result from pilot area are not included in the survey but treated separately (Shadrach and Summers, 2002). After pre-testing, corrections were made on the questionnaires to suit the actual situation in the field as per enumerators' results. The actual data collection was then carried out with each enumerator taking a village. The data from completed questionnaires were entered into the computer for analysis of various statistical packages.

Figure 14: Enumerator interviewing a grain amaranth farmer


Figure 15: A farmer, Mr. Sammy Diego, explains to enumerator


Figure 16: Enumerator tries weighing and packing of amaranth flour for market

## 3.5 Data Analysis

### 3.5.1 Introduction

Data analysis and modeling through descriptive statistics and data visualization were guided by objectives of the study.

The respondents were asked which Agricultural Knowledge and Information System tools were accessible to them for the purpose of obtaining Grain Amaranth production and marketing information and responses were tabulated.

To evaluate whether use of Agricultural Knowledge and Information System tools had influence in adoption of Grain Amaranth, respondents were asked whether they got information on Grain Amaranth from Fellow-farmer, Faith based organizations, Researchers, extension agents or any other extension provider. Researchers, extension agents/other extension service providers and farmers are key elements in AKIS.

Farmers were evaluated on their opinion on the use of Agricultural Knowledge and Information System tools by asking them to state in their own opinion, the extent to which each of the listed Agricultural Knowledge and Information System tools has helped them get information and knowledge on Grain Amaranth production such as; 'to very great extent' 'to great extent' to little extent' and 'not at all." 4= very great extent, 3= great extent, 2=little extent, 1=Not at all.

In order to carry out data analysis, coding of questionnaire was done. Descriptive analysis using SPSS was done. With SPSS predictive analytics software, it was possible to predict with confidence what would happen to the rest of the population so that smarter decisions are made, problems are solved and improve outcomes are improved.

Quantitative analysis was done using STATA software. STATA is a general-purpose statistical software package with capabilities including data management, statistical analysis, graphics, simulations, and custom programming.

### 3.5.2 Regression Analysis

From the study the multiple regression model is of the form:

$Y = \alpha + \beta_1 X_1 + \beta_2 X_{2+} \ldots\ldots\ldots\ldots \beta_n X_n + \varepsilon$ equation 1

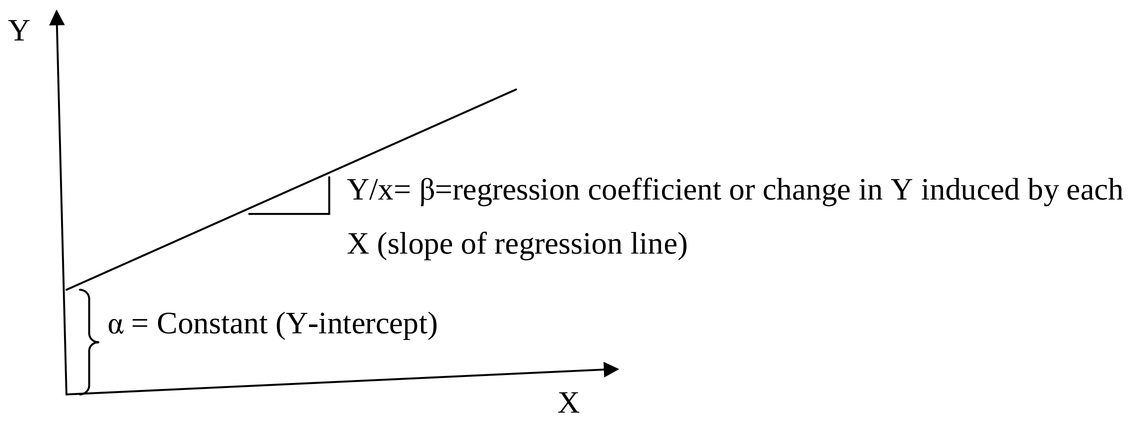
Where: Y – response or endogenous variable is dependent variable (adoption of grain amaranth production by smallholders using of AKIS tools)

$X_{1\text{-}n}$ - multiple predictor or exogenous variables are the independent variables (AKIS tools used)

$\alpha$ - is the constant (Y- intercept)

$\beta_{1\text{-}n}$ - are the regression coefficients or change induced in Y by each X (slope of regression line)

$\varepsilon$ – is the error (noise component that includes unobservable factors).



## 3.6 Definition of the variables

The variables in the study were: adoption as the dependent variable while AKIS tools (Radio, mobile, extension agent, researcher and farmer to farmer) and socio-economic factors (age, education, gender, occupation and income) were independent variables. The table 4 below summarizes the variables.

Table 4: Variable definitions

| **Variable** | **Definition** |
|---|---|
| **Adoption (dependent variable)** | Smallholder grain amaranth farmers who adopt to produce grain amaranth using AKIS tools. YES (1), NO (2) |
| Relationship to Head of Household | 01 – Head of Household. 02 – Wife/husband/partner. 03 – Son or daughter. 04 – Son-in-law or daughter-in-law |
| **AKIS tools used by grain amaranth farmers to get information on amaranth production (independent variable)** | |
| Radio | **Own** – 1 (Yes) 2 (No). **Able to access** – 1 (Yes) 2 (No). **Used for receiving information on grain amaranth** – 1 (Yes) 2 (No) |
| Mobile phone | **Own** – 1 (Yes) 2 (No). **Able to access** – 1 (Yes) 2 (No). **Used for receiving information on grain amaranth** – 1 (Yes) 2 (No) |
| Agricultural extension agent | **Able to access** – 1 (Yes) 2 (No). **Used for receiving information on grain amaranth** – 1 (Yes) 2 (No) |
| Researchers | **Able to access** – 1 (Yes) 2 (No). **Used for receiving information on grain amaranth** – 1 (Yes) 2 (No) |
| FBO/CBO/NGO | **Able to access** – 1 (Yes) 2 (No). **Used for receiving information on grain amaranth** – 1 (Yes) 2 (No) |
| Farmer to farmer | **Able to access** – 1 (Yes) 2 (No). **Used for receiving information on** |

| | |
|---|---|
| | **grain amaranth –** 1 (Yes) 2 (No) |
| Others (specify) | **Own –** 1 (Yes) 2 (No). **Able to access –** 1 (Yes) 2 (No). **Used for receiving information on grain amaranth –** 1 (Yes) 2 (No) |
| **AKIS tools' influence on adoption of grain amaranth (independent variables)** | |
| Radio | Information source (code A). Means of accessing information (code B) |
| Mobile phone | Information source (code A). Means of accessing information (code B) |
| Extension agent | Information source (code A). Means of accessing information (code B) |
| Researcher | Information source (code A). Means of accessing information (code B) |
| Farmer to farmer | Information source (code A). Means of accessing information (code B0 |
| **Socio-economic factors affecting use of AKIS tools (independent variables)** | |
| Gender (sex) | 1 – Male 2 – Female |
| Age | Completed years from date of birth |
| Occupation | 1 – Subsistence/mixed farmer. 2 Pastoralist. 3 Employed (formal). 4 Employed (informal). 5 Business ( commercial) |
| Marital status | 1 Married. 2 Single 3 Divorced. 4 Separated. 5 Widowed. |
| Education level | 1 Nursery/kindergarten. 2 Primary. 3 Post primary/vocational. 4 Secondary , A-level. College (middle). 5 University |
| Lack of money to buy AKIS tools | Very serious=3, Serious=2, Not serious=1 |
| Cost of batteries | Very serious=3, Serious=2, Not serious=1 |
| Lack of electricity | Very serious=3, Serious=2, Not serious=1 |
| Lack of money to buy | Very serious=3, Serious=2, Not serious=1 |

| | |
|---|---|
| air time | |
| Language used | Very serious=3, Serious=2, Not serious=1 |

In this study, regression analysis also yielded a statistic called coefficient of determination ( $R^2$ ). $R^2$ refers to the amount of variation explained by the independent variable or variables that were used in the study.

# CHAPTER FOUR

# 4.0 RESULTS AND DISCUSSION

## 4.1 Introduction

The chapter examines socio-economic characteristics of the respondents and the existing AKIS tools commonly used by grain amaranth farmers in Lugari Sub-County to seek and/or receive information on grain amaranth production. Socio-economic factors that influence farmers' use of these AKIS tools were analyzed and determined. Regression model was then used to test hypotheses that socio-economic factors like gender, education levels, occupation and age do not influence the use of AKIS tools in grain amaranth production and that use of AKIS tools has no influence on adoption of grain amaranth respectively.

## 4.2 Descriptive data results

### 4.2.1 Socio-economic characteristics of the Respondents

Descriptive analysis of the data collected showed that 87.8% of the respondents are married, 3.8% are single, 1.5% divorced and 6.1% widowed. 51.9% of the respondents interviewed had 3.7 hectares and 44.3% had 2 hectares of grain amaranth. 65.6% of respondents are engaged in subsistence/mixed farming while only 13% are in formal employment. The age range was between 20 and 75 years. Educational attainment of the respondent cut across all levels with the majority having completed primary (52.7%), secondary level (23.7%), and tertiary/college (9.9%) and only 2.3% had University education. 8.4% indicated that they did not attain any education. Only 13% are in formal employment with 65.6 being small scale farmers. The following tables ( table 5, table 6 and table 7) show farmers' responses on socio-economic characteristics:

Table 5: Farmers' response on household head, gender, marital status and age.

| Response | Frequency | Percentage | Statistics | | | |
|---|---|---|---|---|---|---|
| **Relationship to Head of Household** | | | **Mean** | **Mode** | **Std dev.** | **Variance** |
| Head | 109 | 82.9 | 1.13 | 1 | 0.998 | 0.975 |
| Wife/husband/partner | 13 | 10.2 | | | | |
| Others (son/daughter/parent/in-law/relative/brother/sister/farm manager) | 9 | 6.9 | | | | |
| **Gender** | | | | | | |
| Male | 112 | 85.5 | 1.15 | 1 | 0.353 | 0.125 |
| Female | 19 | 14.5 | | | | |
| **Marital status** | | | | | | |
| Married | 115 | 87.8 | 1.35 | 1 | 1.074 | 1.153 |
| Single | 5 | 3.8 | | | | |
| Widowed | 8 | 6.1 | | | | |
| Divorced | 2 | 1.5 | | | | |
| N/A | 1 | 0.8 | | | | |
| **Ages of Respondents in years** | | | | | | |
| 20-29 | 9 | 6.9 | 50.11 | 40 | 13.0 | 168.91 |
| 30-39 | 8 | 6.1 | | | | |
| 40-49 | 48 | 36.6 | | | | |

| | | |
|---|---|---|
| 50-59 | 39 | 29.8 |
| 60-69 | 17 | 13.0 |
| 70+ years | 10 | 7.6 |

Table 6: Farmers' responses to education, acreage and occupation

| Response | Frequency | Percentage | Statistics | | | |
|---|---|---|---|---|---|---|
| | | | Mean | Mode | Std dev. | Variance |
| **Education level** | | | | | | |
| None | 12 | 9.5 | 3.48 | 2 | 2.047 | 4.190 |
| Primary incomplete | 1 | 0.8 | | | | |
| Primary complete | 69 | 52.7 | | | | |
| Secondary complete | 32 | 24.7 | | | | |
| Tertiary/college | 14 | 10.0 | | | | |
| University | 3 | 2.3 | | | | |
| **Grain amaranth acreage (Acres)** | | | | | | |
| <2.5 | 58 | 44.3 | 1.72 | 1 | 1.1 | 1.14 |
| 3-4.5 | 68 | 51.9 | | | | |
| 5-10 | 1 | 0.8 | | | | |
| >10 | 1 | 0.8 | | | | |
| **Occupation** | | | | | | |
| Subsistence/mixed farmer=1 | 86 | 65.6 | 2.21 | 1 | 2.09 | 4.37 |
| Formal employment=3 | 17 | 13.0 | | | | |
| Informal employment=4 | 15 | 11.5 | | | | |
| Business=5 | 4 | 3.1 | | | | |
| Domestic worker=6 | 2 | 1.5 | | | | |
| Home maker/House wife=7 | 4 | 3.0 | | | | |

| | | |
|---|---|---|
| Other= 8 | 3 | 2.3 |

Table 7: Farmers response on income and distance to. get service

| Response | Frequency | Percentage | Statistics | | | |
|---|---|---|---|---|---|---|
| | | | Mean | Mode | Std dev | Variance |
| **Income** | | | | | | |
| **Off farm income** | | | | | | |
| Yes | 76 | 58.0 | 1.42 | 1 | 0.495 | 0.245 |
| No | 55 | 42.0 | | | | |
| **Income (Kshs)** | | | | | | |
| Income levels <5000 | 59 | 44.8 | 10,321 | 0 | 24338.8 | 592377736.6 |
| 5000<10,000 | 37 | 28.5 | | | | |
| >10,000 | 35 | 26.7 | | | | |
| **Distance to get service** | | | | | | |
| Distance to nearest agriculture office: <3km | 97 | 74.1 | N/A | N/A | N/A | N/A |
| 4 < 10 km | 20 | 15.4 | | | | |
| 10< 15 km | 14 | 10.5 | | | | |
| Distance to top up point for mobile phone: within 3km | 130 | 99.1 | N/A | N/A | N/A | N/A |
| 4km | 1 | 0.9 | N/A | N/A | N/A | N/A |
| Distance to the nearest internet service: Within 4km | 10 | 7.7 | N/A | N/A | N/A | N/A |
| With modem/internet-enabled phone | 3 | 2.6 | N/A | N/A | N/A | N/A |
| Between 10-40km | 115 | 87.7 | N/A | N/A | N/A | N/A |
| **Nearest electricity charging** | | | | | | |

| point | | | | | | |
|---|---|---|---|---|---|---|
| With power at home | 76 | 57.8 | N/A | N/A | N/A | N/A |
| Within 3km | 55 | 42.2 | N/A | N/A | N/A | N/A |

### 4.2.2 AKIS tools used for information in grain amaranth production

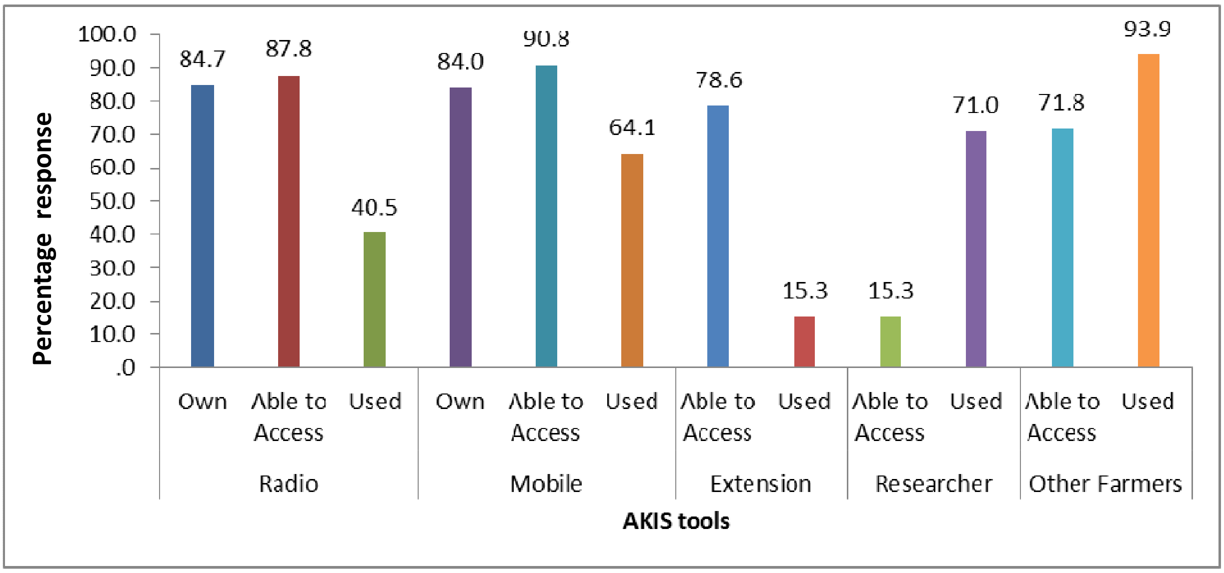



Figure 17: AKIS tools used for information in grain amaranth production.

Figure 19, above shows various AKIS tools available to smallholder grain amaranth, the degree of ownership, accessibility and use. The results show that majority of the respondents interviewed own Radio and mobile phone at 84.7% and 84.0% respectively. All the respondents accessed radio (87.8%), mobile phone (90.8%), agricultural extension (78.6%), researchers (71.0%) and other farmers (71.8%. The results indicate that 40.5% of respondents use radio, 64.1% use mobile, 15.3% use agricultural extension, 15.0% use researchers and 93.9% use other farmers as a source of information on production or/and marketing of their grain amaranth. This study confirms Kiplang'at and Ocholla (2005), Farooq *et al* (2007) and Ovwigho *et al* (2009) findings that mobile phones and other farmers were used widely by smallholders in getting information for agricultural production. The most common FM Radio stations broadcasting agricultural programmes in the local language include *Mulembe FM* and *West FM.* Radio, and mobile phones are commonly used probably due their affordability, availability, portability and durability.

Agricultural extension is supposed to be the main source of information to smallholders on agricultural technical matters but as the results show farmers believe in getting information from their fellow farmers more than any other source ( Ocholla, 2005).

### 4.2.3 AKIS tools' influence on grain amaranth adoption

Table 8: Information source and accessing it on new varieties of grain amaranth

| Type of information on grain amaranth | Information source/ means of accessing it | AKIS tools | Frequency. | Percentage |
|---|---|---|---|---|
| New varieties of grain amaranth | | | | |
| | **Information Source** | Agricultural Extension Officer | 46 | 33.1 |
| | | CBO | 15 | 11.8 |
| | | NGO Staff | 1 | .8 |
| | | Neighbor/Fellow Farmer | 54 | 42.5 |
| | | Agrochemical Dealer | 0 | .0 |
| | | Research Institution | 0 | .0 |
| | | FBO | 15 | 11.8 |
| | | **Total** | **131** | **100** |
| | **Means of accessing information** | Visit Agricultural Office | 46 | 35.9 |
| | | Visit by extension office | 21 | 16.4 |
| | | Neighbor/Fellow Farmer | 49 | 38.3 |
| | | Radio | 2 | 1.6 |
| | | Mobile Phone (Voice) | 12 | 7.0 |
| | | Mobile Phone (SMS) | 1 | .8 |
| | | **Total** | **131** | **100** |

Table 9: Time factor of accessing information on grain amaranth

| Type of information on grain amaranth | Information source/ means of accessing it | AKIS tools | Frequency. | Percentage |
|---|---|---|---|---|
| Time | **Information Source** | | | |
| | | Agricultural Extension Officer | 42 | 33.3 |
| | | CBO | 14 | 7.7 |
| | | NGO Staff | 1 | .8 |
| | | Neighbor/Fellow Farmer | 2 | 1.6 |
| | | Agrochemical Dealer | 54 | 42.9 |
| | | Research Institution | 0 | .0 |
| | | FBO | 18 | 13.7 |
| | | **Total** | **131** | **100** |
| | **Means of accessing information** | Visit Agricultural Office | 43 | 33.9 |
| | | Visit by extension office | 18 | 14.2 |
| | | Neighbor/Fellow Farmer | 54 | 42.5 |
| | | Radio | 3 | 1.5 |
| | | Mobile Phone (Voice) | 4 | 2.4 |

| | | | | |
|---|---|---|---|---|
| | | Mobile Phone (SMS) | 9 | 5.5 |
| | | **Total** | **131** | **100** |

Table 10: Grain amaranth value addition information

| Type of information on grain amaranth | Information source/ means of accessing it | AKIS tools | Frequency. | Percentage |
|---|---|---|---|---|
| Value Addition | **Information Source** | **Agricultural Extension Officer** | **74** | **57.0** |
| | | CBO | 4 | 3.1 |
| | | NGO Staff | 1 | .8 |
| | | Private Company | 4 | 3.1 |
| | | Neighbor/Fellow Farmer | 35 | 26.6 |
| | | Agrochemical Dealer | 0 | .0 |
| | | Research Institution | 0 | .0 |
| | | FBO | 13 | 9.4 |
| | | **Total** | **131** | **100** |
| | **Means of accessing information** | Visit Agricultural Office | 55 | 42.6 |
| | | Visit by extension office | 14 | 10.9 |
| | | Neighbor/Fellow Farmer | 38 | 29.5 |
| | | Radio | 7 | 4.6 |

| | | | | |
|---|---|---|---|---|
| | | Mobile Phone (Voice) | 14 | 10.9 |
| | | Mobile Phone (SMS) | 3 | 1.5 |
| | | **Total** | **131** | **100** |

Table 11: Grain amaranth utilization information

| Type of information on grain amaranth | Information source/ means of accessing it | AKIS tools | Frequency. | Percentage |
|---|---|---|---|---|
| Utilization | **Information Source** | Agricultural Extension Officer | 78 | 59.5 |
| | | CBO | 8 | 6.3 |
| | | NGO Staff | 0 | .0 |
| | | Neighbor/Fellow Farmer | 6 | 4.6 |
| | | Agrochemical Dealer | 32 | 25.2 |
| | | Research Institution | 0 | .0 |
| | | FBO | 7 | 5.3 |
| | | **Total** | **131** | **100** |
| | **Means of accessing information** | Visit Agricultural Office | 56 | 41.5 |
| | | Visit by extension office | 13 | 10.2 |
| | | Neighbor/Fellow Farmer | 36 | 28.1 |
| | | Radio | 9 | 7.0 |
| | | Mobile Phone (Voice) | 14 | 10.9 |

| | | | | |
|---|---|---|---|---|
| | | Mobile Phone (SMS) | 3 | 2.3 |
| | | **Total** | **131** | **100** |

Table 12: Grain amaranth marketing information

| Type of information on grain amaranth | Information source/ means of accessing it | AKIS tools | Frequency. | Percentage |
|---|---|---|---|---|
| **Marketing** | **Information Source** | Agricultural Extension Officer | 42 | 33.0 |
| | | CBO | 19 | 13.0 |
| | | NGO Staff | 1 | .8 |
| | | Neighbor/Fellow Farmer | 7 | 5.1 |
| | | Agrochemical Dealer | 47 | 37.0 |
| | | Research Institution | 0 | .0 |
| | | FBO | 15 | 11.1 |
| | | **Total** | **131** | **100** |
| | **Means of accessing information** | Visit Agricultural Office | 37 | 28.9 |
| | | Visit by extension office | 28 | 19.6 |
| | | Neighbor/Fellow Farmer | 46 | 35.9 |
| | | Radio | 8 | 6.3 |
| | | | | |
| | | Mobile Phone (Voice) | 9 | 7.0 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| | | Mobile Phone (SMS) | 3 | 2.3 |
| | | **Total** | **131** | **100** |

Table 13: Grain amaranth prevailing market prices information

| Type of information on grain amaranth | Information source/ means of accessing it | AKIS tools | Frequency. | Percentage |
|---|---|---|---|---|
| **Prevailing Market Prices** | **Information Source** | Agricultural Extension Officer | 39 | 30.7 |
| | | CBO | 18 | 14.2 |
| | | NGO Staff | 2 | 1.2 |
| | | Neighbor/Fellow Farmer | 6 | 4.7 |
| | | Agrochemical Dealer | 50 | 39.2 |
| | | Research Institution | 0 | .0 |
| | | FBO | 16 | 10.0 |
| | | **Total** | **131** | **100** |
| | **Means of accessing information** | Visit Agricultural Office | 41 | 29.5 |
| | | Visit by extension office | 26 | 20.2 |
| | | Neighbor/Fellow Farmer | 48 | 37.2 |
| | | Radio | 7 | 5.8 |

| | | | | |
|---|---|---|---|---|
| | | Mobile Phone (Voice) | 7 | 5.7 |
| | | Mobile Phone (SMS) | 2 | 1.6 |
| | | **Total** | **131** | **100** |

Table 14: Grain amaranth Gross margin analysis information

| Type of information on grain amaranth | Information source/ means of accessing it | AKIS tools | Frequency. | Percentage |
|---|---|---|---|---|
| **Profit (Gross margin analysis)** | **Information Source** | Agricultural Extension Officer | 88 | 67.2 |
| | | CBO | 7 | 5.5 |
| | | NGO Staff | 0 | .0 |
| | | Neighbor/Fellow Farmer | 4 | 2.1 |
| | | Agrochemical Dealer | 31 | 24.4 |
| | | Research Institution | 0 | .0 |
| | | FBO | 1 | .8 |
| | | **Total** | **131** | **100** |
| | **Means of accessing information** | Visit Agricultural Office | 59 | 44.1 |
| | | Visit by extension office | 14 | 10.9 |
| | | Neighbor/Fellow Farmer | 33 | 25.6 |
| | | Radio | 9 | 7.0 |

| | | | |
|---|---|---|---|
| | Mobile Phone (Voice) | 5 | 3.9 |
| | Mobile Phone (SMS) | 11 | 8.5 |
| | **Total** | **131** | **100** |

From tables 8, 9, 10, 11, 12, 13 and 14, the respondents confirmed that information sources and means of accessing the information are very important in adoption of grain amaranth. They indicated that they get technical advice from extension agents i.e. new seed varieties 46%, time of planting 33.3%, value addition 57%, utilization, 59.5%, marketing 28.9% and gross margin analysis 44.1%. Any other information comes from fellow farmers, mobile phones, radios and faith based organizations. This study showed that AKIS tools play a key role adoption of grain amaranth production.

### 4.2.4 Buyers of grain amaranth from farmers

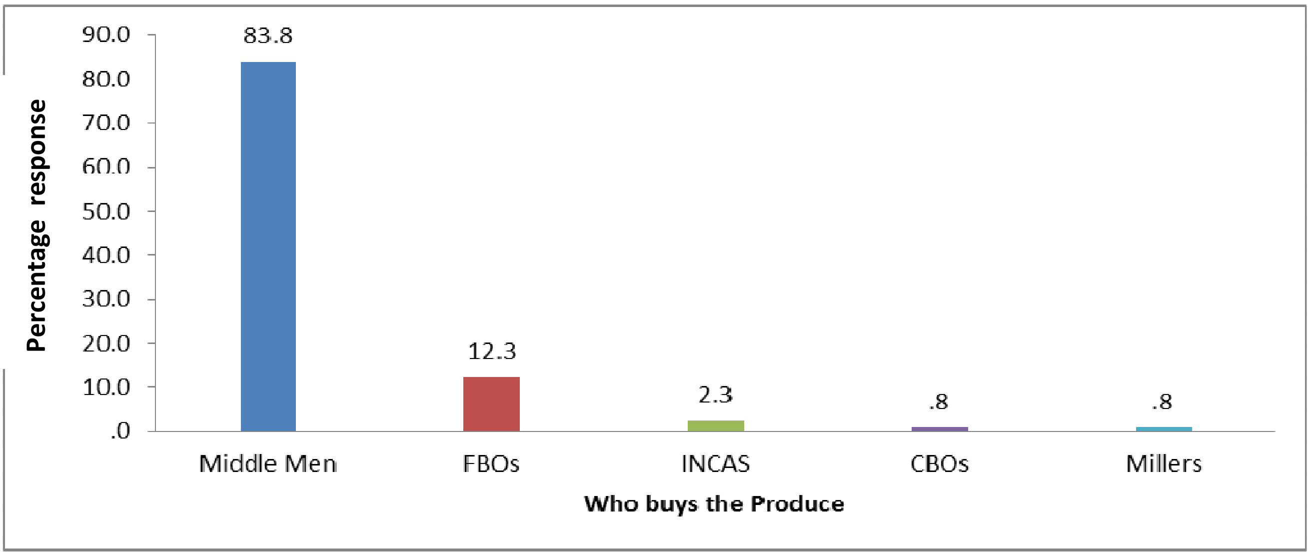



Figure 18: The buyers of grain amaranth from farmers

From figure 18 above, farmers are exploited by middle men when selling their produce. 83.8% goes to middle men and only 0.8 goes to millers, the rest goes to INCAS, FBOs and CBOs.

### 4.2.5 Mode transport for grain amaranth

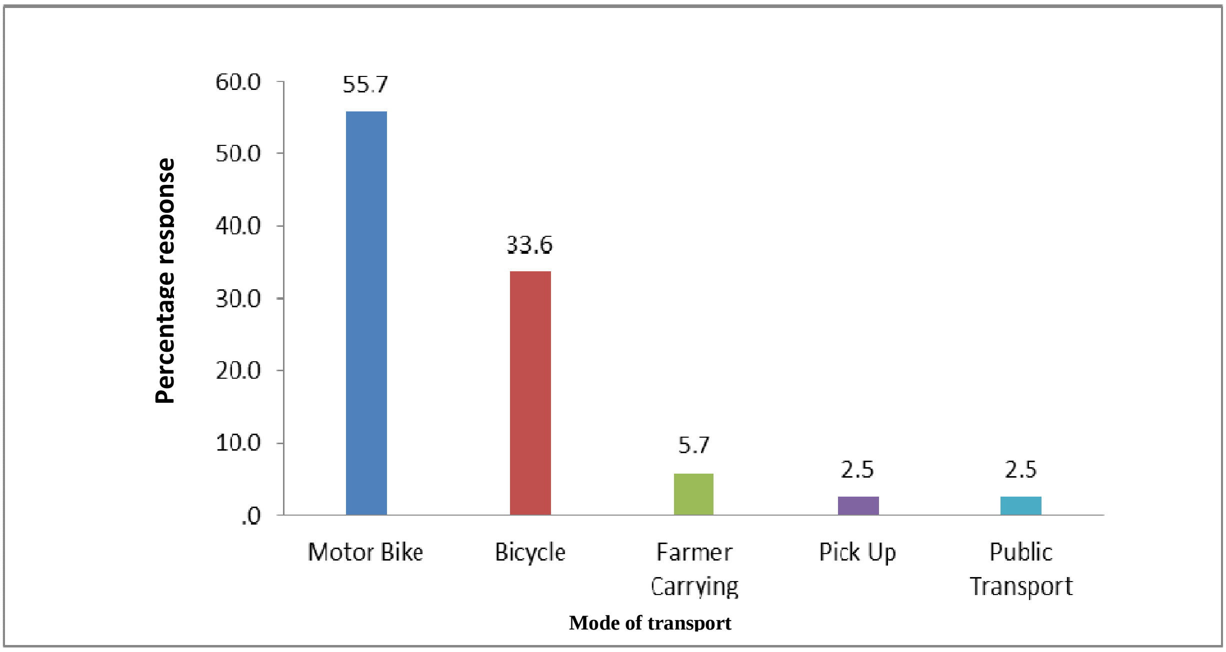



Figure 19: Mode of Transport for grain amaranth and other farm produce

From figure 19 above, motor cycles have revolutionized transport in the rural set up and are used up to 55.7%. Bicycle is at 33.6%, and the farmer's own carrying being 5.7%, and public transport noted at 2.5%

### 4.2.6 The extent to which AKIS tools help farmers in adoption.

Table 15: AKIS tools influence on grain amaranth adoption

| AKIS tool | Assistance extend | Frequency. | Percentage |
|---|---|---|---|
| Radio | Not at all | 92 | 70.2% |
| | little extend | 23 | 17.6% |
| | great extend | 16 | 12.2% |
| | very great extent | 0 | .0% |
| | **Total** | **131** | **100.0** |
| Mobile | Not at all | 42 | 32.1% |
| | little extend | 47 | 35.9% |
| | great extend | 36 | 27.5% |
| | very great extent | 6 | 4.5% |
| | **Total** | **131** | **100.0** |
| Agriculture Extension Officer | Not at all | 40 | 30.5% |
| | little extend | 45 | 34.4% |
| | great extend | 22 | 16.8% |
| | very great extent | 24 | 18.3% |
| | **Total** | **131** | **100.0** |
| Researchers | Not at all | 101 | 77.1% |
| | little extend | 27 | 20.6% |
| | great extend | 3 | 2.3% |
| | very great extent | 0 | .0% |
| | **Total** | **131** | **100.0** |
| Fellow Farmers | Not at all | 14 | 10.6% |
| | little extend | 8 | 6.1% |
| | great extend | 34 | 26.0% |
| | very great extent | 75 | 57.3% |
| | **Total** | **131** | **100.0** |
| Other | Not at all | 99 | 75.3% |
| | little extend | 3 | 2.3% |
| | great extend | 15 | 12.5% |
| | very great extent | 13 | 9.9% |
| | **Total** | **131** | **100.0** |

### 4.2.7 Factors influencing respondents' use of AKIS tools

Table 16: Lack of money, battery cost and lack of electricity influence on AKIS use

| Constraints | AKIS tools | Influence | Frequency. | Percent |
|---|---|---|---|---|
| Lack of Money to buy the tools | **Radio** | Not Serious | 113 | 86.3 |
| | | Serious | 10 | 7.6 |
| | | Very Serious | 8 | 6.1 |
| | **Mobile** | Not Serious | 100 | 76.3 |
| | | Serious | 19 | 14.5 |
| | | Very Serious | 12 | 9.2 |
| | **Other** | Not Serious | 8 | 57.2 |
| | | Serious | 3 | 21.4 |
| | | Very Serious | 3 | 21.4 |
| Cost of Batteries | **Radio** | Not Serious | 91 | 69.5 |
| | | Serious | 26 | 19.8 |
| | | Very Serious | 14 | 10.7 |
| | **Mobile** | Not serious | 1 | .8 |
| | | Serious | 68 | 51.9 |
| | | Very serious | 62 | 47.3 |
| | **Other** | Not serious | 8 | 47.1 |
| | | Serious | 5 | 29.4 |
| | | Very Serious | 4 | 23.5 |
| Lack of electricity | **Radio** | Not Serious | 74 | 56.5 |
| | | Serious | 35 | 26.7 |
| | | Very Serious | 22 | 16.8 |
| | **Mobile** | Not Serious | 75 | 57.3 |
| | | Serious | 35 | 26.7 |
| | | Very Serious | 21 | 16.0 |
| | **Other** | Not Serious | 56 | 93.3 |
| | | Serious | 1 | 1.7 |
| | | Very Serious | 3 | 5.0 |
| Lack of money to buy airtime | **Mobile** | Not Serious | 99 | 75.6 |
| | | Serious | 1 | .7 |
| | | Very Serious | 31 | 23.7 |
| | **Radio** | Not Serious | 89 | 67.9 |
| | | Serious | 1 | .7 |

Table 17: Irrelevant content, wrong program time and language influence AKIS tools use

| Constraints | AKIS tools | Influence | Frequency. | Percent |
|---|---|---|---|---|
| Irrelevant content | | Very serious | 41 | 31.4 |
| | **Mobile** | Not Serious | 124 | 94.7 |
| | | Serious | 3 | 2.3 |
| | | Very Serious | 4 | 3.0 |
| | **Researchers** | Not Serious | 127 | 97.0 |
| | | Serious | 2 | 1.5 |
| | | Very Serious | 2 | 1.5 |
| Wrong time of the programme | **Extension Officers** | Not Serious | 106 | 80.9 |
| | | Serious | 0 | .0 |
| | | Very Serious | 25 | 19.1 |
| | **Radio** | Not Serious | 111 | 84.7 |
| | | Serious | 13 | 9.9 |
| | | Very Serious | 7 | 5.4 |
| | **Mobile** | Not Serious | 122 | 93.1 |
| | | Serious | 4 | 3.1 |
| | | Very Serious | 5 | 3.8 |
| Language used | **Researchers** | Not Serious | 128 | 97.7 |
| | | Serious | 3 | 2.3 |
| | | Very Serious | 0 | .0 |
| | **Extension Officers** | Not Serious | 123 | 93.9 |
| | | Serious | 1 | .8 |
| | | Very Serious | 7 | 5.3 |
| | **Radio** | Not Serious | 129 | 98.4 |
| | | Serious | 1 | .8 |
| | | Very Serious | 1 | .8 |
| | **Mobile** | Not Serious | 126 | 96.2 |
| | | Serious | 2 | 1.5 |
| | | Very Serious | 3 | 2.3 |
| | **Researchers** | Not Serious | 117 | 89.3 |
| | | Serious | 12 | 9.2 |
| | | Very Serious | 2 | 1.5 |

Table 18: Education level influence on use of AKIS tools

| Constraints | AKIS tools | Influence | Frequency. | Percent |
|---|---|---|---|---|
| | | Serious | 13 | 10.0 |
| | **Extension Officers** | Not Serious | 116 | 88.5 |
| | | | | |
| | | Very Serious | 2 | 1.5 |
| Low level of education | **Radio** | Not Serious | 118 | 90.1 |
| | | Serious | 10 | 7.6 |
| | | Very Serious | 3 | 2.3 |
| | **Mobile** | Not Serious | 115 | 87.8 |
| | | Serious | 13 | 9.9 |
| | | Very Serious | 3 | 2.3 |
| | **Researchers** | Not Serious | 78 | 59.4 |
| | | Serious | 14 | 10.9 |
| | | Very Serious | 39 | 29.7 |
| | **Extension Officers** | Not Serious | 78 | 59.5 |
| | | Serious | 7 | 5.4 |
| | | Very Serious | 46 | 35.1 |
| Summary: Influence of AKIS tools | | Not at ALL | 9 | 6.9 |
| | | Little extend | 16 | 12.2 |
| | | Great Extend | 38 | 29.0 |
| | | Very great extend | 68 | 51.9 |

From tables 15, 16, 17 and 18, summary on influence of use of AKIS tools shows that 6.9% of the respondents are not influenced by AKIS tools in adoption, 12.2% are influenced to a little extend, 29% are influenced to a great extend and 51.9% are influenced to very great extend. The results show clearly that AKIS tools have influence on adoption of grain amaranth production. Low level of education influences the language used in rural set up.

These results confirm objective two on the influence of AKIS tools' use by farmers in accessing information for grain amaranth adoption.

## 4.3 To test significance of AKIS tools on grain amaranth adoption

Table 19: To test significance of owning, accessibility and use of AKIS tools on adoption

| | | Methods to Improve Yields | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Chemical Fertilizer** | | **Organic Fertilizer** | | **Pesticide** | | **Traditional Methods** | | |
| **AKIAS Tools** | **Possession** | **Frequency** | **Percent** | **Frequency** | **Percent** | **Frequency** | **Percent** | **Frequency** | **Percent** | **p value** |
| **Radio** | Own | 21 | 95.5 | 95 | 84.8 | 40 | 90.9 | 18 | 85.7 | 0.471 |
| | Able to access | 21 | 95.5 | 98 | 87.5 | 39 | 88.6 | 19 | 90.5 | 0.744 |
| | Use | 9 | 40.9 | 44 | 39.3 | 28 | 63.6 | 5 | 23.8 | ***0.009*** |
| **Mobile** | Own | 21 | 95.5 | 96 | 85.7 | 36 | 81.8 | 14 | 66.7 | 0.065 |
| | Able to access | 21 | 95.5 | 103 | 92.0 | 43 | 97.7 | 20 | 95.2 | 0.565 |
| | Use | 13 | 59.1 | 78 | 69.6 | 40 | 90.9 | 17 | 81.0 | ***<0.001*** |
| **Agricultural Extension** | Able to access | 20 | 90.9 | 89 | 79.5 | 35 | 79.5 | 18 | 85.7 | 0.657 |
| | Use | 14 | 63.6 | 69 | 61.6 | 32 | 72.7 | 15 | 71.4 | 0.341 |
| **Researchers** | Able to access | 3 | 13.6 | 15 | 13.4 | 3 | 6.8 | 6 | 28.6 | 0.245 |
| | Use | 4 | 18.2 | 15 | 13.4 | 3 | 6.8 | 4 | 19.0 | 0.354 |
| **FBO/CBO/NGO** | Able to access | 9 | 40.9 | 50 | 44.6 | 29 | 65.9 | 15 | 71.4 | ***0.002*** |
| | Use | 16 | 72.7 | 81 | 72.3 | 30 | 68.2 | 14 | 66.7 | 0.235 |

Table 20: To test significance of AKIS tools as source of information

| | | Methods to Improve Yields | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Message** | AKIS tools | **Chemical Fertilizer** | | **Organic Fertilizer** | | **Pesticide** | | **Traditional Methods** | | |
| | | **Freq.** | **%** | **Freq.** | **%** | **Freq.** | **%** | **Freq.** | **%** | **P value** |
| **New varieties Source of Information** | Agricultural Extension Officer | 5 | 22.7 | 41 | 36.9 | 27 | 61.4 | 7 | 33.3 | |
| | CBO | 3 | 13.6 | 12 | 10.8 | 2 | 4.5 | 2 | 9.5 | |
| | NGO Staff | 0 | .0 | 1 | .9 | 0 | .0 | 0 | .0 | |
| | Private Company | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | 0.021 |
| | Neighbor/Fellow Farmer | 9 | 40.9 | 45 | 40.5 | 14 | 31.8 | 9 | 42.9 | |
| | Agrochemical Dealer | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Research Institution | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | FBO | 5 | 22.7 | 12 | 10.8 | 1 | 2.3 | 3 | 14.3 | |
| **Time of Planting** | Visit Agricultural Office | 10 | 45.5 | 39 | 35.5 | 27 | 61.4 | 8 | 40.0 | |
| | Visit by extension office | 3 | 13.6 | 11 | 10.0 | 1 | 2.3 | 3 | 15.0 | |
| | Newspaper/magazine | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Internet/e-mail | 0 | .0 | 2 | 1.8 | 1 | 2.3 | 0 | .0 | 0.345 |
| | Radio | 6 | 27.3 | 48 | 43.6 | 14 | 31.8 | 8 | 40.0 | |
| | Television | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (Voice) | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (SMS) | 3 | 13.6 | 10 | 9.1 | 1 | 2.3 | 1 | 5.0 | |
| **Value Addition** | Agricultural Extension Officer | 14 | 63.6 | 67 | 60.4 | 30 | 68.2 | 13 | 61.9 | |
| | CBO | 0 | .0 | 3 | 2.7 | 0 | .0 | 1 | 4.8 | |

| Methods to Improve Yields | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Message** | AKIS tools | **Chemical Fertilizer** | | **Organic Fertilizer** | | **Pesticide** | | **Traditional Methods** | | |
| | NGO Staff | 1 | 4.5 | 0 | .0 | 1 | 2.3 | 0 | .0 | |
| | Private Company | 0 | .0 | 4 | 3.6 | 2 | 4.5 | 0 | .0 | 0.254 |
| | Neighbor/Fellow Farmer | 5 | 22.7 | 28 | 25.2 | 9 | 20.5 | 6 | 28.6 | |
| | Agrochemical Dealer | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Research Institution | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | FBO | 2 | 9.1 | 9 | 8.1 | 2 | 4.5 | 1 | 4.8 | |
| **Utilization** | Visit Agricultural Office | 12 | 54.5 | 62 | 55.9 | 30 | 68.2 | 14 | 66.7 | |
| | Visit by extension office | 2 | 9.1 | 7 | 6.3 | 1 | 2.3 | 1 | 4.8 | |
| | Newspaper/magazine | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Internet/e-mail | 0 | .0 | 4 | 3.6 | 4 | 9.1 | 2 | 9.5 | |
| | Radio | 5 | 22.7 | 27 | 24.3 | 8 | 18.2 | 3 | 14.3 | 0.689 |
| | Television | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (Voice) | 1 | 4.5 | 2 | 1.8 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (SMS) | 2 | 9.1 | 9 | 8.1 | 1 | 2.3 | 1 | 4.8 | |
| **Marketing/Market Needs (Quality, Volume)** | Visit Agricultural Office | 8 | 36.4 | 39 | 35.1 | 27 | 61.4 | 7 | 33.3 | |
| | Visit by extension office | 3 | 13.6 | 16 | 14.4 | 1 | 2.3 | 2 | 9.5 | |
| | Newspaper/magazine | 1 | 4.5 | 0 | .0 | 1 | 2.3 | 0 | .0 | |
| | Internet/e-mail | 1 | 4.5 | 6 | 5.4 | 3 | 6.8 | 1 | 4.8 | 0.003 |
| | Radio | 5 | 22.7 | 41 | 36.9 | 11 | 25.0 | 9 | 42.9 | |
| | Television | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (Voice) | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (SMS) | 4 | 18.2 | 9 | 8.1 | 1 | 2.3 | 2 | 9.5 | |
| **Prevailing Market Prices** | Visit Agricultural Office | 7 | 31.8 | 37 | 33.6 | 24 | 54.5 | 6 | 28.6 | |

| Message | AKIS tools | Chemical Fertilizer | | Organic Fertilizer | | Pesticide | | Traditional Methods | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Prevailing Market Prices** | Visit by extension office | 3 | 13.6 | 14 | 12.7 | 1 | 2.3 | 4 | 19.0 | |
| | Newspaper/magazine | 2 | 9.1 | 1 | .9 | 1 | 2.3 | 1 | 4.8 | |
| | Internet/e-mail | 0 | .0 | 6 | 5.5 | 3 | 6.8 | 1 | 4.8 | |
| | Radio | 7 | 31.8 | 41 | 37.3 | 13 | 29.5 | 8 | 38.1 | 0.056 |
| | Television | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (Voice) | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (SMS) | 3 | 13.6 | 11 | 10.0 | 2 | 4.5 | 1 | 4.8 | |
| **Profit (GM Analysis)** | | | | | | | | | | |
| | Visit Agricultural Office | 11 | 50.0 | 65 | 59.1 | 29 | 65.9 | 15 | 71.4 | |
| | Visit by extension office | 1 | 4.5 | 4 | 3.6 | 2 | 4.5 | 0 | .0 | |
| | Newspaper/magazine | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Internet/e-mail | 0 | .0 | 3 | 2.7 | 2 | 4.5 | 1 | 4.8 | |
| | Radio | 4 | 18.2 | 26 | 23.6 | 10 | 22.7 | 4 | 19.0 | |
| | Television | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (Voice) | 0 | .0 | 1 | .9 | 0 | .0 | 0 | .0 | |
| | Mobile Phone (SMS) | 6 | 27.3 | 10 | 9.1 | 1 | 2.3 | 1 | 4.8 | |

From table 19 above, adoption of grain amaranth is significant using radio with P value of 0.009(0.9%), mobile use has P value of 0.001(0.1%) showing very significant influence on adoption of grain amaranth production. FBO/CBO/NGO has P value for accessibility by the farmers of 0.002 (0.2%) showing that farmers depend on FBO/CBO/NGO in getting information.

From table 20, AKIS tools used for source of information for new varieties by the farmers have P value of 0.021(2.1%). From table 20, AKIS tools used for marketing information for methods used to improve yields by the farmers have P value of 0.003(0.3%).

These results confirm objective two (2), on the assessment of AKIS tools use on adoption of grain amaranth. The results also show that there is significant relationship between the use of AKIS tools and adoption of grain amaranth production disapproving hypothesis one(1).

### 4.4 Regression Analysis results

According to Mugenda and Mugenda, ( 2003), regression analysis can be applied where the independent variable predicts a given dependent variable. Regression was applied in this study using STATA. This is where a group of independent variables together predict a given dependent variable. This was applied in this study on AKIS tools influencing adoption of grain amaranth production. Other variables in the study include: socio-economic factors influencing use AKIS tools.

From the study, the regression model is of the form:

$Y = \alpha + \beta_1X_1 + \beta_2X_{2+} \beta_3X_3 + \beta_4X_4 + \beta_5X_{5+} \varepsilon$…………………….**equation 1**

Where: Y – is dependent variable ( adoption of grain amaranth production by smallholders using of AKIS tools)

$\alpha$ - is the constant (adoption when no AKIS tools are used).

$X_{1\text{-}n}$ - are the independent variables (AKIS tools used) where:

$X_1$ - farmer to farmer information (F)

$X_2$ – information through radio (R)

$X_3$ – information through mobile (M)

$X_4$ – information through researchers (R)

$X_5$ – information through other means such as extension agents (E)

$\beta_{1\text{-}5}$ - are the regression coefficients or change induced in Y by each X

$\varepsilon$ – is the error which is noise component that includes unobservable factors.

### 4.4.1 Regression analysis on AKIS significance on adoption

Survey results on the above equation are tabulated in the table 21 below

Table 21: AKIS significance on adoption of grain amaranth

| |
|---|
| regress adoption q5_fellow_farmer q6_radio q6_mobile q6_researcher q6_other |
| Source SS df MS Number of obs = 33 F( 5, 27) = 2.62 |
| Model .891949272 5 .178389854 Prob > F = 0.0465 |
| Residual 1.83532346 27 .067974943 R-squared = 0.3270 Adj R-squared = 0.2024 |
| Total 2.72727273 32 .085227273 Root MSE = .26072 |
| adoption Coef. Std. Err. t P>t [95% Conf. Interval] |
| q5_fellow_farmer - .9241417 .2698172 -3.43 0.002 -1.477761 -.3705225 |
| q6_radio .0771231 .1593207 0.48 0.632 -.249776 .4040221 |
| q6_mobile - .0110628 .049217 -0.22 0.824 -.1120477 .0899222 |
| q6_researcher .0621099 .2686661 0.23 0.819 -.4891474 .6133672 |
| q6_other .0045828 .0086879 0.53 0.602 -.0132434 .022409 |
| _cons 1.71553 . 48643 3.53 0.002 . 7174583 2.713602 |

From table 21 above:

$\alpha$= 1.72 $\beta_{5=}$ 0.01

$\beta_1$= 0.92 $\varepsilon$= 0.27+0.16+0.05+0.27+0.01/5=0.152

$\beta_{2=}$ 0.08

$\beta_{3=}$ 0.01

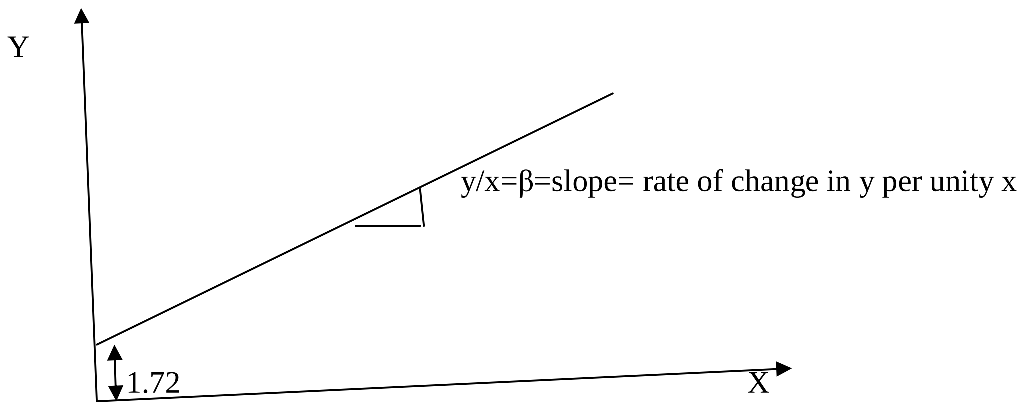
$\beta_{4=}$ 0.06

Using these results in equation 1 above:

Y (adoption) = $1.72 + 0.92X_1 + 0.08X_2 + 0.01X_3 + 0.062X_4 + 0.01X_5 + 0.15$….**equation 2**

From equation 2: Adoption=1.72 + 0.92Fellow farmer + 0.08Radio + 0.01Mobile + 0.06Researcher + 0.01Others+ 0.15…………………………………………….……**equation 3**

### 4.4.2 Graphical representation of the regression model.




From the model, adoption is positively related to AKIS tools i.e. the use of AKIS tools has positive significance in adoption of grain amaranth production by smallholder grain amaranth farmers in Lugari Sub-County.

The Y – intercept (1.72) indicates that adoption can still occur without using AKIS tools at a rate of Y – intercept value. Using fellow farmers brings 92% adoption, using radio brings about 8% adoption using mobile has only1%, researcher has 6% and others have 1%. Therefore from the model, farmer to farmer communication is the most effective way of passing the message on adoption of grain amaranth productions

Other factors that can influence adoption of grain amaranth by smallholders include market prices, the taste, climatic conditions and prices of inputs used. Due to limitation in resources, these factors were not investigated.

### 4.4.3 Hypothesis test using F distribution test at α=0.05

From table 21 above, F- test has the value of $F(5, 27)$, F- statistics= 2.62, probability of $P=0.0465$ and degree of freedom (df) = 5+27=32. From percentage points of the F distribution at $\alpha=0.05$, df(5, 27) has critical F approx. =2.57.

Therefore F-statistics >F-critical. We reject the null hypothesis (Ho) that there is no significance in the use AKIS tools by grain amaranth smallholder farmers and their adoption for production in Lugari Sub-County. Therefore use of AKIS tools has significance in the adoption of grain amaranth production by smallholder grain amaranth farmers.

### 4.4.4 Linear correlation test

From the table 21, above, the coefficient of determination ($R^2$) is 0.2024. $R^2$ explains the deviation of dependent variable from the regression line. $R^2$ can be calculated as (1-sum of squared estimated errors – SSE). 0.2024 is a low figure indicating that there are important factors that were unobserved hence high deviation of dependent variable from regression model line.

Coefficient of correlation ( R ) is the square root of coefficient of determination ( $R^2$ ) and it shows whether there is strong linear relationship between variables. Therefore R value=0.5. For R values > or = 0.5 then the linear relationship is strong. From the study, it can be concluded that the relationship between dependent variable and independent variables is strong.

### 4.4.5 ANOVA test on AKIS significance on grain amaranth adoption

Table 22: ANOVA test on AKIS (radio) significance on grain amaranth adoption

| . **One - way adoption q6_radio** | | | | | |
|---|---|---|---|---|---|
| Analysis of Variance | | | | | |
| Source | SS | df | MS | F | Prob > F |
| Between groups | 1.78512397 | 3 | . 595041322 | 3.99 | 0.0096 |
| Within groups | 17.4545455 | 117 | .149184149 | | |
| Total | 19.2396694 | 120 | .160330579 | | |

From table 22 above, degree of freedom df(3, 117) has F-statistics value of F =3.99 and probability of P=0.0096=0.01 (1.0%). Since the probability is <0.05 at α=0.05 (5%) then the relationship is very significant. From F- distribution tables, F-critical at df(3 117) is approx 2.68. Since F- statistics > F-critical, null hypothesis (Ho) is rejected. Therefore there significance in the use of AKIS tools (radio) in adoption of grain amaranth by grain amaranth smallholder farmers of Lugari Sub-County.

Table 23: ANOVA test on AKIS (mobile) significance on grain amaranth adoption

| **One - way adoption q6_mobile** | | | | | |
|---|---|---|---|---|---|
| Analysis of Variance | | | | | |
| Source | SS | df | MS | F | Prob > F |
| Between groups | .933422149 | 3 | .311140716 | 2.01 | 0.1157 |
| Within groups | 18.383651 | 119 | .154484462 | | |
| Total | 19.3170732 | 122 | .158336665 | | |
| Bartlett's test for equal variances: chi2(3) = 5.6311 Prob>chi2 = 0.131 | | | | | |

From table 23 above, df(3, 119) has F-statistics=2.01 and probability P=0.1157 (11.6%). From F- distribution tables, df(3 119) has F critical value approx.=2.68. Since F- statistics < F-critical, null hypothesis (Ho) is accepted hence there is no significance in the use of mobile for grain amaranth adoption by smallholder grain amaranth farmers in the Lugari Sub-County.

### 4.5 To test the significance of socio-economic factors on AKIS tools' use

Table 24: Regression model on gender, education, age and occupation

| | | | | |
|---|---|---|---|---|
| Source \| | SS | df | MS | Number of obs = 125 F( 4, 120) = 2.54 |
| Model \| | 1.56285681 | 4 | .390714204 | Prob > F = 0.0431 |
| Residual \| | 18.4371432 | 120 | . 15364286 | R-squared = 0.0781 |
| -------------+----------------------------- | | | | Adj R-squared = 0.0474 |
| Total \| | 20 | 124 | .161290323 | Root MSE = .39197 |

| adoption \| | Coef. | Std. Err. | t | P>\|t\| | [ 95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| Gender1 \| | -.2727167 | .0984342 | -2.77 | 0.006 | -. 4676096. | 0778237 |
| age \| | . 0032617 | . 0029648 | 1.10 | 0.273 | - .0026084 | .0091318 |
| occupation1 | .0246875 | .0169395 | 1.46 | 0.148 | -.0088516 | .0582265 |
| education1 | -.0092047 | . 0177084 | -0.52 | 0.604 | -.0442662 | .0258567 |
| _cons \| | .9267385 | . 1929637 | 4.80 | 0.000 | .5446839 | 1.308793 |

From the table 24 above, df(4, 120) has F – statistics = 2.54, while from F – distribution table, F – critical =2.45. Since F – statistics > F – critical, null hypothesis (Ho) is rejected. Therefore there is significance relationship between adoption of grain using AKIS tools and socio-economic factors.

From table 24 above, regression model results on socio-economic factors such as gender, age, occupation and education have coefficient of determination ($R^2$) value of 0.0474. $R^2$ refers to the amount of variation between adoption and socio-economic variables that were used in the study. The coefficient of correlation ( R ) is square root of $R^2$, hence R=0.22. Since R<0.5 then the linear relationship between adoption and socio-economic factors is not strong.

From the survey results, P value for gender is 0.006(0.6%), implying that gender as a socio-economic factor affects use of AKIS tools hence significant. The other factors, age, occupation and education have P values more than 0.05 hence not significant

## 4.6 To test the significance of use of AKIS tools on adoption

Table 25: significance on use of AKIS tools on grain amaranth adoption

| |
|---|
| Source \| SS df MS Number of obs = 103 F( 9, 93) = 2.38 |
| Model \| 3.02076651 9 .335640724 Prob > F = 0.0179 |
| Residual \| 13.0957383 93 .140814391 R-squared = 0.1874 |
| -------------+------------------------------ Adj R-squared = 0.1088 |
| Total \| 16.1165049 102 .15800495 Root MSE = .37525 |
| adoption \| Coef. Std. Err. t P>\|t\| [95% Conf. Interval] |
| q7_o3_radio (lack of money to buy radio)\| -. 1165927 .1399946 -0.83 0.407 - .3945941 .1614088 |
| q8_o3_mobile (lack of money to buy mobile)\| - .0415904 .076682 -0.54 0.589 -. 1938657 .1106848 |
| q9_o3_mobile (lack of money to buy airtime)\| -. 1146109 .081515 -1.41 0.163 -.2764836 .0472618 |
| q10_o3_radio (lack of money to buy battery)\| - .0269168 .0839374 -0.32 0.749 -.1935999 .1397662 |
| q11_o3_other \| - .0913102 .0620148 -1.47 0.144 -.2144594 .031839 |
| q12_o3_radio (level of education)\| -.0223863 . 0884948 -0.25 0.801 -.1981195 .1533469 |

| | | | | | | |
|---|---|---|---|---|---|---|
| q13_o3_radio (language used\| | - .016653 | . 0376408 | -0.44 | 0.659 | -.0914002 | .0580942 |
| q14_o3_mobile (level of education)\| | .3762645 | .2332592 | 1.61 | 0.110 | -.0869421 | .8394711 |
| q15_o3_radio wrong time of the programme\| | - .3121062 | .1926017 | -1.62 | 0.109 | -.694575 | .0703625 |
| _cons \| | 1.71807 | .1876337 | 9.16 | 0.000 | 1.345467 | 2.090674 |

From table 25 above, regression model results on the use of AKIS tools have coefficient of determination ($R^2$) value of 0.1088. $R^2$ refers to the amount of variation between the dependent and the independent variables that were used in the study. The coefficient of correlation ( R ) is the square root of the coefficient of determination ( $R^2$ ), R=0.33. Since this value is less than 0.5, then the relationship between adoption and lack of money to buy AKIS tools, lack of money to buy battery and airtime is not strong.

From table 25 above, F – distribution test has F(9, 93), F=2.38, and probability of P=0.0179. Since the probability <0.05, it implies there is significance relationship between the dependent and independent variables. From the F- distribution tables, F-critical at df(9 93) is approx..=2. Since F statistic > F – critical, the null hypothesis (Ho) is rejected. Therefore there is significant relationship between use of AKIS tools and grain amaranth adoption by smallholder grain amaranth farmers of Lugari Sub-County.

# CHAPTER FIVE

## 5.0 KEY FINDINGS, CONCLUSION AND RECOMMENDATIONS

### 5.1 Key findings

#### 5.1.1 Interpersonal communication

The results show that farmer to farmer (interpersonal) communication plays a key role in adoption of grain amaranth. From the results, diffusion of innovation on grain amaranth among farming communities is effective through interpersonal communication (93.9%). This could be due to the fact that farmers trust each other and feel confident when learning new technologies from each other. Opinion leaders in rural communities play key role in sieving what they feel is good for their people as explained by two step theory in communication. The extension agents much as they are at the grass root level and are supposed to interact with farmers on day-to-day basis, they are not felt on the ground. There are many factors such as language barrier, cultural factors, attitudes, poverty levels literacy level among others that affect effective communication between farmers and extension agents

Interpersonal communication backed with technical advice from extension agents can be extrapolated to other orphan (traditional) crops such as sorghum, finger millet and cassava. These orphan (traditional) crops are very important for food security since they do not require a lot of inputs such as chemical fertilizers.

#### 5.1.2 Research-Extension-farmer communication

The results show research-extension-farmer linkage is not strong. Farmers say that technical language used for research findings normally hinder them from understanding the meaning of technologies from researchers. The majority of farming communities have education up to primary level hence illiteracy level. The results show that 63% of the grain amaranth farmers went up to primary level. This makes it difficult to understand the research findings which are normally packed in technical languages. The interaction between researchers and extension agents has not been frequent. Centre Research Advisory Committee (CRAC) meetings between researchers and agricultural extension managers normally lack focus. Instead of discussing critical research issues, the meetings are normally turned into general management and public relations discussions.

### 5.1.3 Accessibility to AKIS by farmers for information

The results indicate that majority of the respondents own radio (84.7%), are able to access radio (87.8%) and are able to use radio for grain amaranth information (40.5%). 84% of respondents own mobile, 90.8% are able to access and only 64.1% use it for grain amaranth information. 78.6% of respondents are able to access extension agents but only 15.3% use them for grain amaranth production. Researchers are only accessed by 15.3% of respondents. Farmer-farmer communication is very effective as they access each at 71.8 and use each other's information at 93.9%. The findings suggest that farmer – farmer communication, FM Radio stations and cellular phones are important AKIS tools in improving small scale agriculture in rural areas**.**

### 5.1.4 Youths involvement in grain amaranth farming

The results show that youths involvement is only 13% ( 20-35 years ). Youths are very innovative with AKIS tools hence their involvement in farming activities is very important. Most youths have taken negative attitude towards farming. Also most parents do not encourage their children to view farming positively by allocating land for farming activities.

### 5.1.5 Results analysis

From regression model equation analysis Y – intercept is 1.72 meaning that grain amaranth smallholder farmers can only adopt grain amaranth production to a limited extend without using AKIS tools. From the regression model, using fellow farmers brings 92% adoption, using radio brings about 8% adoption using mobile has only1%, researcher has 6% and others have 1%. Therefore from the model, farmer to farmer communication is the most effective way of passing the message on adoption of grain amaranth productions

Testing of hypothesis one on the significance of AKIS tools on adoption, from table 24, shows that F-statistics >F-critical hence we reject the null hypothesis (Ho) that there is no significance in the use AKIS tools by grain amaranth smallholder farmers and their adoption for production in Lugari Sub-County. Therefore use of AKIS tools has significance in the adoption of grain amaranth production by smallholder grain amaranth farmers. This test also answers objective two of the study

Testing of hypothesis on socio-economic issues, shows from the table 24, above that df(4, 120) has F – statistics = 2.54, while from F – distribution table, F – critical =2.45. Since F – statistics > F – critical, null hypothesis (Ho) is rejected. Therefore there is significance relationship between adoption of grain using AKIS tools and socio-economic factors. This answers objective three of the study.

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## 5.2 CONCLUSION

The study concludes that use of AKIS tools, enable smallholder grain amaranth farmers to transact their farming activities. The services of extension agents are not utilized by the farmers because of language barriers. Farmer to farmer communication is the most appropriate to rural communities but the content of the messages shared is very low. Researchers are not utilized by the farmer for the agricultural innovations, because of high level illiteracy. Therefore the adoption of grain amaranth information as found out by the study is mainly through farmer-farmer communication, radio and to small extend through mobile and extension agent. The extension agents are mainly used for market and gross margin information.

## 5.3 Recommendations

The results show that interpersonal (farmer-farmer) communication is the most effective among grain amaranth farmers. The technical content of this communication is low bearing in mind low education level of the farmers as over 60% are up to primary level. This study recommends that extension agents are facilitated by the ministry of Agriculture, Livestock and Fisheries to reach farmers using AKIS tools. Also deployment of these extension agents should be based on the enterprise where he/she is working i.e. Livestock technical officers should be posted to arid and semi-arid areas whereas crops based technical officers should be posted to high potential areas. Though there is need for demand driven extension, extension agents should trigger such demands from farmers depending on the enterprise potential within the locality. This makes farmers appreciate the services of extension agents. Extension agents should be facilitated with airtime for mobile to trigger the demand. Since the results show that mobile use has significant influence on innovation adoption, extension agents and researchers should work hand using mobiles to communicate with their farmers

From the survey results, it is evident that research-extension-farmer communication is weak. There is need to make Centre Research Advisory committee (CRAC) meetings between researchers and agricultural extension managers objective. The meetings should have their agenda based on the new research findings that are meant to benefit the farmers instead of making them general management meetings. Researchers should share their new research findings with agricultural extension officers by interpreting them clearly to make them understandable. Researchers should take agricultural extension officers' feedback from the field on their researched technologies positively so that technologies can be packaged as per the farmers views.

All organizations that provide extension services should come up with a framework that allows sharing of information through AKIS tools and other information and communication technologies. The sharing of information enhances adoption of new technologies such grain amaranth production for increased nutrition income.

There is therefore need to strengthen collaboration among many actors involved in agricultural research and extension who are increasingly using various AKIS tools in dissemination of agricultural information. Policy makers should look into the prices of mobile phone hand sets of various companies and their accompanying air time to make them affordable for rural communities.

The study recommends that further research should be contacted to find out how other factors such as market prices, farmers taste and cultural factors affect adoption of grain amaranth production. Also further study should be contacted on how adoption of other orphan (traditional) crops such as finger millet, sorghum and cassava is affected by various factors. Traditional crops are very important for food security.

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# APPENDICES

## Appendix I – Questionnaire

**Agricultural Knowledge and Information Systems (AKIS) Utilization by Small Holder Grain Amaranth Farmers in Lugari Sub-County, Kakamega County, Kenya.**

Questionnaire Code. |__|__|__|__|__|__|

Date__/___/___(Day/Month/Year)

## AKIS House Hold Interview Questionnaire

| General Information |
|---|
| COUNTY ______________________________ |
| SUB-COUNTY ______________________________ |
| WARD ______________________________ |
| LOCATION ______________________________ |
| SUB – LOCATION______________________________ |
| VILLAGE ______________________________ |
| HOUSEHOLD NUMBER______________________________ [ ][ ][ ] |

| A. INTERVIEWER VISITS | | | | |
|---|---|---|---|---|
| VISIT 1 | VISIT 2 | FINAL VISIT | | SUPERVISOR'S CHECK |
| DAY \|_\|_\|<br>MONTH \|_\|_\|<br>*RESULT \|_\| | DAY \|_\|_\|<br>MONTH \|_\|_\|<br>*RESULT \|_\| | DAY \|_\|_\|<br>MONTH \|_\|_\|<br>*RESULT \|_\| | | DAY \|_\|_\|<br>MONTH \|_\|_\|<br>*STATUS \|_\| |
| TIME START: _____ /____<br>TIME END: _____ /_____ | TIME START:_____ /_____<br>TIME END: _____ /_____ | TIME<br>START:____/____<br>END:_____ /_____ | TOTAL NO. OF VISITS \|_\|_\| | * STATUS CODE<br>1=INTERVIEW ACCEPTABLE<br>2=INTERVIEW TO BE FURTHER COMPLETED |

| | | | |
|---|---|---|---|
| *RESULT CODES:<br>1=COMPLETED | 2=NOT AT HOME<br>3=POSTPONED<br>4=REFUSED<br>5=PARTLY COMPLETED | 6=INCAPACITATED<br>7=VACANT / UNOCCUPIED<br>8=OTHER (*SPECIFY*) | 3=INTERVIEW TO BE REJECTED |

| ENUMERATOR | SUPERVISOR | KEYED BY |
|---|---|---|
| \| \| \| | \| \| \| | \| \| \| |
| NAME ____________________ | NAME ____________________ | NAME ____________________ |

## SECTION 1: AKIS HOUSEHOLD DEMOGRAPHICS

1.1 Get information about members who live in the household. *(Start with the household head and remember to include the respondent).*

| Serial No. (1) | Name (2) | Sex (3) | Age (Completed yrs) (4) | Relationship to head of HH (5) | Occupation (6) | Marital Status (7) | Education Level (8) | Religion (9) |
|---|---|---|---|---|---|---|---|---|
| 01 | | | | | | | | |
| 02 | | | | | | | | |
| 03 | | | | | | | | |
| 04 | | | | | | | | |
| 05 | | | | | | | | |
| 06 | | | | | | | | |
| 07 | | | | | | | | |
| 08 | | | | | | | | |
| 09 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |

1.2 Indicate the serial number of the respondent from the above table [ | ]

***CODES FOR HOUSEHOLD DEMOGRAPHICS***

*(3) Sex:* *1- MALE* *2 – FEMALE*

| *(5) Relationship to Head of Household:* | *(6) Occupation:* | *(7) Marital status:* | *(9) Religion:* |
|---|---|---|---|
| *01 Head of Household* | *1. Subsistence/mixed farmer* | *1. Married* | *1. Catholic* |
| *02 Wife/husband/partner* | *2. Pastoralist* | *2. Single* | *2. Protestant* |
| *03 Son or daughter* | *3. Employed (formal)* | *3. Divorced* | *3. Other Christian* |
| *04 Son-in-law or daughter-in-law* | *4. Employed (informal)* | *4. Separated* | *4. Hindu* |

| | | | |
|---|---|---|---|
| *05 Grandchild* | *5. Business (include: commercial,* | *5. Widowed* | *5. Traditional* |
| *06 Parent* | *livestock and crop production)* | *6. N/A* | *6. No religion* |
| *07 Parent-in-law* | *6. Domestic worker* | *7. Don't Know* | *7. Muslim* |
| *08 Brother or sister* | *7. Home maker/House wife* | *8. Other* | *8. Others (specify)* |
| *09 Co-wife* | *8. Student* | *(8) Educational Level:* | |
| *10 Other relative* | *9. N/A* | *1. Nursery, kindergarten* | |
| *11 Adopted* | *10. Don't Know* | *2. Primary* | |
| *12 Non relative* | *11. Others (specify)* | *3. Post-primary, vocational* | |
| | | *4. Secondary, A-level* | |
| | | *5. College (middle level)* | |
| | | *6. University* | |
| | | *7. Child – not yet gone to school* | |
| | | *8. Adult education (Gumbaru)* | |
| | | *9. None* | |
| | | *10. Don't Know* | |

**Section 2 – income and information access**

1. What is the size of your farm?

   1. 1-3 acres { }   2. 4-6 acres { }   3. 7-10 acres{ } 4. 11-15 acres{ }

   i) How many acres of the land do you currently cultivate? _____ Acres

   ii) Out of the cultivated land, how much is under grain amaranth?

   (a) =<2.5 acres { } (b) 3-4.5 acres { } (c) 5-10 acres { }

iii). How many acres do you lease outside your farm for growing amaranth? _____(acres)

   iv). How many times in a year do you plant grain amaranth? 1. Once { } 2. twice { }

   3. Thrice { }

   v). What is the average yield? 1. Season 1 ______(kg/acre) 2. Season 2________(kg/acre)

   season 3______(kg/acre)

   vi) How much produce of the grain amaranth did you harvest last year?_______Kgs

2. Do you have any off farm income? Yes [ ]   No [ ]
3. What is your average income per month? KShs ………………
4. Distance to agricultural field office (km) ……………………………………………………..…………...
5. How far do you repair your phone? (km)……………………………

6. How far do you top-up your phone? (km)……………………………

7. How far are you from the nearest electricity/solar/battery Charging point (km)………………………………….

**Section 3 – objective based questions**

**Objective 1**: **To identify AKIS tools used to get information on grain amaranth production by small-scale farmers in Lugari, Kakamega County.**

8. Among the AKIS tools listed below which ones do you own or are able to access. Which ones do you use to receive or seek information on Grain Amaranth production? (**Circle appropriately in the corresponding box**).

| **S/No** | **Type of AKIS tools** | **Own** | | **able to access** | | **Used for receiving information on Grain Amaranth** | |
|---|---|---|---|---|---|---|---|
| **1.** | Radio | Yes | no | Yes | no | yes | no |
| **2.** | Mobile phone | Yes | no | Yes | no | yes | no |
| **3.** | Agricultural Extension | Yes | no | Yes | no | yes | no |
| **4.** | Researchers | Yes | no | Yes | no | yes | no |
| **5.** | FBO/CBO/NGO | Yes | no | Yes | no | yes | no |
| **6.** | Other farmers | Yes | no | Yes | no | yes | no |
| **7.** | Others (specify) | Yes | no | Yes | no | yes | no |

**Objective 2: To assess whether use of AKIS tools has significant influence on adoption of Grain Amaranth production in Lugari, Kakamega County.**

1. What are your major sources of information on Grain Amaranth on each of the following?

| **Type of information on grain amaranth** | **Information Source. (Code)** | **Means of accessing information. (Code)** |
|---|---|---|

| | A | B |
|---|---|---|
| New varieties of amaranth | | |
| Time of planting & harvesting | | |
| Value addition | | |
| Utilization | | |
| Market/Market needs (quality, volume, type) | | |
| Prevailing market prices | | |
| Profits (GM analysis) | | |

Code A

1. Agricultural extension officer
2. CBO
3. NGO staff
4. Private company
5. Neighbor/Fellow Farmer
6. Agrochemical dealer
7. Research institution
8. FBO

Code B

1. Visit agricultural office
2. Visit by CBO/NGO/FBO
4. farmer -farmer
5. Radio
7. Mobile phone (voice)
8. Mobile phone (sms)
9.Fielddays/shows/Barazas/demonstrations/tours
10. Training

2 Grain Am ]

If

| A | B | C | D |
|---|---|---|---|
| Amount sold (Kg) | Price/kg Kshs. | Who Buys your Grain Amaranth? | What is the Mode of transport? |
| | | | |

3. Where do you get your seed?

KARI [ ]
Own Farm/Fellow farmer [ ]
Open market [ ]
Kenya Seed company [ ]
Private company [ ]
FBO [ ]
Others (specify)………………………………………………

4. What methods to you use to improve yields of your Grain Amaranth?

(a) Fertility Improvement: Chemical fertilizer? Yes [ ] No [ ]
(b) Fertility improvement: organic fertilizer? Yes [ ] No [ ]
(c)Pest Control: Pesticides? Yes [ ] No [ ]
: Traditional methods? Yes [ ] No [ ]

5. How do you make your business contacts?

Sending notes/letter [ ] sending mobile SMS [ ] e-mail [ ]

Agricultural Officer [ ] Via mobile phone [ ] Visit by trader/Middlemen [ ]
Fellow farmer [ ]
Visit to market [ ]

6. From your own opinion to what extent has each of the following helped you in issues pertaining to Grain Amaranth production and marketing? (**On scale of 1-4: 4=very great extent, 3=great extent 2=little extent, 1= Not at all**).

Radio [ ] via mobile phone [ ] Agricultural extension officer [ ] F [ ] Researchers [ ] Fellow Farmers [ ]
Others (Specify)……………………………………………….

**Objective 3**: **To determine socio-economic factors that influence farmers' use of AKIS tools in Grain Amaranth production and marketing.**

9. On a scale of 1 –3, how do the following constraint influence your use of AKIS in obtaining Grain Amaranth production and marketing information?

**(Very serious=3, serious=2 Not serious=1) Put 3, 2 or 1 in respective cells**

| | **Constraints** | **Type of ICT equipment** | **Likert-scale** | | |
|---|---|---|---|---|---|
| | | | **Not Serious =1** | **Serious =2** | **Very serious=3** |
| 7. | Lack of money to buy AKIS tools | Radio | | | |
| | | Mobile phone | | | |
| | | (others, specify) | | | |
| 8. | Cost of batteries | Radio | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | Mobile phone | | | |
| | | (others, specify) | | | |
| 9. | Lack of electricity | Radio | | | |
| | | Mobile phone | | | |
| | | (others, specify) | | | |
| 10. | Lack of money to buy air time | Mobile phone | | | |
| | | (others, specify) | | | |
| 11. | Irrelevant content | Radio | | | |
| | | Mobile phones | | | |
| | | Researchers | | | |
| | | Extension officers | | | |
| 12. | Wrong time of the programme | Radio | | | |
| | | Mobile phones | | | |
| | | Researchers | | | |
| | | Extension officers | | | |
| 13. | Language used | Radio | | | |
| | | Mobile phones | | | |
| | | Researchers | | | |
| | | Extension officers | | | |
| 14. | Low level of education | Radio | | | |
| | | Mobile phones | | | |
| | | Researchers | | | |
| | | Extension officers | | | |
| 15 | Poor road conditions | Researchers | | | |
| | | Extension officers | | | |

## Appendix 2: Introduction letter to the District Agriculture Officer

Wekulo Saidi Fwamba

P.O. Box 30028-00100

Nairobi

15th Nov. 2012

District Agricultural Officer,

Lugari Sub County,

P.O. Box 381-30106 Turbo.

Dear sir/madam

**Re: Field study in your Sub County**

I am Wekulo Saidi Fwamba, a Masters student for the Master of Science Degree in agricultural Information and Communication Management (AICM) in the Department of agricultural Economics, the University of Nairobi.

I would like to carry out the above exercise in your Sub County in Lugari sub-location between Dec. 2012 and Jan. 2013. My area of concern is **adoption of grain amaranth by smallholders using agricultural knowledge and information systems (AKIS).** The purpose of this letter is to therefore request you organize for me to collect both primary and secondary data from your office and field. I also request you to allow me use your staff in Lugari Division as enumerators.

Wekulo Saidi Fwamba

+254-722-643749

Fwamba05@gmail.com

## Appendix 3: Introduction letter to Grain Amaranth farmer Representatives

Wekulo Saidi Fwamba

P.O. Box 30028-00100

Nairobi

15th Nov. 2012

To Grain Amaranth farmer representatives

Lugari sub-location

P.O.Turbo.

Dear sir/madam

**Re: Field study on grain amaranth farmers – Lugari sub-location**

I am Wekulo Saidi Fwamba, a Masters student for the Master of Science Degree in agricultural Information and Communication Management (AICM) in the Department of agricultural Economics, the University of Nairobi.

I would like to carry out the above exercise in your area between Dec. 2012 and Jan. 2013. My area of concern is **adoption of grain amaranth by smallholders using agricultural knowledge and information system (AKIS) tools.**

I am happy to inform you that I have identified you as farmers who will participate in this study. My study is purely for my education purpose and the outcome of the study will be availed to you on request.

Wekulo Saidi Fwamba

+254-722-643749

Fwamba05@gmail.com

## Appendix 4: A table of grain amaranth soil fertility improvement

Table 26: Mode used by farmers for improving soil fertility for grain amaranth production

| Mode Improving | Frequency | Percentage |
|---|---|---|
| Chemical Fertilizer | 19 | 14.5 |
| Organic Fertilizer | 112 | 85.5 |
| **Pest control** | | |
| Pesticide | 44 | 33.6 |
| Traditional Methods | 21 | 16.0 |
| **Total** | | |

## Appendix 5: A table of responses for sales of grain amaranth

Table 27: Farmers' mode of contact for sales of grain amaranth

| Business | Frequency. | Percentage |
|---|---|---|
| Sending Notes/Letters | 5 | 3.8 |
| SMS | 21 | 16.0 |
| E-mail | 3 | 2.3 |
| Extension officers | 46 | 35.1 |
| Via Mobile | 75 | 57.3 |
| Trader/Middlemen | 104 | 79.4 |
| Fellow Farmers | 108 | 82.4 |
| Visit to Market | 35 | 26.7 |

## Appendix 6: A table of source of grain amaranth seed

Table 28: The farmers' source of grain amaranth seed

| | Frequency. | Percent |
|---|---|---|
| KARI | 0 | .0 |
| Own Farm/Fellow farmer | 122 | 93.1 |
| Open Market | 0 | .0 |
| Kenya Seed Company | 0 | .0 |
| Private Company | 0 | .0 |
| FBO | 9 | 6.9 |
| Other | 0 | .0 |
| **Total** | **131** | **100** |

From table 28, above, 93.1% source of grain amaranth seed is from fellow farmers with nothing from KARI and private companies.