

**ANALYSIS OF EXISTING AGRICULTURAL INFORMATION
SYSTEMS FOR POST HARVEST MANAGEMENT AMONG
SMALLHOLDER FARMERS IN BOMET COUNTY.**

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**Dissertation Submitted in Partial Fulfillment for the requirements of the
degree of Masters of AICM in the Faculty of Agriculture, Department of
Agricultural Economics, University of Nairobi.**

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DECLARATION

This dissertation is my original work and has not been presented for degree award in any University.

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DEDICATION

To my mum,

Sofia , who taught me that success comes from fear of God and hard work

and in memory of my late father, Rasto,

who laid good foundation in my education

and my loving family

for their support in quest for more knowledge in Agricultural information.

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ABSTRACT

This study analyzed the existing Agricultural information systems on post harvest management of cereal crops among smallholder farmers in South Rift, Kenya. The objectives of the study were to 1) Document information sources, requirements and accessibility on post harvest management of cereal crops among smallholder farmers. 2) Establish the role of service providers in Agriculture in enhancing smallholder farmers' access effective agricultural information on post harvest management of cereal crops. 3) Find out socio-demographic characteristics of smallholder farmers which influence agricultural information on post harvest management of cereal crops. A descriptive research design was used for the study. A multi-stage sampling and simple random sampling methods were used to randomly select a total of 140 smallholder cereal farmers for the survey. Five Agricultural information service providers were purposively selected. The study used open and close ended questionnaires, semi-structured interviews and direct observations to collect primary data. Descriptive statistics were used to establish associations between agricultural information systems and selected socio-economic variables. The study yielded 136 respondents representing 97 % response rate. Results revealed that 61% of smallholder farmers reported extension agents as source of agricultural information, 48% from mass media and 1 % from public research institutions and Universities thus showing lack of information support from the institutional sources for agricultural production. The results further showed that 15.4 % of smallholder farmers have no access to agricultural information on Post harvest management, 61 % access agricultural information once/year which is inadequate for effective agricultural information dissemination since there are two cropping seasons per year. The main problems cited were low agricultural incomes and limited agricultural experience. The study recommended retraining of extension agents on new post harvest management technologies in ever changing ICT environment and closer cooperation between different actors on common post harvest activities.

LIST OF ABBREVIATIONS

AGRIS	International Information System for the Agricultural Science and Technology
AGORA	Access to Global online Research in Agriculture
AICM	Agricultural Information and Communication Management
AIS	Agricultural Information Service
AKIS	Agricultural Knowledge and Information Systems
ASARECA	Association for Strengthening Agricultural Research in East and Central Africa
FAO	Food and Agricultural Organization of the United Nations
Ha	Hectare
ICT	Information Communication Technology
KACE	Kenya Agricultural Commodity Exchange
KAINet	Kenya Agricultural Information Network
KARI	Kenya Agricultural Research Institute
KEFRI	Kenya Forestry Research Institute
KES	Kenya shillings
LM	Lower Midland
MOA	Ministry of Agriculture
MOH	Ministry of Health
NCPB	National Cereals Produce Board
OARE	Online Access to Research in the Environment
RAIN	Regional Agricultural Information Network
UH	Upper Highland
UM	Upper Midland
WHO	World Health Organization of the United Nations.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Agricultural information is essential for improving agricultural production. Specifically, agricultural productivity can arguably be improved by relevant, reliable and useful information and knowledge (Demiryurek et al, 2008). There is, therefore need to understand the functions and use of particular Agricultural Information Systems in order to manage and improve them.

Previous studies have shown that there is failure of Agricultural Information Systems in the third world countries including Kenya in providing relevant information to support food production (Shiraz, 1987). Limited data shows that inadequate post harvest management of food crops leads to household food insecurity, reduce income sources (Komen et al, 2006) and can even lead to loss of lives when contaminated produce especially maize is eaten. No studies have been carried out on analysis of Agricultural Information Systems for post harvest management of cereal crops among smallholder farmers in South Rift, Kenya. Analysis of existing Agricultural Information Systems was necessary in order to provide a framework to identify the strengths and weaknesses of the existing systems. This study analyzed the existing Agricultural Information Systems for post harvest management of cereal crops among smallholder farmers in Bomet county in order to examine if the existing systems meet the intended objectives. The study employed Agricultural information theory in order to analyze information access, degree of usefulness of information sources and ranked the information sources used by smallholder cereal crops farmers.

1.2 Statement of the problem

There is limited data on post harvest losses of cereal crops especially maize (Komen et al, 2006) and no analysis has been done on existing agricultural information systems for post harvest management for these crops in South Rift, Kenya . Past relevant research reports (KARI, 2006) in the region embarked on the economics of post harvest without focusing on relationship between Agricultural information systems and post harvest management. Reports from Cereal Growers Association in 2009 indicated that Kenya loses between 30 and 40 per cent of its harvest due to inefficiencies in handling while data from the Kenya Agricultural Commodity Exchange (KACE) shows a huge drop in prices, usually after a huge harvest (Kirimi, 2009). This affects household food security, reduces income sources and even lead to loss of lives due to eating of aflatoxin contaminated produce especially maize (Republic of Kenya, 2004). Kenya is faced with a threat of aflatoxin in maize (WHO, 2005) as shown by findings that between 2004 and 2006, nearly 200 Kenyans have died after consuming contaminated maize (Bandyopadhyay, 2010). Lack of timely and relevant information and knowledge on post harvest management of cereal crops especially maize crops lead to grain and human losses. These losses affect food security, causing hunger and low farm incomes (Republic of Kenya, 2004).

Decision-making by farmers is made more complex by inappropriate and inefficient information transfer from research and extension services (Demiryurek et al, 2008). In addition, low literacy levels among farmers (Rees et al, 2000) make it difficult for farmers to use agricultural information. Thus, data was collected from the study area with the aim of answering the research questions raised.

1.3 Objectives of the study

The overall objective of the study was to analyze the existing Agricultural Information Systems for post harvest management of cereal crops among smallholder farmers in South Rift, Kenya.

The specific objectives of the study were:

- (i) To document the sources of Agricultural information, requirements and accessibility in existing Agricultural information systems.
- (ii) To find out personal and socio-economic factors which influence Agricultural information for post harvest management of cereal crops.
- (iii) To establish the role of Extension service providers in enhancing farmers access to Agricultural information for post harvest management of cereal crops.

1.4 Research questions

The study sought to answer the following questions:

- (i) Where do smallholder farmers source Agricultural information on post harvest management of cereal crops?
- (ii) How often do smallholder farmers access Agricultural Information Systems on post harvest management of cereal crops?
- (iii) Which personal and socio-economic factors affect agricultural information for post harvest management of cereal crops among smallholder farmers?

1.5 Justification of the study

Kirimi (2009) of Tegemeo Research Institute documented that Kenya is losing a lot of its harvest due poor storage methods and as a result farmers have been forced to bear the losses that arise from the wastage.

This study analyzed the influences of the existing Agricultural Information Systems on post harvest management of cereal crops among smallholder farmers in South Rift, Kenya and their influence on sustainable food security and improved farm incomes. The data from the study will be used by three main stakeholders in agriculture namely the farmer, research and extension. The data will advance frontiers of knowledge in agricultural information since farmers can have information on where to get useful agricultural information post management of cereal crops while the information service providers will know the preferred media for agricultural information presentation. Efficient post harvest management can tremendously contribute to social economic aspects of smallholder farmers in Kenya.

CHAPTER TWO

LITERATURE REVIEW

2.1 Review of agricultural information and related concepts

Information can be defined as “structured data within a context that gives it meaning” (Checkland et al 1998). Rölöing (1988) explained that information can be processed, generated, transformed and shared, through complex processes of coding and decoding, generally known as communication. In Agricultural productivity, the communication of information is a major concern for the agricultural extension services (Demiryürek, 2000). Samuel (2001) defined agricultural information as the “data for decision-making and as a resource that must be acquired and used in order to make an informed decision”.

As pointed out by Demiryurek (2000), analysis of Agricultural Information Systems is useful in identifying weakness of an information system and necessary improvements to be made in information management. This approach is also useful to identify possible defaults and improve coordination between components.

2.2 Systems and System Approach

A system is “a group of interacting components, operating together for a common purpose” (Spedding, 1998). According to Checkland (1981), a system is a model of an entity and is characterized in terms of its hierarchical structure, emergent properties, communication and control. This approach entails looking at an entity and dealing with problems in order to improve the particular system (Spedding, 1998) and also shown a high potential for offering a conceptual framework to analyze , manage and improve a current system and design a better one (Cavallo,1982).

2.2.1 Systems theory and Information System

According to system theory, Information System is accepted as “a system, automated or manual, that comprises people, machines and methods to collect, process, transmit, disseminate data which represent information”, as cited by Demiryurek et al, (2008). In addition, Ciborra (2002) proposed that Information Systems “deal with the deployment of information technology in organizations, institutions and society at large”.

2.2.2 Agricultural Information System

Several authors including Roling (1988), have defined Agricultural Information System as a “system in which agricultural information is generated, transformed, consolidated, received and fed back, to enable knowledge utilization by agricultural producers”.

Generally, an Agricultural Information System consists of components (subsystems), information related processes, system mechanisms and system operations. Research, extension and farmer can be seen as the major components of an agricultural information system. However, various actors and organizations can be found in a system. System approach can be applied to any specific farming systems in order to analyze how the information system works. The study focused on information related processes component of Agricultural Information System for post harvest management of cereal crops.

As cited by Chartman (1983); Aboyado (1987) and Ozowa (1995) a wide range of Agricultural information sources are available to farmers . Due to this wide sources of available agricultural information, there is therefore need to identify sources of Agricultural information that farmers prefer (Opara, 2008). This identification may help Agricultural information providers to re-examine the current media of information presentation to farmers. Radhakrishna and Thomson (1996) reported that demographic variable such as gender, age, educational level, and area of programme were related to the use of information sources.

Milan et al. (2003) reported that a research conducted between 1997 and 1998 showed that some sources of information were considerably more important than others to farmers in general and that particular farmers selected sources to construct individual information systems. They continued to explain that as the number of sources in the systems was most closely related to the levels of general education and agricultural education of the farmers and as these levels increased from basic formal education to higher levels, so too did the acquisition and search for information.

According to Cidro and Radharkrisna(2005), a variety of information sources are used in disseminating information to farmers and the usefulness of information sources such as print, electronic, personal is very important to make informed decisions about the effectiveness of each information source. They explained that usefulness of information sources depends on the subject matter or content taught in an extension program and indicated that usefulness of information sources also depended on demographic characteristics including age, gender and educational level. They are also depended on situational characteristics such as society or community, family groups, infrastructure in terms of finance, input supply, marketing, land resources and climatic conditions.

Previous studies by Bruening et al (1992) have also indicated that perceived usefulness of information sources depends on the subject matter or technical content taught, background characteristics of farmers, including their social situation, and infrastructure .

Ozowa (1995) argued that no one can categorically claim to know all the information needs of farmers especially in an information dependent sector like agriculture where there are new and rather complex problems facing farmers every day.

He further stated that if the approaches to agricultural development programs are to work, African governments need to take new approaches to information dissemination and

management that grow out from a clear understanding of what farmers information needs are. Venkatsen(1995) noted that mass media are particularly effective in making farmers aware of new technologies and thereafter they can always approach extension agent whose job is to deliver repackaged Agricultural information to farmers. This was elaborated by Shibanda (1999) who maintained that awareness of information services is usually associated with awareness stage, where farmers learn about new ideas by being introduced to new sources of information.

According to Tadesse (2008), information access is defined as receiving messages related to agricultural production activity from different sources and extension methods. Studies by Adomi et al (2003) showed that farmers need to have access to Agricultural information in order to improve agricultural production . Motjo (2010) concluded that farmers need to have access to Agricultural information if their Agricultural efforts are to be realized. In his studies, Iriwieri (2007) highlighted that that rural people who are mainly illiterate require access to appropriate information to be able to make decisions and participate fully in national development process.

Rolls et al (1994) analyzed the information system for smallholder farmers in Malaysia and documented their roles as producer, inventor and communicator.

There was a considerable information exchange among the actors in the system and the farmers in particular were active in disseminating innovative information and technology.

Ramkumar (1995) analyzed the information systems of dairy farmers in two villages in India and found that each farmer's information system was unique and that there was little linkage between farmers and non-farmers in and outside the villages.

Garforth & Usher (1996) reviewed various models of information system processes such as development and transfer. They noted that these processes showed that information does not simply flow, but is continually being transformed and adapted through communication.

Huirne et al (1997) analyzed the critical success factors and information needs on dairy farmers in Netherlands and USA (Michigan) and found that they varied widely across regions but were consistent over time.

Several studies have been carried out on Agricultural information systems in the past. Ortiz (1997) analyzed an agricultural knowledge and information system and researched on the dissemination of integrated pest management related information among research, extension and potato producers in Peru.

Ortiz found that potato- related pest management is a kind of technology which demanded from farmers the management of more complex types of information and knowledge.

Demiryurek (2000) used Agricultural information system theory to analyze information systems used by organic and non-organic hazelnut producers in Turkey and found out that the information systems for two groups of farmers were largely separate.

Rolls et al. (1999) analyzed the information systems in Czech agriculture and farmers appeared to regard information as a social good to be exchanged and discussed within social networks. Naido and Rolls (2000) also investigated agricultural information use by small-scale farmers in Mauritius and found out that the farmers managed information as a production resource. Demiryurek et al (2006) analyzed an agricultural information system and communication networks of dairy farmers in Samsun province of Turkey.

He concluded that lack of information support from institutional sources resulted in the development of personal information sources to exchange information among the farmers themselves. Opara (2008) studied Agricultural information sources used by farmers in Imo

state in Nigeria and found out that a variety of agricultural information sources such as interpersonal, impersonal, expert, and non-expert sources were available to the farmers . Much of the information reached the farmers through the interpersonal and expert sources. Mokotjo and Kasulopa(2010) evaluated Agricultural Information Services in Lesotho and reported that AIS services were somehow of good quality in terms of relevance, sufficiency and currency and had improved productivity but were not easily accessible to most farmers.

2.2.3 Agricultural Information System in Kenya

The Kenya Agricultural Information Network was initiated as a response to demand from the national and international community to promote information exchange and access among stakeholders in the agricultural sector. Initial project of KAINet aimed at building capacities in information management, dissemination and exchange in network members in Kenya.

The broad project's objectives include establishing institutional repositories of agricultural information, facilitating the development of institutional and national Information and Communication Management policies and legal frameworks for addressing issues that are critical to content development and information exchange. At the national level, KAINet is a response to a recommendation to build a Kenyan national agricultural science and technology information system in line with Kenya Government Strategy for Revitalizing Agriculture (SRA) and the National Information and Communication Policy.

Most agricultural research institutions work in isolation and their information does not reach the intended consumers (Ndungu et al. ,1995). Aiming at bridging this gap, KAINet was established to provide a collaboration platform for agricultural information availability and access.

Various Products and services of KAINet are available and include access to the national agricultural electronic repository of information in full-text ,data used to aid the identification, description and location of networked electronic resources. They also include access to web portal with links to other national and international resources such as Access to Global online Research in Agriculture (AGORA), Online Access to Research in the Environment (OARE), and Food an Agricultural Organization of the United Nations (FAO), as well as open access to public domain agricultural information.

The main stakeholders in the implementation of KAINet are five national institutions: the Kenya Agricultural Research Institute (KARI), the Kenya National Agricultural Research Laboratories (KARI-NARL), the Kenya Forestry Research Institute (KEFRI), the Ministry of Agriculture (MoA) and Jomo Kenya University of Agriculture and Technology (JKUAT). At the international level, FAO, CABI Africa and the Regional Agricultural Information Network (RAIN) of the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) participated in developing the project and are supporting its implementation through providing expertise in Agricultural Information and Communication Management.

According to the Agricultural knowledge and information systems (AKIS) paradigm, technology transfer centered on three main stakeholders where the information flow was one way , from research through extension to the farmer.

However, Ndungu et al. (1995) reported that there were a considerable diversity of actors, organizations and institutions involved in agriculture in Kenya, who may have positive or negative influence on agricultural technology development and uptake thus the need to inform the end-users the opportunities and limitations of AKIS. Furthermore, the Agricultural knowledge and information systems (AKIS) of Kenya's smallholder farmers are diverse and

complex, varying with agricultural enterprise, agro-ecology, and from district to district (Rees et al, 2000).

2.2.4 Personal, Demographic and Socio-economic factors of smallholder farmers affecting agricultural information

Sheba(1997) argued that exposure to education permits an individual to control the rate of message input and develop the ability to store and retrieve information for later use . However, for certain technical information, the retrieval capacity may be quite important (Mohammedali, 1977). This is due the fact that education enables the individual to know how to seek for and apply information in day-to-day problem solving and as an individual gains the ability to read, he is able to extend the scope of his experience through the print media. As observed by Opara (2010), income is crucial in agricultural information use because the higher the income of the farmer, the more likely he would seek and obtain information for use. A study by Tadesse (2008) on household's personal and demographic characteristics which are mostly associated with farmers' access and utilization of agricultural information, reported that age is one of demographic character important in describing households and that young farmers are keen to get knowledge and information than older farmers. In addition, gender difference was found to be one of the factors influencing access to and utilization of agricultural information.

Opara (2010) found out, that married farmers are likely to be under pressure to produce more, not only for family consumption but also for sale and the desire to produce more could lead to agricultural information seeking and use . Studies by Tadesse (2008) showed that Agricultural experience is another important household related variable that has relationship with the production process . He added that longer agricultural experience implies

accumulated farming knowledge and skill which contributes to utilization of agricultural technologies. Mere provision of agricultural information to farmers does not guarantee its use. This is because a host of social, economic, and psychological factors influence the rate of agricultural information use (Akande, 1999). Among the factors Rogers (1995) identified, is the social system into which the information is delivered.

Rolls et al (1999) emphasized that comparing the socio-economic characteristics of farmers and their farms is essential to develop the appropriate methods to transfer information and analyze the information systems, since the information systems are the construct of the personal characteristics of the farmers and together with the production practices they are major influences on their information management (Naidoo and Rolls, 2000).

2.2.5 The role of extension service providers

Purcell and Anderson (1997) define extension as “a process that helps farmers become aware of improved technologies and adopt them in order to improve their efficiency, income and welfare”. Birner et al (2006) revealed that Agricultural advisory services in developing countries have assumed a much more holistic and facilitators role, and the field staff of an agricultural advisory service is not just a conduit of information, but an advisor, facilitator, and knowledge broker . They added that farmers are seen as partners in the technology generation process, rather than as simply recipients of technology.

Kalusopa (2005) confirmed that there is a need for closer relationship between information providers and users. He pointed out that a closer contact between information providers and end-users enables provision of broad and variety of information.

According to Berhanu et al (2006), extension service is a service of information, knowledge and skills development to enhance adoption of improved agricultural technologies and

facilitation of linkages with other institutional support services (input supply, output marketing and credit). Therefore, the role of extension service has been changed from technology transferring service to information and knowledge brokering and facilitator role.

2.3 Post harvest management of food crops and related concepts

Post harvest losses occur during harvesting and handling due to grain shattering, due to spillage during transport and also from bio-deterioration at all stages in post harvest chain including storage and processing. According to EU Commission and other partners, the principle agents of bio-deterioration are moulds, insects, rodents and birds (www.Postlosses.net). Most farmers do not dry crop produce properly before storage. When moisture content is higher than 13.5 per cent, most cereals especially maize develops a mould or fungus that produces aflatoxin. Aflatoxins are toxic substances produced by certain fungi that grow on plants and seeds.

major aflatoxins (Aflatoxin B₁, Aflatoxin B₂, Aflatoxin G₁ and Aflatoxin G₂) occur in plants contaminated with fungi. *Aspergillus flavus* produces aflatoxin B₁ and B₂ while *Aspergillus parasiticus* produces aflatoxin B₁, B₂, G₁, and G₂. Aflatoxins cause many complications when consumed such as liver cancer and weaken immune system of the body. The upper limit of aflatoxin levels accepted under Kenyan conditions is above 20 parts per billion (MOH, 2004).

2.4 Previous studies on Agricultural Information Systems for post harvest management

In previous studies in Northwest Kenya, Komen et al. (2006) found that losses in maize occurred during pre-harvesting, during harvesting, shelling, drying and storage. Post-harvest losses were also influenced by pre-harvest decisions like time of planting, harvest periods and choice of varieties .They recommended that storage interventional activities must be provided to farmers and traders to reduce maize grain losses for enhanced food security.

In addition, improvements in communication structure that assist in effective dissemination of market information as well as predicting future prices will play a key role in enhancing profitability and encourage maize grain storage among farmers and traders.

National Cereals and Produce Board (NCPB) needs to pay farmers on time to reduce post-harvest losses on the side of farmers (Komen et al., 2006).

From these studies , it was deduced that the existing agricultural information systems on post harvest managemt does not effectively disseminate information to farmers so that they can make better decisions in order to take advantage of market opportunities and manage continuous changes in their production systems. This study intended to fill this gap in Agricultural Information Systems.

2.5 Methodologies used in analysis of Agricultural Information Systems

In the study of Agricultural Information System and communication networks of dairy farmers in Samsun province of Turkey Demiryurek et al (2008) used structured interviews to generate primary data. Structured interviews were conducted with forty –three members and sixty-five non-members of the dairy farmers Association. Following the identification of study population, the sampling frame was defined and the sample size was determined by simple random sampling method. In their survey, Komen et al. (2006) used semi-structured questionnaire and checklist during both individual and informant interviews to collect quantitative and qualitative data.

2.6 Data needed in analysis of Agricultural Information Systems

This literature review shows that there have been no studies on agricultural information systems for post harvest management of food crops among smallholder farmers in South Rift, Kenya. Effective agricultural information systems efficiently support post harvest management of cereal crops. Thus, this study will contribute to the understanding of how to improve agricultural information systems for post harvest management of cereal crops among smallholder farmers.

2.7 Interpreting data in analysis of Agricultural Information Systems

According to Demiryurek (2010), important questions arise when analyzing Agricultural Information Systems for farmers and their information sources. These questions are the sources of information, the content of information, the exchange of information, the extent of the information contact, the degree of usefulness, the reason for not using information and the type of information needed.

He further explained that the information matrix can be used to analyze a specific agricultural information system. This matrix may include possible sources of information, their extent of contact, usefulness of information and other related subjects can be questioned and all respondents can be asked to indicate their status related to these questions for each sources of information.

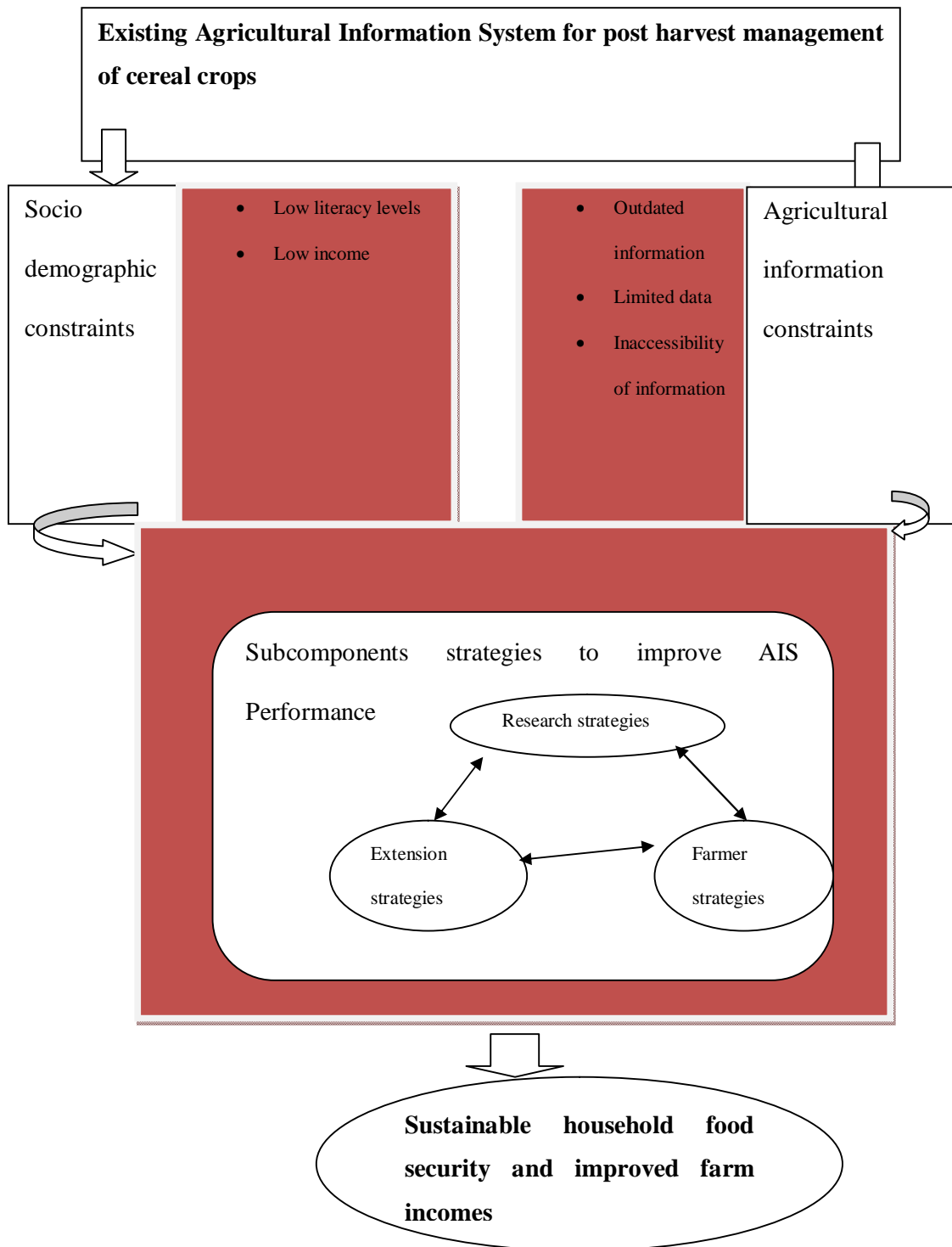
Limited numbers of studies have discussed the methods for analyzing the agricultural information systems (Röling 1988; Engel 1995; Garforth and Usher 1996).

Some studies (Jones et al. 1987; Rolls et al. 1994; Ramkumar 1995) had only used the frequency of information contact with various information sources in order to measure the information score. In the study of agricultural information system and communication networks of dairy farmers in Samsun province of Turkey Demiryurek et al (2008) calculated information scores for each component of the farmers' agricultural information system by multiplying the weights of information contacts with degree of information usefulness. They also used three statistical tests:-the Student test, the Partial Correlation Coefficients (r) and Kendall's Rank Correlation. This study used similar statistical tests to analyze data. In their survey Komen et al (2006) used descriptive and correlation methods to analyze the collected data.

2.8 Conceptual framework of the study

According to Goetz et al (1984) a conceptual framework increasingly strengthens and keeps research on track by providing clear links from literature to the research goals and questions and by contributing to the formulation of the research design. The researcher conceptualized in the study that, an Agricultural Information System can be effective if the constraints in Agricultural information processes are adequately addressed by relevant stakeholders.

Figure 2.1: Conceptual framework



Source: Own conceptualization, 2012

CHAPTER THREE

METHODOLOGY

3.1 Description of study area

The study was carried out in Chepalungu and Bomet districts of Bomet County, South Rift, Kenya. Bomet County is one of the nine counties in the Rift Valley Province. It lies between $0^{\circ}39'$ and $1^{\circ}02'$ south of the Equator and between longitudes $35^{\circ}00'$ and $35^{\circ}32'$ east of prime meridian. The County borders Bureti district to the North East, Narok South district to the south and Transmara to the South West. The total area of the County is 1050km².

Figure 2 shows the location of the County in Kenya.

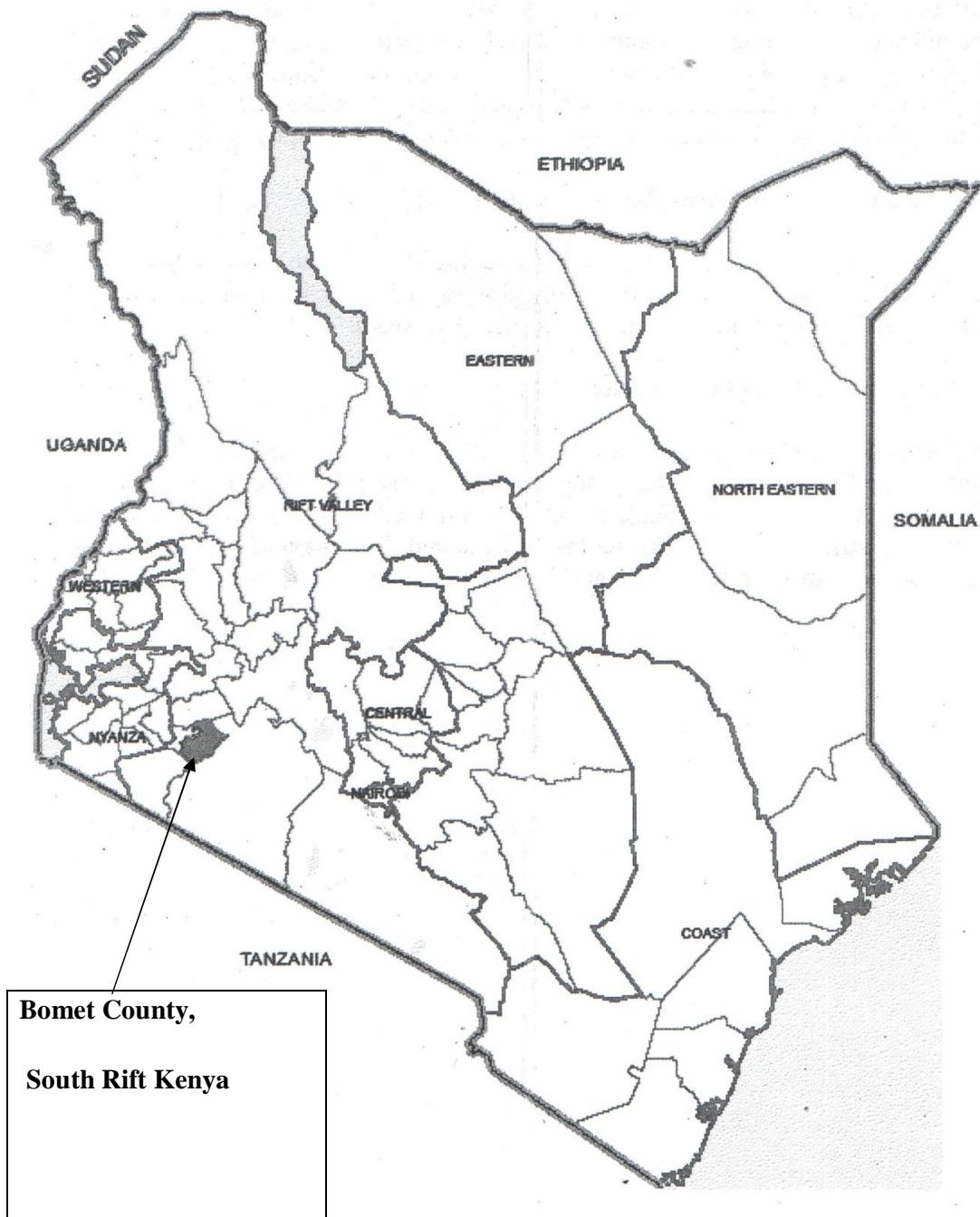


Figure 3.1: Map of Kenya showing position of Bomet County.

Source: District Development Office, Bomet District, 2011.

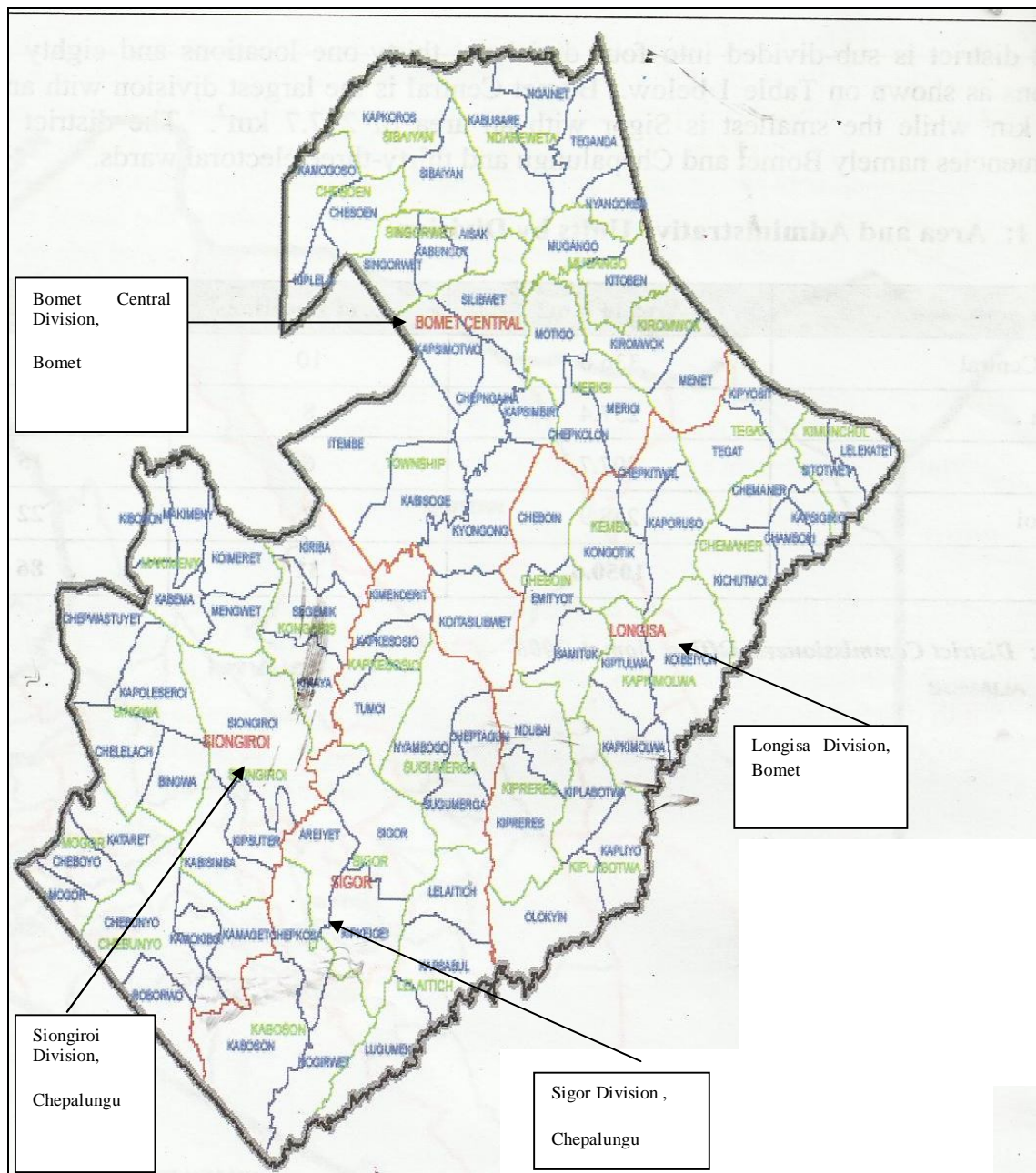


Figure 3.2: Map of Bomet County showing the study area.

Source: District Development Office, Bomet District, 2011.

The two districts lie in the agro-ecological zones Upper highlands (UH), Lower humid 2

(LM₂), Lower midlands1(LM₁) , and Upper midlands1-3(UM₁₋₃).

This area was purposively selected because it is a food crops producing region and post harvest management of food crops is a major constraint to smallholder farmers. Post-harvest losses occur during pre-harvesting, during harvesting, shelling, drying and storage Komen et al (2006) and furthermore the existing Agricultural information systems on post harvest management does not effectively disseminate information to farmers. Hence, this study was intended to close this gap by suggesting ways of improving the performance of existing Agricultural Information Systems.

3.2 Sample size and sample selection

Research design constitutes the blueprint for collection, measurement and analysis of data (Kothari, 2004).This study used descriptive research design to describe the current situation of Agricultural information systems for post harvest management of cereal crops among smallholder farmers. Kerlinger (1969) points out that descriptive studies are not only restricted to fact finding, but may often result in formulation of important principles of knowledge and solution to significant problems.

This study attempted to find out how successfully Agricultural information is generated, channeled and utilized by smallholder cereal crops farmers in South Rift, Kenya. The study started from initial survey and making site visits to the areas which were relevant to the posed research questions and objectives, considering heterogeneity of study population and identified and selected accessible smallholder farmers who fulfilled these criteria. Quantitative and qualitative research methods was employed to identify answers to research questions with the help of research assistants who were trained adequately on administering questionnaires and sampling techniques.

The study used multi-stage sampling method for selecting household respondents. In this type of sampling, the sample population was stratified into strata or subpopulations before making a selection of a random sample from each population or stratum. The sub populations were based on the Chepalungu and Bomet districts of Bomet County. From each of the two districts, households were selected for interviews using simple random sampling.

The sample frame in the study was defined as the list of smallholder cereal crops farmers and sample size defined aiming at 95% confidence interval using the formula:-

$$n = \frac{z^2 pq}{d^2}$$

(Fischer et al, 1991)

Where, **n** is the desired sample size, **z** is the standard normal deviate, usually set at 1.96 and **p** is the proportion of population estimated to have a particular characteristic.

p can be the proportion of households using Agricultural information on post harvest management of cereal crops(0.9) , **q=1-p** (0.1),the proportion of households not using Agricultural information on post harvest management of cereal crops and **d** is the degree of accuracy usually set at 0.05. This formula was used because there was an assumption that there was a large population adopting agricultural information on post harvest management in the county.

The proportion of households using Agricultural information on post harvest management of cereal crops was based on the results of a study by Ndungu et al. (1995) which showed that 90% of the respondents interviewed source and use information from public information sources, mass media and stockists.

Thus,

$$n = \frac{(1.96)^2(0.9)(0.1)}{0.05^2}$$

0.05²

$n=138.3$ which is approximately 140. Hence, this study was to sample 140 households.

The study consisted of two phases; the non-sample pilot study on the same study population and the main fieldwork. The aim of the pilot study was to test and refine the interview questions and ensure that they functioned effectively.

3.3 Data collection Methods and Instruments

The study used open and close ended questionnaires, semi-structured interviews and direct observations to collect primary data. These multiple data collection techniques were used in order to increase the validity and reliability of the obtained. The research instruments were in form of questionnaires. There were two types of questionnaires used in the study namely:

- (i) **Cereal crops storage household survey questionnaire.** This was used to capture socio-demographic information such age, sex, education level, land sizes, occupation and information related processes on agricultural information for post harvest management.
- (ii) **Agricultural service providers interview questionnaire.** This was be used to capture information on names of institutions, type of services offered and the role of the service providers in disseminating information on post harvest management of cereal crops and improvements on agricultural information systems. These questionnaires are annexed in this report in Appendix 3 and Appendix 4 respectively.

3.4 Data Analysis

Information scores for smallholder farmers were calculated by multiplying the weight of the information access with the degree of information usefulness. The Total Information Scores (TIS) is formulated as;

TIS = number of access × degree of usefulness of information.

The weights were given according to the extent of the information access. A weight of 0 can be given for no contact, 1 for once a year, 2 for two times a year and so on. Similarly, the degree of usefulness of information sources was also weighted. A weight of 1 was given to not useful at all, 2 for a little useful, 3 for relatively useful, 4 for useful and 5 for very useful.

The Total Information Scores reflect not only the quantity but also the quality of the information contact thus it can be used to rate the performance of existing Agricultural Information System.

The quantitative data were analyzed using descriptive statistical tools including mean, frequency distributions, percentages, charts and simple correlations.

Correlation analysis was employed to examine the relationship between the personal, demographic and socio-economic factors of farmers (independent variables) and the performance of Agricultural Information System (dependent variable). Pearson's coefficient of correlation is the most widely used method of measuring the degree of relationship between two variables (Kothari, 2004). Pearson's Correlation Coefficient (r) measures interval or ratio level variables by determining the strengths of relationship. It is used to establish whether the variables in question are related to each other and is calculated as,

$$r = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{n}}{\sqrt{\left(\sum X^2 - \frac{(\sum X)^2}{n}\right) \left(\sum Y^2 - \frac{(\sum Y)^2}{n}\right)}}$$

(Sarantakos, 1988).

Where, X = ith value of X variable

Y = ith value of Y variable

n = number of pairs of observations of X and Y.

The value of the test statistics of Pearson's Correlation Coefficient range from -1 to 1.

3.5 Description of Variables

3.5.1 Dependent Variables

The dependent variable in this study is the performance of existing agricultural information System. The agricultural activity requiring information is post harvest management of cereal crops. The analysis of Agricultural Information Systems in a specific farming system may provide the identification of basic components and structure of the system, different sources of information used by different components in the system, the understanding of how successfully the system works and how to improve system performance (Demiryurek, 2000).

3.5.2 Independent Variables

The following independent variables were hypothesized to influence the performance of existing Agricultural Information System in the study area.

1. Agricultural Information sources

Agricultural information sources were identified initially in collaboration with the extension staff in the study area.

In order to document these sources, the respondents were asked to specify each source of information and their degree of usefulness. The degree of usefulness was ranked as 0 for not useful, 1 for less useful, 2 for relatively useful, 3 for useful and 4 for very useful.

2. Agricultural Information access

Available literature has shown that farmers need to have access to Agricultural information in order to improve agricultural production. In order to document information access, the respondents were asked to first specify the source of information and the frequency of access

the previous year. A weight of 0 was given for no access, 2 for two times a year, 4 for four times a year and 5 for more than four times a year.

3. Agricultural Information requirements

Working in collaboration with extension staff in the study area, the researcher initially identified the agricultural information requirements of smallholder farmers on post harvest management and these includes understanding of what post harvest loses are and estimating of post harvest loses, causes of crop contamination, awareness of aflatoxin and getting operational skills on proper drying of produce, acquiring technical skills on storage facilities and storage chemicals.

In this study, the respondents were asked to specify the information they require on post harvest management from different sources.

4. Personal and socio-economic factors of smallholder farmers.

This study sought to find out personal and socio-demographic factors that influence Agricultural information for post harvest management of food crops.

Formal education is the highest education qualification attained by the smallholder food crops farmers. This was measured in terms of 0=illiterate, 1=Primary, 2=Secondary3=College, 4=University and 5= Others.

Agricultural income is the income obtained from sale of crops and livestock. High income earned from the agricultural activities generally increases the farmers' financial capacity and may help in adoption of new technologies.

Subsequently, agricultural income is expected to positively influence the performance of Agricultural Information System. Agricultural experience is the number of years farmers

have been in farming and longer farming experience implies accumulated farming knowledge and skills. Marital status is the status of being married or not married. Available literature shows that in agriculture, married farmers produce more and the desire to produce more could lead to agricultural information seeking and use.

Thus, marital status is expected to directly or indirectly influence the performance of Agricultural Information System. Sex of householdhead refers to biological differentiation of the respondents. It is nominal variable thus was used as dummy (1 if male, 0 otherwise). The mean of each variable was computed and correlated with the performance of Agricultural Information System.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents and discusses the findings of the study. The first section gives and discusses the results of sources of Agricultural Information and the second section gives the results of the degree of usefulness for the preferred information source. The third section gives and discusses the results of the access of Agricultural Information while the fourth section gives and further discusses the results of Agricultural information requirements and Awareness of Aflatoxin.

The fifth section summarizes the results of personal, demographic and socio-economic and their relationship with the performance of Agricultural Information System. Finally, the results of the role of Agricultural extension service providers in enhancing farmers' access to Agricultural information for post harvest management of cereal crops are presented and discussed in section six.

The study yielded 136 respondents useable for data analysis representing 97% of response rate. Five Agricultural extension service providers were interviewed. The data was presented using tables, charts, frequencies and percentages where appropriate.

4.1 Sources of Agricultural Information

This study sought to find out where smallholder farmers source agricultural information on post harvest management of food crops and ranks these sources by giving their degree of usefulness. The results are presented in Tables 1 and 2.

Table 4.1: Sources through which smallholder farmers obtain Agricultural Information

Agricultural Information Sources	Responses	
	Frequency	Percentage
1.Mass media	48	35.3
2.Personal information sources	4	2.90
3.Extension agents	83	61.0
4.Public research institutions and Universities	1	0.70
Total	136	100

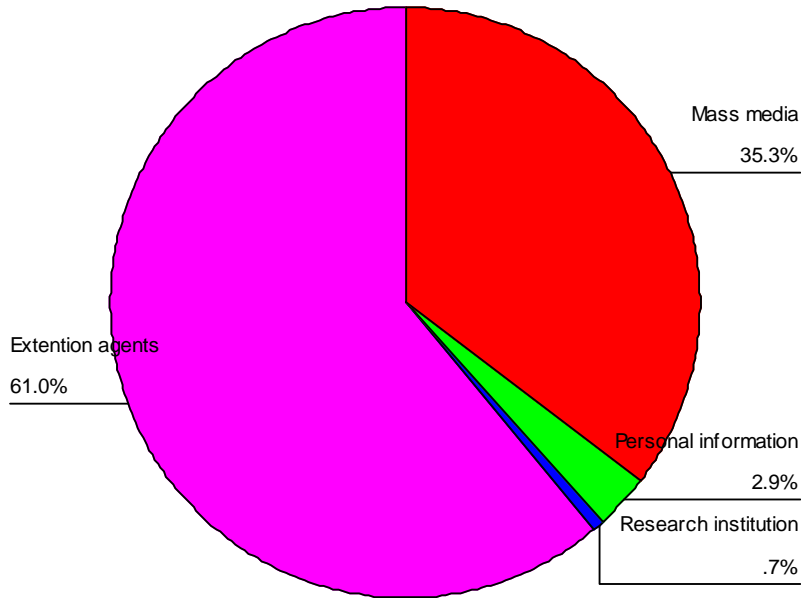


Figure 4.1: Sources through which smallholder farmers obtain Agricultural Information

Source: Own survey data, 2012

4.2 Degree of usefulness of sources of preferred Agricultural Information source.

In order to document the degree of usefulness of information sources, the respondents were asked to give the usefulness of the information source. The weight of 0 was given to not useful, 1 to less useful, 2 to relatively useful, 3 to useful and 4 to very useful (Demiryurek , 2010).

Table 4.2: Degree of usefulness of Agricultural Information from extension agents.

Usefulness	Responses	
	Frequency	Percentage

Less useful	1	0.7
Relatively useful	2	1.5
Useful	25	18.4
Very useful.	108	79.4
Total	136	100

Source: Own survey data, 2012

The results showed that the majority of smallholder farmers 61 % ranked the Extension agent as their highest source of Agricultural information. This result is consistent with findings of Ndungu et al (1995) and thus this study re-emphasizes the importance of the Extension agents in Agricultural information dissemination channel. Other significant sources of Agricultural information to the smallholder farmers revealed in this study include mass media. As noted by Rogers (1995), the preference for public information sources such as the Extension agents is attributed to the built-in feedback potential and this source being highly credible.

Based on smallholder farmers' current knowledge, these sources of information fairly support in dissemination of information on post harvest management. However, in view of emerging Information Communication Technologies applicable to agricultural, more interactive information sources are needed. The results further indicated that the majority (79.4 percent) of smallholder farmers viewed the extension agent as a very useful source of their Agricultural Information.

4.3 Access of Agricultural Information

The results of frequency of smallholder farmers accessing Agricultural Information are presented in Table 3.

Table 4.3: Frequency of smallholder farmers accessing Agricultural information per year

Agricultural Information access	Responses	
	Frequency	Percentage
No access	21	15.4
Once/year	61	44.9
Twice/year	27	19.9
Four times/year	10	7.4
Other(more than Four times/year)	17	12.4
Total	136	100

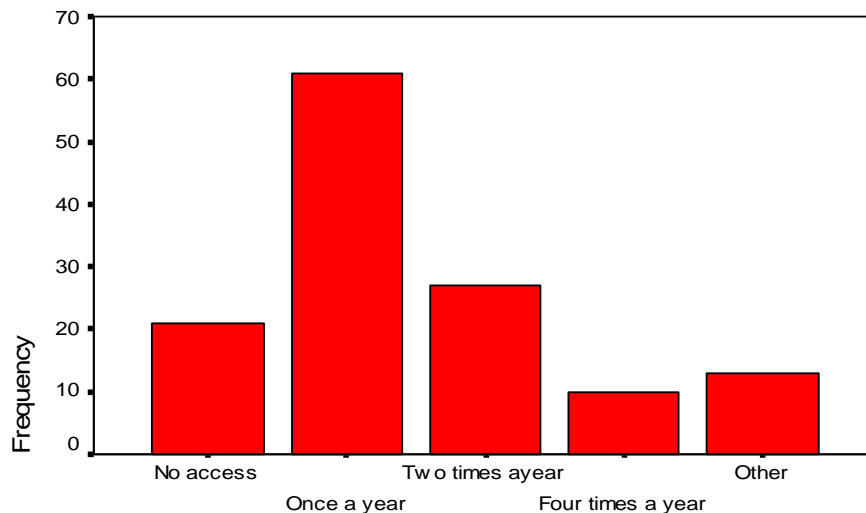


Figure 4.2: Frequency of smallholder farmers accessing Agricultural Information

Source: Own survey data, 2012

The findings of this showed that 15.4 % of smallholder farmers have no access to Agricultural information on post harvest management. Majority of the farmers surveyed; 44.9 % access Agricultural information once per year. Since most cereal crops are grown in the county twice a year, smallholder farmers need to at least access Agricultural information twice per year. However, only 19.9 % access Agricultural information twice per year.

4.4 Agricultural Information requirements of smallholder farmers on Post harvest management.

In this study, the respondents were asked to specify the information they require on post harvest management from different sources. The results are presented in Table 4.

Table 4.4: Agricultural Information requirements of smallholder farmers on Post harvest management.

Type of Agricultural Information required	Responses	
	Frequency	Percentage
1.Understanding what Post harvest losses are	19	13.3
2. Estimating of Post harvest losses	9	6.7
3. Causes of crop contamination	2	1.5
4. Awareness of Aflatoxin	37	27.4
5.Operational skills on proper drying of produce	28	20.6
6. Technical skills on storage facilities and storage chemicals.	41	30.4

Total	136	100
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Source: Nyaururu self help Group, Longisa Division in Bomet District

Figure 4.3: Proper maize drying by farmers as a result of their information requirements being addressed.

The findings of this study indicated that 30.4 percent require information on storage facilities and storage chemicals, 27.4 percent require information on aflatoxin and 20.6 percent on drying of crop produce. Smallholder farmers' agricultural information requirements on post harvest management are not being addressed adequately due to inadequate human resource, lack of joint planning by different actors and low farmers' education levels.

Post harvest management requires technology specific agricultural information thus newer approaches are needed to assess the information requirements of this particular smallholder farmers.

4.4.1 Awareness of Aflatoxin

This study also focused on the awareness of Aflatoxin. The respondents were asked to state whether they were aware of Aflatoxin or not aware of Aflatoxin. These findings are presented in Table 5.

Table 4.5: Awareness of Aflatoxin by smallholder farmers

Response	Awareness of Aflatoxin	
	Frequency	Percentage
Yes	125	91.9
No	11	8.1
Total	136	100

Source: Own survey data, 2012

The findings revealed that majority of smallholder farmers (91.9 %) knew about aflatoxin. This is attributed to the wide coverage of vernacular radio programs used to disseminate agricultural messages on post harvest management at least on weekly basis.



Non provision of agricultural information results in fungi infecting maize which is not dried properly before storage.

Figure 4.4: Maize cob contaminated with aflatoxin producing fungi.

Source: MOA Bomet, 2011. Training notes on Staff sensitization on Aflatoxin.

4.5 Relationship between selected personal, demographic and Socio- economic factors and performance of Agricultural Information System.

Table 4.6: Correlation coefficient calculation

Variables	Mean of respondents(X) n=136	Information score of respondents(Y)	X²	Y²	XY
Age of farmers(in years)	35.81	300.96	1282.36	90576.92	10777.38
Formal education of farmers (in years)	10.22	166.32	104.45	27662.34	1699.79
Agricultural income(% in total income)	25.95	318.40	673.40	101378.56	8262.48
Agricultural experience(in years)	15.75	269.29	248.06	72517.10	4241.31
Total	87.73	1,054.97	2308.27	267,238.92	24,953

r=0.02081, hence r² = 0.00043 Source: Own survey data, 2012

The results indicated that the average age of the respondents was 35.81 years and mean number of years of farmers' formal education was 10.22. The mean number of years of agricultural experience was 15.75 while the mean of agricultural income (% in the total income) was 25.95.

Results from Pearson's coefficient of correlation when age, formal education agricultural income and experience were correlated with the Total information score showed that r was 0.02081. This indicates positive correlation between these variables.

Thus, as a strategy to constraints in the existing agricultural information systems the focus should on addressing the low levels of formal education, low agricultural income and less agricultural experience.

4.6 The role of extension service providers

It was also necessary in this study to establish the role of Extension service providers in enhancing farmers access to Agricultural information for post harvest management of food crops. In order to determine role of extension service providers in enhancing farmers access to Agricultural information for post harvest management of food crops, five respondents representing purposively selected institutions were interviewed. These institutions were:

1. National Cereals and Produce Board-Bomet,
2. Kenya Farmers Association-Bomet,
3. Kenya National Agricultural Producers- Bomet,
4. Silibwet Agrovet Services,
5. Ministry of Agriculture -Bomet District,

The findings of this study are presented in Table 8 and Table 9.

Ministry of Agriculture being a government department disseminates agricultural information to smallholder farmers on post harvest management of food crops in the County. Kenya Farmers Association and Kenya National Agricultural Producers are farmers' associations and co-operatives societies and play farmer advisory roles and engage in supplying storage agrochemicals of crop produce.

National Cereals and Produce Board mainly deals with purchase, storage and marketing of cereal crops in the region. Silibwet Agrovvet Services supplies farm inputs including storage agrochemicals of cereals to farmers.

All the five Institutions indicated that they are involved in dissemination of agricultural information to farmers on issues of post harvest management of crops such as drying of produce, understanding post harvest losses and applying of storage agrochemicals. The results of this study further confirms the findings of Berhanu et al (2006) on the facilitator role of extension service providers in enhancing adoption of improved agricultural technologies .

4.7 Limitations of the study

The study was limited to cereal crops smallholder farmers in Bomet county. The study only on focused on information sources, requirements, accessibility and socio-economic characteristics of farmers in post harvest management of cereal crops in the region. However ,one of the limitation in data collection in the study area was the emergence of unidentified maize disease which had discouraged farmers from growing this cereal crop .

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

There is need to strengthen the existing Agricultural information system in order to provide quality information since study showed smallholder farmers' agricultural information requirements on post harvest management are not being addressed adequately. Agricultural information theory is useful in understanding the system as a whole and to identify strengths and weaknesses of the system studied.

One of the strengths of the institution based Agricultural Information System is open access to public domain agricultural information and it should be exploited. However, less agricultural experience, low agricultural income and low farmers' education levels limit the effective utilization of Agricultural Information on post harvest management. Education level of smallholder farmers has a role to increase the ability to obtain, process and use of agriculture related information and use post harvest management technologies in a better way.

The analysis also showed that majority of smallholder farmers source Agricultural Information from extension agents thus preferred media for Agricultural Information presentation to smallholder farmers on post harvest management is the extension agent.

5.2 Recommendation to Agricultural policy makers

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

1. Research results indicated that extension agent is preferred source of Agricultural Information. Therefore, the policy makers in the government should ensure that programmes on Agriculture by all service providers should focus more on capacity building of the extension agents with the emphasis on skill development on post harvest management ICTs.
2. Consequently, extension agents should be retrained by Ministry of Agriculture on promoting post harvest management activities bearing in mind the changing ICT environment.
3. In order to achieve effective dissemination of agricultural information, there should be joint planning by all players in extension service on post harvest management common activities.
4. All the leading agents in Agriculture sector spearheaded by Ministry of Agriculture need to develop a small holder farmers' friendly Agricultural Information system which can address problems of post harvest management using ICTs.

The following future researches are also recommended:

1. Mandated Agricultural Research Stations on cereal crops in the country should conduct research on economics of post losses in the County in order to attach monetary value to the losses.
2. Similarly, future research undertaken be conducted to ascertain quality of information smallholder farmers in the County in terms of content, accuracy, appropriate format and how current the information is.
3. Lastly, research on farmer friendly post harvest management ICTs on cereal crops specific to the County should be undertaken.

REFERENCES

- Aboyade, B. Olabimpe.(1987) The provision of information for rural development. Ibadan: Foundation Publications.
- Adomi, E. E., Monday, O., Ogbomo, & Inoni, O. E. (2003). Gender factor in crop farmer's access to agricultural information in rural areas of Delta State, Nigeria. *Library Review*, 52(8), 388–393.
- Akande, S.O. (1999). A study of agricultural research system of Nigeria. NISER Monograph Series No. 6. Ibadan: Nigeria Institute of Social and Economic Research (NISER).
- Azu, J (2002). Post-harvest losses reduction: OICI Tamale's quick interventions for reducing food insecurity, Ghana, OICI International.
- Bandyopadhyay (2010). *New Cure for Aflatoxin in Maize still miles away from farmers :Daily Nation Publications,16th June2010.Nairobi, Kenya.*
- Berhanu Gebremedhin, Hoekstra D and Azage Tegegne. 2006. *Commercialization of Ethiopian agriculture: Extension service from input supplier to knowledge broker and facilitator* .Improving Productivity and Market Success of Ethiopian Farmers Project. Working Paper 1. ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Birner, R., Davis, K., Pender, J., Cohen, M. (2006). FROM “BEST PRACTICE”TO “BEST FIT”: *A Framework For Analyzing Pluralistic Agricultural Advisory Services Worldwide*. IFPRI. Washington, DC.
- Bruening, T.H., Radhakrishna, R.B., & Rollins, T.J. (1992). Environmental issues: Farmers' perceptions about usefulness of informational and organizational sources. *Journal of Agricultural Education*, 33(2), 34-42.

- Cavallo, R.E. (1982). *Systems methodology in social science research: recent developments*. Boston, MA: Kluwer Publishing.
- Checkland, P.B. (1981). *Systems thinking, systems practice*. Chichester, UK: John Wiley and Sons.
- Checkland P., Holwell S. (1998): *Information, Systems and Information Systems: Making Sense of the Field*. John Wiley and Sons, Chichester.
- Ciborra C., (2002): *Labyrinths of Information*. Oxford University Press, Oxford.
- Cidro,D.A., Radhakrisma(2005). *Usefulness of information sources in the promotion of hybrid rice program in the Philippines*, Philippine Rice Research Institute, Philippines.
- Compton, J. A. F,(1992). *Reducing Losses in Small Farm Grain in the Tropics*:Catham,Nbi.
- Demiryurek, K. (2000). *The analysis of information systems for organic and conventional hazelnut producers in three villages of the Black Sea Region, Turkey*. Unpublished doctoral dissertation, University of Reading, Reading, UK.
- Demiryurek, K. (2006). Distance education for rural people in developing countries: Turkish experience. *Journal of Extension Systems*, **22**(2), 83-94.
- Demiryurek, K. (2008). Agricultural information systems and communication networks: the case of dairy farmers in samsun province of Turkey. *Information Research*, 13, 2, Mayis Univ, Samsun ,Turkey. *Journal of Information Research*. Vol 13 no. 2 .
- Agricultural information systems and communication networks for rural people. *Agric. Econ. – Czech*, 56, 2010 (5): 209–214
- Engel P.H. (1995): *Facilitating Innovation: An Action-Oriented Approach and Participatory Methodology to Improve Innovative Social Practice in Agriculture*.

[PhD Dissertation.] Department of Communication and Innovation Studies, Wageningen Agricultural University, the Netherlands.

Fischer, W., (1991). Sampling formula for Wright Fischer model.

Garforth C., Usher R. (1996): Methodologies for analysing and improving the effectiveness of promotion and uptake pathways for renewable natural resources information and technology: a review paper . AERDD Working Paper 96/8. The University of Reading, Reading.

Goetz, O. M and LeCompte, S. Z (1984). *Educational Research : An Introduction*. Cape Town: Mc Gregory Publishers.

Huirne, R.B.M., Harsh, S.B. & Dijkhuizen, A.A. (1997). Critical success factors and information needs on dairy farms: the farmer's opinion. *Livestock Production Science*, 48, 229-238.

Irivwieri, J. W. (2007). Information needs of illiterate female farmers in Ethiopia East

Jones G.E., Rolls M.J., Tranter R.B. (1987): Information Management in Agriculture. British Library R&D Report 5931. AERDC, The University of Reading, Reading. *Journal of Extension*, 34(1).

Kalusopa, T. (2005). The challenges of utilizing information communication technologies (ICTs) for small-scale farmers in Zambia. *Library Hi Tech*, 23(3), 196–204.

KARI (2006). Food Crops Research Programme. Available at <http://www.kari.go.ke>
Accessed on 5.11.2011

Kerlinger, F.N.(1973). *Foundation of Behavioral Research*. New York: Holt, Rinehart and Winston.

- Kirimi, L. (2009). *Crisis as farmers grapple with huge harvest : Field report,2009*, Egerton Univ., Tegemeo Institute of Agricultural Policy and Development, Kenya
- Komen, J.J, and Mutoko, C. M., (2006). Economics of Post-harvest Maize Grain Losses in Trans-Nzoia and Uashin –Gishu of Northwest Kenya .
- Kothari, C. R.(2004). Research Methodology, Methods and Techniques. New Age International and Publishers, New Delhi.
- Made, J. (2010). Financing Smallholder Farmers Agriculture and Rural Development, Zimbabwe.
- Mohammedali, O.N. (1977). Practical agriculturists, literacy and agricultural information in East Africa. *Libri*, 27(4).
- Milan, S. and Emil, Kriz., (2003) Change in Management of Information Systems in Czech Agriculture. WORKSHOP 4-Knowing and Learning: labour and skills at stake for a multidimensional agriculture, Czech University of Agriculture in Prague, Department of Education.
- Mokotjo, W. and Kalusopa, T., (2010). Evaluation of Agricultural Information Service (AIS) in Lesotho. *International Journal of Information management*, Vol 30 no. 4, 350-356.
- Ndugu,F.W., Nkonge C., Rees, D. J.,(1995). Agricultural knowledge and information systems (AKIS) paradigm: Its potential in disseminating soil management Technologies.
- Naidoo, G. & Rolls, M.J. (2000). A method to investigate agricultural information use by small-scale Mauritian cattle keepers. *Journal of Agricultural Education and Extension*, 7(1), 57-65.

- Opara, U. N., (2008). Agricultural information Sources Used by Farmers Imo State, Nigeria. *Sage journal of Information Development* 2008 24: 289.
- Opara, U. N., (2010). Personal and Socio-Economic Determinants of Agricultural information Use by Farmers in the Agricultural Development Programme (ADP) Zones of Imo State, Nigeria,
- Ortiz, O.O.E. (1997). *The information system for IPM in subsistence potato production in Peru: experience of introducing innovative information in Cajamarca Province.* Unpublished doctoral dissertation, University of Reading, Reading, UK.
- Ozowa, V.N. (1995) Information needs of small scale farmers in Africa: the Nigeria example. *Quarterly Bulletin of the International Association of Agricultural Information Specialists*, 40 (1).
- P HL Network: Post Harvest Losses Information System-What are the PHLs .Available at <http://www.phlosses.net> Accessed on 15.10.2010.
- Purcell DL and Anderson JR. 1997. Agricultural research and extension: Achievements and problems in national systems. World Bank Operations Evaluation study, World Bank, Washington, DC, USA.
- Radhakrishna, R.B. & Thomson, J.S. (1996). Extension agents' use of information sources. *Journal of Extension*, 34(1).
- Ramkumar S.N. (1995): The analysis of farmer information systems for feeding of dairy cattle in two villages of Kerala State, India. [PhD Thesis.] The University of Reading, Reading.
- Rees, D. and Wekundah, J. (2000). Agricultural Knowledge and Information Systems in Kenya. Agricultural Research & Extension Network. Network paper No.107.
- Republic of Kenya (2004). Strategy for revitalizing Agriculture 2004-2014, Nairobi, Kenya.

- Republic of Kenya (2008). Ministry of Planning, National Development and Vision 2030. Bomet District Development plan 2008-2012.
- Republic of Kenya (2010). Agricultural Sector Development Strategy 2010-2020, Nairobi, Kenya .
- Rogers, E.M. (1995). Diffusion of innovations. 4th ed. New York: The Free Press.
- Röling N.G. (1988). Extension Science: Information System in Agricultural Development. Cambridge University Press, Cambridge
- Rolls M.J., Hassan S.H.J., Garforth C.J., Kamsah M.F. (1994): The agricultural information system for smallholder farmers in Peninsular Malaysia. Rural Extension and Education Research Report No. AERDD, The University of Reading, Reading.
- Samuel G., (2001). The Development of Integrated Management Information System for Agricultural Extension institutions of Developing Countries: The case of Oromia Agricultural Development Bureau of Ethiopia.
- Sarantakos, R., 1988. Social Research, Second Edition. Macmillan Press Londen.
- Sheba, N.R. (1997). Using the library for problem solving in African agriculture. Information Development, 13(3), 132-134.
- Shibanda, G. G. (1999). Optimising fisheries information for decision making among Kenyan fish pond smallholders. Library Review, 48(8), 408–412.
- Shiraz, D. (1987) Agricultural Information Services in Kenya and Third world needs . *Journal of Librarianship and Information Science*,19, 2, pp 108-120.
- Spedding, C.R.W. (1988). *An introduction to agricultural systems*. (2nd. ed). London: Elsevier Applied Science.
- Venkatesan, Venkatachalam. (1995) The World Bank's experience with T & V in Africa: issues for the future agricultural extension in Africa. Proceedings of an International

Workshop, Yaoundé, Cameroon. The Netherlands: Technical Centre for Agriculture and Rural Cooperation.

WHO (2005). Impacts of Aflatoxins on Health and Nutrition. Report of an Expert group meeting. Brazzaville.

APPENDICES

APPENDIX I: CEREAL CROPS STORAGE HOUSEHOLD SURVEY

QUESTIONNAIRE

HHID _____

(3digit code)

Note to respondents: This questionnaire is intended to collect data on existing agricultural information on post harvest management of Cereal crops. The data collected will only be used for academic purposes and thus it will be treated with maximum confidentiality and never be made available in its raw form.

Please assist to fill in so as to improve the system.

1a	Eunemerator's first,second name	
B	Eunemerator's surname /third name	
2	Date of interview ("dd mm yyyy")	
3a	Responent's first,second name	
B	Responent's surname/third, name	
4	Household location	
a.	County	
B	Subcounty	

C	Division	
D	Location	
E	Sublocation	
F	Village	

Part A: HOUSEHOLD IDENTITY	
5a	First,second name of head of household
B	Surname/third name of head of household
6	Relationship of the respondent to head of household

6 CODE
1-Self
2-Wife
3-Son
4-Daughter
5-Relative
6-Labourer
7-Other,specify

PART B: SOCIO-DEMOGRAPHIC INFORMATION

7	8	9	10	11	12	13		15
Household member ID 1 = HH Head 2 = Spouse of HH head 3=Other	Sex of the HH member	What is the age of HH member?	What is the education level of HH member?	Main occupation of HH member?	What are the sources of household income?	Agric income	Marital status	Agric experience
						% in total income	yrs

B8 CODE

1=Male
2=Female

B9 CODE

1=15-24YEARS
2=25-35YEARS
3=36-45YEARS
4=Above 45 years

B11 CODE

1-Farmer
2-Trader
3-Formal employment(specify)
4-Jobless
5-Other(specify)

B12 CODE

1-On-farm
2-Off-farm
3-Other(Specify)

B10 CODE

0=None
1=Primary
2=Secondary
3=College
4=University
5= other. specify

B13 CODE

1= >10
2=10-25
3=26-40
4=41-55
5=Above 55

B14 CODE

1=Married
2=Single
3=Divorced
4=Widowed
5=Other, specify

PART C: CULTIVATED LAND FOR FOOD PRODUCTION

16a	How many acres of land does this household own?	-----Acres
16b	How many acres were rented in this season?	-----Acres
16c	How many acres were rented out this season?	-----Acres
17	Total acres available for cultivation this season ?	-----Acres
18	How many acres were used for cereal crops?	-----Acres

PART D : CEREAL CROPS PRODUCTION

19. Which cereal crops do you grow and rank them in order of importance?

Crop name	Crop ID	Rank
	C1	1= Most important
	C2	2 = Important
	C3	3 =

4. often		
5. All the time		
25. Have you seen pests, insects, rodents in you storage facility? (last 12 months)		
	1- Yes ; 0 - No	
26. If Yes, which insects attacked crops in storage facility?		
1=LGB	3=Bruchids	
2=weevils	4=Other,specify	
27. Main consequences of insect damage		
1- Lower prices 2 - Unplanned, hurried sales		
3 - other, specify		
28 .Estimate crop loss due to insect damage _____%		
29a. Did you use any pesticides or chemicals on cereal crops?		
1= Yes ; 0 = No		

29 b. If **Yes**, which chemical did you use against insect damage?
(last 12 months)

- | |
|-------------------|
| 1. Actellic dust |
| 2. Actellic super |
| 3. Skana super |
| 4. Malathion dust |
| 5. Other, specify |

30a. Do you know what **Aflatoxin** is? 1 = Yes; 0 = No.

30b. Where did you learn about **Aflatoxin**?

- | |
|--------------------------|
| 1. - TV |
| 2 - English radio |
| 3 - Kiswahili radio |
| 4 - Local language radio |
| 5 - Newspaper |
| 6 - Neighbour |
| 7 - Extension Officer |
| 8 - Other specify |

PART F: AGRICULTURAL INFORMATION NEEDS, AND SOURCES

31a. **What type** of technical assistance do you require on post harvest practices and rank the source of this assistance in order of importance.

Type of technical assistance	Rank Order	F31 CODE
	1 = Most important	1. What are post harvest loses? 2. Estimating post harvest loses 3. Agents of bio-deterioration 4. Drying of Produce 5. Storage facilities and chemicals 6. Aflatoxin
	2 = Important	
	3 =	
	4 = etc	
	last = least important	
	Source	Rank/Usefulness
	1 Mass media - Radio, TV	0 = Not useful
	Newspapers	1 = Less useful

2. Other farmers	2 = Relatively useful
3. Research institutions	3 = Useful
4. Extension officer	4=Very useful
5. Other, specify	

APPENDIX II: EXTENSION SERVICE PROVIDERS INTERVIEW QUESTIONNAIRE

Enumerator's first, second
name.....
 Enumerator's surname / third
name.....
 Date of interview (**dd mm yyyy**).....
 Respondent's surname/ third
name.....

Part A: Institutional Identity

- 1) Name of Institution.....
- 2) Contact of Institution
 - a. Postal address.....Code.....
 - b. Telephone.....
 - c. Email address.....

- 3) Category of Institution
 - 1=Public
 - 2=Private
 - 3= Other

- 4) What is your
coverage/mandate?
 - 1-Local
 - 2-Regional
 - 3-National
 - 4-International
 - 5-Other,specify

5) Please explain briefly the job descriptions of your institution. .

.....
.....

6) a. Do you provide agricultural information on post harvest management?
1=Yes; 2=No.

6)b. What type of agricultural information on post harvest management of food crops do you provide?

Agricultural information on: 1=Drying 2=Storage 3 Agents of post harvest losses 4=Aflatoxin 5=Other
--

6) c. Please specify how agricultural information on post harvest management is disseminated.

1- Mass media –opinion leaders-farmers 2-Institution-extension officers-farmers 3 Farmer-farmer

6) d. How often do you provide agricultural information on post harvest management?

1-Once/ year 2-Half yearly 3-Quarterly 4-Other, specify
--

6) e. How do you get feedback on disseminated agricultural information from smallholder farmers?

.....
.....

Part C: Socio-economic factors

7) In your opinion, what socio-economic factors influence agricultural information on post harvest management?

.....
.....

Part D: Improvements

8) Please briefly give suggestions on how to enhance smallholder farmers' access agricultural information on post harvest management of food crops in the region.

.....
.....
.....
.....
.....

Thank you for your cooperation

APPENDIX III: INSTITUTIONS VISITED

Name of person Interviewed	Designation and Contact Information
1.Mr. Antony Tanui	Manager National Cereals and Produce Board P.O. Box 30586, Bomet Telephone:020536028 Email:bomet@ncpb.co.ke
2.Mr. Jonathan Koech	Crops Development Officer Ministry of Agriculture P.O. Box 27-20400,Bomet Telephone:052-22271 Email:bometdao@yahoo.com
3. Ms. Mwikani Jecinta	District Coordinator KENFAP P.O. Box 434-20400, Bomet Telephone:0714673342 Email:producers@kenfap.org
4.Mr. Joseph K. Kirui	Proprietor Silibwet Farmers Centre P.O. Box 53-20422, Silibwet Telephone:0720861095 Email:kipsielekirui@yahoo.com
5.Ms. Lily B. Cherotich	Clerk Kenya Farmers Association P.O. Box 261-20400 Bomet

Source: Own compilation, 2012

APPENDIX IV: ROLE OF INSTITUTIONS

Name of Institution: National Cereals and Produce Board
Type of services offered: Purchase, storage and marketing of cereal crops.
Role in Agricultural information dissemination: Provision of information on drying, storage and aflatoxin contamination
Suggested improvements on Agricultural information System: Joint planning and use of mass media to reach more farmers.
Name of Institution : Ministry of Agriculture
Type of services offered : Disseminates agricultural information to farmers
Role in Agricultural information dissemination : Training farmers on recommended methods of drying, storage and awareness of aflatoxin.
Suggested improvements on Agricultural information System: Use of mass media such as vernacular FM radio stations to reach farmers. Enhanced use of methods such as field days, Barazas, shows etc.
Name of Institution : Silibwet Farmers Centre supplies farm inputs
Type of services offered : Supplies farm inputs to farmers
Role in Agricultural information dissemination: Provision of information on usage of storage chemical and safe use of chemicals.
Suggested improvements on Agricultural information System: Agro-dealers to use vernacular radio to educate farmers on post harvest management.
Name of Institution : Kenya Farmers Association
Type of services offered: Supplying storage agrochemicals of crop produce.
Role in Agricultural information dissemination: Dissemination of agricultural information on use of storage chemicals.
Suggested improvements on Agricultural information System: MoA should take a leading role in planning of post harvest management activities.
Name of Institution: KENFAP
Type of services offered : Advisory roles and engage in supplying storage agrochemicals of crop produce.
Role in Agricultural information dissemination: Dissemination of agricultural information, lobbying and advocacy on farmer friendly policies.
Suggested improvements on Agricultural information System: Participatory planning with other stakeholders.

Source: Own compilation, 2012