

**AN EVALUATION OF THE EFFECTS OF AGRO-METEOROLOGICAL
INFORMATION ON MAIZE ENTERPRISE MANAGEMENT AMONG
SMALLHOLDER FARMERS IN MIGORI, KENYA.**

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Science in Agricultural Information and Communication Management.**

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Declaration

I declare that this is my original work and has not been presented for an award of any degree in any university.

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Dedication

This thesis is dedicated to my beloved family, father, mother brothers and sister, whose understanding and sacrifice have given me an inspiration and courage in fulfilling this study.

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Abbreviations and acronyms

AAS: Agro-meteorological Services.

AC: Agro-meteorological information accessibility.

AGMET: Applied, Agricultural Meteorology.

AM: Agro-meteorological information access through the mass media.

ANOVA: Analysis of Variance.

AW: Agro-meteorological information awareness.

CIA: Coleambally Irrigation Area.

DSS: Decision Support Systems.

EAS: Extension and Advisory Services.

Educ.: Education level of the respondents.

GDP: Gross Domestic Product.

KMD: Kenya Meteorological Department.

MEAS: Modernizing Extension and Advisory Services.

MEM: Use of agro-meteorological information in maize enterprise management.

MES: Use of agro-meteorological information in maize enterprise selection.

MoALF: Ministry of Agriculture, Livestock Development and Fisheries.

NGOs: Non-Governmental organizations.

SPSS: Statistical Package for Social Sciences.

VCRs: Video Cassette or Disk Recorders.

VF: Video forecasts.

Abstract

This study sought to determine the awareness, access to and the effects of agro-meteorological information on the maize enterprise management among smallholder farmers in Suna-East of Migori County, Kenya. The objective of this research was to assess how effective agro-meteorological information is in maize enterprise management and selection among small-holder maize farmers. This study was informed by the fact that the frequency and severity of extreme weather events such as floods and prolonged droughts has compromised small holder farmers' agricultural productivity. Agro-meteorological information application has proven to yield benefits in crop production. A systematic random sampling procedure was employed to select 217 farmers from a total population of 529 smallholder farmers. The socio-economic characteristics of the farmers were described using descriptive statistics. Multiple linear regression statistical model, correlation analysis and Analysis of variance (ANOVA) were employed to determine variables influence of awareness, access and use of agro-meteorological information on maize enterprise selection and management. The results indicate that (63.4%) of the farmers were aware of agro-meteorological information, while only (43.7%) indicated to have access to the information either from friends, neighbors, mass media or agricultural extension agents. Correlation analysis conducted revealed that access to agro-meteorological information ($r=0.149$ at $p\leq 0.015$) and ($r=0.074$ at $p\leq 0.142$) had influence on maize enterprise selection and management respectively. The results of multiple linear regression models showed that there is correlation coefficient $p\leq 0.493$ and an F value of 0.972 among the variables that influence the use of agro-meteorological information in maize enterprise selection. A correlation coefficient $p\leq 0.045$ and an F value of 3.458 among the variables that influence the use of agro-meteorological information in maize enterprise management. This shows that farmers who have access to agro-meteorological information do not use the information in enterprise selection but use the information in the management of maize enterprise. The study recommended the need to make use of different dissemination channels for different periods, priming and proper framing of agro-meteorological information on the mass-media. It is necessary to consider not only the provision of the information but also specify the information to a particular geographical zone and avoid generalizations in giving advisories by both the mass media and advisory groups. An important goal in agro-meteorology should be developing models for enterprise selections.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Crop production to a large extent depends on weather forecasts (Winarto *et al.*, 2011). Forecasts in all ranges are desirable for effective management and planning of agricultural activities. Development of response strategies help smallholder farmers accrue the benefits of utilizing agro-meteorological information in minimizing losses that result from extreme weather conditions hence increasing crop yield, quality and amount of agricultural production (Stewart, 2008). Short-term and long-term weather forecasts are significant in role adjustments in daily agricultural operations. Large part of Africa fall under the already climatically stressed arid and semi-arid lands (ASALS) characterized by high variability of rainfall and scarcity of water for crop and livestock production on regular basis every year (Shahbaz *et al.*, 2009).

The millennium development goals (MDGs) with an ambitious development agenda, focused on eradicating poverty and hunger by reducing by half the number of people suffering from extreme hunger and achieve employment for men, women and young people, entirely depends on the success of the agricultural sector especially in the developing countries (FAO, 2011). According to FAO, (2011) reducing poverty or poverty alleviation has been vastly due to the overall growth in the economy and increased food security. The desire to spur economic growth and food security led to initialization of the well-publicized industrial revolution. The beginning of industrial revolution resulted in increased growth in the economy, elimination of extreme poverty in what is regarded the developed world. To date, continued economic developments can be improved by properly managed agricultural systems.

Agriculture is sustainable in nature but with high dependence on rainfall, the small areas under irrigation are however characterized by low irrigation efficiency. In Kenya specifically, the agricultural sector is the greatest contributor to the current spur in the economy averaging to 24% of the country's Gross Domestic Product (GDP) (Kenya Agricultural Research Institute (KARI), (2012). Agriculture benefits abundantly from the use of the agro-meteorological information, it is benefiting greatly together with other categories of specialized weather information getting realized so as to avoid and keep reducing the meteorological risks in crop and livestock production and also to enable sustainable agricultural development strategies (Gommes *et al.*, 2007). Forecasting and monitoring of extreme weather events like hail-storms, floods, droughts, dangerous down pours squalls or frost always is done in so as to avoid and keep reducing negative impacts on the agricultural production. Agricultural meteorological programs therefore support food and agricultural production activities.

The continued spread of environmental risks pose a lot challenges which agro-meteorology can successfully address (Stefanski, 2007). According to Stefanski, (2007) practices like intensification of low inputs in agricultural production, advanced effects of climate change, wind erosion, indiscriminate cutting down of trees, desert encroachment, labour scarcity, water erosion, migration into vulnerable areas, at crucial times in the crop growing seasons and pest infestations pose a lot of challenges. On the basis of all these, agro-meteorology and its related applications can effectively contribute to the development of the knowledge required to cope with the afore-mentioned risks and their resultant negative consequences to obtain economically viable and timely sustainable agricultural systems improvement in the country.

1.2 Statement of the problem

Food insecurity and hunger are problems that many people endure today especially in Africa. Slightly more than 830 million people world over are dangerously malnourished because they cannot be able to obtain enough food by all means (Winarto *et al.*, 2011). Among smallholder farmers food insecurity has been due to the farmers' failure to produce its food requirements as a result of lack of access to crop production resources and unfavorable production environment (Zendera *et al.*, 2011). Climate variability many a times is disadvantageous to agriculture due to its observed seasonal uncertainties (Bert *et al.*, 2006; Awuor 2008). A larger proportion of crop production takes place in a natural environment and at the same time planning and management of the production by farmers is negative influenced by fluctuations in weather conditions. Crop production managers and producers as a result should keenly observe the weather and pay close attention to agro-meteorological forecasts to enable them decide when and how to undertake crop production operations (Stewart, 2008). Better predictions of the weather within 4-6 months would most likely result in effective decisions that can help reduce extreme impacts while at the same time taking advantage of the favorable weather conditions like timing of operations such as timely application of pesticides, field cultivation, application fertilizers, harvesting and irrigation (Zuma, 2013).

Unfortunately this has not been the case in Migori County, as most smallholder maize farmers have no access to agro-meteorological information while those who access the same fail to put them into effective use to inform their decisions and choices to enable them match crop varieties and enterprises to rainfall distribution and amount for every season. Farmers only stick to the traditional staple food crops like maize in most regions despite the rapid changing climate variability which do not allow good productivity of such crops (Chase *et al.*, 2013).

Consequently, smallholder farmers suffer low crop yields, severe pest and disease incidences and food insecurity. Irrespective of the availability of agro-meteorological information, its applications in decision making in agricultural enterprise selection and management has been limited (Clough *et al.*, 2013). The smallholder peasants lack the resources to invest in irrigation or sometimes drought resistant seeds. Crop failure therefore happens especially when lack of rainfall or little precipitation and inadequate application of the available weather information is not used in the selection and management of agricultural enterprises leading to harvest failures. This in the past has led to unreliable and inadequate food availability in Migori County. Decline in agricultural production has led to emphasis on weather forecasting in dealing with problems like agricultural enterprise management and selection. It is against this background that this research evaluated the effects of agro-meteorological information in influencing enterprise selection and management among small scale maize farmers in Migori County.

1.3 Justification

The severity and frequency of adverse weather occurrences such as floods and prolonged droughts has severely affected small holder maize farmers' level of production. Despite efforts by government agencies like weather institutes to provide timely agro-meteorological forecasts and timely warning services, food unavailability and malnutrition continues, reported cases of major crop failure are repeatedly common in the climatically stressed areas. The Ministry of Agriculture (MoA) provides Agro-meteorological Advisory Services (AAS) to the country's farming community in the form of bulletins and extension advisory. These advisories even though tailored to the requirements of smallholder maize farmers in Migori County do not help much to improve maize productivity.

Available data reveal that external inputs used in agricultural production varied particularly between Agro-metrological advisory service farmers and non-Agro-meteorological advisory service farmers, for example timely application of agricultural inputs leads to -4% change in the cost of production. The timing of weather information given for different farm operations helped crops from the possibility of nutritional stress, pest attack and moisture stress; this is attributed to a 13% change in profit per acre of maize crop. A comparison between non-AAS farmers crop yield who were found to be using the same amount of inputs, with different timing of the applications was found to be different from their AAS counter parts which show that timely application of agro-meteorological information has led to 6% increase in beans yield.

The AAS farmers registered success in their production activities which is attributed to timely meteorological information compared to their non-AAS counterparts. Most maize farmers in Migori County depend to a great extent on the local traditionally indigenous weather knowledge for weather forecasting and selection of appropriate agricultural practices to undertake. Despite increased variability in weather and seasonal weather patterns as well as advances in technology that should make scientific weather forecasting more accurate, agro-meteorological information services are rarely utilized daily farm operations and if utilized, majorly it is only by large scale farmers or by government farms and research institutions like KARI but rarely by smallholder maize farmers.

The maize production problems are as a result of farmers' failure to put into use agro-meteorological information, inaccuracy in forecasts and ignoring of the agro-meteorological services. Nevertheless smallholder farmers always have the potential to accrue benefits largely the from weather forecasting services provided. It's against this background that this research

assessed the effects of agro-meteorological information on agricultural enterprise selection and management among small holder farmers in Kenya.

1.4.0 Objectives

1.4.1 General objective

The purpose of this study was to assess how optimal crop production can be achieved through enterprise management and selection using the available agro-meteorological information to increase socio-economic benefits among small-holder maize farmers.

1.4.1.1 Specific objectives

- I. To determine the influence of education level on maize enterprise selection.
- II. To evaluate the influence of smallholder maize farmers' level of accessibility to agro-meteorological information on maize enterprise selection.
- III. To determine utilization of agro-meteorological information on maize enterprise management.

1.5 Research questions

- I. What is the influence of education level on maize enterprise selection?
- II. What is influence of smallholder maize farmers' level of accessibility to agro-meteorological information on maize enterprise selection?
- III. Do smallholder farmers' use agro-meteorological information in the management of maize enterprises?

1.6 Significance of the study

The study ascertained the timeliness and effectiveness of agro-meteorological information so as to inform the relevant stakeholders of the situation at hand in the farmers view. The advantages of comprehending the agro-meteorological information help in the establishment of controls and techniques to foster a profitable and economically viable agricultural sector. The study also sought to establish the role played by the mass media in agricultural development, especially in boosting agro-meteorological information dissemination.

Show that farm operations like application of fertilizers, pesticides, planting or harvesting all are weather sensitive and yield better when carried out under the best weather conditions. Agro-meteorology's intention is to enable maize farmers take advantage of any optimal weather conditions.

1.7 Limitations of the study

Although this research was carefully prepared and conducted, it's important to acknowledge the limitations and shortcomings. Firstly, the research designed to measure farmers' accessibility to agro-meteorological information though it looks like not to giving satisfactory evidence of the farmers' real access to agro-meteorological information but rather programs aired by the mass media. The population of the study group was only consisting of exclusively maize farmers which is only a small group of the farmers who grow some other crops, which may not represent the majority of the farmers in Migori County. On the other hand since the assessment of the questionnaire and the post-test were all done by the researcher himself, it becomes less avoidable that in this research findings to a certain degree of subjectivity may be realized.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Small holder farmers consists of a good portion of the world's populace, with an estimation of 450-500 million small scale farmers world over, and represents about 85% of the farms (FAO, 2011). Across the tropics, small holder farmers regularly face several risks in the execution of their crop production including, extreme weather, market shocks, severe pest and disease outbreaks undermining the farmers household food security and income. Partly, this has been due to variability in the elements of weather and climate change.

Climate variability to a large extent is expected to negatively influence peasant farmers' level of production. Previous research for example show that even slight increases in temperature have negative consequences on wheat, maize and rice which are presently the major cereal crops grown by smallholder farmers (Winarto *et al.*, 2011). Climate variability is expected to increase the frequency and severity of droughts, floods, pest and disease out breaks and ultimately advance the possibility of crop failure, low yield and animal mortality rate (Osbahr *et al.*, 2011).

Agro-meteorological information ought to contribute to objective choice of agricultural activities that improve of crop yield allocation of farm enterprises. Agro-meteorology is used to refer to the interaction between hydrological factors and meteorological experiences on one side and agricultural production in a broad sense on the other hand (Stigter, 2013). The aim of agro-meteorological information should be to improve farming practices and increase agricultural productivity in quality and quantity. In drought prone areas characterized by unreliable rainfalls, poorly distributed throughout the year and constantly fluctuating temperatures, there are

subsistence farmers who only depend on naturally rain fed agricultural support in crop and livestock production.

2.1 Access and utilization of agro-meteorological information

Weather variability and climate change are the greatest agricultural production risks and uncertainty influencing crop yield and livestock rearing (Zendera *et al.*, 2011). Climate change is spontaneously negatively impacting on crop performance due to its associated unpredictable seasonal variations (Bert *et al.*, 2006; Awuor, 2008). According to Zendera *et al.*, (2011) access to meteorological services by small holder irrigation farmers in Perkerra irrigation scheme in Kenya is enabled by the mass media like the radios, bulletins, extension advisory efforts, village barazas, Mobile phones and the internet. Zendera *et al.*, (2011) contended that more than (90%) of the peasant farmers are able to access agro-meteorological information through radio and slightly above(60%) of the contacted farmers revealed that they have not been able to access meteorological information from sources like extension advisory officers, internet or even news bulletins.

According to Zendera *et al.*, (2011) inadequate extension at (72%) was the major impediment affecting peasant farmers' access to agro-meteorological information forecasts. Slightly above (45%) of the farmers made farming decisions always if only they received timely meteorological forecasts. On the other hand some of the factors influencing farmers' adoption of weather information were inadequate weather forecast information for meaningful decisions, inaccurate forecasts and delayed weather information forecasts thereby enabling peasant farmers' minimal time to put in place timely preparations (Kuyper *et al.*, 2012).

Kuyper *et al.*, (2012) argued that farmers' social and economic status greatly influenced the level of utility of weather information. He emphasizes that extension training is necessary to enable effective dissemination of important agro-meteorological services. Most farmers from the irrigation schemes according to Zendera *et al.*, (2011) indicated limited access to the internet (70%), limited access to television at (55%) and late delivery of newspapers as the major factors that highly affected farmers' accessibility to weather information. On the use of agro-meteorological information in influencing farm decisions, more than (45%) of the smallholder farmers showed that they most likely preferred following the normal seasonal or irrigation patterns when making crucial planting decisions, while (25%) preferred to wait for the onset rains every season while only (20%) made use of the provided agro-meteorological information from weather institutes.

Farmers take risks by planting based on the usual seasonal patterns thus making them vulnerable to climatic variability (Zuma, 2013). Some of the factors that influence small holder farmers' utility of weather information include a number of social and economic factors concerning how the weather information was communicated to the farmers. More than (80%) of the farmers contacted said that non adoption of the information was due to inaccuracy of the weather information forecasts, forecasts that were not sufficiently detailed enough for meaningful decision making. (Kenya meteorological department, KMD 2009).

2.2 Importance of agro-meteorological information to farmers

Climate change and the impacts already predicted can help in ensuring that the seasonal irrigation amounts are more uncertain, erode crop and livestock production profitability and economic gains (Shahbaz *et al.*, 2009). Irrigation forecasts are of economic value to small holder

farmers especially in knowledgeable farm practices (Gonzalez *et al.*, 2014). Shahbaz *et al.*, (2009) observed that the economic value of accurate irrigation water allocations in southeastern Australia using programming model is quite encouraging. The model used profit and production functions to ascertain yield and profits for different allocation rates. According to the study improved cropping decisions made by small holder farmers were based on water allocation requirements all through the cropping seasons. The responses included using varied crop rotational programmes, temporal sale or purchases of water and deficit irrigation and not irrigating for a proportion of the farm crops.

The economic analysis of increased irrigation allocation forecasts to the farmers at the (100%) allocation level was more than \$ 45 million having undertaken accurate forecasts in every season's allocations. More realistically it generated a forecast value of about \$ 8.9million decrease in the projects gross margin and \$ 1.6million in foregone gross margin for about (6%) change in the outlook about the real water allocation level of (50%).

This indicated that economic losses increased in case water allocations are over estimated or under estimated by farmers, as water and manpower is wasted and inputs could be overly committed to accomplish the poorly informed cropping decision (Gonzalez *et al.*, 2014).

Agro-meteorological forecasts are important in the management and good planning of farming practices. A study involving crops like food grains, oil seeds, cash crops, fruits and vegetable crops indicated that there is an increase in yield due to agro-meteorological advisory services (Frankema, 2013).

According to the study the percentage increase or decrease if any in productivity and the net return a result of agro-meteorological advisory services in central east Antarctica, the results

obtained suggested that due to agro-meteorological services, farmers accrue an increased benefit of (7-10%) in productivity and a decrease by about (3%) in the cost of land preparation over the non-agro-meteorological advisory farmers (Petit *et al.*, 2013).

The agro-meteorological advisory service farmers received included meteorological information bulletins majorly from various sources such as television, newspapers or radios. Of all the sources, radio and television were listed as the most accessible with ease and popular mediums through which (55%) of small holder farmers could seek information on agro-meteorological information forecasts (Petit *et al.*, 2013). This indicated that selection of seeds as a result of farmers' awareness programs in the community, timely meteorological information and control of pests and diseases as directed by extension advisory helped save the external input costs (Winarto *et al.*, 2011).

Engaging in timely farm activities by adopting agro-meteorological advisory services disseminated frequently, helps in improving the productivity of different crops (Cooper *et al.*, 2011). The economic assessment should be taken advantage of to optimize agricultural crop production because it is season specific, season-specific and crop-specific.

2.3 Agro-meteorological needs and analysis

Accurate forecasts with temporal variations that are specified to different geographical areas as opposed to the current forecasts with content focused on specific needs of different daily farm activities are of need (Applied Agricultural Meteorology, AGMET 2011). Small holder farmers require weather information that they can understandable with ease and readily utilize in their farms (Simpson *et al.*, 2013). Simpson *et al.*, (2013) examined the agro-meteorological products presented to the farmers directly in particular weather forecast services. A vast proportion of the

small holder farmers feel that weather predictions should have been given a fixed time each day, when most farmers are free to pay attention to the forecasts and to primarily enable the farmers to plan their weeks work (Meinke, 2010). According to Minke, (2010) one can easily conclude that short-term and medium term forecasts are the more significant agro-meteorological products which farmers require and used on practices like timing fertilizer applications, weeding, crop harvesting, planting, general crop management and harvesting. On education and training Simpson *et al.*, (2013) states that (60%) of the small holder farmers contacted opined that they understood the signs and symbols used in the television forecasts while (30%) only understood some of the symbols used . On the other hand (75%) said that they would like to learn more about the weather.

The most preferred ways of receiving trainings on weather forecasts include television programs, found to be the most preferred means; this was followed by radio and newspapers. Several farmers suggested that priority be given to dissemination of weather information in the school curricula and designed weather courses be offered at secondary schools and even primary levels to increase awareness to the young generation (Chase *et al.*, 2013). The survey also found out that there was need to encourage agro-meteorology trainings be kept as a major part of tertiary level courses in the agricultural institutions.

2.4 Coping with meteorological risks and uncertainties

Some risks in crop and livestock production are unavoidable while others can be managed (Huda *et al.*, 2009). Agro-meteorological risks in the farming sector include the temporary or permanent changes in the amounts of temperature, hail storms, rainfall, evaporation levels and, in situations of climate change; atmospheric carbon (IV) oxide levels (Shahbaz *et al.*, 2009). Huda *et al.*,

(2009) outlines the major approaches of dealing with the agro-meteorological risks and uncertainties in agricultural production on the basis of Australian experience with wheat and canola crops.

The need to comprehend the relationship between temporal weather variations and pest life cycles is shown. There is also the need to involve factors related to local crop farming practices and farming economy in the risk management processes. A decision support tool called Rust man was developed for stripe rust of wheat. Rust man estimates the likely impact that stripe rust will have on wheat yield and the benefits from spraying to control the disease (Huda *et al.*, 2009).

Estimates require the input of average weather conditions occurring over one agricultural season (Shiferaw *et al.*, 2013). Sufficient macro-climate data has now been collected for the development of a similar tool for *sclerotinia* stem rot on *canola* although the higher impact of post-treatment climatic variation demands a longer-term forecast record.

The effectiveness of decision making tools depends on their ability to predict and to facilitate risk management or mitigation, with subsequent assessment of outcome (Ani *et al.*, 2009). According to Beintema *et al.*, (2012) some of the factors relating to this effectiveness of decision making tools are: Farmers are only able to respond and adapt to climatic conditions, they cannot expect the model to assist them to manage or mitigate the climatic events, The pro-active dimension in risk amelioration is important if damage is to be minimized, Adaptation or response adjustment as risk ameliorating strategy must be targeted and may be complex and Outcomes need to be seen in practical terms if individual and societal benefits through improved risk management practices and better targeted policies are to be optimized.

Shiferaw *et al.*, (2013) demonstrated the importance of rainfall distribution in relation to disease development, having observed that in years with low rainfall and high temperatures sclerotinia stem rot (*Sclerotinia sclerotium*) is not a limiting factor for crop development. In such years the application of fungicide had effect on early disease but no ultimate impact on yield. Such findings suggest that in similar years finances can be directed away from this problem to be used more productively in other areas with the provision that this practice is not rigidified so as to prevent successful re-targeting in subsequent growing seasons.

In addressing risks and uncertainties for integrated pest management, Huda *et al.*, (2009) there is need to know more about complex relationships between climate and pest cycles relevant to local places. In regard, collaborative activity is required between scientists, risk managers, government and local farmers to determine best practice approaches for addressing pest management, with the aim of achieving economically sound and ecologically sustainable outcomes.

2.5 Use of traditional weather and climate knowledge in agricultural production

A number of natural indicators are closely related to agro-meteorological information forecasting and climate predictions are used by a large number farmers. Meteorological scientists and local indigenous farmers use varied methods in weather conditions forecasting and the predictions of a likely behavior of the weather events during the crop growing seasons. Agro-meteorologists have developed varied types of modern science based knowledge that can help deal with climate change for instance adoption of drought resistant crop varieties but many farmers are yet to implement such developments (Zuma, 2013).

Additionally, indigenous small holder farmers utilize traditional culture based observations of nature as guide lines for agricultural operations to be undertaken in their farms. The research

documented traditional culture base observations and their practical applications in effective planning and management of crop production. Many smallholder farmers are said not to be well conversant with the practical applications of meteorological forecasts for crop and livestock production. The small holder farmers depended on their farming experiences and indigenous knowledge which shown in broad terms, depending on the tales and indicators from years of farming experience by the farmers (Frankema, 2013).

The means of interaction with the natural indicators are skills not clearly comprehended by many meteorological scientists, but very beneficial to the peasant farmers (Stigter, 2013). The traditional indicators include animal behavior observation, constellation of stars, cloud cover and type, appearance and disappearance of reptiles, migration of bird species and blossoming of certain traditional trees (Zuma, 2013).

This suggested that the culture based traditional predictions or forecasts can be successfully merged with science based weather forecasts (Garay *et al.*, 2011). The traditional knowledge and its use is what scientists learn from farmers. Small holder farmers use weather forecasts indicated in their traditional culture based predictions, regularly of immediate rains or droughts. Decisions are made based on the traditional culture associated understanding of the prevailing ecological conditions in their local geographical areas (Garay *et al.*, 2011). Comprehending the farmers' perceptions of weather becomes a very crucial step to facilitate effective dissemination of science based agro-meteorological knowledge.

2.6 Agricultural enterprises and its susceptibility to climatic factors

Natural disasters such as droughts, hurricanes, fires, floods, fires and earthquakes greatly challenge crop and livestock production (Chase *et al.*, 2013). Agriculture is easily influenced by

environmental disasters since it heavily depends on the good weather and availability of water to enhance its productivity. Drought most severe effects on agriculture involves reduced crop and livestock production which negatively influences forage and feed and or plant population (Green, 2010). Before cropping commences the farmer has to make important decisions which profoundly affects the subsequent operational management. Such operational requirements at farm level include water management in relation to crop moisture requirements (Chase *et al.*, 2014).

Due to continued human population growth, as the current trends indicate, and the ever rising levels of consumption as the world economy stretches the impacts are felt on agriculture (Petit *et al.*, 2013). This will stress the ability of agriculture to fulfill all the need to feed the increasing population without further degrading the ecological integrity. Agricultural systems major for the risks in the future is to provide enough feeds and food for the increasing world population at an affordable environmental cost. To address this, it requires an environmental friendly way tackle agriculture that is greatly missing from today's operational planning and management of agricultural systems. (Green and Raygorodetsky, 2010).

Agricultural production systems ought to be managed as ecosystems, with decisions fully informed of ecological costs and benefits. Today, not much is known concerning significant environmental relationships with the crop production systems. (Shiferaw *et al.*, 2013). Recent research findings on the adaptation to climatic change has done an evaluation on the merit of the adaptations, and also on the suitability of specific adaptation mechanisms. The findings propose that there is need to comprehend the uptake of the adaptations. (Clough *et al.*, 2013).

On the basis of the data from over 16 000 farm systems operations, it was observed that specific farms are more specialized in their rotational programmes and cropping patterns for about two decades, which is a trend that is most likely to change as time goes by, not ignoring the much expected climate variability and the known risk-preventing merits of diversifying crops to spread the risks (Gonzalez *et al.*, 2014). Climate change adaptations that are suitable and with greater possibility of sustainability should be more rigorously assessed to enable the practicing farmers comprehend their wider advantages and disadvantages in crop production activities practiced (Friori *et al.*, 2014).

2.7 Agricultural information dissemination

The demand for agro-meteorological information and services are increasing mostly by the farmers to enable them adapt more effectively with climate change and the ever increasing incidences of adverse meteorological occurrences such as wind erosion, hail storms, frost, floods or droughts (Silarsky *et al.*, 2008). The absence of enough interaction with the farming community in evaluating the most appropriate agro-meteorological information dissemination procedures that are able to improve the value of crop and livestock production as well compounds the problem and prevent farmers from receiving the information on time (Gudza, 2010). Irrespective of the larger differences in the interests of the small holder farmers, preferred methods of disseminating agro-meteorological information still remains remarkably similar (Hattotuwa, 2009). Hattotuwa, (2009) states that while extension advisory services still prefers to use field days, on-farm visits and farmer to farmer meetings, a lot of agro-meteorological information could be disseminated through other approaches or methods like the mass media and social media formats such as computer software packages, videos and the internet. There is the

need to completely understand the target audience is bound to influence the most preferred approaches to disseminate agro-meteorological information.

Even though videos are used in the dissemination of agro-meteorological information, farmers ought to be empowered on better crop production practices for example sustainable seed varieties or timely seed sowing for their farms (Hsain, 2009). According to Hsain (2009), video enhanced training is gaining significance as a better means of not only reaching several small holder farmers but also reduces the need and the cost of facilitating many extension advisory service agents. The use of video is a proven way of triggering farmer experimentation, it is an indicator of change sometimes more than the traditional face-face training (Nordehn and Manfre, 2013). Information contained in videos is used to strengthen the curriculum of the extension services and help build the confidence of the extension agents in interacting with farmers. The farmers who watch the videos accordingly actively seek additional advice from extension agents (Gudza, 2010).

Though agricultural extension has been shown to have (41%) rate of return, rigorous evaluation remains surprisingly rare (Hsain, 2009). Hsain (2009) states that even though classical training and visit extension approach for example is considered expensive and of limited effectiveness it remains the method majorly employed by agricultural agents. As an alternative Farmer Field Schools have gained popularity against the training and visits, though their long term cost-effectiveness is also doubted and even their ability to scale up (Silarsky *et al.*, 2008). A study to assess the cost effectiveness of digital green's video extension approach suggests that it is ten times as cost-effective as the training and visit in motivating farmers to take up new practices and allows an expert extension officer to spread across a wider population (Silarsky *et al.*, 2008).

Video cassette or discs recorders (VCRs) are becoming an integral part of home entertainment for both children and adults, more than (30%) of all households in America have VCRs (Gonzalez *et al*, 2014). Video discs are also gaining more prominence and are marketed much like books or records and corporate videos are increasingly becoming a major communication medium through which important agro-meteorological information can be passed on to the target audience. In the agricultural on farm training arena interactive video gives a means to gain knowledge as well as to be with the knowledge itself (Gale *et al.*, 2013). The use of videos in the dissemination of agro-meteorological information encourages individual farmer's autonomy and shows great respect for private farming knowledge acquisition. This training mode of information giving further privatizes agro-meteorological information accessibility and utility.

2.8 Gaps in literature

Some of the factors that greatly influence farmers' adoption of weather information as indicated in literature include delayed release of seasonal agro-meteorological information forecasts thereby giving farmers less time to make preparations, inaccurate weather information forecasts and less adequate meteorological information forecasts for use in making meaningful farm decisions.

Losses increase when irrigators over estimate water allocations in the farms, as water is wasted and external inputs in most cases overly committed to implement the less informed crop rotation and planting patterns. The knowledge benefits gained from weather forecasts are more significant at the lower ends of water resource allocation as a result of relative water unavailability. Nevertheless for greater allocation levels (> 75%), the benefits of the knowledge gained are enormous and negligible due to limited water scarcity. Water allocation forecasts and closely related agro-meteorological information are thus useful for policy makers, insurance industry smallholder farmers and agribusiness. The utility of accurate weather information in

selection and management of farming practices where irrigation is practiced can help improve the productivity of maize in Kenya.

2.9 Theoretical framework

2.9.1 Agenda Setting Theory

This research was based on the agenda setting theory which indicates that the mass media and the opinion leaders can tell someone what to think about but it cannot tell someone what to think. Farmers always look upon the media, community opinion leaders and agricultural extension agents to introduce new ideas to them. Agricultural extension strives to facilitate ideas and practices to increase their productivity (Katz, 1940). This theory asserts that the mass media as well as the contacts that people make amongst themselves give information and as well determine people's opinions and judgments that they impose on issues of relevance to them (McCombs and Shaw, 1972). This comes in the two step flow of information, a study conducted in the US during the 1940's general elections, and states that may be the mass media did not have the kind of influence on the electorate as was greatly believed (Katz, 1940). The electorate made substantive decisions more by means of interaction among themselves but not directly with the influence of the mass media.

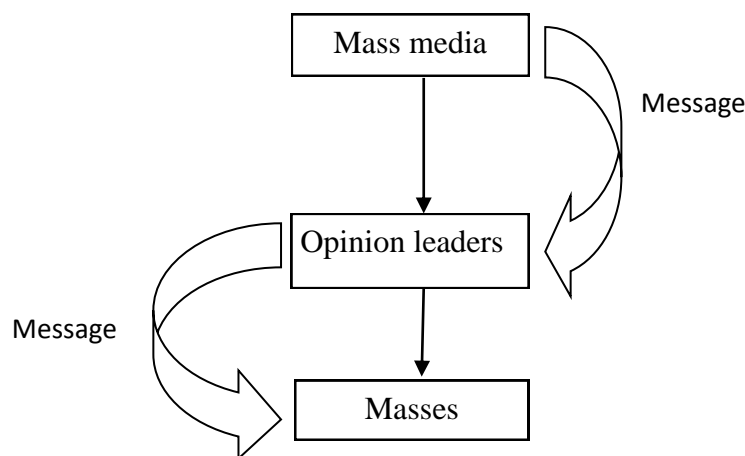


Figure 1: Two step flow of information.
Source: Communication theories (Elihu Katz, 1940).

The Agenda Setting Theory, as a result of a study of North Carolina voters, was coined by Maxwell McCombs and Donald Shaw in 1972. This study determined an auto-correlation between what the voters believed were significant to their lives and what that the mass media gave priority. The theory asserts that the mass media has the influence required to enable them focus the general public's discussion and ultimately their decisions on specific relevant matter. The mass media determines and mostly dictates the procedure of news reports and relevant presentations about news events. The importance attributed to news by audience is determined by the media.

2.9.2 Priming

This is an involvement of the mass media in influencing the standards and values within which issues of the mass media are judged. Content in the mass media makes some issues more avid and gives a lot of time and space to certain issues. Media gives great significance to news content and as a result giving the audience the impression some issues are more significant information than others. The specific news to which this is done on a daily basis is regarded as a heading and given coverage daily for a number of months. Special news features, headlines, expert opinions discussions are further used to advance the issues in such media contents. The mass media even primes news through repeated broadcasts to the selected news hence according it more significance (Baran and Davis, 2006). This has not been done with agro-meteorological information with content on the same totally missing from most public debates therefore some smallholder farmers do not have any idea of the relevance agro-meteorology should inform their public debates, the kind of information they seek for or be ready to put into use to inform management of their enterprises.

2.9.3 Framing

It refers to the process of selectively controlling, a means in which issues of relevance in news are generally put to context and shaped reference by the target audience. In a similar way the target audience puts into use the same frames of reference given and starts seeing the world in the same way as is made to look like in the mass media. The importance the target population attaches to news and how its context is perceived is the similar context within which the issue at hand is viewed. Framing emphasizes on how people attach significance to some specified news for instance in case of defeat, a terrorist attack, win and loss, the way the mass media selectively controls the news to the extent that target population perceive it in a more varied way.

McCombs in 1998 improved the theory to involve 'framing'. McCombs suggested that telling people *what* to think about, the mass media has the ability to tell us *how* to think about an issue of significance. Several research already done are in concrete support of the agenda setting function theory and make it seem possibly applicable to determine how the target audience thinking and decisions are shaped by the mass media. Most obviously, the research shows a close auto-correlation between how significant the target audience think of an issue and the number of new stories aired by the mass media.

Even though The Agenda Setting Theory has been with us for four decades, it still provides a better way to think about media influence especially in relation to overall communication and dissemination of weather forecasts in the farming communities.

2.9.4 Criticisms of Agenda setting function theory

First of all, mass media users are not real, as the audience rarely pay attention to the details as they are given by the media. Given that the theory uses a scientific approach to communication, which is not humanistic in nature and therefore is not able to stand the test of scrutiny in practical terms given that humans are always known for their unpredictability (Rahja *et al.*, 2010).

The effect of agenda setting theory is strong for a population that has made up their minds concerning an issue (Littlejohn, 1999). According to Littlejohn (1999) the theory fails to consider personal interests of individuals. The audience consciously choose a media product that gives them gratification or that addresses their needs and that it is such issues they consider salient. The theory assumes that once the media considers any issue to be salient and gives it dominance then the public automatically regards the issue as salient.

The assumption is that if an audience is exposed to the same news contents according to the agenda setting theory, the audience will most likely place more significance on the specific issues (Baran and Davis, 2006). The assumption is not true as people have different frames of reference and therefore what one may consider important after filtering the issues through his frame of reference is different from the other persons. People are not likely to place importance on the same issues even if they are all exposed to the same media content.

2.10 Conceptual framework

Unavailability of food among small holder farmers has been contributed to by the inability of farmers to effectively produce their food requirements as a result of limited awareness, accessibility and utilization of agro-meteorological information in decisive agricultural enterprise

selection and management. Climate change is frequently negatively impact agricultural production due to the unpredictable weather uncertainty leading to most smallholder maize farmers becoming fairly vulnerable to food insecurity.

The conceptual framework illustrated in Figure 2 shows relationships between the independent variables (socio-economic characteristics, awareness of agro-meteorological information, access to the mass media and accessibility to weather forecasts) and the dependent variable (use of the agro-meteorological information on maize enterprise selection and management).

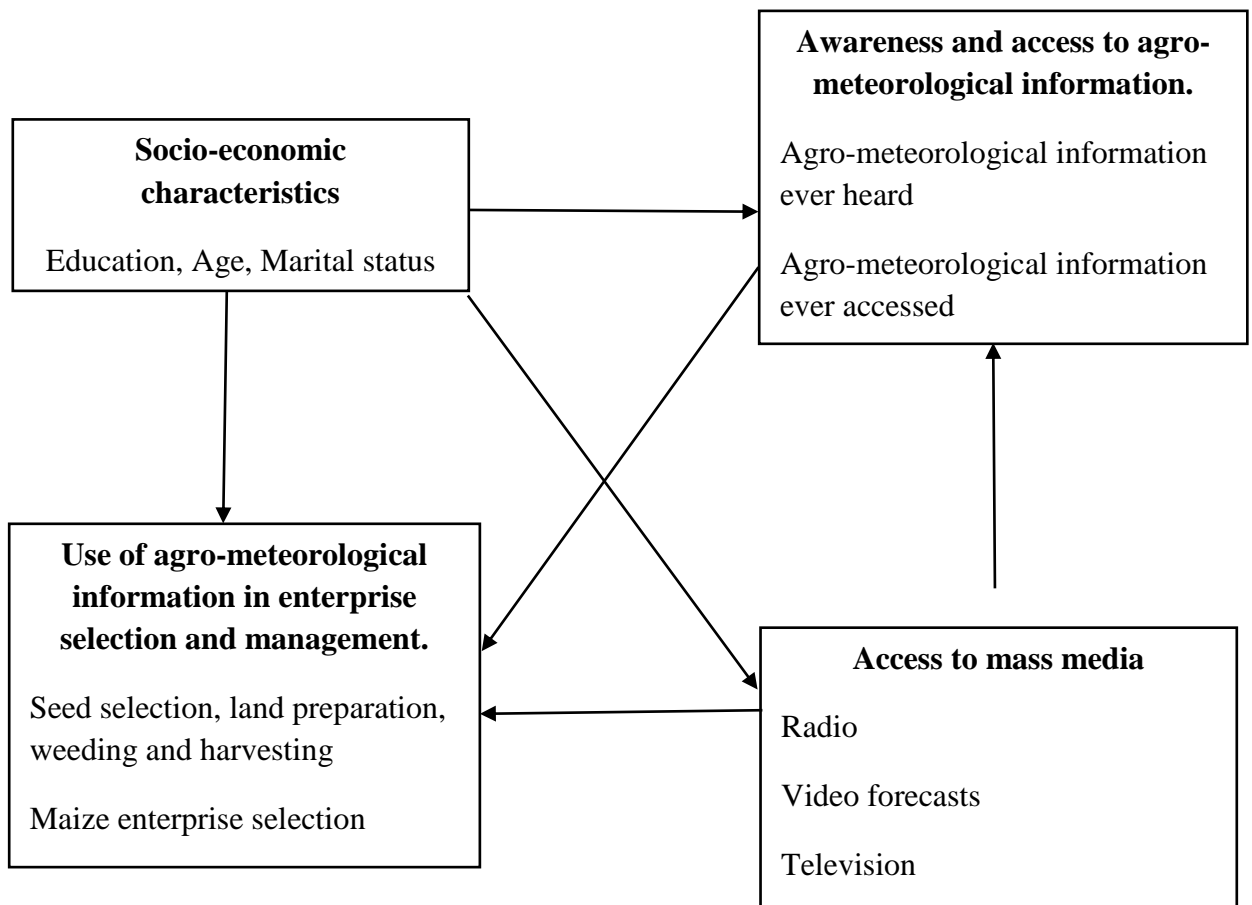


Figure 2: Conceptual framework used in the study.

The study conceptualizes that the social and economic factors determines the respondents access to the mass media, awareness and accessibility to broadcasted weather forecasts and in turn influences the use of agro-meteorological information in maize enterprise selection and management.

Small scale farmers always take production activities under inadequate preparedness for variations in weather conditions. Their decisions are always based on their general understanding based on non-scientific traditional climatic patterns for their regions. Increased frequency, the negative impacts of extreme weather events such as irregular precipitation, extremely severe droughts and failure to access agro-meteorological information on the mass media promptly has compromised small scale maize productivity. National meteorological institutes have put in place efforts to issue weather forecasts and timely warning services have not been put to better use hence low productivity and consequently food insecurity.

Many small holder farmers still heavily rely to an extensively on the local culture based and traditional and indigenous experiences in predicting weather occurrences. Nevertheless, improved changes in seasonal patterns and weather events seems to diminish farmers' confidence in normal seasonal weather patterns. Limited use of agro-meteorological innovation products in maize enterprise selection and management has led to persistent low maize productivity. However small holder farmers have the potential to accrue maximum benefits from accurate and timely agro-meteorological forecasts provided. If only these farmers were accessible to weather information and uses the information in management of their maize enterprises, productivity would increase abundantly.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study area

The study was conducted in two locations namely Suna-East Location ($0^{\circ} 15'N$, $34^{\circ} 59'E$), Migori-East sub-county and Ragana Location ($0^{\circ} 17'N$, $34^{\circ} 41' E$), Migori-West sub-county both found within Migori County in the western side of Kenya bordering Homabay, Kisii and Narok Counties. The target smallholder farmers are found within agro-ecological zones (III) and (IV) (medium to low agricultural potential), where weather elements experienced are favorable for rain-fed agricultural maize crop production in the Suna-East Location experiencing approximately 1200mm annually and unfavorable for rain-fed agricultural maize crop production in the Ragana Location experiencing about 900mm annually.

At about 1450m above sea level the area experiences two seasons (bimodal) of rainfall and temperatures of 21-35 °C thereby supporting agricultural crops like maize, sugarcane, sorghum, millet, groundnuts, cassava, sweet-potatoes, beans, kales and sweet-bananas (Creative Commons Attribution, 2014).

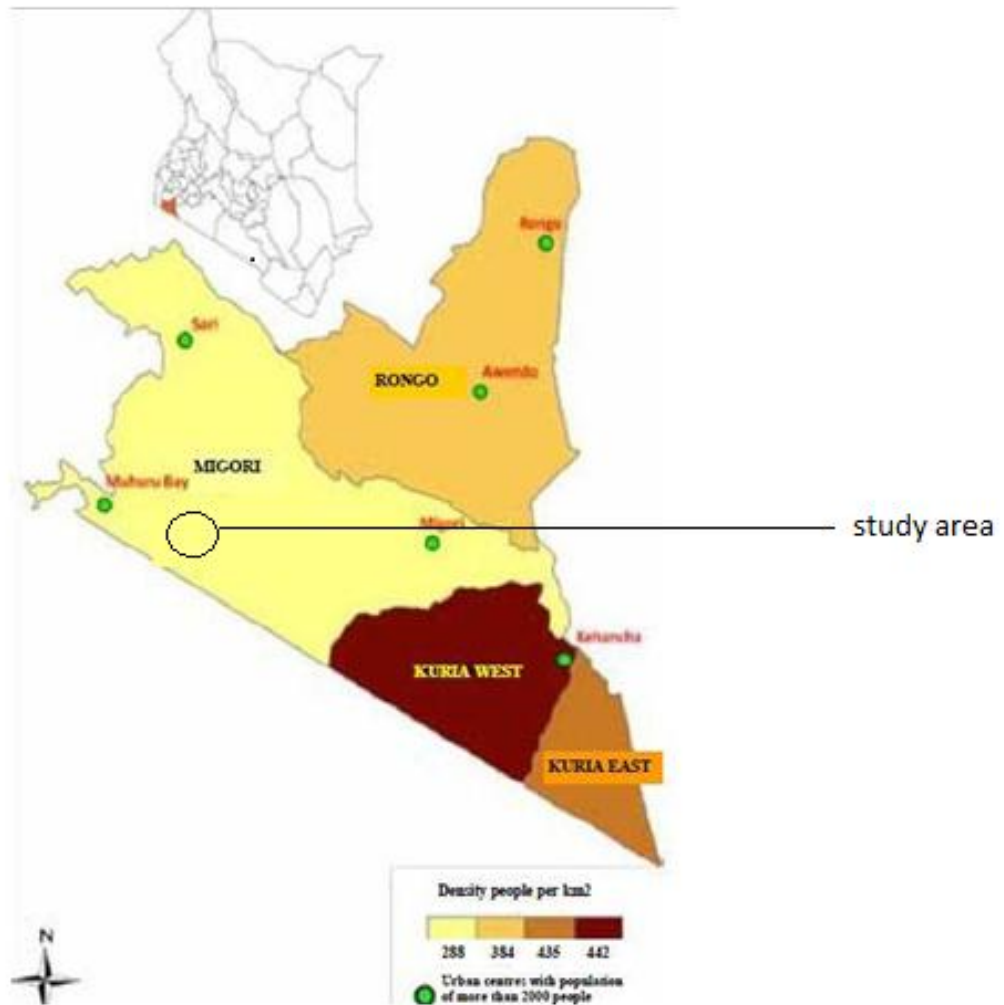


Figure 3: Map of the study area

3.2 Sampling design and techniques

A systematic random sampling technique was used to select 217 small holder farmers from a total population of 529 small scale farmers in the two selected locations in the Suna-East sub-county. The farmers were interviewed on their use of agro-meteorological information on agricultural enterprise selection. Predetermined structured questionnaires was used to elicit

responses from the small holder farmers. The formula for arriving at the sample size was the Cochran (1963) formula to yield representative sample for proportions;

Equation 1: $n_o = Z^2Pq/e^2$

Where;

n_o = sample size

Z^2 =abscission of normal curve $(1.96)^2$

e =desired level of precision

p =estimated proportion of an attribute that is present in the population

$q=1-p$

$n_o = Z^2Pq/e^2 = (1.96)^2(0.6)(0.4)/(0.05)^2 = 368$

The accessible population in the study is 529 smallholder maize farmers: Mugenda & Mugenda (2003) recommends the formula; **$nf = n/1 + n/N$** Where;

nf = desired sample size when the population is less than 10,000

n = desired sample size when the population is more than 10,000

N = estimate of the population size

Using the above formula the sample size is; **$nf = 368/1 + 368/529 = 368/1.6957 = 217$ farmers**

A sampling interval (K) was established by dividing the population by the sample (Mugenda & Mugenda, 2003; Kothari, 2004). The list of farmers was obtained from the ministry of agriculture county offices. The formula for arriving at the sample interval is;

$$k=N/n =529/217=2.4$$

Where; n=desired sample size

N=estimate of the population of smallholder farmers.

K=sample interval

3.3 Data collection

Primary data was collected directly from the small scale farmers by progressively conducting interviews, by use of well-structured questionnaires. Secondary data in support of the primary sources was also retrieved from the local Ministry of Agriculture, Livestock and Fisheries (MoALF) data repositories in Migori County.

3.4 Data analysis

Data analysis commenced with questionnaires being keyed into the Statistical package for the social sciences (SPSS) software. Data analysis was carried out using descriptive statistics such as percentage, mean, ranking, standard deviation and Pearson's correlation coefficient. A multiple regression model was used to analyze the influence of agro-meteorological information on agricultural maize enterprise selection. SPSS was used to analyze the research data.

Multiple linear regression was used to find out the relationship between age, gender, enterprise types, agro-meteorological information awareness, agro-meteorological information accessibility, access to mass media, use of video in weather forecasts and the use of agro-meteorological in maize enterprise management and selection.

The model below represents the explanatory variable used in the regression analysis of the relationship between dependent variable (use of agro-meteorological information in enterprise selection) and independent variables age, gender, marital status, agro-meteorological information awareness, enterprise type, agro-meteorological information accessibility, access to mass media and use of video in agro-meteorological information dissemination.

, given by the following equation;

$$Y = B_0 + X_1(P_1) + X_2(P_2) + X_3(P_3) + X_4(P_4) + X_5(P_5) + X_6(P_6) + X_7(P_7) + X_8(P_8) + e \dots \dots \dots (i)$$

Where;

Y-Dependent variable (use of agro-meteorological information in enterprise selection).

B₀-constant term or y intercept.

X₁-X₈- Coefficient of variable. (Independent contributions of each independent variable to predict the dependent variables).

P₁-(age), P₂-(gender), P₃-(marital status), P₄-(agro-meteorological information awareness), P₅-(enterprise type), P₆-(agro-meteorological information accessibility), P₇-(access to mass media) and P₈-(use of video in agro-meteorological information dissemination) (Independent variables).

e- is the error term.

Appropriateness of the multiple regression model was tested by the F-test in an ANOVA table.

Where significant F indicates a linear relationship between Y (dependent variable) and one of the Xs (independent variable).

The model below represents the explanatory variable used in the regression analysis of the relationship between dependent variable (use of agro-meteorological information in maize enterprise management) and independent variables age, gender, marital status, agro-meteorological information awareness, enterprise type, agro-meteorological information accessibility, access to mass media and use of video in agro-meteorological information dissemination., given by the following equation;

$$R=B_0\pm B_1(P_1)\pm B_2(P_2)\pm B_3(P_3)\pm B_4(P_4)\pm B_5(P_5)\pm B_6(P_6)\pm B_6(P_6)\pm B_7(P_7)\pm B_8(P_8)\pm e.....(ii)$$

Where;

R-Dependent variable (use of agro-meteorological information in maize enterprise management).

B₀-constant term or y intercept.

B₁.B₈-coefficeinet of variable. (Independent contributions of each independent variable to predict the dependent variables).

P₁-(age), P₂-(gender), P₃-(marital status), P₄-(agro-meteorological information awareness), P₅-(enterprise type), P₆-(agro-meteorological information accessibility), P₇-(access to mass media) and P₈-(use of video in agro-meteorological information dissemination) (Independent variables).

e- is the error term.

The appropriateness of the multiple regression model was tested by the F-test in an ANOVA table. Where a significant F indicates a linear relationship between Y (dependent variable) and one of the Xs (independent variable). The probabilities for the significance of the F values were determined. Levels of significance at the 5% probability levels were also considered (Steel and Torrie, 1980).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents and discusses the results of the study.

4.1.0 Socio-economic characteristics of the respondents

Table 1 shows the socio-economic characteristics of the respondents in this study including their age, gender distribution of the farming population, education level and the different occupations in which the farmers contacted were involved in.

4.1.1 Gender distribution of the respondents

Maize farming is dominated by the male farmers with (58.7%) being male while only (41.3%) being female (Table 1). More men than women take part in maize farming probably due to the fact land ownership of farming land is mostly on the hands of males. Only men are traditionally allowed to inherit land from their parents therefore denying the women an opportunity to own land and subsequently practice crop production. On the other hand rural women have multiple roles, which include motherhood, being house wives and caregivers that quite deny them the opportunity to fully attend to their maize farms and seek extension and advisory services that bring with them agro-meteorological information. Nevertheless, it is within the women's roles as peasant maize farmers to at least greatly utilize Extension Advisory Services (EAS) and other basic significant services, like agro-meteorology, health care, trainings, water and sanitation, to help reduce their workloads in the farms (Nanja, 2010). EAS delivery should use gender sensitive approaches increasingly, to enable the system address the challenge of how women farmers' accessibility to crop and livestock production advisory services (Hattotuwa, 2009).

Tables 1: Socio-economic characteristics of the respondents in Migori County.

| Attributes | Frequency | Percentage |
|------------------------|------------------|-------------------|
| Gender | | |
| Male | 127 | 58.7% |
| Female | 90 | 41.3% |
| Age | | |
| 20-35 | 42 | 19.3% |
| 36-50 | 65 | 30.1% |
| 51-65 | 54 | 24.7% |
| 66 and above | 56 | 25.9% |
| Education level | | |
| Primary dropout | 25 | 11.7% |
| Completed primary | 31 | 14.1% |
| Secondary dropout | 22 | 9.9% |
| In secondary | 4 | 1.9% |
| Completed secondary | 58 | 26.8% |
| Tertiary level | 31 | 14.1% |
| University level | 30 | 14.0% |
| Adult education | 16 | 7.5% |
| Occupation | | |
| Salaried employees | 34 | 15.5% |
| Full time farmer | 72 | 33.4% |
| Self employed | 38 | 17.3% |
| Casual laborer | 35 | 16% |
| Student | 20 | 9.4% |
| Unemployed | 18 | 8.4% |

4.1.2 Age distribution of the respondents

The farmers who responded had an average age of 52 years. Those falling in the age group of 21-35 years being (19.3%), 36-50 years were (30.1%), 51-65 years were (24.7%) while those above 65 years of age were (25.9 %) most of who were very old and only practiced maize farming in very small land parcels since they did not have the energy to do large pieces of land (Table 1). The mean age was 52.5540 (1.0610*) which shows that above more than half of the maize crop farmers in Migori County were over 50 years of age. Most of the young people opted for other jobs with faster cash income such as casual labour. The study indicated that age was an important factor in the small holder farmers' empowerment by basically utilizing diverse voluntary and participatory on farm activities, including adoption of agro-meteorological information, selection of agricultural practices and even the choice of seed varieties by farmers depending on seasonal forecasts. Younger farmers mainly below the age of 50 years adopted agro-meteorological information and incorporated the information on their daily farm decisions much faster compared to their counterparts who were above 50 years of age and more conservative to their normal way of practicing farming without involving agro-meteorological information in farm decisions.

4.1.3 Educational level of the respondents

Migori County had farmers with different educational backgrounds ranging from primary school dropouts to university graduates (Table 1). Out of the population studied (11.7%) were primary school dropouts, (1.9%) were still in secondary school though they had families and farms in which they were practicing maize production, (26.8%) successfully completed secondary school but never proceeded beyond that level of which they are the majority of the respondents, (14.1%)

managed to pursue education from tertiary institutions while only (14.0%) were university graduates (Table 1).

Table 2 shows that there is a negative correlation (-0.108 at $p \leq 0.058$) between farmers' of educational level and agro-meteorological information awareness (Table 2). The correlation is not significant at the 0.05 level. A negative correlation between farmers' level of education and agro-meteorological information awareness shows that at the farmer level, making farm decisions on enterprise selection is based on EAS delivery systems and not the respondents' education level. This disagrees with Leakey *et al.*, (2010) which suggests that farmers with higher level of education have higher understanding of maize production risks associated with weather.

Table 2: Pearson's correlation analysis

| | | Educ. | AW | AC | AM | VF | MES | MEM |
|-------|-----------------------|-------|-----|-------|-----|-------|-----|-----|
| Educ. | Pearson's correlation | 1 | | | | | | |
| | Sig. (1-tailed) | | | | | | | |
| | N | 217 | | | | | | |
| AW | Pearson's correlation | -.108 | 1 | | | | | |
| | Sig. (1-tailed) | .058 | | | | | | |
| | N | 217 | 217 | | | | | |
| AC | Pearson's correlation | | | 1 | | | | |
| | Sig. (1-tailed) | | | | | | | |
| | N | | | 217 | | | | |
| AM | Pearson's correlation | | | .155* | 1 | | | |
| | Sig. (1-tailed) | | | .012 | | | | |
| | N | | | 217 | 217 | | | |
| VF | Pearson's correlation | | | | | 1 | | |
| | Sig. (1-tailed) | | | | | | | |
| | N | | | | | 217 | | |
| MEM | Pearson's correlation | | | .149* | | .058* | 1 | |
| | Sig. (1-tailed) | | | .015 | | .199 | | |
| | N | | | 217 | | 217 | 217 | |
| MES | Pearson's correlation | | | .074* | | | | 1 |
| | Sig. (1-tailed) | | | .142 | | | | |
| | N | | | 217 | | | | 217 |

N/B:

Educ- Education level.

AW- Agro-meteorological information awareness.

AC- Agro-meteorological information accessibility.

AM- Agro-meteorological information access through the mass media.

VF- Agro-meteorological information access through video forecasts.

MES- Use of agro-meteorological information in maize enterprise selection.

MEM- Use of agro-meteorological information in maize enterprise management.

4.1.4 Occupation of the respondents

Majority of the people contacted were fulltime farmers (33.8%) most of who diversified the types of enterprises. They planted a variety of crops like maize, beans, bananas, potatoes, sugarcane, sorghum, millet, groundnuts, cassava, sweet-potatoes and kale. The result indicate that (15.5%) were salaried employees of other institutions who also apart from maize crop production also were salaried employee who practiced maize production part time, (9.4%) were students who with the help from other family members or hired labor took part in maize production while (8.4%) were unemployed and kept on crop production as they waited for tangible employment (Table 1). The results show that most users of agro-meteorological information were full time farmers. The way the information is communicated matters as it is reached differently by different categories of farmers (Clough *et al.*, 2010). For example the salaried employees rarely met the extension advisory officers during organized field days. This makes internet the most suitable way to reach them. This might make the internet a powerful tool for considering the impact of agro-meteorological information and also to add meaning to short term forecasts (Friori *et al.*, 2014).

The findings could be interpreted to mean that a majority of the farmers knew of the existence of agro-meteorological information. Awareness of agro-meteorological information can be

attributed to inter-farmer extension advisory services developed by the farmers themselves in Migori, which helped improve maize farmers' participation agro-meteorology awareness creation, networking and agro-meteorological decision-making processes. Though, agro-meteorological information awareness do not guarantee accessibility and utility which are key to successful crop production (Zendera *et al.*, 2011).

4.2.0 Agro-meteorological information awareness and accessibility

4.2.1 Agro-meteorological information awareness

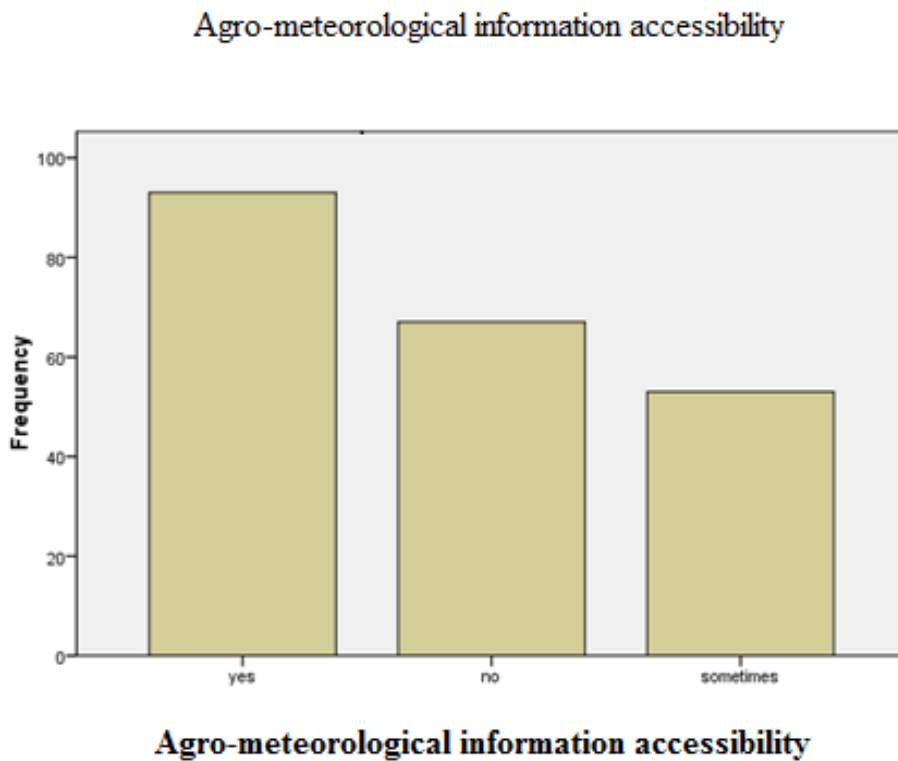
Table 3 shows that (63.4%) of the respondents were aware of agro-meteorological information and had at one point or severally used the information in their farming practices in the past year while (36.6%) indicated that they were not aware of such information suggesting that they do not consider the information in farming practices.

4.2.2 Agro-meteorological information accessibility

The research established the level to which agro-meteorological information was accessed by maize crop farmers, according to the findings out of the (63.4%) (Table 3) of the farmers who were aware of the availability of agro-meteorological information only (43.7%) indicated to have access to the information either from friends, neighbors, mass media or agricultural extension agents, (24.9%) indicated that they sometimes had access to the information and they put it into use in the management of their maize farms while (31.4%) admitted to have no access to the very vital agro-meteorological information (Figure 3). Awareness of agro-meteorological information precedes accessibility, awareness about agro-meteorological information do not necessarily guarantee accessibility. Many initiatives are today being put in place to help increase farmers' EAS focused agro-meteorological information not every smallholder farmer is reached (Friori *et*

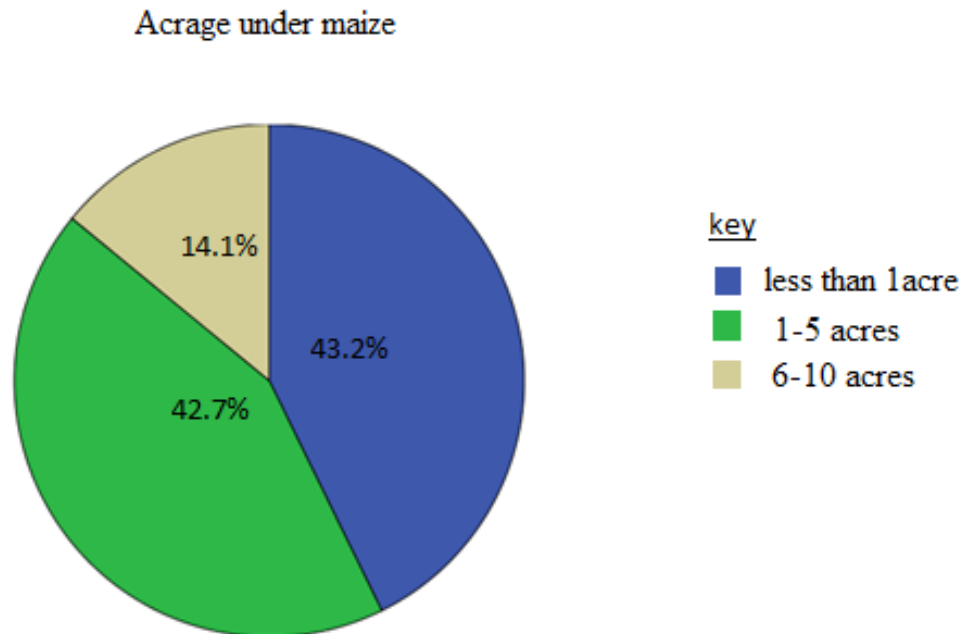
al., 2014). More farmers should be reached through the mass media to enhance accessibility. Nevertheless, crucial to accessibility is effectiveness and the efficiency of various the various EAS methods in order to enable significant agro-meteorological dissemination and improve rural livelihoods.

Figure 4: Agro-meteorological information accessibility in Migori County.



The study sought to establish the respondents' farm size in acreage. The mean farm size acreage was 1.7170 (0.69874*). According to the findings of the respondents (43.2%) practiced maize farming in pieces of land between less than an acre, (42.7%) had between 1-5 acres under maize while the remaining (14.1%) had relatively larger tracks on maize of between 6-10 acres (Figure 4). This implied that most respondents were smallholder maize farmers.

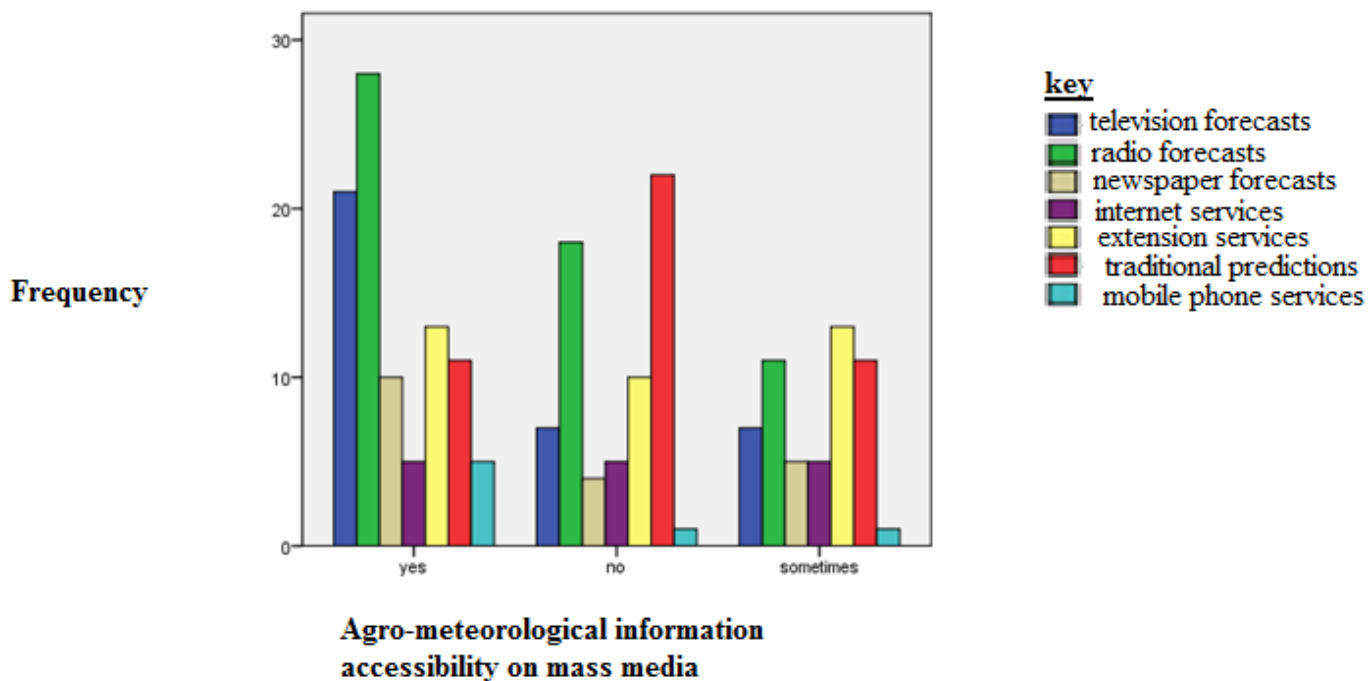
Figure 5: Mean acreage under maize in Migori County.



4.3.0 Agro-meteorological information dissemination

This research indicated that away from accessing forecasted weather information on radio, television forecasts, extension services and culture based traditional predictions, access to agro-meteorological information through other media channels was extremely low (Figure 5). Slightly above 75% of the small holder farmers revealed that accessibility of weather information through internet services, mobile phone services and newspaper forecasts was very minimal (Figure 5).

Figure 6: Channels of agro-meteorological information dissemination in Migori County.



The results indicate that more than (50%) of the respondents had access to radio of which up to (48.4%) of the respondents listened to radios on a day-to-day basis, (26.6%) listen to radio forecasts sometimes while (25.0%) had no access to radio forecasts (Table 4). Other significant dissemination channels were farmer groups for mid-season predictions, newspapers, internet and extension advisories were considered more by small holder farmers. All the channels for information dissemination were found to be significant and virtually complemented one another regarding the meteorological content and the frequency used to transfer and disseminate weather forecast information to the target audience (Awuor, 2008). Of the farmers contacted (87%) indicated that they would favor radio forecasts that can educate farmers more on maize farming.

It was noted that radio plays a very vital role in the dissemination of agro-meteorological information though the weather forecasts are very short and covers a vast geographical coverage which do not possess similar ecological characteristics as most forecasts were meant for larger cities or generalized, for example forecasts for the wider western Kenya region. Zendera *et al.*, (2011) observed that radio as a channel of information dissemination cuts across several barriers that one must possess in acquiring information in a written format. Radio forecasts in short requires no minimal literary qualifications for its accessibility. Traditional predictions as well even though not so popular still plays a very important role in informing farmers' decisions.

Table 2 shows that there is a weak positive correlation ($r= 0.155$ at $p\leq 0.012$) between channels like newspapers, traditional predictions, radio, extension services, television, internet services and mobile phone services and small holder farmers accessibility to weather information (Table 2). The auto-correlation is significant at 0.05 level.

Accessibility to agro-meteorological information was dependent on access to mass media and extension services. Without these channels the dissemination of agro-meteorological information would not be realized. Agro meteorological information dissemination through different channels enhances decision-making in day-to-day activities of maize farmers. Besides the information comprises other agro meteorological data which can be useful for maize enterprise management. However, the respondents noted that this agro-meteorological information is more valued incase its communicated in such a way that the target small holder farmers potentially benefit in practical application of its content. Even though current meteorological innovations has largely increased weather information and improved the number small holder farmers who use it in effective management and planning of cropping systems, continuous improvements are of great significance to improve what the information contains and by ensuring that the content is

specific enough adequately fulfilling all the necessary requirements of the target farmers (Leaky *et al.*, 2010).

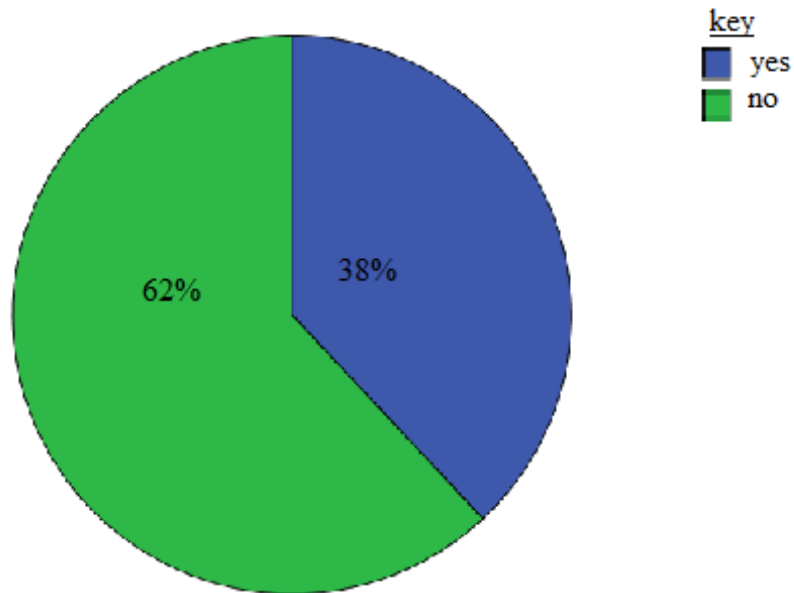
4.3.1 Television forecasts

According to the study, (32.9%) of the farmers who watched television forecasts after every news bulletins, (39.4%) of the respondents never paid attention to the weather forecasts while (27.7%) indicated that they did watch the forecasts sometimes in the event that they had watched news bulletins (Figure 4). Farmers reached on television in the agro-meteorological information dissemination process are few. This is because not all the farmers own television sets so they cannot be able to access agro-meteorological information through regular forecasts. Television forecasts enhances content shaping and priming during the process of dissemination (Christopolos, 2010). Agro-meteorological information predictions as well as advisory services are broadcasted together with visuals that are much faster and can be understood with more ease by several users since it can be used for demonstration.

4.3.2 Use of video in the dissemination of agro-meteorological information

This research indicated that a majority (62%) of the farmers contacted have not received agro-meteorological information though videos while only (38%) had received the information when video clips are played to them (Figure 7).

Figure 7: Use of videos in agro-meteorological information in Migori County



Use of videos in agro-meteorological information

Table 2 shows that there is a correlations ($r=0.058$ at $p\leq 0.199$) between agricultural enterprise selection and small holder farmers' accessibility to agro weather information forecasts through video recordings. The correlation is not significant at 0.05 level. It can be concluded that there is no dependence of accessibility to agro-meteorological information using video recordings in disseminating agro-meteorological information to maize enterprise selection.

4.3.3 Usefulness of the agro-meteorological information presentations to the farmers.

Table 5 shows the usefulness of the presentations in this study and the different categories of information that were incorporated in the forecasts.

Table 3: Usefulness of agro-meteorological information presentations in Migori County.

| Usefulness of the presentations | Frequency | Percentage |
|--|------------------|-------------------|
| Forecasts for the next 48 hours | 49 | 22.5% |
| Information on alternative enterprise to give priority | 49 | 22.5% |
| Information on the seed varieties recommended | 37 | 17.4% |
| Summary of the past weeks forecasts | 37 | 16.9% |
| Overview of the coming week | 28 | 12.7% |
| Information on current temperatures | 17 | 8% |

This study as shown in Table 3 revealed that farmers would not give priority to information on the summary of the past events but would rather focus on weather forecasts of the coming weeks, (22.5%) indicated that the forecasts focused on weather information for the next 48 hours, (22.5%) information on the enterprises to give priority, (17.4%) seed variety to be given priority, (16.9%) said that they benefited most on information focusing on summary of the past week, (12.7%) on overview of the coming week while only (8%) preferred information on the current temperatures suggesting that most respondents rarely utilize or even pay attention to information regarding daily temperature forecasts. Majority of the farmers contacted indicated that they would prefer forecasts on future occurrences to inform their decisions concerning land preparation, planting, pest and disease control, weeding, harvesting, choosing seed varieties for a particular season.

4.3.4 Preferred media for communication agro-meteorological information

Extension advisory was the most preferred media for dissemination of agro-meteorological information at (28.2%) suggestively because they already had developed some trust on the extension services. Videos' which came second at (16.4%) (Table 4).

Table 4: Preferred media for learning more about agro-meteorological information in Migori County.

| Best ways to learn more about weather | Number of farmers | Percentage |
|--|--------------------------|-------------------|
| Books | 26 | 12.2% |
| Videos | 36 | 16.4% |
| Leaflets | 26 | 12.2% |
| Internet | 22 | 10.3% |
| Television programs | 25 | 11.3% |
| Extension agents | 61 | 28.2% |
| Courses in agricultural collages | 19 | 8.9% |
| Others | 1 | 0.5% |

Leaflets and books came third in preference both coming at (12.2%) each for the farmers who were able to read and understand the information contained in the leaflets and books. According to the study ((11.3%) of the farmers in Migori County would prefer future agro-meteorological information to be communicated to them through television programs, (10.3%) would prefer the information to be put on the internet so that they could access at will any time of need without necessarily soliciting for any help from any one to access the information while (8.9%) of the respondents would prefer agro-meteorological information learnt in courses in agricultural collages (Table 4).

4.4.0 Agro-meteorological warning services

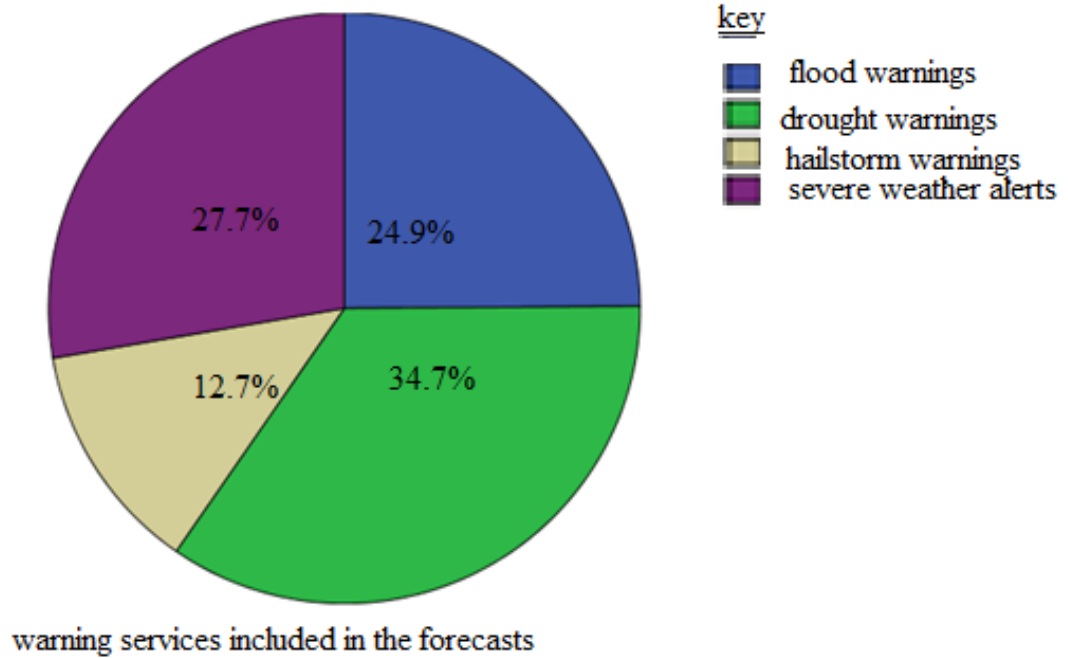
This study indicated that farmers also depend on warning services offered to them through the channels of dissemination. Some of the warning services that were important to the farmers included drought warnings, flood warning, hailstorm warning and severe weather alert. More than 70% of the respondents indicated that they considered warnings services very important to

them. Drought warning in essence was most important to the farmers to enable them plant their crops early enough to prevent them from limited moisture conditions especially during their flowering period.

The result indicate that (34.7%) would prefer the forecasts with drought warnings, (27.7%) preferred warnings on severe weather alerts, (24.9%) favored flood warnings while only (12.7%) showed preference for hailstorm warnings since the regions around Migori County rarely experience hailstorms (Figure 7).

Weather predictions and climatic forecasts long before the currently modern meteorological innovations, crop and livestock production proceeded with success, not to mention the frequent disasters (Zuma, 2013). Agro-meteorological warnings according to the farmers contacted are too general and not location specific thereby always used to give blanket recommendations on what decisions to make, area specific weather warnings would prove to be more economically beneficial. This can be interpreted to mean that even though warning services were important to the farmers in preparation for extreme weather conditions some of the farmers never put it in to consideration when making critical farm decisions.

Figure 8: Agro-meteorological warning services



Even though the warning services were offered a good number of the respondents attested to the fact that the services provided were not appropriate. According to the results (48.8%) of the respondents attested to not using the warning services provided, (34.8%) indicated that they quite often put the warning services into use while (16.4%) use the services on the event that they were available (Table 5).

Table 5: Use of agro-meteorological warning services in Migori County.

| Use of agro-meteorological information warning services | Frequency | Percentage |
|---|-----------|------------|
| Yes | 76 | 34.8% |
| No | 106 | 48.8% |
| Sometimes | 36 | 16.4% |

4.4.1 Farmers understanding of the symbols used on the television and weather charts.

According to this study the results show that only (39%) of the farmers quite clearly understood the symbols used, (29.6%) admitted to have understood the symbols sometimes but not all the times the forecasts were given and (31.4%) lacked sufficient understanding of the symbols used in television forecasts or weather charts (Table 6). Agro-meteorological information given could easily be misunderstood or misinterpreted by the maize farmers. However, a majority of the farmers showed interest in learning more about weather symbols. Agro-meteorologists since the 1970s, have come up with varied kinds of modern scientific knowledge, to more easily enable the small holder farmers adapt to climatic changes, even though operationally, the knowledge is not satisfactory to all the farmers (Stigter, 2013). Additionally, local indigenous culture based small holder farmers still utilize traditional predictions to serve as a guideline for crop production activities that the farmers undertake in their farms (Zuma, 2013).

Table 6: Farmers understanding of the symbols used in forecasts in Migori County.

| Understanding of the symbols used in forecasts | Frequency | Percentage |
|--|-----------|------------|
| Yes | 85 | 39% |
| No | 68 | 31.4% |
|]]Sometimes | 64 | 29.6% |

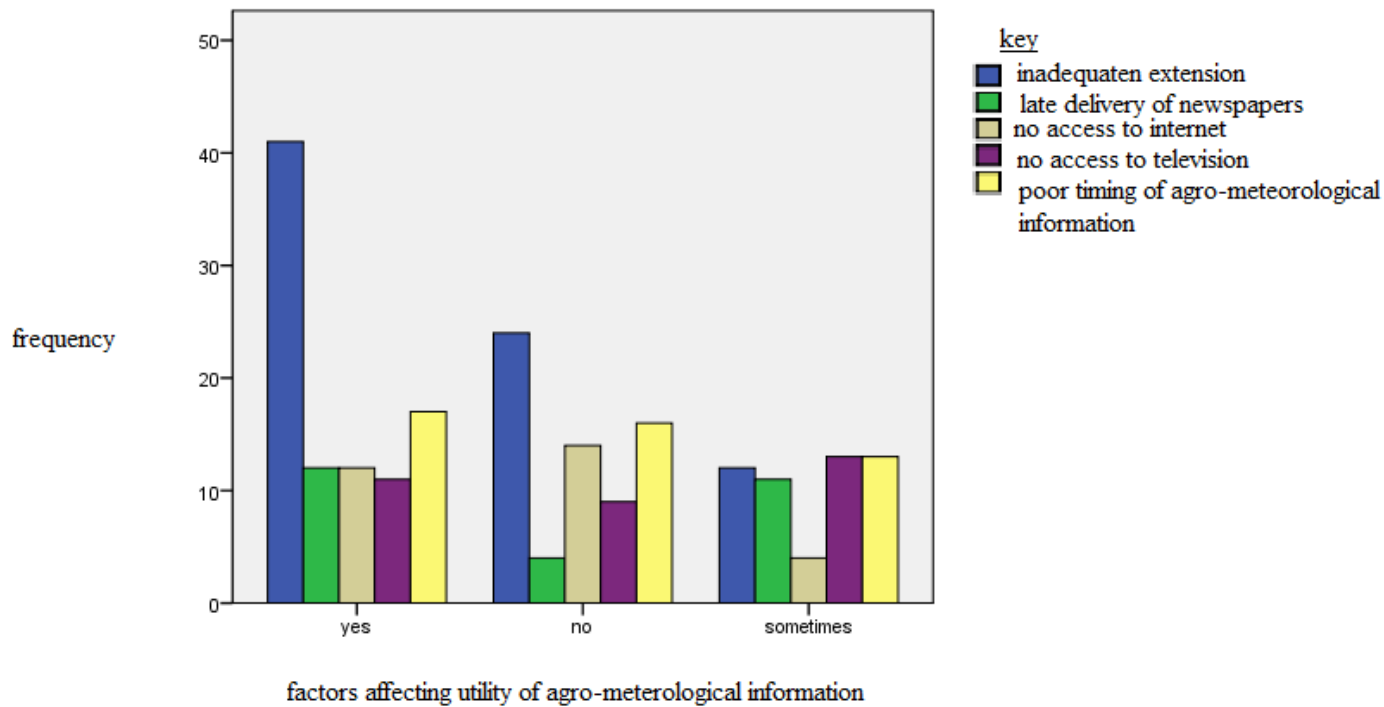
4.5.0 Factors influencing accessibility to weather information forecasts

Several small holder farmers opined that inadequacy in extension advisories at (36.2%), poor timing of agro-meteorological information (21.6%), no access to television (15.5%), no access to the internet (14.1%) and late delivery of newspapers (12.7%) as the major factors influencing small holder farmers' accessibility to weather forecast information (Figure 8). Given that a majority of the factors influencing crop and livestock productivity in the arid and semi-arid areas is fluctuations in the weather elements that are relevant to production (Frankema, 2013).

Subsistence farmers need deliberate assistance in disseminating agro-meteorological information so as to cope with the crop production systems that come today's drastic changes in the weather experiences. Small holder farmers need to satisfactorily plan their crop production systems to enable succeed, since the weather elements keep failing the production patterns for example through response initiatives in the farms and careful contingency planning putting all the interacting factors into consideration.

Advisory services should be enhanced by effective close co-ordination and healthy collaboration amongst the concerned institutions, organizations and agencies. Optimizing agricultural production practices under extreme conditions of drought that may lead to low productivity and diminish the improved economic benefits from external inputs utility and enhanced deliberate effort get the benefits from the high unusual amounts of rainfalls (Nanja, 2010).

Figure 9: Factors affecting agro-meteorological information accessibility in Migori County.



4.6.0 Use of weather forecast information in the management of maize enterprises

Farmers use agro-meteorological information in timing different farm operations like land preparation, planting, weeding, in pest and disease control, harvesting and other important decisions like selection of seed varieties to be planted in a particular season.

According to this study, (31.5%) of the farmers indicated that they would prefer to use agro-meteorological information in order to make planting decisions for example when to purchase planting materials or plant, while (26.8%) preferred to use the information on timing land preparation operations like primary tillage, secondary cultivation or tertiary tillage, (16%) indicated that agro-meteorological information was important to them in timing harvesting to prevent their produce from rotting due to bad weather and even give them enough time for land reparation to take off, (14.1%) valued the weather forecasts in timing weeding, the method of weeding to be used and the frequency of weeding to avoid crop-weed competition while (10.8%) preferred using the information in pest and disease control timing in order to enable effective action by the chemicals used and prevent eutrophication that could result in pollution of water bodies like rivers (Table 7).

Table 7: Use of agro-meteorological information in management of maize farms in Migori County.

| Attribute | Frequency | Percentage |
|---------------------------------|------------------|-------------------|
| During land preparation | 58 | 26.8% |
| During planting | 68 | 31.5% |
| During weeding | 31 | 14.1% |
| During pest and disease control | 23 | 10.8% |
| During harvesting | 35 | 16% |
| Others | 2 | 0.9% |

Most farmers in Migori County valued the agro-meteorological information they received from different sources and they used the information in the management of their various farm activities. For improved decision making in the farms there is need to introduce of farmers to agro-meteorological knowledge and information (Stighter *et al.*, 2010).

Table 2 shows that there is a weak positive correlation ($r=0.149$ at $p \leq 0.015$) between farmers' accessibility to weather forecasts information and use of agro-meteorological information in maize crop management activities like planting, land preparation, harvesting, weeding, and pest and disease control (Table 2). The auto-correlation is significant at the 0.05 level.

Farmers in Migori who were accessible to agro-meteorological information considered the information in the management of their maize enterprises. It can be concluded that accessibility of agro-meteorological information leads to better management of maize farms. Even though some farmers observed that they preferred following the usually normal planting time for each seasonal program in order to make planting decisions, some preferred to wait for the rains while others preferred to make use of scientific forecast appropriately (Zuma, 2013).

4.7.0 Use of ago-meteorological information in maize enterprise selection

The results indicate (37.6%) of the farmers contacted selected their maize enterprises in the last season of production depending on the forecasts given, (62.4%) indicated that they do not considered the forecasts in their decisions as to which enterprise to give priority (Table 8).

Table 8: Use of agro-meteorological information in maize enterprise selection

| Use of agro-meteorological information in maize enterprise selection | Frequency | Percentage |
|---|------------------|-------------------|
| Yes | 82 | 37.6% |
| No | 135 | 62.4% |

Table 2 shows a weak positive correlation ($r=0.074$ at $p \leq 0.142$) between peasant farmers' accessibility to weather forecast information and its use in maize enterprise selection among small holder farmers (Table 2). The correlation is not significant at the 0.05 level. Farmers in Migori County do not consider agro-meteorological information in the selection of their maize enterprises therefore putting their crops into risk of extreme limited moisture content and increased incidences of pests and diseases consequently low maize crop productivity. This is because some of them do not know that their enterprises should be guided by weather forecasts to prevent them from extreme risks of climate variability. This has led to adverse maize crop failure and consequently food insecurity simply because agricultural productions in the Sub-Saharan Africa undertaken in conditions of rain fed production systems and as well in conditions of irrigation though on a limited scale (Zendera *et al.*, 2011).

4.8.0 Regression results

Regression results for the following research questions;

- I. What is influence of smallholder maize farmers' level of accessibility to agro-meteorological information on maize enterprise selection?
- II. Do smallholder farmers' use agro-meteorological information in the management of maize enterprises?

4.8.1 Regression results for the first research question.

The model below represents the explanatory variables used in the regression analysis to test the first hypothesis;

$$Y = B_0 \pm X_1 P_1 \pm X_2 P_2 \pm X_3 P_3 \pm X_4 P_4 \pm X_5 P_5 \pm X_6 P_6 \pm X_7 P_7 \pm X_8 P_8 \pm e \dots \dots \dots (i)$$

Where;

Y-dependent variable (Use of agro-meteorological information in enterprise selection)

B₀-constant term or y intercept.

X₁- X₈- Coefficient of variable. (Independent contributions of each independent variable to predict the dependent variables).

P₁-(age), P₂-(gender), P₃-(marital status), P₄-(agro-meteorological information awareness), P₅-(access to mass media), P₆-(agro-meteorological information accessibility), P₇-(access to mass media) and P₈-(use of video in agro-meteorological information dissemination) (Independent variables).

e- Is the error term.

The results of the regression were as follows;

The correlation tests (see appendix 3) show that there is correlation among the variables that are not stronger than 0.7. Any pair of variables with correlation of more than 0.7 should be removed because stronger correlations affect the regression model (Kerlinger and Lee, 2007).

From the same significance column of the same table on (appendix 3), a conclusion is made that two variables (“age” (significance=0.845) and “gender” (significance=0.946)) are not making any significant unique contribution to the model because their significant values are more than 0.05.

This leaves “marital status” (significance=0.004), “agro-meteorological information awareness” (significance=0.02) and “access to mass media” (significance=0.08) as the most influential factors maize enterprise selection among smallholder farmers.

4.8.2 Analysis of Variance for the first research question.

The ANOVA (Table 9) also from the SPSS analysis.

ANOVA^b

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|-------|------------|----------------|-----|-------------|-------|-------------------|
| 1 | Regression | 15.707 | 8 | 1.963 | 0.972 | .493 ^a |
| | Residual | 127.091 | 204 | .623 | | |
| | Total | 142.798 | 212 | | | |

From analysis the F value from the table is 0.972 at the 0.05 significance level. The farmers do not use agro-meteorological information in the selection of their enterprises. These findings are consistent with (Zendera *et al.*, 2011) who notes with concern that the farmers who have access to agro-meteorological information do not put the information into utility appropriately in selecting maize enterprises.

4.8.3 Regression results for the second research question.

The model below represents the explanatory variables used in the regression analysis to test the second hypothesis;

$$R = B_0 \pm B_1 P_1 \pm B_2 P_2 \pm B_3 P_3 \pm B_4 P_4 \pm B_5 P_5 \pm B_6 P_6 \pm B_7 P_7 \pm B_8 P_8 \pm e \dots \dots \dots (ii)$$

Where;

R- Dependent variable (Use of agro-meteorological information in maize enterprise management)

B₀-Constant term or y intercept

B₁- B₈. Coefficient of variable. (Independent contributions of each independent variable to predict the dependent variables).

P₁-(age), P₂-(gender), P₃-(marital status), P₄-(agro-meteorological information awareness), P₅-(access to mass media), P₆-(agro-meteorological information accessibility), P₇-(access to mass media) and P₈-(use of video in agro-meteorological information dissemination) (Independent variables).

e- Is the error term

The results of the regression were as follows;

The correlation tests (see appendix 3) show that there is correlation among the variables that are not stronger than 0.7. Any pair of variables with correlation of more than 0.7 should be removed because stronger correlations affect the regression model (Kerlinger and Lee, 2007).

From the same column of the same table on (appendix 3), a conclusion is made that two variables (“awareness of agro-meteorological information” (significance=0.444) and “use of videos in weather forecasts” (significance=0.483)) are not making any significant unique contribution to the model because their significance values are more than 0.05.

This leaves (“access to mass media” (significance=0.026) and “agro-meteorological information accessibility” (significance=0.045)) as the most influential of maize enterprise management.

4.8.4 Analysis of Variance for the second research question.

The ANOVA (Table 10) also from the SPSS analysis and was used to test the regression model.

ANOVA^b

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|-------|------------|----------------|-----|-------------|-------|--------------------|
| 1 | Regression | 20.641 | 8 | 2.580 | 3.458 | .0045 ^a |
| | Residual | 418.233 | 204 | 2.050 | | |
| | Total | 438.873 | 212 | | | |

From the analysis the F value from the table is 3.458 at the 0.05 significance level. The farmers were found to use agro-meteorological information in the management of their maize enterprises.

These findings are consistent with Stigter, (2013) who notes that farmers valued the agro-meteorological information they received from different sources and they used the information in the management of their various farm activities. Introducing small holder farmers' practical applications of agro-meteorological information, other modern meteorological innovations and available knowledge should be done for improvement in decision making in the agricultural sector (Stigter, 2013).

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Summary and Conclusion

The socio-economic characteristics of the respondents have influence on the awareness, accessibility, adoption and utility of weather forecast information. There is a negative auto-correlation between farmers' education level and awareness about agro-meteorological information. Farmers still use traditional culture based predictions like migration of animals for example birds, varied sounds made by animals, their behavior appearance, color and shapes of clouds in their indigenous predictions and forecasts. Such small holder farmers make farming decisions based on the indigenous understandings and experiences of the earlier mentioned ecological occurrences in their localities.

Access to the mass media had an influence on access to agro-meteorological information. In this regard the availability of the currently developed modern meteorological methods for weather predictions and forecasts increased awareness and access to agro-meteorological information. Nevertheless, farmer education about the practical applications of modern meteorological innovations, agro-meteorological information and products like on rotational cropping, seed selection, timely planting, plant population, pest and disease control, water conservation, weeding and top dressing, were necessary for issuing guidelines to small holder farmers for enhanced farm decision-making to ensure improved productivity for maize farmers.

Radio was the most popular dissemination channel compared to any of the other channels such as newspapers, videos, internet, mobile phones, and extension services. A number of mass media channels are significant supplying weather forecast information for different agro-meteorological

content or for different periods of time. Lack of access to television, inadequate extension services, lack of access to internet facilities, newspapers not delivered on time and inaccuracy of forecasts were observed and mentioned by the small holder farmers as the most crucial factors influencing access, adoption and utility of weather forecast information in maize enterprise selection and management among the farmers.

Farmers use agro-meteorological information management in activities like timing of planting, harvesting, weeding and pest control but not selection of the enterprise. Awareness and accessibility to agro-meteorological information do not guarantee utility of the information in maize enterprise selection. Even though data on meteorology plays a greater role in cropping systems surveys, crop and livestock production decisions were found to be made depending on indigenous experiences, understanding and knowledge of these ecological conditions of the peasant farmers' locality, which are acquired after a number years of experiences. To facilitate efficient and effective dissemination of modern agro-meteorological knowledge, an understanding of the small holder farmers' perceptions of weather is very crucial.

5.2 Recommendations

The study recommends that:

Agro-meteorology advisory services should integrate agro-meteorological services with indigenous experiences on climate predictions and agro-meteorological forecasts to enhance copying strategies and ascertain that meteorological products, services and knowledge are practically applied at the farm level.

In the development of various agro-meteorological products for effective and economically beneficial cropping systems, it is of necessity to put into consideration the provisions of the information and as well specify the information to a particular geographical zone and avoid generalizations in giving advisories by both the mass media and advisory groups. It is possible from this research to conclude that area specific, accuracy in giving short-term and medium-term forecasts is greatly significant in the provision of agro-meteorological products that are much needed by the small holder maize farmers. Farmers want forecasts to be more localized as opposed to the general forecasts, therefore production of local forecasts that are improved ought to be a priority to the small holder farmers. Additionally, forecasts that are clearly tailored are needed to avoid agro-meteorological information overload.

The Migori County government in collaboration with the national government should develop models for enterprise selections, management and put into consideration ecological sustainability in the event of receiving a particular weather forecasted for a given period within a season fails.

A number of mass media channels are of significance for communicating weather based agricultural information for varied agro-meteorological content and for different periods of time.

The mass media should increase time and space allocated to agro-meteorological information dissemination to make the information more vivid and give the information utmost importance.

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APPENDIX I

QUESTIONNAIRE TO EVALUATE AGRO-METEOROLOGICAL INFORMATION EFFECTSON THE MAIZE ENTERPRISE MANAGEMENT AMONG SMALLHOLDER FARMERS

SECTION A

Q1.Profile information (Identification)

Questionnaire No.....

County..... Location

Sub county..... Date of interview...../...../..... (Dd/mm/yyyy)

Respondent's name.....

Gender: Male [] Female [] Age []

SECTION A: DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

(Tick appropriately)

| Marital status | Education | Occupation |
|----------------|------------------------|-------------------------|
| 1= married[] | 1= In Primary[] | 1= salaried employee[] |
| 2=Separated[] | 2=Primary drop-out[] | 2=farmer[] |
| 3=Widowed[] | 3=Completed primary[] | 3=Self-employment[] |

| | | |
|--|---|--|
| 4=Single [<input type="checkbox"/>] | 4=Secondary drop-out [<input type="checkbox"/>] | 4=Casual laborer [<input type="checkbox"/>] |
| 5=Divorced [<input type="checkbox"/>] | 5=In secondary [<input type="checkbox"/>] | 5=Student [<input type="checkbox"/>] |
| | 6=Completed secondary [<input type="checkbox"/>] | 6=Unemployed [<input type="checkbox"/>] |
| | 7=Tertiary level [<input type="checkbox"/>] | 7=Others |
| | 8=University [<input type="checkbox"/>] | (specify)..... |
| | 9=Adult education [<input type="checkbox"/>] | |
| | 10= Other (specify) [<input type="checkbox"/>] | |

SECTION B

Q2. Type of enterprises undertaken (tick appropriate boxes); Maize [] others (specify).....

Q3. Number of acres farmed (tick appropriately); Less than 1[] 1-5[] 6-10[] 10+ []

Q5. Which of the following meteorological services to agriculture are you aware of and which services do you use?

| Service | Aware of | | Access to | | Number of times used in the past month (e.g. once, twice, thrice etc.) |
|--------------------------|----------|----|-----------|----|--|
| | Yes | no | Yes | No | |
| Television(TV) forecasts | Yes | no | Yes | No | |
| Radio forecast | Yes | No | Yes | No | |
| Newspaper forecasts | Yes | No | Yes | No | |
| Internet services | Yes | No | Yes | No | |
| Extension services | Yes | No | Yes | No | |
| Traditional predictions | Yes | No | Yes | No | |
| Mobile phone | Yes | No | Yes | No | |

| | | | | | |
|----------|--|--|--|--|--|
| services | | | | | |
|----------|--|--|--|--|--|

1. How did you learn about the agro-meteorological information?

a) In the mass media [] b) from an agricultural officer [] c) through a friend d) from a farmers group [] others please specify.....

Q6. Do you use the meteorological information obtained from the above services in selecting agricultural enterprises? Yes [] No [] Sometimes []

If no then why?

1. In your opinion what should be done to increase awareness of agro-meteorological information?.....
2. In what way(s) is the meteorological information helpful to you in the management of your maize enterprise?
 - a) During land preparation[]
 - b) During planting[]
 - c) During weeding[]
 - d) In pest and disease control[]
 - e) During harvesting[]
 - f) Others (specify).....

Q7. Forecast services (weekly farming forecasts)

1. Do you watch any forecast services on television? Yes[] No[] Sometimes[]
2. If yes, on which television channel? Citizen[] Ntv[] ktn[] kbc[] Qtv[] K24[] Others(specify).....
3. Is it important to you that the forecast was held at a particular fixed time each day? Yes[] No[] No opinion[]
4. If possible to define a single time for the farming forecasts, which of the following times would be the most suitable for? After 7.00pm news [] after 9.00pm news [] others (specify).....
5. What day of the week is most suitable to you for the farming forecast?
.....
6. Would you be in favor of a second farming forecast during the week? Yes[] No [] No opinion []
7. In each box below, please give marks out of 10 for each of the following elements of the forecast TV presentation in terms of usefulness to you. If an element is not relevant to you leave the box blank.
 - a) The summary of the past weeks weather(rainfall, temperature or sunshine) []

- b) The detailed forecast over the next 48 hours []
 - c) The overview for the coming week []
 - d) Information on current soil temperatures []
 - e) Information on the alternative enterprises to give priority []
 - f) Information on the seed varieties recommended []
8. Please give any additional comments and suggestions you have in relation to the farming forecast presentations.....

Q8. Radio forecasts

1. Do you listen to a weather forecast presentation on radio each day? Yes[] No[]
Sometimes[] if yes, which, if any, of the following radio presentations do you listen to;
Radio Ramogi 7.45am[] Radio Citizen 7.30am[] Radio Ramogi 7.45pm[] Radio
Citizen 7.45pm[] Others (specify).....
2. Of the Radio Citizen forecasts, the time which is most suitable and useful for me is
7.45am [] 12.45pm [] 7.35pm [] 9.30pm [] others (specify).....
3. Would you be in favor of a daily radio forecast primarily geared towards maize farming
Yes[] No[] No opinion[]
4. If yes, what time would you recommend this forecast to be presented at?
5. Please give any additional comments and suggestions and suggestions you have in
relation to the radio forecast
presentation.....

Q9. Newspaper forecasts

1. Do you read the weather forecasts in the daily papers Yes[] No[] Sometimes[]
2. Do you read the agricultural sections Yes[] No[] Sometimes[]
3. Please give any additional comments you in relation to the weather pages on the
newspapers.....

Q10. Mobile phone weather services

1. Do you use mobile phone forecasting weather services? Yes[] No[]
2. Is the information given detailed enough to help you as a maize farmer? Yes[] No[]
] No opinion[]
3. Is the outlook satisfactory in terms content? Yes[] No[] No opinion[]
4. Please give any additional comments you have in relation to mobile phone weather
services.....

Q11. Internet services

1. Do you use a computer for farm use? Yes[] No[]
2. Do you have access to the internet? Yes[] No[]

3. If yes, do you use a weather service on the World Wide Web? Yes [] No []
4. If so what service do you use?
5. The Kenya Meteorological Services is currently with their website. What services would you like placed on the site?

Q12. Video discs presentations

1. Do you use videos forecasting weather services? Yes [] No [] sometimes []
2. is the information given detailed enough to help you as a maize farmer? Yes [] No [] No opinion []
3. Is the outlook satisfactory in terms content? Yes [] No [] No opinion []
4. Please give any additional comments you have in relation to mobile phone weather services.....

SECTION C

Q12. Warning services

The following warning services are included in the weather forecast services where appropriate.

- a) Flood warnings[]
- b) Drought warnings[]
- c) Frost warnings[]
- d) Severe weather alert[]
1. Do you use any of the above warning services? Yes[] No[]
2. If yes, which do you use frequently.....
3. Are the warnings provided satisfactory? Yes[] No[] No opinion[]
4. Suggest ways in which current warning services might be improved?.....

Q13. Knowledge of weather and education

1. Do you understand the lines and symbols on the weather charts in the TV forecasts? Yes[] No[] Sometimes[]
2. Would you be interested in learning more about weather? Yes[] No[] No opinion []
3. If yes, please state the three best ways for you to learn more about the weather. Mark your preference 1, 2, 3 in the appropriate boxes. Books [] Videos [] Leaflets [] Internet [] TV programs [] Extension agents [] Course in an agricultural collage [] others (specify).....
4. Please give any comments/suggestions you may have in relation to education in weather.....

Q14. Factors affecting utility of agro-meteorological information among smallholder maize farmers.

1. Do you access agro-meteorological information on time? Yes[] No[]
2. If no, which of the following affect accessibility (tick appropriately)
 - a) Inadequate extension[]
 - b) Late delivery of newspapers[]
 - c) No access to internet[]
 - d) No access to television
 - e) Poor timing of agro-meteorological information[]

Please give any additional comments on the weather services available to you and list any other products and services that you feel would be useful and should be made available to you.....

Appendix 2: Interview schedule

| DAY | ACTIVITY |
|-------------------------------------|--|
| 15 DEC—30 DEC 2014 (DAY 1-10) | Testing the workability of the questionnaires with several farmers. |
| 2 JAN—5 JAN 2015 (DAY 11-15) | Training of enumerators (10) on the techniques and procedures of qualitative and quantitative data collection. |
| 6 JAN—10 JAN 2015 (DAY 16-20) | Testing the enumerators on their understanding of the techniques of data collection to be used. |
| 11 JAN—20 JAN 2015 (DAY 16—25) | Sampling of the farmers to be used as respondents in the actual data collection using the probability sampling technique (stratified random sampling). |
| 21 JAN—20 FEB 2015 (DAY 26-55) | Actual data collection from the each of the selected villages in the Suna-east and Ragana locations (data collection not in any distinct order of the villages). |
| 10 MAR —20 MAY 2015 (DAY 56-115) | Data analysis and thesis writing |

Appendix 3: Regression results

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|-------------------------------|----|----------------|--------|--------------|
| Corrected Model | Use of agro-meteorological information in maize enterprise selection | 13.431 | 37 | .363 | 1.912 | .003 |
| | Use of agro-meteorological information in maize enterprise management | 72.738 | 37 | 1.966 | .940 | .573 |
| Intercept | Use of agro-meteorological information in maize enterprise selection | 4.342 | 1 | 4.342 | 22.876 | .000 |
| | Use of agro-meteorological information in maize enterprise management | 10.171 | 1 | 10.171 | 4.861 | .029 |
| Age | Use of agro-meteorological information in maize enterprise selection | .155 | 3 | .052 | .273 | .645 |
| | Use of agro-meteorological information in maize enterprise management | 9.519 | 3 | 3.173 | 1.517 | .212 |
| Gender | Use of agro-meteorological information in maize enterprise selection | .001 | 1 | .001 | .005 | .546 |
| | Use of agro-meteorological information in maize enterprise management | .145 | 1 | .145 | .069 | .692 |
| Marital status | Use of agro-meteorological information in maize enterprise selection | 2.994 | 4 | .749 | 3.944 | .004* |
| | Use of agro-meteorological information in maize enterprise management | 4.563 | 4 | 1.141 | .545 | .603 |
| Enterprise type | Use of agro-meteorological information in maize enterprise selection | .157 | 1 | .157 | .829 | .364 |
| | Use of agro-meteorological information in maize enterprise management | 1.219 | 1 | 1.219 | .583 | .446 |
| Agro-meteorological information awareness | Use of agro-meteorological information in maize enterprise selection | 1.051 | 1 | 1.051 | 5.535 | .020* |
| | Use of agro-meteorological information in maize enterprise management | 1.230 | 1 | 1.230 | .588 | .444 |
| Agro-meteorological information accessibility | Use of agro-meteorological information in maize enterprise selection | .090 | 1 | .090 | .972 | .493 |
| | Use of agro-meteorological information in maize enterprise management | 7.234 | 1 | 7.234 | 3.458 | .045* |
| Access of information on the mass media | Use of agro-meteorological information in maize enterprise selection | 2.167 | 6 | .361 | 1.902 | .083* |
| | Use of agro-meteorological information in maize enterprise management | 15.614 | 6 | 2.602 | 1.244 | .026* |
| Use of videos in weather forecasts | Use of agro-meteorological information in maize enterprise selection | .041 | 1 | .041 | .218 | .641 |
| | Use of agro-meteorological information in maize enterprise management | 1.033 | 1 | 1.033 | .494 | .483 |

Appendix 4: Map of the study area

