THE ASSOCIATION BETWEEN AGRICULTURAL EXTENSION SERVICES AND FOOD SECURITY AMONG SMALL-HOLDER FARMING HOUSEHOLDS IN UASIN GISHU COUNTY, KENYA

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DECLARATION

DECLARATION BY THE CANDIDATE

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DEDICATION

To my son Steven Kiptoo and my parents: Christopher Kimaru (late) and Margarina Kimaru.

ABSTRACT

In spite of the importance of the agricultural sector to the economy and as a livelihood to many Kenyans, the sector has been underperforming. In Uasin Gishu County, extension service ineffectiveness has resulted in low agricultural production thus leading to marginal levels of food security. This study sought to examine the association between "availability, access and utilization of agricultural extension services and smallholder farming household's food security" in two Sub counties in Uasin Gishu County, Kenya. The study employed a survey method using multistage sampling, which included both purposive and simple random sampling to get 397 respondents in Soy and Turbo subcounty. Both primary and secondary data were collected and analysed to understand the various aspects of "availability, access and utilization of agricultural extension and food security. Data was analysed using descriptive, logistic, and ordinal regression models". The findings revealed availability, accessibility of extension albeit with limited utilization. Results from the respondent self-assessment of the food security showed that majority (70%) of the households had not experienced food insecurity with a few (19%) having occasional food insecurity and 11% reporting to often being food insecure. The results revealed a "positive association between the availability, access to extension services and food security" (β=0.197 & β=0.420) and statistically significant ($p<0.000$ & $p<0.008$) The Chi-square analysis also revealed an insignificant (χ^2 =0.812 and χ^2 =0.369) positive relationships between respondent households' access and utilization of agricultural extension services and food insecurity. The overall findings of this study show a weak link between agricultural extension and small holder household food security. This underlines the importance of supporting the utilization of the information provided by the extension service providers. This could be through more involvement of the small holder farmers in the identification of the problems and needs. To enable access and push for utilization of agricultural services by more farmers, emphasis should be put in additional financial resources both at the County and National government to enhance the human capacity and logistical support to extension service. The use of information technology and adoption of a pluralistic agricultural extension approach using varied methods such as farmer cooperatives may expand delivery and deepen engagement with diverse types of farming households leading to greater utilization of the knowledge gained. The study recommends further research over a long time to establish trends, cause, and effect both in extension service and household food security.

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LIST OF ABBREVIATIONS

AES:	Agricultural Extension Service
AGRA:	Agricultural Green Revolution in Africa
CAP:	Community Action Plans
CBOs:	Community Based Organizations
CESA:	Community-Based Extension Service Agent
CIMMYT:	International Maize and Wheat Improvement Centre
CRF:	Coffee Research Foundation
ELM:	Elaboration Likelihood Model
FAO:	Food and Agriculture Organization
FBOs:	Faith Based Organizations
FFDS:	Farmer Field Days
FFS:	Farmer Field Schools
FPEAK:	Fresh Produce Exporters Association of Kenya
FSAP:	Farm Specific Action Plans
FSR&E:	Farming Systems Research and Extension
GDP:	Gross Domestic Product
GRT:	Green Revolution Technologies
ICRISAT:	International Crops Research Institute for Semi-Arid Tropics
ICT:	Information Communication Technology
IFAD:	International Fund for Agriculture and Development
IFPRI:	International Food Policy Research Institute
IITA:	International Institute of Tropical Agriculture
KALRO:	Kenya Agricultural and Livestock Research Organization
KENAFF:	Kenya National Federation of Farmers

KESREF:	Kenya Sugar Research Foundation
KNFP:	Kenya Food and Nutrition Policy
NAEP:	National Agricultural Extension Policy
NALEP:	National Agriculture and Livestock Extension Programme
NASEP:	National Agricultural Sector Extension Policy
NEP:	National Extension Programme
SCT:	Social Cognitive Theory
SIDA:	Swedish International Development Agency
T&V:	Training and Visit Model
TPB:	Theory of Planned Behaviour
TRA:	Theory of Reasoned Action
TRFK:	Tea Research Foundation of Kenya

OPERATIONAL DEFINITION OF TERMS

Agricultural Extension: a "service or system which assists farm people, through educational procedures, in improving farming methods and techniques, increasing production efficiency and income, bettering their levels of living and lifting the social and educational standards of rural life" (World Conference on Agrarian Reform and Rural Development (WCARRD).

Agricultural Extension Technologies: These are the new and/or existing information as introduced and relayed by extension service providers. Extension technologies may be tangible of non-tangible (i.e., can sometimes be just information).

Agricultural Extension Package: This relates to grouping of extension services related to one aspect of agricultural production system e.g., crop production or livestock production, for crop this would relate all aspects from soil testing, input, crop management to post harvest management and marketing.

Agricultural Households: A group of families practicing agricultural activities for their livelihoods.

Availability of Agricultural Extension: This relates to enough supply and appropriate number of agricultural extension providers, with the competencies and skill-mix to match agricultural needs of the population.

Accessibility of Agricultural Extension: The ability of the agricultural extension service providers to reach and benefit small holder farming the considering the demographic composition, farming households' density and under-served areas or populations.

Farmer Field School: It is an "experiential group-based learning approach, seeking to empower farmers to learn, understand and make informed decisions. In a farmer

field school, groups of farmers meet regularly in the field with a facilitator to observe, talk, ask questions and learn together" on a particular subject.

Food Security: It refers to a "situation when all people at all times, have physical, social, and economic access to enough, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"(FAO, 1996)

Household: It is a group of people who live together and feed in one place.

Household Head: In this study, it refers to the lead member of the household who responsible in making crucial decisions of the household on a day to-day operation.

Pluralistic Extension Systems: Encompasses a "range of service providers, approaches, funding streams, and sources of information available to farmers and clients."

Utilization of Agricultural Information: This relates to conversion into action of the knowledge and information by the smallholder farming households to perform their agricultural production activity.

Smallholder Farming Household: this refers to families owning less than 2 hectares of land on which they grow subsistence crops, keep few livestock and sometimes engage in off-fare activities.

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To you all, I say thank you!

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter is an introduction and offers a summary of the basic concepts; background information, problem statement, objectives, hypotheses, justification, scope, and limitations of the study.

1.2 Background of the Study

Other than being one of the major global debates, agriculture is a critical economic growth driver. It is also essential in reducing poverty for most developing countries and a crucial investment area as well as a source of food security. According to a 2018 report by FAO, "global food security mainly relies on productivity of 570 million farms that differ broadly by size, production system, product, resource base, level of technology, productivity among other factors, majority (90%) of these farms are family enterprises." The role played by agriculture in industrial growth and immense development of most industrialized countries can not be emphasized enough. In developing countries like Kenya, the significance of this sector is more pronounced. Muhammud (2009) asserts that, "it is the central survival thrust of the nation, employment and food." For the rural people, agriculture is even more significant because it is their central way of life. Although agriculture's significance as an essential contributor to the country's GDP, "agriculture still represents an important input to the national economy and to rural livelihoods in Kenya" (Ephrem 2009).

According to the Republic of Kenya (2002), "Kenya's economy is heavily dependent on the agricultural sector that also provides the basis for the development of the other

sectors." It directly contributes to 25% of the GDP and further contributes indirectly to 27% by means of "linkages with agro-based and associated industries." (KARI 2002). Additionally, "The sector employs about 75% of the total labour force, generates 60% of export earnings, and provides 75% of industrial raw materials and 45% of Government revenue" (KARI 2002). Maize farming is specifically practiced by most people living in the rural areas, and KARI (2002) adds that, "about 80% of Kenya's population live in the rural areas and are engaged in agricultural activities including maize farming. The majority of the populations are smallholder farmers who account for 75% of the total agricultural output in the country".

Adult education is critical in any country and Indabwa & Mpofu (2006) defines it as, "any learning or educational activity that occurs outside the structure of the formal education system and is undertaken by people who are considered to be adults in their society." Several scholars highlight the significance of adult education, mentioning that it "seeks to meet the learning needs and interests of adults outside the formal education." (Indabawa & Mpofu, 2006). Non-formal education is defined as, "an activity outside the structure of the formal education system that is consciously aimed at meeting specific learning needs of particular subgroups in the 3 community be they children, youth or adults." (Fordham, 1993). Extension is a form or non-formal education that focuses on adults in the rural areas, who belong outside the formal school system. Its central aim is to better the quality of life through acquisition of knowledge and skills. Extension education for farmers often occur outside formal institutions. Agricultural extension "focuses on the non-formal education of rural adults, in particular farmers, to improve their agricultural knowledge and skills for increasing farm production, which is meant to result in enhanced income for farmers, leading to improvement in their lives. Adult education can cover community health

education, nutrition, and agricultural extension, vocational skills training, in short, any form of education and training for adults." (Gboku & Lekojot).

The intervention of agricultural extension has become common in the rural areas with the main intention of making their lives better. This has also seen the coming up of extensive extension programmes. Despite the popularity of these programmes, Habtemariam (2007) asserted that, "the impacts of all of these extension interventions have not had much influence in terms of improving the life of the rural population in general and the mode of maize farming and productivity in particular."

Worldwide, "agricultural extension has been recognized as a formal institution with legal structural arrangements with various approaches relying on government extension, private services and other stakeholders on pluralistic systems" (Rivera, 1991). "Agricultural extension was institutionalized and organized in the 1960s and 1970s in many countries across the world" (Swanson, 2008). However, there is difference among farmers in "their access to and utilization of agricultural information from extension service providers and other agricultural sources".

Smallholder farmers are recognized for their contribution to food supply in the better parts of the world. Guneralp et al., (2017) posits that an approximate of "500 million smallholder farmers produce 80% of food supply in Sub Saharan Africa and Asia". It is important to note that this remains consequential to these farmers since they are needed to adapt for more productivity, diversification, and resilience in the existence of climate change and any other changes that may occur based on nature. These have consequences on smallholder farmers who need to adapt to become more productive, diversified, and resilient in the presence of climate change and other nature-based changes.

Agricultural extension has also been described as advisory services for agriculture. In practical terms, it involves giving farmers agronomic knowledge, skills and techniques that would aid them in improving their productivity, livelihoods, and food security. It involves two main components; delivering practical information on aspects such as soil quality, management of water, crop protection, and how to apply this knowledge on the farm to achieve desired objectives.

One of the major identifications of agricultural extension across the globe is its role as an institution. Rivera (1991) describes it as having "legal structural arrangements with various approaches relying on government extension, private services and other stakeholders on pluralistic systems". However, there is difference among farmers in terms of accessing and utilizing information offered by extension service providers among other sources.

The significance of agricultural extension is emphasized by Ijatuyi, Omatayo & Mabel (2017), who mention that "agricultural extension means provision of need and demand-based knowledge in agronomic techniques and skills to improve production, income and general livelihoods and quality of life". Both participatory and methodical delivery modes were implemented. Challenges in rural development are best tackled through agricultural extensions which offer technology and information access for development purposes. It is important to highlight the smallholder farmers' need of sufficient information and skills. These two elements are achieved through formation of links between farmers' organizations and other important players (Davis & Heemskerk, 2012).

Investment and supportive policy and regulatory framework and institutional changes can enhance agricultural extension and food security (FAO, 2010). However, budget allocation in agriculture in Africa has remained low. While the average government expenditure in Africa is 4.5% as me provided by the International Budget Partnership (IBP), the Kenya Government allocations to the agricultural sector has been below par. IBP adds that, "they were two percent in 2015/16, 1.3 percent in 2016/2017 and 1.8 percent in 2017/18". Mengoub (2018) mentions that "In 2018, only four African countries (Malawi (23 %), Mozambique (18 %), Niger (12 %) and Zimbabwe (10 %) exceeded the level of agricultural expenditures compared to the total public expenditures of 10% set by the African Union within the Maputo Declaration". The extension departments remain under funded, on average county governments have allocated a budget of 6% of their total budget to the agricultural sector, limiting the equipping of existing staff and recruitment of new staff. The underfunding has remained persistent over the last decades, further compromising the extension service and the growth of the agricultural sector. Reduced farm incomes as well as unemployment are the two major causes of poverty.

According to Lowder et al. (2016), Africa's 51 million farms are relatively "smaller of these farms 80% are smaller than two hectares in size with the number of such farms increasing due to land subdivisions". Larson et al., (2014) add that most of these farms produce at efficient costs compared to the larger farms that enjoy the advantage of fair opportunity. The small farms produce approximately 30% of total agricultural output.

Both hunger and food security are among the priorities of the Achieving Sustainable Development Goal. This is made possible through promotion of sustainable agriculture that fosters more production of food.

However, hunger remains prevalent in Africa, with undernourishment rising from 17.6% in 2014 to 19.1% in 2019. (FAO et al., 2020). One of the main aspects of food security in any rural household is farming, especially because majority of household expenditure include food purchases (van de Ven et al., 2020).

For countries with advanced agricultural sectors such as US, Canada, and Australia, extension services are very strong and offer increased benefits to the farmers. This is very different in developing countries where the existing extension services fail time and again to comprehensively meet the needs of the farmers. In a bid to offset this failure, the World Bank established the training and visit system that played a critical role in the 1970s Green Revolution in India. However, this system was not successful as it failed in significant areas such as diversified farming systems in areas with increased rainfall. The system also failed to meet the evolved challenges such as improved sustainability, promotion of diversification, and linking farmers to markets. Prioritizing agricultural extension in Africa will therefore play a great role in promoting and sustaining food security and livelihoods for smallholder farmers. This will further enhance technology adoption to boost agricultural production though it has been slow in Sub-Saharan Africa (Raidimi, & Kabiti (2017). Udry, 2010; Duflo, Kremer & Robinson, 2011).

It has become paramount for farmers to constantly adapt and innovate over time due to different opportunities, circumstances and the immense global demand for food and other farm produce. A 2018 FAO report mentions that “Continuous farm-level

invention will be essential to meet an expected 59-98% increase in global demand for food between 2005 and 2050".

One of the positive aspects of agricultural extension is the resultant constructive behavioral changes among smallholder farmers. It also serves as a source of information regarding issues around food storage, processing, management of the farm and marketing (Rivera et al. 2001). Agricultural effectiveness is one of the major approaches recommended by Zwane (2012)) for viewing agricultural extension.

Services from extension present a chance to better resilience of rural households. This is attained by "improving the access to actual resources including knowledge and inputs. All these factors foster the productivity of the farm that eventually has a positive impact on food security" (Spielman, et. al 2008). Educating and training the farmers are some of the main features of agricultural extension. It ensures that these farmers gain knowledge regarding the appropriate farm activities to engage in and how to best apply scientific research for agricultural success.

Kenya's small-scale farmers living in high potential areas (owning less than 10 hectares) produce "more than 75% of the total agricultural production and 70% of marketed production". When drought is a non-factor, these farmers produce majority of the country's food requirements. Due to recent deficits against crops such as sugar, rice, maize and consumable oils. The reduction in production is linked to the reduced sizes of arable land, high costs of agricultural inputs and reduced soil fertility (Chukwu, 2014). It is clear that the sector's productivity is dwindling leading to food insecurity in nearly most parts of the country.

The agricultural production of smallholders' farmers has been gradually declining, hence the need for agricultural extension reforms. In Kenya, the policy of agricultural development acknowledges the role played by the public and private sector that operates on the extension service. This existence guides the country towards goal of transforming semi-substance farming into a modern aspect that allows the achievement of food security. It also helps to improve the incomes and actively reduce poverty. The means for proper management and agricultural extension organization have been highlighted by the National Agricultural Sector Extension Policy (NASEP) 2012.

Extension service providers include specific actors such as ministries in the public sector including agricultural departments. Other actors are in non-profit sector that comprises if NGO, community-based organizations, commercial companies from the private sector. Anderson et al., (2004) mentions that "effective extension involves adequate and timely access by farmers to relevant advice, with appropriate motivations to adopt the new technology if it suits their socioeconomic and agroecological circumstances".

The Kenya Integrated Household Budget Survey (KIHBS) 2015/16, indicated that "41% of the population in the county live below the poverty line while the Kenya Demographic and Health Survey stated that thirty-two percent of households in Uasin Gishu County experienced food shortages." From the KDHS (2014), "prevalence of stunting was 31.2% with 11.5% of children under-five being underweight. This scenario is primarily attributable to less diet diversification with overdependence on maize meals".

The Uasin Gishu County Integrated Development plan (CIDP) 2018-2019 recognises that investment in agriculture, being the mainstay of the county, will ensure food security and improve the nutritional status of the people of the county. It is recognised that the sector has continued to face challenges including high cost of inputs, post-harvest losses and low profitability of the sector. With this backdrop, the County as outlined in the CIDP plans to revamp extension services by ensuring sufficient officers and integrate information communication technology ICT into extension service, support post-harvest management and subsize farm inputs (seeds and fertilizer).

The changing climate will worsen the scenario above. The County has been facing rainfall variability which has increasingly been compromising productivity and hence food security. Climate projections indicates even greater challenges in the coming years if farmers are not supported to build their resilience.

The Kenya Vision 2030 depends on food security as one of its main drivers as provided by the Kenyan Government. In the Jubilee administration, food security has been highlighted as one of the major agendas. When farmers access these extension services, they are able to improve farm productivity and help solve the issue of food insecurity.

1.3 Statement of the Problem

The agricultural sector in Kenya mostly comprises of small to medium scale farmers, owning an average of 0.2 to 3 hectares, and these farmers "account for 78% total production and 70% of commercial production" (World Bank, 2015). Kenya's historical analysis of agricultural productivity recorded steady and modest growth between 1961 and 2008 (Fugile and Rada, 2013). However, there have been reported

decline in productivity of cereals, for example, yields per hectare of maize has been decreasing.

Smallholder farmers are undergoing "agricultural production decline as arable land sizes are also decreasing, rising cost of agricultural inputs, soil fertility is declining; coupled with low rates of technology adoption and changes in climate leading to low amounts of rainfall among others" (Chukwu, 2014). In Kenya's economy, extension service is a critical change agent playing an important role in technology transfer, knowledge sharing and linking farmers to other actors along the value chain. Since the 1980's, extension service has been provided by the public sector, however the continued low budgetary allocation and recent transfer to the county level, has hindered the effectiveness and the subsequent transformation of small holder agriculture. A correlation exists between reduced productivity and low utilization of extension services. Some of these challenges could be addressed through a functioning and effective extension service.

The effectiveness and efficiency in the delivery of extension services is one of the main objectives of the National Agricultural Sector Extension Policy (NASEP). The policy mainly focuses on fostering an inclusive extension service that is driven by demand. However, there is limited access to extension by a large proportion of Kenyan farmers, whereby the national extension to farmer ratio stands at 1:1500 against the recommended ratio of 1:400. This has the effect of compromising the extension service, a situation that has not changed with a devolved system under the Constitution of Kenya 2010.

On the other hand, the policy objective on pluralism of the extension service was anchored on the premise that pluralistic extension service would provide suitable mix

of players from public and private institutions and delivery system which would achieve varied agricultural goals and serve diverse target population (Zhou, 2010, Ong'ayo, 2017), however the evidence of success of plural service providers in extension is scanty.

This study will determine the current availability, accessibility, and utilization of agricultural extension services. The broad aim being to understand the types of agricultural extension service providers, availability, and accessibility of the service; and finally, level of utilization and establish its association to the status of food security in the smallholder farming households.

1.4 Objectives

1.4.1. General Objective

The purpose of this study was to assess the association of "availability, accessibility and utilization of agricultural extension services on food security of smallholder farmers in Uasin Gishu County".

1.4.2. Specific Objectives

i. To ascertain the availability of agricultural extension services and its association with food security of smallholder farming households
ii. To assess the accessibility to agricultural extension services and its association with food security of smallholder farming households.
iii. To establish the utilization of knowledge and practises of agricultural extension services and its association with food security of smallholder farming households.
iv. To assess the association food security situation of smallholder farming households.

1.5 Research Hypotheses

$H_{o1:}$ Enhancing availability of agricultural extension improves the food security of smallholder farming households.

H_{o2} Enhancing the accessibility to agricultural extension improves the food security of smallholder farming households.

$H_{o3:}$ Enhanced utilization of agricultural extension services improves the food security of smallholder farming households.

$H_{o4:}$ The small holder farming households in Uasin Gishu are food secure.

1.6 Significance of the Study

Production of food was deteriorating when this study was conducted, with the risk of food security for the growing population. Agricultural extension services enhance agricultural productivity. Over time, agricultural extension has evolved in its structure, delivery, and approach but there is a gap in knowledge and understanding as far as "availability, accessibility and utilization of the agricultural knowledge and technologies" is concerned. Furthermore, the nexus between the agricultural service accessibility and utilization to smallholder farmers' food security of is not well established.

This study will offer significance contribution to the literature on understanding the effects of agricultural extension on food security as well as provide recommendations to policy makers on improvement of agricultural extension services for increased farm productivity and ultimately household food security.

1.7 Scope of the Study

This study was conducted in Turbo and Soy Sub-Counties of Uasin Gishu County. The two sub-counties were chosen purposively, the main consideration being areas

with high concentration of smallholder farming households with maize growing as the main agricultural activity in relatively smaller farm sizes compared to the other Sub Counties. The study centred on smallholder farmers' socio-economic characteristics, availability, accessibility, utilization of extension services and their effect on household food security. Availability of extension focused on the type of institutions of offering the extension services, accessibility emphasized on the characteristics of the agricultural system, the extension techniques used, the quality of services, the timeliness and effectiveness as perceived by the respondents, utilization focused on the use of knowledge to inform the farming decision.

The Household Food Insecurity Access Scale (HFIAS) helped establish the extent of food insecurity. Using this method factored in the idea that reduced access to food security results in actions that can be recorded and analysed by means of survey and summarized in a scale. This is a qualitative measure that provides insights on household's experience food insecurity for the last 12 months before the survey. The questions to respondents aimed at obtaining information on these main areas: 1) anxiety levels regarding food supply and budget 2) perceptions of inadequacy of food quality or quantity 3) reported reductions and consequences of a reduction in the intake of food among adults and children. By using the study's results, assigning households according to the severity of food insecurity.

1.8 Limitations and Delimitations of the Study

Food security is a "multidimensional issue which cannot be adequately measured by a single indicator". A multidimensional measurement approach was used indicator was used at any particular time may bring the risks of inability of respondents to accurately recall coupled with changing rain patterns on an annual basis, this limits

the extent of use of the conclusions on food security status based on an assessment of only one period.

Due to time and resource constraints, this research modified food security measurements questions, asking respondents to report on the occurrence of conditions and behaviors that reflect constraints to household food access and satisfaction. For the same reasons, the study focused on availability, accessibility and utilization of agricultural extension and the resultant effect on current food security situation of the sampled households. It did not measure the actual farm productivity arising from adoption of the knowledge gained from agricultural extension services. Findings from this study can be generalized for other smallholder households in as far as they reside in similar agro-ecological zones in Kenya.

CHAPTER TWO

LITERATURE REVIEW

2.1. Overview

This chapter reviewed the literature relevant to the research study objectives on agricultural extension. It provided an overview of trends in agricultural extension service globally and locally. It also summarised the extension models and state of food security. This chapter also reviewed relevant theories on adoption and human behaviour.

2.2 Small holder Farming Households

There are roughly "1.5 billion smallholder farmers in the world, a figure that incorporates 75% of the world's poorest people" (Ferris et al. 2014). Agriculture is depended by most of the people that are extremely poor. In most developing countries, 80% of the food is produced by smallholder farmers. This does not prevent the under-sourcing of the farmers as well as lack of access to better farming inputs, and better markets. All these result in reduced productivity and missing opportunities to break the chain of poverty. Anderson & Feder (2007) posit that, "agricultural productivity in many developing countries, and predominantly in Africa, remains far below that of developed countries and many middle-income countries; ineffective and inefficient extension services is one explanation, among others."

According to IFAD, (2012), agricultural investments and policy have not led to small holder farmers empowerment. Smallholder farmers have often been left out in policy making on the future of agriculture (Wiggins 2011; Vorley et al., 2012). Murphy (2010) posits that farming households "are defined by marginalization, in terms of ease of access, resources, information, technology, capital and assets."

In Kenya, smallholder farmers owning about 0.47ha of land produce over 63% of the total agricultural output. The farms provide food for home-consumption and for the market (Rapsomanikis, 2015).

2.3. Global Perspective of Agricultural Extension Services

Agriculture is key in addressing rural poverty, hunger, and livelihoods. Improved agricultural productivity is a factor of research and development of technologies and good practices for better yields, promotion of crops resistant to climate change impacts, improved access to markets, among others. The agricultural extension service communicates this information to farmers. Agricultural extension includes "all the activities that provide information and services required and demanded by farmers and other actors to support them to improve their production and livelihoods. Technologies and practices can only lead to expected development impact if they are communicated well and implemented appropriately by farmers and other users at scale."

During post-independence, the agricultural extension service was mainly public led. Across many developing countries, agricultural extension has evolved significantly over the years with a transition from traditional government -led approaches to a pluralistic system. Mbo'o-Tchouawou, & Colverson, (2014) mention that. "most of the approaches were built from Training and Visit (T&V) model designed to train extension agents on technical skills to be passed on to the farmers using on-farm demonstrations, farmer field days and in-service training courses." The T&V though reported to have achieved some positive outcomes was proven not to be effective and viable due to its "inflexibility, top-down nature, high operational costs, and inadequate funding". Farmers' inactive role arising from the approach, "non-responsiveness to farmer's concerns plus the inability to consider in country specific

economic, social, cultural and institutional contexts contributed to its failure" (Anderson et al., 2006; Birner et al., 2009). The exclusive provision of AES by the public sector remains debatable given the challenges in budgets and general inefficiencies in the public sector.

There was little consideration to the farmer's participation in problem characterisation or design of extension programs. Further, the latter half of 20th century saw developing countries and governments funding public extension systems with inadequate resources organized top-down (Swanson, 2008). Likewise, experiments and demonstrations were largely carried out in research stations rather than in the farms of farmers (Davis & Place, 2003). Furthermore, resource-deficient and food insecure farmers perceived to be less likely innovative and unlikely to adopt the propagated technologies were often disregarded.

2.3.1. Changes in Agricultural Extension Service

Arising from past failures, agricultural extension service has witnessed evolution towards a more sustainable and inclusive approach. These "range from demand-driven systems to decentralised pluralistic extension approaches" (Mbo'o-Tchouawou & Colverson, 2014).

These methods aim at promoting farmers contributions to AES delivery process. Examples include farmer first, farmer-to-farmer, farmer-field schools, among others. These approaches based on the common principle of participatory models with the farmers being the main actors whereas the extension agent becomes the facilitator. supporting and coordinating knowledge acquisition.

Other reforms include the “decentralization and privatization of rural agricultural service delivery systems”. Consequently, there has been multiplicity of non-state actors involved in AES delivery with differing clientele, quality, and nature of AES provision. Despite this increasing number of actors offering diversified options in provision of AES, challenges remain in exploiting the full capacity and potential of agricultural extension systems. NGOS and cooperatives are constrained by limited funding and capacity while the private companies often target well-off farmers growing high-value agricultural commodities mainly for export hence leaving behind rural poor and subsistence farmers (Hassan et al. 2013).

The recent advancement in “economics and agricultural extension literature has focused on the need to address key constraints to improving performance” and changing the persistent low productivity of smallholder agriculture for enhancement of food security. “Numerous verified technologies and improved farming practices have a huge potential for boosting agricultural production and reducing poverty in developing countries. However, the adoption of such technologies by smallholder farmers, in Sub Saharan Africa, has been persistently remained low and slow” (Udry 2010; Duflo, Kremer & Robinson 2011) resulting in persistent low agricultural productivity (World Bank 2008).

According to Commission on Sustainable Agriculture and Climate Change, (2011), “limited awareness and low understanding of Climate Smart Agriculture technologies by smallholder farmers, together with the related high cost of farming technologies have been major impediments to adoption of current and emerging climate smart technologies and practices”.

Most research on agricultural extension have focused on the "adoption of comparatively expensive agricultural inputs, such as high yielding seed varieties" (HYSV) and chemical fertilizers; on the other hand, there is limited empirical evidence on the adoption and the results of improved basic cultivation methods. Or even such basic methods such as crop rotation and use of organic manure which could be extremely important for marginalized smallholder farmers, who are less likely to adopt improved cultivation techniques on their own. In addition, a small number of studies have reviewed the causal relationship between "extension achievements beyond input adoption and production" (Anderson & Feder 2007).

According to Pan et al., (2018), "agricultural extension programs have recorded mixed success". They add that the effects of extension services have been highlighted in "seed varieties fertilizer, and pesticide use, and on productivity on crop yield per hectare, crop value, and net profits from agriculture, results from this examination are mixed".

"Smallholders in many developing countries remain deprived when it comes to accessing quality agricultural extension and advisory services (EAS)" (Glendenning et al., 2010). Manfre et al., (2013) adds that, "An examination of the selection criteria for farmer targeting in Kenya, notes the addition of 'unofficial' selection factors such as minimum land size, literacy, and ability to purchase inputs, apparently was designed to increase the probability of production increase by the farmers". They found that it was often the village leaders and chiefs plus the field extension agents, generally of male gender men who made this selection, and that, because of the underlying biases in the selection criteria, comparatively few women ever received services.

2.4. Agricultural Extension in Kenya

Agricultural extension in Kenya often involves "recommendations for improved soil fertility management that are disseminated to farmers in a farming area, covering certain regions in the country" (Shehu et al. 2018). However, "such agricultural extension practices fail to consider the varied and complicated biophysical and socio-economic conditions of smallholder farming" (McCarthy et al., 2018). Agricultural extension that is site-specific incorporates suggestions that are tailored to the condition and situation of an individual farmer or farm.

The effectiveness of these suggestions in causing productivity are more compared to former practices of extension. "Information, and communication technology (ICT) driven decision support tools (DSTs) offer great potential in improving the capacity of agricultural extension providers in the delivery of site-specific extension recommendations in a more cost effective and innovative way to farmers" (Fu & Akter, 2016, Vanlauwe et al., 2017, & Verma & Sinha, 2018).

Kondylis, Mueller & Zhu (2017), a detailed and rigorous study that aimed at addressing the "impact of an extension activity on adoption of basic farming methods found out that adding extra contact (to the model) farmer training to their existing extension program training had no impact on adoption choices of other farmers."

2.4.1 Evolution of Kenya's Agricultural Extension Service

Kenya's agricultural extension is more than 100 years old, having begun in the early 1900s. The extension system has changed tremendously over the years. Certain approaches were used in the colonial times were purposed to serve the farming systems of the settlers. They included comprehensive programs marked with extension services and subsidized inputs. Indigenous Africans were only served by the

extension approach since their systems were not complex. It was also because they indulged in activities such as pastoralism and the coerciveness nature made it difficult to be accepted (Mwangi, 1998).

Upon attaining independence, increasingly persuasive and educational approaches were utilized and enabled through projects funded by donors. Notable success during this period was the dissemination of hybrid maize technology. This system characterized by farm level participation in the form of farmer input in on-farm trials (Collinson, 2000). The "peculiar feature of the FSR&E technique was its three-way connection between farmers, researchers, and extension service providers. However, the above systems were costly, inefficient, and performing below its potential" (Gautam, 2000).

The farming systems, training, and visit approaches were introduced in the 1980s and 1990s, alongside these, the "commodity specialized approach' was mostly used in the large export commodity subsector spearheaded by commodity boards and private companies. In 1982, Training and Visit (T&V) agricultural extension system was introduced in collaboration with the World Bank. This system employed profitably in Turkey and India was initiated to correct the deficiencies of top-down approach and FSR & E systems. Kenya became "the first African country in which this model was applied" (Farrington, 1998). The World Bank "funded T&V in two phases, under the National Extension Program (NEP) I and NEP II to develop institutional arrangements that would provide efficient and effective delivery of agricultural extension services to smallholder farmers" (Mwangi, 1999).

FAO (1997) asserted that, "after the implementation of structural adjustment programs (SAPs) in the 1980s, the Kenyan government came under substantial

pressure to scale down its central role in national economy". "At the same time, the performance of the public agricultural extension service in Kenya was questioned and its effectiveness became a very contentious subject" (Gautam and Anderson 1999). The "traditional public extension system was perceived as outdated, top-down, authoritarian, uniform (one-size fits-all), rigid, subject to bureaucratic inefficiencies and therefore unable to cope with the dynamic demands of modern agriculture". The unitary top-down extension mainly comprising the Training and Visit system (T&V) delivered messages to "groups of farmers, promoting the adoption of Green Revolution technologies"(Leeuwis & van den Ban, 2004). Nonetheless, Purcell & Anderson (1997) found evidence of "accountability problems in many World Bank extension projects including training and visit, crop-oriented programs, farm demonstrations programs and land grant college approach."

Preference has been "towards decentralized and demand-driven public extension systems" (Rivera et al., 2001). This was motivated by the desire for dissemination of technologies that are suitable to "explicit agro-ecological and socio-economic conditions" (Swanson, 2008). In addition, there has been an inclination towards privatization (Umali-Deininger, 1997). Input suppliers have been deploying extension service through contract farming, these are food processing and distribution companies (Swinnen & Maertens, 2007). In addition, "producer cooperatives and civil society organizations began to participate in the provision of extension services to poor farmers in pluralistic extension systems based on public-private partnerships. However, private, and pluralistic arrangements of agricultural extension have not yet broadened explicitly in the poorest ones" (Anderson & Feder, 2004)

To respond to the changes and to encourage main improvements in delivering extension services, the Ministry of Agriculture and Rural Development in 2001 formulated the National Agricultural Extension Policy (NAEP). The NAEP "acknowledged the need to diversify, decentralize and strengthen the provision of extension services to increase their sustainability and relevance to farmers. The NAEP was supposed to form the basis for all extension work within the government and in its interaction with other stakeholders in agricultural research and development. It was structured to bring on board both public and private service providers as a way of finding means of addressing the intricate, methodical issues that affect rural communities" (Mwangi, 1999).

To operationalize the NAEP, "the ministry prepared a National Agricultural and Livestock Extension Program (NALEP) and NALEP Implementation Framework". (MoA & MoLD, 2010)

2.4.2 Objectives and Activities of NALEP

NALEP's main implementation strategy was "to form and promote institutions at the local level. These institutions were to sustain programme initiatives and activities and support agricultural sector reforms related to the delivery of agricultural research and extension services and strengthen research extension-farmers linkages" (NALEP, 2007). NALEP, I started in July 2000 ending in 2005, while Phase II begun in 2007 ending in 2011. NALEP had two-pronged goal: to ensure development within the agricultural sector and contribute to the nation's priority of eliminating poverty. NALEP was created from the experiences of the National Soil and Water Conservation Programme (NSWCP), a programme funded by the Sida from 1974 to 2000. The NSWCP was a land husbandry programme registering success in leading to

considerable decrease in soil erosion and increased agricultural productivity reaching 1.5 million small holder farmers.

NALEP Activities were in "four components: (1) Planning, Monitoring and Evaluation; (2) Training; (3) Collaboration and Research and (4) Gender and Poverty Focus" (NALEP). The programme emphasized "a systems approach to diagnosing problems at farm level with efforts to ensure that farmers in the focal areas were equipped with an individual farm action plan (FSAP). It also emphasized the role of the extension service as a facilitator, connecting the farmer with private sector services rather than managing government handouts. The focus was on a demand-driven and participatory delivery of extension services in a transparent and accountable manner. The farm level plans were drawn up as a joint effort between the extension agents and the farmers, while the transparency and accountability were promoted through a decentralized activity planning and budgeting process."

The aim was to "make extension demand driven, increasing efficiency in extension service provision, and mobilise alternative funding apart from the exchequer, promoting gender equality and controlling environmental degradation" (Deschamps-Laporte, 2013). In addition, NALEP identified and targeted vulnerable groups such as "the disabled, orphans and resource-disadvantaged among the clientele ensuring they access extension messages and outreach programmes" (Deschamps-Laporte, 2013).

The current extension system is "a product of gradual evolution in extension management practices and the entry of private sector, NGOs, and civil society players over time in response to changes in economic policies".

Additionally, the past decade has seen widespread use of "mobile phone-based applications and services in the agricultural sector, providing information on market prices, weather, transport and agricultural techniques via voice, short message service (SMS), radio and internet. While they are innovative and cost effective, it is known if and how they will substitute existing agricultural extension systems". (Aker et al, 2010). It may also not be affordable to smallholder farmers (Aker et al, 2010).

However, use of mobile phones in agricultural extension is not affordable by several smallholder farmers and the empirical evidence on their impact remains limited.

2.4.3 Kenya's Agricultural Policy Frameworks

In June 2008, the GoK adopted Vision 2030 as a new blueprint for Kenya's development. This "provides a road map for the country's economic and social development over the next two decades. It aims at transforming Kenya into a newly industrialized, middle income country providing a high quality of life to all its citizens in a clean and secure environment". (GoK, Vision 2030)

Vision 2030 identifies "Agriculture as a key sector in achieving the envisaged annual economic growth rate in. This is through the transformation of smallholder agriculture from subsistence to a modern, innovative, and market-oriented part of Kenya's economy." (Mwangi, 2010).

Implementation of Vision 2030 agriculture objectives is through the Agricultural Sector Development Strategy (ASDS) 2010 – 2020, guided by the Agriculture and Fisheries Act of 2013. The aim of the ASDS, "aligned to both the Kenya Vision 2030, and the Comprehensive Africa Agriculture Development Program (CAADP), is to realize increased sector productivity, commercialization, and competitiveness, as well

as the development and more effective and efficient management of key factors of production. The ASDS implementation is through three (3) year Medium Term Investment Plans (MTIP) linked to the national planning and budgeting process." (Mwangi, 2010).

Kenya is in its Third Medium Plan, this period has seen prioritization of "Big Four: food security, affordable housing, manufacturing, and affordable healthcare" for all. The food security agenda is aims at increasing the average daily income of farmers by 34%, "reduce malnutrition among children under 5 years of age by 27% and create 1000 agro-processing SMEs and 600,000 new jobs." "Fifty percent reduction in the number of food insecure Kenyans, 48% increase in agriculture contribution to GDP and 47% reduction in the cost of food as a percentage of income". In driving small holder productivity, some initiatives have been proposed including establishment of "1,000 targeted production level SMEs using a performance-based incentive model in the entire value chain and improving access to credit/input for farmers through Warehouse Receipt System and strengthen commodity fund".

Kenya has also developed a "Country Programme Paper (CPP) on Ending Drought Emergencies (EDE) as part of the IGAD Drought Disaster Resilience and Sustainability Strategy". The paper presents Kenya's framework approach towards ending recurrent drought emergencies. The paper translated into a medium-term plan "under the leadership of the National Drought Management Authority (NDMA), implements key components of the ASAL policy and Vision 2030's strategy for the development of northern Kenya and other arid lands. The paper focuses on creating a more conducive environment for building drought resilience through building stronger foundations and institutions for development."

Kenya's Constitution 2010 ushered in a new governance system from centralised to devolved system. "The Fourth Schedule of the Constitution provides for devolution of specific functions in agriculture to the county governments namely: crop and animal husbandry; livestock sale yards; county abattoirs; plant and animal disease control and fisheries. The National government retains the functions of policy making under Part 1 Section 29 of the Fourth Schedule; establishment of quality standards; capacity building and technical assistance; information management and technology transfer; drought and flood disaster preparedness; conservation of crop, animal, and forage genetic resources; research agenda setting and promotion of private sector investment in agriculture. Other functions of the National Government include coordination of livestock agribusiness, value addition and product value chain; development of strategic marketing infrastructure and management of National agricultural training institutions. Implementation of national policies mainly takes at the county level." (GoK, 2010).

Several policies have been drafted to "provide the overall framework for the new devolved system of governance such as Agriculture Sector Transformation and Growth Strategy" (ASTGS 2019 – 2029) which replaced the Agriculture Sector Development Strategy (ASDS 2010 - 2020) "change in government in early 2013 saw the establishment of the Ministry of Agriculture, Livestock and Fisheries (effectively combining three ministries into one". In Uasin Gishu, the agricultural sector goal is to enhance food security and improve livelihoods through increased agricultural production and productivity. In fulfilment of its mandate, the county has made progress as reported in the CIDP 2018-22, the county has trained farmers, recruited additional extension officers, subsidized maize seed, established a soil testing laboratory, constructed potato cold storage store, ware potato stores and one diffuse

light store to contribute post-harvest management and reduce post-harvest losses, among others (CIDP 2018-2022

2.5. Food Security among Small Holder Farming Households

Food security is defined as a "situation in which all people, at all times, have physical, social, and economic access to enough, safe, and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Apart from availability of food, there are other equally "fundamental dimensions of food security such as access to and utilization of food, agricultural supply, and productivity" (Burchi & Muro, 2016). Food insecurity has a time-related dimension defined as temporary when a person suffers from a short-term decline in food consumption.

Chronic food insecurity is a situation where a person is continuously unable to secure enough food. During transitory food insecurity period, a household adopt several coping strategies, including depletion of productive assets, mainly common in poor households, which may lead to chronic food insecurity in the longer term.

The Sustainable Development Goals (SDGs) number two rally "countries and stakeholders to work together to end hunger and prevent all forms of malnutrition" by 2030. It "seeks sustainable solutions to end hunger in all its forms by 2030 and to achieve food security."

The aim is to "ensure that everyone everywhere has enough good-quality food to lead a healthy life. Achieving this Goal will require better access to food". This means working on "improving the productivity and incomes of small-scale farmers by promoting access to land, technology and markets, sustainable food production

systems and resilient agricultural practices. It also requires increased investments through international cooperation to strengthen the productive capacity of agriculture in developing countries" (UN, 2015).

There are an "estimated 500 million smallholder farmers in the world, contributing to most of the food consumed in low-income countries" (Lowder, 2014). These smallholder farmers mainly relying on rain fed agriculture are frequently food insecure. The "smallholder farmers have limited resource endowments starting from the limited land size, mainly use household labour and have minimal training and finance to enable adoption of new technology. Smallholder farmers with limited capacity to invest in good agricultural management practices and technology to increase productivity are sometimes not able to produce more than they consume throughout the year, and many are therefore net buyers of the food crops that they produce" (Niles & Brown, 2017). Additionally, complex factors influence the inability by smallholder farmers to ensure consistent food security, among them are, "agricultural management of farming system, social capital of household as it relates to networks in the community, and household characteristics such as education level and gender of the head of households" (Brown, 2015).

There is evidence that "agricultural interventions built in productivity enhancing agricultural technologies such as quality fertilizer and better seed varieties have the potential to increase income by 80-140%" (Holland et al., 2017). In addition, social capital in the form of farmer-to-farmer knowledge and information access increases food security. Consequently, "access to financial capital increases adaptive capacity to food shortages and it is positively associated with market access" (Lowitt et al. 2016, Holland et al. 2017).

In a 12-country assessment in East and West Africa and South Asia of "factors related to food security in varying rainfall conditions" Niles & Brown, (2017), found that "food insecurity is prevalent across the countries with 80% of households experiencing at least one month of food insecurity." The study further reports that "among two otherwise equal households, those having certain agricultural inputs, agricultural practices, financial access and participating in groups are all correlated with reduced occurrence of food insecurity outside the context of rainfall anomalies. This demonstrates that agricultural extension could provide smallholder farmer households with strategies to reduce food insecurity without consideration of rainfall as a factor".

A cross-country study by Irz et al. (2001) in Asia and Sub-Saharan Africa on "the links between agricultural yields and poverty", found "strong evidence of crop yields increases leading to a decrease in the number of the poor by about 0.7 per cent. The study estimated every 10 per cent increase in farm yields, reduces poverty by seven and five per respectively in Africa and Asia. Small holder farmers tend to spend extra income locally, on construction materials, locally made furniture, entertainment, thereby stimulating local (small-scale) business and job creation" (Diao et al., 2010; Wiggins, 2011).

World Bank (2008) states that, "Expansion of smallholder farming leads to faster rate of poverty reduction, by raising the incomes of farmers and reducing food expenditure, and thus contributing to reduction in income inequality". Majority of "impact evaluations conducted in Sub-Saharan Africa have reported a positive impact of agricultural extension programmes, with a return on investment in the range of 13%-500%" (Birkhaeuser et al., 1991). The studies have measured the "impact of public agricultural extension programmes on farmers' knowledge of technologies,

best agronomic practices, rate of adoption of technology and practices, farmer productivity and efficiency and level of output."

In Ethiopia, and India (Feder & Slade, 1993) reported that in "areas where farmers accessed extension, there was higher probability of adoption of recommended technology information as compared to non-agricultural extension areas which led to better production and thus improvement in farmers food security". Everson (2001), in economic impact of extension, found that extension have an increasing effect on "farm productivity, farm income and overall farmers food security with a mean estimated rate of return of about 40%. Notably, some empirical studies have reported mixed results, some point to failure of present-day extension systems to lead to growth of agricultural productivity and income gains" (Feder et al, 2004).

Other studies have also reported "positive effects of extension on agricultural productivity, rural incomes, and poverty reduction". In Ethiopia, Dercon et al. (2009), analysis of the "impact of agricultural extension in Ethiopia found that public extension visits reduced poverty headcount by 9.8 percent and increased consumption levels by 7.1 percent"; however, the two (poverty headcount and consumption) only capture the survey period status.

A study on "impacts of extension access and cooperative membership on technology adoption and household food security" by Wossen et al., (2015), found that "the impact of extension access on poverty reduction had a strong significant effect on the small holder's access to formal credit than for those without access". Therefore, suggesting that financial inclusion can optimise "the positive impacts of extension services on farmer's productivity and food security. Improving the access to extension services by small holders is a better pathway for breaking the poverty trap" (Andersen

& Feder, 2007; Shiferaw et al. 2008). Therefore, access to extension can accelerate economic growth, create market linkages and opportunities, and hence assist in moving farmers out of poverty. Extension access is "a supply-side policy instruments that influences agricultural productivity in developing countries. It also facilitates improved household food security by educating farmers on the best farming and management practices that shall guarantee better productivity" (Anderson & Feder et al., 2007).

In addition, formation of farmer-controlled cooperatives is highly esteemed as a crucial institutional arrangement that helps overcome the constraints that hinder smallholders' access to extension and the market. These farmer-controlled cooperatives can provide credit to ease capital constraints farmers' face. They can also improve farmer livelihood sources by availing market condition. They can also improve farmer income by "offering better prices for their produce and lastly pooling different resources to create economies of scale and hence improve farmers' welfare" (Abebaw & Haile, 2013). Gebremichael (2014) found that being a member of farmer-controlled cooperative improves household's welfare through improved "food security especially for rural women, thus, suggesting that cooperative membership helps households to diversify their livelihoods through extension access, improves market bargaining power and promote opportunities for gender equity and equality."

Studies provide evidence of "linkages between agriculture, health, food, and nutrition confirming in a dynamic and multifaceted nature" (Gillespie, 2001). There are studies that have pointed out the weaknesses of the impact evaluations; they argue that the outcomes of the impact evaluations are not consistent with the agricultural growth trends and that some of the studies are contradictory. Ayele et al., (2005) and IFPRI

(2008) reports a positive and significant effect of agricultural extension service on smallholder farmer's productivity in Ethiopia.

Another study conducted by EEA/EEPRI (2006) asserted that "the Ethiopian extension programme suffers from various problems and its impact on farm income, productivity, food security and poverty is not significant", contradicting the study by Ayele et al., (2005) and IFPRI (2008) which reported a "positive and significant contribution of agricultural extension in Ethiopia". Walker et al. (2004) study in Mozambique reported a "negative and statistically insignificant impact of agricultural extension on individual and household income. It reported that agricultural extension services did not lead to any perceived improvement in the economic condition of household. They postulated that the absence of positive and statistically significant results on household and community variables could be due to limited access to improved inputs and location-specific adapted technologies."

The "importance of agricultural extension in relation to the fight against poverty has been underscored in the Strategy to Revitalize Agriculture (SRA). A general 20 consensus exist that agricultural extension services, if properly designed and implemented, improve agricultural productivity" (Rahaman, 1991 & Levinson,2001). The "term „extension‟ is here understood to mean „advisory and other services‟ that help rural families to make the best possible use of the productive resources at their disposal" (Katz 2002). Agricultural extension services provide farmers with "important information, such as patterns in crop prices, new seed varieties, crop management, and marketing. Exposure to extension education services is intended to increase farmers‟ ability to optimize the use of their resources. Further at times even when technologies are available farmers do not access them. Many educators argue

that participation is the basis for grassroots development" Gboku & Lekoko (2007), for example, emphasize that "sustainable development can only be ensured through people's participation". Oakley (1991) identifies some of the "benefits of promoting people‟s participation: to obtain information about needs, priorities and capabilities of local people, to mobilize local resources, to improve utilization of facilities and services, to obtain more reliable feedback, to build the capacity of local institutions." Involving maize farmers in training programmes is "vital for social change when they start valuing the process of collective analysis. It is also important to enable maize farmers to identify what types of change they wish to achieve and how to go about attaining that change." There are various degrees of "participation ranging from simple consultation to self-management by maize farmers themselves. The specific degree of participation of different stakeholders is determined through a negotiation."

The World Bank Economic Analysis (2006) rejected the above conclusion reporting that "extension services in Mozambique had positive effects on rural livelihoods achieved through promotion of new varieties, inputs such as natural pesticides and soil conservation practices". These contradictions have led to "scepticisms of the outcomes of evaluation studies conducted in sub-Saharan Africa. There are various reasons for such contradictions and exaggerations in impact evaluation studies conducted on agricultural extension programmes in the region" (Davis 2008). They relate to "challenges and limitations that arise from the nature of impact evaluation, extension science applied, the impact evaluation procedures" and competence of the evaluators.

Farmers assess extension services based on availability, sufficiency, accessibility, and timeliness; extension workers on the other hand "perceive communication skills to be the primary competency that they require" (Lopokoiyit et al. 2012).

Furthermore, studies propose that "core competencies for extension professionals may vary from place to place for the reason that competencies are contextual" (Suvedi and Ghimire 2015). "Lack of political will and a dedicated bureaucracy prevent enhancement of the capabilities of extension service providers including their communication and innovation skills. Extension agents have limited motivation and couple with lack of incentives to improve because current compensation schemes do not reward performance, staff are rewarded at the same level."

In addition, "staff morale is low because of such things as frequent transfer of extension staff members from extension unit to farms or technical departments" (FAO 2010). Because the few field-level extension technicians must provide services to many farmers, there is minimal access to extension technical services. For strengthening the linkages, an innovation system could entrench "technological change within a larger, more complex system of actions and interactions among diverse actors, social and economic institutions, and organizational cultures and practices. Such a system goes beyond the traditional linear thinking centred on research systems" (World Bank 2006), "leading to an in-depth analysis of farmer-oriented, integrated policy intervention in agricultural extension."

The Kenya Integrated Household Budget Survey (KIHBS) 2015/16, reported 41% of people living below the poverty level in the Uasin Gishu. As reported in the CIDP 2018-2022, "some of the root causes of poverty in the County include; limited economic diversity with over dependency on subsistence agriculture, households

producing for their own food as well as incomes, limited opportunities for employment, inadequate access to credit, disempowered groups especially women and youths who have limited access to property and incomes as well as lack of relevant skills amongst the youths to enable them to participate in the labour market". The County proposes to "promote agribusiness given the county has a high agricultural potential sufficient to address the poverty problem; promotion of horticulture as opposed to traditional cash crops; and promotion of value addition by developing and supporting agro-processing initiatives and soliciting for both local and international markets for local agricultural produce."

2.5.1. The Influence of Agricultural Extension Services on Smallholder Food Security

Agricultural knowledge is important in livelihood transformation for those "relying on agriculture for a living and in enhancing food security" (Lwoga 2011). Agricultural knowledge access is associated with "acquiring skills and techniques for enhancing farming practices, sustaining the environment, and optimising production within a given farm size. For this to happen, a strong linkage between agricultural research and farmers is required. The linkage is through effective extension and various outreach channels" (Nazari, Bin & Hassan, 2011). If "agricultural technologies and developments are not accessible to farmers, transforming agriculture and farmers' livelihoods remains impossible."

There is growing worldwide interest in better "leveraging Agricultural Extension Services (AES) as a foundation for food and nutrition security. Agricultural extension is one of the effective tools in attaining the Sustainable Development Goals related to end extreme poverty and hunger globally". A review by de Graaff et al. (2010) of the

food security and agricultural trends in the past 40 years in Sub-Sahara Africa shows "challenges in achieving food and that food aid will still be indispensable. Moreover, the rural households in most developing countries remain disproportionally poor. As a result, the primary goal of many of the developing countries remains producing enough food" (de Graaff et al. 2011; Luan et al. 2013). The aim of extension services is undisputed in its role to "increase agricultural production in the world where about 85% of the population depend on rain fed agriculture for their livelihoods."

Smallholder farmers normally produce for both their own consumption and for the market and may obtain half or more of their food from the marketplace (Remans, Flynn et al. 2011). According to Chege et.al (2018), the major task of extension is assisting "farmers to make their own decisions by increasing the number of choices from which they can select, and by helping them to develop insight into the outcomes of each option". As well, it helps in promoting farm technologies by working closely with the smallholder farming communities.

Despite the many years of extension services in countries, it is evident that not much improvement in household food security has been achieved. The literature presented here critically analyse the level of access to agricultural extension services and its influence on food security. Traditionally, "agricultural extension is often implemented through extension officers who visited individual farmers to provide advice on specific topics" (Anderson and Feder, 2004). "Newer extension approaches often operate through farmer groups, which can not only increase cost-effectiveness but also facilitate mutual learning and sharing of experiences among farmers" (Fischer and Qaim, 2012). Kipkurgat & Tuigong (2015), postulates that "extension is both a political and an organizational instrument implemented to enable development

ranging from transfer of mono-crop technology to participatory problem-solving educational approaches". This aims at "ending poverty and enhancing smallholder farming households' involvement in the processes of achieving food security" (Rivera and Qamar, 2003).

In Uganda, Pan et al. (2015) found that "adoption of agricultural extension services that focused on improving the cultivation method increased agricultural production, savings, and wage income. There are also many studies that investigate adoption decisions of various agricultural technologies" (Abate et al. (2016), Abiy et al. (2017), Beaman et al. (2015), Magrini et al. (2014), Teklewold et al. (2013). A study by Duflo et al. (2011), stated that "involvement through skill development, increased the opportunities for improving food security status, employment, and a rise in community wealth and lastly, it gave farmers the opportunity to build the skills and networks that were needed to address social marginalization."

Tchale (2009) reported that "extension was one of the factors among several others (farmer organisation, favourable commodity, and input costs) that would improve efficiency of smallholder farmers". On the other hand, Phiri et al. (2018) found that farmers were aware of information sources and unlike in this study, predominant source of information was a fellow farmer. This suggest that there is need to strengthen both extension services and farmers to farmer interaction. Recent research revealed that the "adoption of pro-nutrition technologies is higher in settings where farmers have a good grasp of the technologies' agronomic and nutritional attributes" (de Brauw et al. 2018). This suggests that "training and extension could play a major role in technology dissemination. Agricultural extension services have the obligation to facilitate technology transfer and improve innovation processes in the farming

sector, but solid experience with pro-nutrition technologies hardly exists." (de Brauw et al., 2018).

Wossen et al. (2017) study in rural Nigeria on the impacts of "extension access and cooperative membership on technology adoption and household welfare found a very strong relationship between socio-economic and demographic characteristics of the households." The study further established that older households and those who are more learned had a higher tendency of seeking extension access. Farm size had a negative and statistically significant influence on the likelihood of receiving extension services suggesting that the extension agents are more likely to target small holders.

Ragasa, Mazunda and Kadzamira (2016) studied the "impact of agricultural extension services on Heavily Subsidized Input System in Malawi. They established that years of education and age of the household head was statistically significant in explaining access to agricultural extension services". As well, male-headed household were more likely to receive agricultural advice than those headed by female. Moreover, household wealth index revealed it was a significant determinant of access to agricultural extension services.

Despite differences in modalities and success across countries, extension has five elements: "transferring knowledge from researchers to farmers; advising farmers in making choices; educating farmers to make similar choices in future; enabling farmers to make clear their own goals, competences and to achieve them; and stimulating desirable agricultural developments with stimulation of desirable agricultural development" (Purcell & Anderson, 1997). According to Anderson (2007), "adoption of technologies and better practices is the core of extension interventions, a valuable tool for improving productivity and increasing farmers' incomes."

Target farmers in extension just need to pass through awareness, knowledge, and adoption of technology to achieve goals of improving productivity. Therefore, various extension methods are used such as extension farmer contact, meetings, mass media, and farm demonstrations, among others. Furthermore, farmers pass technologies, knowledge, and practices through their informal networks.

Thus, agricultural extension is "both a system and the set of functions that stimulates voluntary change among rural people". The set of roles include "transferring technology and capacity to educate, build human resources, and enhance local capacity, for example in integrated pest management, market intelligence, farm management, and in negotiating financial, input, and market services whereas a system includes all public and private institutions that transfer, mobilize, and educate rural people" (Zijp,1998). Experience shows that a "major impediment for more widespread coverage include the high personnel and logistics costs of reaching out to farm households in rural areas for nutrition and health education campaigns" (Ruel, Quisumbing and Balagamwala, 2018).

In Kenya, although farmers favor "public extension service system, the service providers select the well-endowed households, a trend that is being observed also with the private for-profit service providers" (Tegemeo Institute 2018). This is a bigger risk seeing that smallholder farmers produce about 60% of the required food in the country and thus should be the key beneficiaries of the extension service. The army worm's invasion led to major losses, Tegemeo Institute has reported that "lack of extension information services to control armyworms and post-harvest losses could have costed Kenya an approximate of 10 million bags of maize worth 32 billion in 2018."

These losses would have considerably been reduced through availability and use of agricultural information by farmers minimizing the food loss and hence food insecurity susceptibility. Studies have shown that "levels of returns to extension and research are as high as 80%, therefore, strengthening and supporting agricultural extension at the local level would foster an enabling environment for innovation and entrepreneurialism and empower local farmers to lead in solving their own problems."

A strong case therefore exists for greater support to extension, which can provide the "last mile" support technologies, and better practices for reach and adoption by potential users.

Other benefits of agricultural extension include contribution to social cohesion and governance through emphasis on solving community-level problems, "participatory learning, group dynamics and advocacy to support broader efforts that promote democracy and decentralization. It is a key social service often provided to the rural poor as a "public good" and a commitment by the government to support rural development. Furthermore, through extension services the women and youth can access technologies and information with potentially life-changing opportunities, promoting equity in development."

The national government allocation to agriculture has been low, though they have steadily been rising from 1.2% in 2014/15 to 1.6% in 2015/16 to 1.8% in 2016/17 and finally 2.3% in 2017/18. The total allocation is still below the 10% that the government committed itself to allocate under the Malabo declaration, with an average of 6% of the budget allocated to agriculture. This trend in financing has seen most County governments collectively fund 10% of the priorities identified in the CIDPs in the agricultural sector. The low budgetary allocation to the sector has made

it difficult to support the enhancement of technical competency among the staff; improve their communication and group facilitation skills as well as extension management, as such, the sector continues to stagnate.

Farmers have persistently reported low interactions with agricultural extension services in the country. A study by Tegemeo Institute of Egerton University shows that “a relatively 21% of farmers accessed agricultural information in Kenya in 2014. During the same period, the number of extension staff in public and private service was 5000 and 1000, respectively”. At the time of devolution, “the ratio of extension service providers to farmers was 1:1000 against the expected optimal ratio of 1:400 for better services” (GoK, 2012) Therefore, it is important to improve planning and budget allocation for the agricultural sector, especially at the County where majority of the functions are nested. Improving planning for the sector will result in projects that are realistic and respond to the localized needs of farmers in respective regions. This then forms a strong background for resource allocation. The national government allocation to agriculture has been low, though they have steadily been rising from 1.2% in 2014/15 to 1.6% in 2015/16 to 1.8% in 2016/17 and finally 2.3% in 2017/18. The total allocation is still below the 10% that the government committed itself to allocate under the Malabo declaration, with an average of 6% of the budget allocated to agriculture. This trend in financing has seen most County governments collectively fund 10% of the priorities identified in the CIDPs in the agricultural sector.

Agriculture in developing countries is dominated by women either as farm owners or managers, farm partners, unpaid family workers or as agricultural wage labourers. Despite their critical role, they are “virtually ignored by agricultural extension services. When women attend receive extension agents or attend extension training, they are frequently taught home economics and other subjects unrelated to their

agricultural roles". In jointly managed farms, women rarely receive agricultural information from their husbands or other male household members more so if the work on specific crops or tasks are divided by sex.

Women limited access to extension services is related to the orientation and structure of institutions providing agricultural extension services, the kind of services provided, the types of delivery programmes utilized, the staffing of the institutions. When extensionists do contact women, "it is often to provide information and advice that pertains to women's household, rather than farming, responsibilities. Some Ministries of Agriculture have separate extension units for women that are devoted to home economics, which generally touch on agricultural matters only insofar as they relate to nutrition and family welfare" (Beeyi et al., 2018). Other governments provide this type of extension service "for women within a separate agency or ministry, such as a Ministry of Social Welfare. In farmer training centres, instruction for women has also oriented toward home economics" (Beevi et al,. 2018). This approach "offers little hope for including women in the expanding commercialization of food production that is taking place as Third World countries develop. These factors are influenced by the characteristics of the women farmers" (Kabunga, Dubois & Qaim, 2012).

2.6. Theoretical Review

The following section reviews some applicable theories to the study. This section explores agricultural extension theory, human development approaches, theory of behavioural change, socio-cultural theories of learning, farmer decision making processes, knowledge transfer theory and the cooperative decision-making approach.

2.6.1 Agricultural Extension Theory

Agricultural extension theory evolved in line with the 'enlightenment' and thinking concerns in the 1950 to 1970 period with the 'adoption and diffusion' of science-based innovations. During this period, extension scientists developed an interest in technology adoption decisions. According to Adams (1984), "agricultural extension is the assistance given to farmers to help them identify and analyse their production problems and become aware of the opportunities for improvement." The Agricultural extension theory draws its main lessons from social knowledge and consulting of farmers and educating them on rationale of farming.

Agricultural extension has emphasized that extension is a premeditated, planned, programmed, systematically designed, goal-directed, and purposeful activity. It is an intervention in agricultural production. Roling (1998) explains that "extension science evolved from rural sociology and over time, it has become more and more aligned with social psychology. Traditionally, it was assumed all farmers would eventually see the benefit of innovations and adopt them". Success was measured on the level of technology adoption. The assumption was that information on the innovation communicated through farmer's social networks would increase adoption rates.

Another assumption was that "if agricultural producers are to make sound decisions about future production strategies, they need information on current and new technology, and its performance in real farm settings. More often, some farmers have taken up new ideas for which there is little economic justification" and a few farmers lack access to business management advice, and information on markets and market opportunities.

Briefly, extension theory is very critical in understanding the contextual factors of the adoption process and insights into the communication aspects to influence adoption decision-making by farmers. This study centres on finding out current extension services approaches, understanding farmer's experiences and perceptions. This helps in modelling ideas and lessons that are better embraced by farmers hence changing their behaviours and to farming practices.

2.6.2 Knowledge Transfer Theory

Extension service largely coordinated by the Ministry of Agriculture, dominates the current way of agricultural knowledge diffusion in Sub Saharan Africa (SSA).

Extension service is a "channel between the research community and the farmers" (Marsh, Pannell & Lindner, 2000). Extension service "plays a significant role in introducing new ideas and innovations to the farmer during initial stages of adoption. Over the years, different approaches, frameworks, and models have explained and guided activities around knowledge diffusion in agricultural practices" (Davis, 2008).

"The kind of interactions and communication channels employed are equally diverse and include demonstrations, farmer field schools, mentoring, one-on-one meetings, community radio, training, and visits" (Manning, 2013). Among the above, face-to-face interactions are significant modes of knowledge exchange. Extension models assume that innovations (and knowledge) originate in science and transferred to farmers for adoption.

This transfer is expected to follow a linear and sequential 'one-way' path (Black, 2000). Within this viewpoint, "early empirical approaches sought to determine patterns or predictive factors in the way decisions are made based on farmer socio-economic factors, and provision of information" (Ilbery, 1978). Farmers were

“categorized as ‘laggards’ or ‘innovators’ according to how readily they adopted innovations” (Rogers, 1986). Besides, “farmer-to-farmer extension work was regarded as beneficial because both parties communicate in the same language and the interaction would be relevant and in-context that ensures availability, accountability, and credibility”.

However, knowledge diffusion in agriculture is not always about the “transfer of scientific knowledge from research community to farmers as end users. Over generations, farmers accumulate varied practices and ideas that become part of their indigenous knowledge stock. Indigenous knowledge (IK) is the primary resource and social capital that shapes how local farmers engage with the natural environment and develop problem-solving strategies” (Lwoga, Ngulube, & Stilwell, 2011).

As significant as it is, “IK is generally internal, tacit, unsystematic, and derived from local experiences” (Lwoga, Ngulube, & Stilwell, 2011). Often compared with local knowledge, the definition of IK comprises all forms of knowledge, “Including technologies, know-how skills, practices and beliefs that enable the community to achieve stable livelihoods in their environment” (Manning, 2013). In view of these, it is apparent to postulate that any knowledge diffusion activity “needs to start with the community’s knowledge base, assessment of what is and is not working, build on the best practices, and improve on the ones that will not yield desired results” (Johnson & Segura-Bonilla, 2001).

The goal of knowledge diffusion is to “create a successful environment where end users benefit from the research findings by adopting new ideas and practices in a timely manner. In this regard, learning is an integral part of the end-users embracing innovation and knowledge” (Ghadim, Pannell, Burton, 2005). According to Rogers

(1995), “the rate of adoption, the speed with which latest ideas and innovation are embraced by individuals and groups, is predicated by five factors relative advantage, compatibility, level of complexity, trial-ability, and observability.”

Knowledge transfer was the dominant paradigm (Rogers, 1986) and “captured the concerns of the so-called ‘productivity’ era of the 1970s and 1980s, in describing the translation of science to encourage and promote efficient production. However, it has since been found limiting” (Buttel, 2001). Criticisms can be grouped under three main concerns: “firstly, that the approach is no longer appropriate for modern multi-functional agriculture; secondly, that it does not reflect the empirical evidence of how farmers use information; and finally, that it takes no account of other influences upon the uptake of information and advice. The uni-linear approach also fails to represent the many different sources from which knowledge is generated” (Chambers et al., 1989; Ruttan, 1996; Roling & Wagemakers, 2000).

A knowledge diffusion framework to be introduced or research activity that “takes place to improve existing agricultural practices need to factor-in the existing local knowledge base, often referred to as indigenous knowledge. If any of the research findings are to trickle down to the frontline in the farm field in a timely and usable manner, much work needs to be done to package, re-package, and synthesize the knowledge into context-rich processes, procedures, and guidelines that can readily be used and acted upon by farmers” (Chambers et al., 1989). The use of this theory in the study assists in understanding the approach used in the delivery of extension service, how farmers have contributed to the selection of the delivery method and their perception of effectiveness of these approaches.

2.6.3 Theory of Behaviour Change

The theory of behaviour change and agricultural extension share similar goal of bringing about change. In agriculture, "behaviour change is usually associated with the adoption of an innovation (a change in farming practice" According to Thompson (2009), "the main purpose of the extension service has been to change human behaviour by teaching people how to apply the results of scientific research". He postulates therefore that "all extension workers are change agents-professional persons- who attempt to influence adoption decisions in a direction they feel desirable." (Thompson, 2009)

Studies into behavioral change in agricultural have focused on "attitudinal theories such as the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975) which was later superseded by the Theory of Planned Behaviors, (TPB)," (Ajzen & Madden, 1986). The focus of these models is more on predicting behavior than on how to influence behavior. The other group of 'persuasion theories' "deals with the issue of how behavior can be altered by changing the beliefs underlying attitudes" (Petty et al., 1992) This can be useful for "exploring empirical observations, for example, *why* trusted sources of information are more likely to induce positive behavioral change on farms than non-trusted sources." (Petty et al., 1992).

"Influential paradigms of persuasion are so-called" "dual-process models" (Crano & Prislin, 2006) and arguably the "most widely accepted of these is the Elaboration Likelihood Model (ELM)" (Petty & Cacioppo, 1986). These models contend that "there are two pathways to changing people's attitudes. If receivers are able and motivated, they will systematically examine persuasive messages and if the message

is well reasoned, data based and logical it will succeed". This will produce long-term attitude change and is more likely to result in behavioral change.

Within this theory is the attribute of the source (source characteristics, type of institution or organization, approach used) and message (message characteristics), in concert with motivation and ability to process information (recipient characteristics such as age, gender, level of education among others which may influence the uptake of message), that combine to determine whether change is induced.

The ELM further suggests that "these factors can work by different processes in different situations, and that the process employed (whether central or peripheral) is critical in terms of understanding the consequences of the new attitude" (Petty et al., 1992).

One recurring theme from the reviewed literature is the importance of contact from a trusted source for achieving behavioural change. In general, higher source of credibility results in higher persuasion in changing behaviour. However, "if the message is low quality, using a high-quality source is unlikely to aid the take up of the message. High credibility sources are particularly important when messages are complex, there is little available experience, and/or a message carries a high personal risk" (O'Keefe, 2002). O'Keefe (2002) states that "two broad dimensions have emerged in the source literature namely: 'expertise' and 'trustworthiness'."

As (a) "experience and occupation are key factors that convince people of the reliability of the source and (b) people are both more open minded to and more inclined to process in-group messages, the use of people from farming backgrounds or trusted networks (local if possible) is likely to enhance message uptake. There are

many other source factors, for example liking, similarity and physical attractiveness which may all contribute to the extent to which the source is able to get the message across. However, their influence is complex and often contradictory" (O'Keefe, 2002).

In this case, the perception is that the smallholder farmer has on the extension agent and the choice of delivery method used by the extension service officer determines the adoption of agricultural technology or extension package.

2.6.4 Human Development Approaches

Criticisms of knowledge transfer have led to "formulations of alternative 'human development' approaches which are based on the principles of participation, empowerment and ownership of the problem" (Buttel et al., 1990; Vanclay & Lawrence, 1994; Black, 2000; Russell & Ison, 2000). These approaches also tend to "give validity to non-expert forms of knowledge and view the extension process as one of learning rather than passive knowledge utilization."

This view has underpinned the "development of 'farmer-first' ideology and participatory methods of extension" championed by Chambers et al., (1989). Constructionist perspectives are considered "more suited to conceptualizing the exchange of knowledge within these approaches, particularly in the context of sustainable agriculture" (Morgan & Murdoch, 2000). "The wide range of models and methodologies used in the field has been reviewed extensively" (Robinson, 2006). "Human development models recognize the significance of social interaction and understanding group perspective."

“Communication within a social system or a group is regarded as an important process in articulating, sharing and exchanging ideas among farmers” (Wilson, 2004). Theories drawn from knowledge networking (Sobels et al., 2001); social networking, social movements; social learning (Woodhill & Roling 2000); experiential learning (Roling & Wagemaker, 2000); social capital, (Kilpatrick 2002) and systems research (Blackmore, 2002) “underpinned much of the research undertaken which seeks to understand collective behavior.”

The role of “extension in facilitating collective processes is seen to be critical” (Roling & Wagemakers, 2000). “The complexity of modern agriculture suggests that no single model or strategy for influencing positive behaviour is likely to be sufficient. Whilst the value of human development approaches is recognized, there is still needed to draw on traditional extension models to achieve policy objectives and farmers access to reliable scientific information. Therefore, there is a need to manage the tension between persuasive extension and facilitative advice” (Garforth et al., 2003). In recognition of these considerations “some approaches have attempted to combine different strategies” (Greer & Greer, 1996).

“Top-down technology transfer and bottom-up human development approaches are two ends of a spectrum”; however, “the territory in-between probably provides the most opportunities and flexibility for future extension approaches if well applied” (Black, 2000). As such, a “number of doubts and misgivings have emerged over time regarding the capability approach employed in human development approaches and this has also caused a renewed soul-searching over the conceptual foundations of human development.”

2.6.5 Farmer Decision making Processes

The Interstate Managerial Study by Johnson et al., (1961) is "one of the few studies of how farmers make decisions. Most research and teaching have been in how farmers should make decisions." Orasanu and Connolly (1993) claim that "most research on decision making has focused on the decision event, not the process. While the decision event is critical to good decisions, it is limited in scope. Focusing on the event requires: assuming the decision maker knows his or her goals, purposes, or values."

The decisions must be "clear and stable over time; and the decision maker faces a fixed set of alternatives for which the consequences (including risks) of each alternative are known. Normatively-trained, farm management students usually exhibit a strong tendency to think of the decision process as a series of linear steps. Johnson et al., (1961) identifies six steps of decision making: problem definition, observation, analysis, decision, action and responsibility bearing." Simon (1965) describes the decision process as a "trichotomy: intelligence, design, and choice."

Mintzberg et al., (1976) initially described a similar trichotomy: "identification, development, and selection and then developed a list of 12 routines within the strategic decision process: decision recognition, diagnosis, search, design, screen, evaluation--choice, authorization, decision control, decision communication and political." Correspondingly, there are few research done to understand the processes of family decision-making. "Research has focused on the single farmer as the decision-maker" (Flett et al., 2004).

However, emerging evidence suggests "the concept of the principal decision-maker does not hold true and other family members are also involved in the decision-making process."

This particularly "happens on large farms (to varying degrees)" (Errington, 1986; Marsden, 1984; Marsden et al., (1989), "but the process and its implications for policy and targeting messages are not well-understood. Based on the research just cited, farmers should obviously not be expected to follow a common set of steps in any simple, sequential process."

However, perhaps because of limited human processing capability, we find it useful to identify the separate functions (but not steps) of decision making. Mintzberg et al., (1976) describes decision making as "a groping, cyclical process. They did not find a linear process, nor did all of their studied decisions include every one of the 12 basic routines mentioned earlier. They identified six factors that can create havoc with any idea of a straight, simple decision process: interrupt; scheduling delays, timing delays and speedups, feedback delays, comprehension cycles, and failure recycles."

2.6.6 Co-operative Decision-Making Approach

Institutions can influence (particularly collective) decision-making behavior. A wide range of factors has been found to enhance the success of collective action institutions, including "sharing and minimizing costs; harmonizing multiple objectives; sharing knowledge; sharing and mobilizing resources; increasing credibility of actions and objectives; allowing flexible, locally relevant responses; and, building capacity to cope with future changes" (Cline & Collins, 2003; Mills et al., 2006).

Many decision problems involve “multiple decision makers with multiple goals. Goals can be divided into two types, goals that are mutual for all the decision makers and goals that are different and require cooperation of multiple decision makers to achieve a consensus. A cooperative decision making requires free communication among decision makers. The participants in a decision-making process must pool their efforts together. They must also work towards a common goal, and they have to integrate multiple points of view which may not necessarily be compatible. They have to work together, although not necessarily in the same place or at the same time” They are committed to a “coordination effort in order to solve the problem, where they have to divide the task of making the decision into different sub-tasks which will be assigned to individual contributors.”

Several authors have defined cooperation on several points of view. Schmidt et al., (1992) “propose to use the definition of cooperative work as a starting point. They characterize cooperative work as people working together, who are mutually dependent for their work and who: support one another in the performance of their respective tasks.” This definition is given from the viewpoint of an outside observer of the whole system.

Also, “cooperation can be defined from the point of view of each agent involved in the general process”. According to de Terssac et al., (1996), “cooperation is the way of overcoming individual limitations. Cooperation can also be defined as the set of collective actions finalized and developed to deal with individual limitations. Based on this cooperative paradigm several associated concepts must be defined as coordination and collaboration. Cooperation is richer than collaboration in the sense that a mutual support is generated among the stakeholders.” Coordination is the

“management of dependences involved in all collaboration or cooperation processes” (Zarate, 2013).

There has also been some criticism on the effectiveness of cooperative decision-making processes. Cooperative decision making normally employ democratic decision-making processes which it can prove inefficient when conditions call for fast responses. On the same note, “cooperatives can suffer from ineffective leadership that stems from a variety of sources” (Zarate, 2013). Either members or management may lack sufficient or correct business knowledge to assess what the cooperative decision-making process can realistically be accomplished through agricultural extension. Cooperative decision-making process also often faces a talent deficit. Like any new business, “a cooperative decision-making process may need a strong entrepreneurial personality to get the ball moving, but the limited material returns may function as a barrier to entrepreneurially minded smallholder farmers.”

2.7. Conceptual framework

Guided by the above literature and theoretical reviews, small holder household food security depends on increase in farm productivity achieved through utilization of knowledge and information passed by the agricultural extension service and other indigenous knowledge by the smallholder household. The utilization of knowledge from extension depends on the availability and accessibility of the extension service. The utilization of the extension information will depend on the characteristics of the agricultural system, the extension techniques used, the content/messages delivery methods, targeting, timeliness and relevance to the farmers, among others. At the farmers level utilization will depend on the household socio-economic and farm characteristics such as age, education level, gender, land size and years of farming

experience plus household social capital/farmers (intermediate variables). This concept is illustrated in Figure 1 below showing the interrelationship between various factors and the linkage to the household food security.

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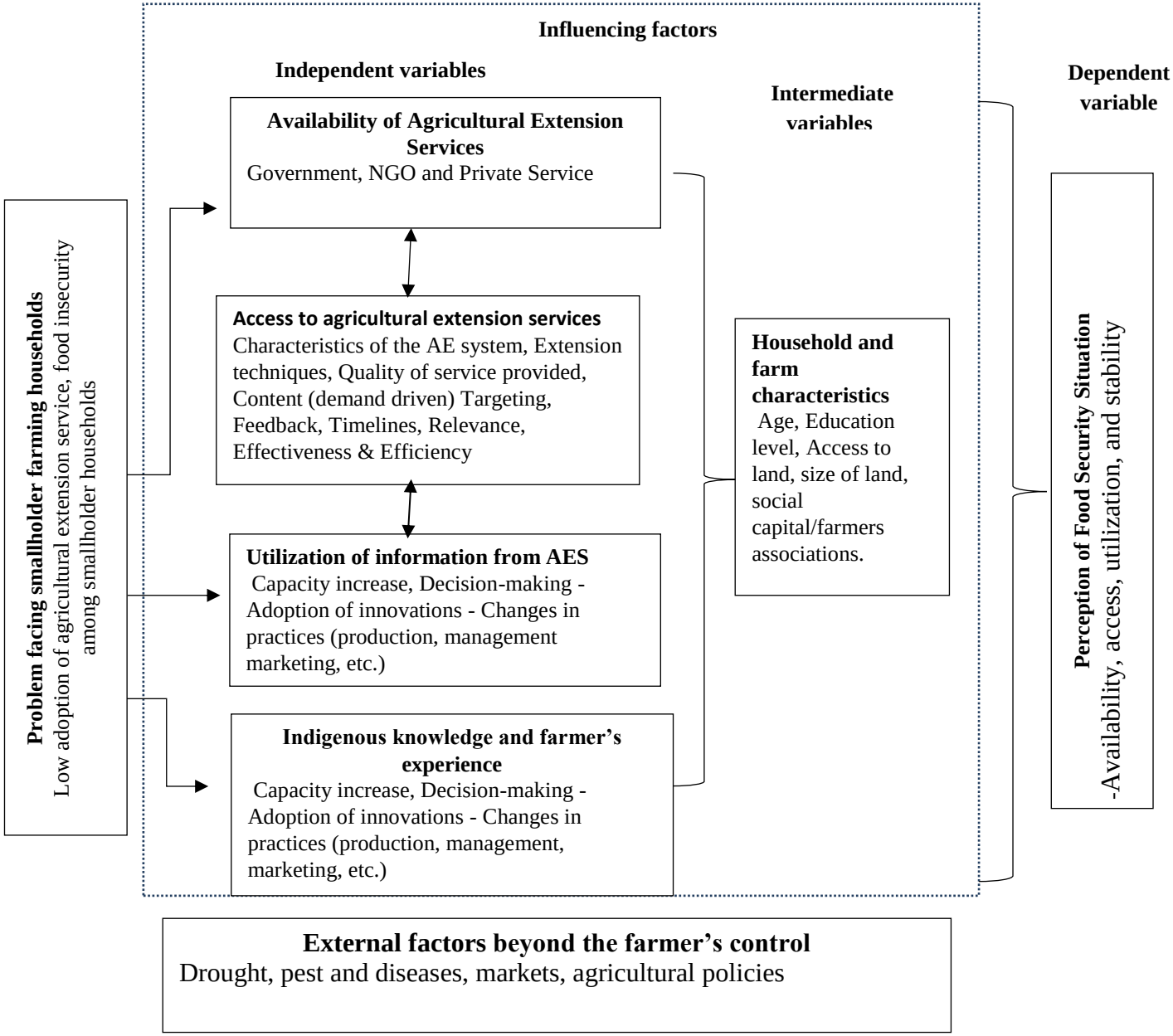

Figure 1. Conceptual Framework

2.8. Knowledge Gaps

When properly guided and invested on, smallholder agriculture is critical in fostering food security and sustainable incomes. Smallholder farmers produce eighty percent of the food consumed in Asia and Sub-Sahara Africa (FAO, 2017). However, international investments in agricultural development and policy have lagged compared to other sectors particularly in empowering smallholder farmers through agricultural extension (Biodiversity et al. 2012).

Marginalization of smallholder farmers continue in terms of accessibility to resources, information, technology, capital, and assets as much as there are regular government budget allocations for agricultural development particularly in Kenya, (Murphy, 2010). Further, smallholder farmer's farms are becoming infertile and plots sizes are decreasing (De Schutter, 2011). The "top-down agricultural extension systems have failed to nurture agricultural growth" (Rivera, 2001). Evidence has shown that "expansion of smallholder farming can lead to a faster poverty alleviation through raising the incomes of rural farmers and reduction in food expenditure hence leading to a faster rate of poverty reduction" (FAO 2017, World Bank, 2008).

The productivity of smallholder agriculture and its contribution to the economy, food security and poverty reduction depend on a supportive agricultural sector, which include effective extension service. However, with limited budgetary allocation agricultural extension services has been left to thrive on demand. This has left many smallholder farmers unattended or unexposed to new farming technologies.

Moreover, ineffective agricultural extension services have limited technology adoption by smallholder farmers. The government has not prioritized agricultural extension provision, which has a big bearing on technology adoption. "Adoption of

technologies and better practices being central in extension interventions are valuable for improving productivity and increasing farmers' incomes" (Anderson, 2007). There are no studies yet showing the link between extension approaches and food security in Uasin Gishu County and therefore, it is not only unclear whether agricultural extension approaches are effective, but also whether they are contributing to food security among smallholder farming households, hence this study objectives.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter provides a description of the methods applied in carrying out the research study. They included: research design, study site and target population, sample size and sampling technique, research instruments, data collection procedures, data management and analysis and ethical considerations.

3.2 Description of the Study Site

The study was conducted in Uasin Gishu County. This County was selected purposively as it is one of the high agricultural potential Counties in Kenya. "The County sits between longitudes 34^{o} 50' East and 35^{o} 37' West and latitudes 0^{o} 03' South and 0^{o} 55' North. It borders Trans Nzoia County to the North, Elgeyo Marakwet County to the East, Baringo County to the Southeast, Kericho County to the South, Nandi County to the Southwest and Kakamega County to the Northwest. The County covers an area of 3,345.2 Sq. Km within the Lake Victoria catchment zone and all its rivers" (Sosiani, Kipkaren, Kerita, Nderugut, Daragwa, and Sambu) draining into Lake Victoria. The County's climate is favorable for agriculture, has a small number of tourist attractions and home to a large and growing urban population.

Eldoret is the administrative and commercial centre of the County. The County consists of six Sub-Counties. Turbo, Soy, Ainabkoi, Moiben, Kesses and Kapseret. There are 30 electoral Wards. Soy Constituency with the highest number of Wards at seven wards, Turbo six, Moiben and Kapseret have five each, Kesses has four and lastly three wards in Ainabkoi, this is summarised in the table below.

Administratively, the County comprises of fifty-one locations and ninety-seven sub-locations.

Table 1. Uasin Gishu Sub Counties and Wards

Sub counties	**Wards**
Turbo	Ngenyilel, Tapsagoi, Kamagut, Kiplombe, Kapsaos, Huruma,
Soy	Moi's Bridge, Kapkures, Ziwa, Segero/Barsombe, Kipsomba, Soy, Kuinet/Kapsuswa
Moiben	Tembelio, Sergoit, Karuna/Meibeki, Moiben, Kimumu,
Kapseret	Simat/ Kapseret, Kipkenyo, Ngeria, Megun, Langas
Kesses	Racecourse, Cheptiret/Kipchamo, Tulwet/Chuiyat, Tarakwa
Ainabkoi	Kapsoya, Kaptagat, Ainabkoi/Olare,

The County is a "highland plateau situated at an altitude of between 1,500 metres above sea level, around Kipkaren, and 2,700 metres above sea level around Timboroa. It receives rainfall of approximately 960 mm/year, which is evenly distributed. This rainfall is bimodal with the two peaks coming in March and September. The wettest areas are Ainabkoi, Kapseret and Kessess Sub-Counties. Turbo, Moiben and Soy Sub Counties receive relatively lower amounts of rainfall as compared to Ainabkoi, Kapseret and Kesses Sub- Counties" (CIDP 2018). The "average temperature is 18^0C during the wet season and a maximum of 26.1^0C during the dry season. February is the hottest and the month of June being the coolest month" (Region Annual Report, 2010).

Agriculture is the core livelihood of the county contributing to “about 80% of rural household income and food security. According to the Agricultural Sector Development Support Programme (ASDSP) household baseline survey” (GoK, 2014), “more than 56% of households in the County are engaged in crop and/or livestock farming. High and reliable rainfall experienced in the county support crop farming, livestock rearing and forestry. The main crops in the county are maize, beans, wheat, sunflower, and potatoes whilst the livestock include dairy farming, beef cattle, poultry, sheep, goats, pigs, beekeeping, rabbit farming and fish farming. The average annual total household income is KES 871,076, while the average annual on-farm income earned by households in Uasin Gishu County is KES 334,320 with crop income accounting for 62% compared to livestock income which accounts for 20%”(GoK, 2014 & CIDP 2018).

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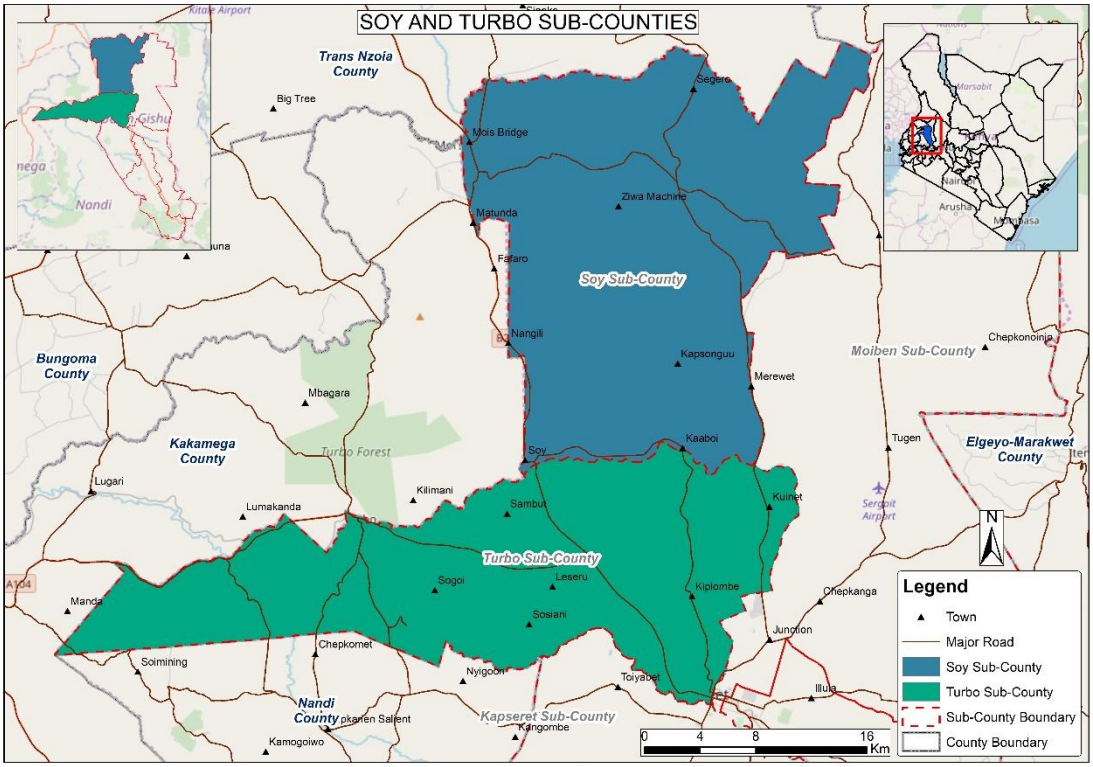

Figure 2 Study Area

3.3 Research Method

The study utilized a mixed research method. The research method involves collection of data quantitative and qualitative analysis and inference from a random sample (Banerjee, A., & Chaudhury, S. (2010). This method enabled the collection of "quantitative data among large population of smallholder farmers in the selected Sub Counties of Uasin Gishu for the purpose of drawing findings. It involved a survey of households on key variables guided by the study objectives. The qualitative data was used to triangulate the quantitative information" collected from households.

Household were the basic units of analysis because it is in the households that farming, and food consumption decisions are made.

3.4 The Target Population

"The target population describes the particular group relevant to the study. The target population of this study were 101,409 smallholder-farming households, a list of which was provided by the County Government of Uasin Gishu Department of Agriculture". Due to funding limitations, two Sub Counties were selected purposively, these are Soy and Turbo. The two Sub Counties had 30,018 number of smallholder farming households.

3.5 Sample Size and Sampling Technique

For this study, "multistage purposive and simple random sampling were employed. In the first stage, Uasin Gishu County, commonly referred as Kenya grain basket was selected purposively based on it being an agricultural County with presence of smallholder farmer. The second stage involved purposive selection of Turbo and Soy Sub-County informed by the budgetary limitation and the characteristics of these sub-counties having a relatively high concentration of smallholder farmers with smaller land holdings". The third stage involved "purposive selection of wards, namely: Sugoi, Kaptebee and Ngenyilel in Turbo Sub County and Soy, Kipsomba and Barsombe in Soy Sub County. The wards have a cumulative smallholder household population of 30,018," as reported in the County Development Plan of 2018. The sampling process is summarised in the flow chart, Figure 3. Below

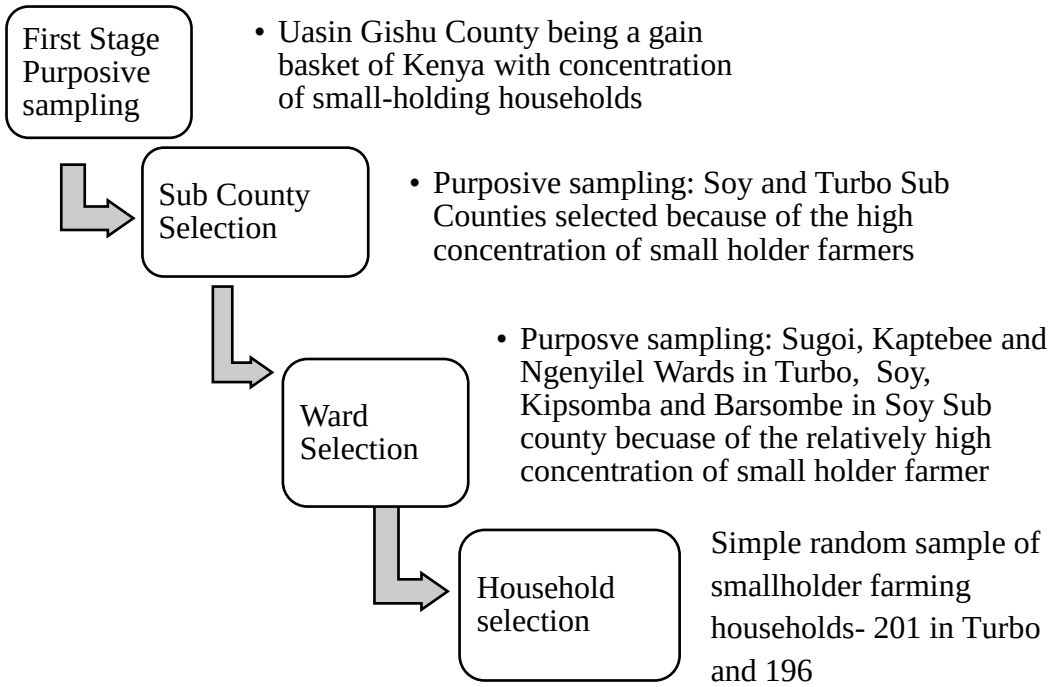

Figure 3. Multistage Sampling Flow Chart

A random sample of "397 households were interviewed, 201 from Turbo and 196 from Soy sub-County. This sample was determined using the Cochran's formula. Cochran's formula allows the calculations of an ideal size given a desired level of precision, desired confidence level and the estimated proportion of the attribute present in the population. It is considered especially appropriate in situations of large population" (Al-Hemyari (2018). The formula is as shown below.

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where:

- "e is the desired level of precision (i.e. the margin of error- 5%)
- p is the (estimated) proportion of the population which has the attribute in question (50%)
- q is 1 – p."

Using the confidence level of 95%

$$n0 = \frac{(1.96*1.96)(0.5*0.5)}{0.05*0.05} = 385$$

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The sample size was increased by a factor of 5 %, to cater for any missing data. A random sample of 402 households were selected randomly out of which 397 respondent households' questionnaires were returned complete for use in data analysis.

3.6 Data Collection Procedure and Instruments

3.6.1 Type of Data

This study utilized "both primary and secondary data. Primary data was collected using questionnaires and key informant interviews." While secondary date was sought from literature.

3.6.2 Research Instruments

The study used a "semi-structured questionnaire" to collect data from the sampled smallholder farming households. (Appendix II). The questionnaire was designed to include both structured and structured questions.

The questionnaire was subdivided into seven sections. The first section targeted information on household demographics characteristics, size of land and years of farmers farming experience. Section II and III covered the first and second objective which sought to determine and assess the availability and the level of access of agricultural extension services by smallholder farmers. Section IV focused on providing information on objective three that sought information on utilization of agricultural extension services.

Section V and VI assessed food security status of smallholder households in Uasin Gishu County. The “questionnaire was organized into closed and open-ended questions.” Likert scales was used to “obtain information on respondent household’s perceptions on various areas of the study interests such as availability, accessibility, utilization of agricultural extension services and state of household food security in the respondent households.”

3.6.3 Key Informants Interview

There was a total of six main informants for the interview including “four ward administrators and two Sub County Agricultural officers.” They offered information about the availability of extension services, how accessible they are, some of the farming practices and the status of food security in the specific areas. This information would help in triangulating the data collected from the smallholder farming households.

3.7 Data Collection Method

“Trained research assistants administered the questionnaire using the Computer Assisted Personal Interviewing (CAPI) method”whereby data collected data for this study was “aggregated in the survey platform on Open Data Kit (ODK). CAPI had various advantages including shorter turnaround time as it integrated data collection, data entry, editing coding and cleaning into a single process”. In addition, it improved data quality and reduced the researcher’s strain.

Interviews were conducted to using interview guides in face-to-face meetings with the key informants.

3.8 Data Analysis and Presentation

Data analysis was conducted using "Statistical Package for Social Sciences (SPSS version 23)". Both "quantitative and qualitative approaches were used in descriptive and inferential statistics in data analysis. For the presentation of socio-economic features and agricultural activities, percentages and frequency came in handy. The descriptive measures are mainly from data on respondent household characteristics such as age, gender, and education level, among others." In order to examine the nature and strength of how independent variables related, binary logistic and ordinal regression analysis were incorporated. "The binary logistic regression was applied for the dichotomous questions while the ordinal regression was used for Likert scale and rating type questions."

The logistic regression model is as presented below:

$$Y = b_0 + b_1X_2 + b_2X_2 + \ldots\ldots b_pX_p$$

"Where Y is the expected state of smallholder food security, X_1 through to X_p are the independent variables, b_0 is the value of Y when all the independent variables (X_1 to X_p) are equal to zero, and b_1 through b_p are the coefcients to be estimated."

The study adopted a limit of 0.05 statistical significance level, with the hypotheses being rejected when the value of its statistics is equal to or less than significance level.

Considering the "multidimensionality of food security", as outlined by the World Food Summit (1996), practitioners and policy makers have recommended the need for diversity in its measurement (FAO, 2013). This study used a combination of methods of measurement to assess the respondent perceptions on the following four dimensions.

- Quality (diversity)- nutritious food that meets dietary needs.
- Quantity (sufficiency)- physical and economic access.
- Acceptability- food preferences.
- Stability- always having food.

The "design the questions, the dimensions, and indicators of food security," developed by Maxwell et al., (2013) was used. The questions assessed household "behaviour signifying insufficient quality and quantity as anxiety over insecure access, frequency, and severity of behaviour in which people engage when they do not have enough food or enough money to buy food." The behaviour includes aspects such as worrying because of lack of money, unable to eat healthy and nutritious food, eating few kinds or less food, skipping meals or going without food for a whole day because of lack of food among others. The respondent household food security assessment was based on 12 months recall period preceding the data collection. The choice of the 12-month period was to cover for any possible seasonal changes in household food security. The self-assessed food security dimensions had ordinal categories (responses: "rarely (once or twice in the past one year) 2Sometimes (three to ten times in the past one year) Often (more than ten times in the past one year) and never) with the exact meaning of these responses differing by question." The indicators are then combined resulting into "food secure", "mildly food insecure", "moderately food insecure" and "severely food insecure" classification. This improved the measurement of household food security and reduced the number of potential false positives and false negatives that would result from solely relying on one measure.

The analysis employed ordinal logistic regression to identify relationships among variables. The results are reported in "odds ratios (OR), which are calculated by exponentiation the variables coefficients. This measure tells the expected change in the odds ratio of food security for each unit increase in each variable. A logistic model provides a better fit to the data if it demonstrates an improvement over the intercept-only model (null model)". The test of hypothesis is based on the Likelihood Ratio Test and Pearson Chi-Square statistic Test. The "H_0 holds that the null model is true and a P value for the overall model fit that is less than 0.05."

3.9 Validity and Reliability

3.9.1 Validity

According to Taherdoost, (2016), "validity is measuring what is intended to be measured. Validity explains how well the collected data covers the actual area of investigation." For this study, both content and construct validity were tested. For validity enhancement, "evaluation of the research tools and verification by the researcher in consultation with research supervisor checking whether it covered the purposes of the research and whether the results it produced correlated with other variables that are expected to be correlated with and not correlated with variables that are theoretically distinct" (Taherdoost, 2016).

3.9.2 Reliability

As provided by Taherdoost, (2016), "reliability is the extent to which results are consistent." This is the consistency of people's responses across the items in the questionnaire; the scores on the items should correlate to each other. The reliability of the "questionnaire items was tested using Cronbach Alpha coefficient α, accepted a

minimum coefficient of ≥ 0.70. Cronbach Alpha is the most appropriate measure of reliability when using Likert scales," which were largely employed in this study.

3.10 Pilot Test

A pilot test is small study for helping design the main research (Arain et al 2010). A pilot study was done to test for reliability of the semi-structured household questionnaire. The questionnaire was "administered to a random sample of 32 farming household heads randomly selected from Kesses sub-County in Uasin Gishu."

3.11. Ethical Considerations and Data Management

Authorization to carry out the study was obtained from University of Eldoret with information communicated to the County Department of Agriculture and the Ward administrators. The study embraced the principle of voluntary participation for the sampled respondents; none of respondents was forced into participating in the research. Additionally, the respondents were informed about the purpose of the study and that their privacy was assured.

CHAPTER FOUR

RESEARCH RESULTS

4.1. Introduction

This chapter presents results of the study. It contains the descriptive and inferential results. Data was collected at the household level using computer assisted personal interviews and complimented by key informant interviews with the Sub-County agriculture officers and ward administrators. The response rate was 99% with 397 respondents (Soy Sub-County 196 and Turbo Sub-County 201).

4.2 Demographic and Characteristics of Smallholder Farmers

Data collected on the demographic characteristics is presented in Table 4.1. Results show that "majority of respondents were male (56%). The average age of the respondents was 38 years, with the youngest being 20 years while the oldest" was 74 years, those below 35 years, the youth, were 42%. Most (78%) of the smallholder household head were married. One hundred and seventy-one (43%) respondents had secondary school as their highest level of education. In relation to gender of head of households, most of the households were male headed, at 78%.

Table 2. Smallholder farmers' demographic information

Indicators	Frequency	Relative Frequency	Cumulative Relative Frequency
Gender of respondent			
Male	222	0.56	0.56
Female	175	0.44	1.00
Age (Years)			
< 25	57	0.14	0.14
26-35	108	0.27	0.42
36-45	130	0.33	0.74
46-55	50	0.13	0.87
>55	52	0.13	1.00
Marital status			
Married	312	0.79	0.79
Divorced/separated	32	0.08	0.87
Widow/widower	22	0.06	0.92
Single	31	0.08	1.00
Highest education level			
Primary	106	0.27	0.27
Secondary	171	0.43	0.70
Tertiary	120	0.30	1.00
Gender- Head of household			
Male	311	0.78	0.78
Female	86	0.22	1.00

N= 397. Source: Survey Data, 2018

The characteristics of the smallholder farmer's show that a large proportion of the households (67%) have farm size below five acres while only (13%) have above 11 acres. The respondent household's average farm size was reported to be 2.29 acres. Majority, 91%, of the respondents owned the land with only 9% indicating that they leased land. Sixty nine percent have more than six years farming experience.

Table 2. Smallholder farm characteristics

Variables	Frequency	Percentage
Size of farm		
<=5 acres	268	67
6-10 acres	79	20
>=11 acres	50	12
Land ownership		
Farm owner	363	91
Tenant	34	9
Years of farming experience		
1-5 years	124	31
More than 5 years	273	69

N = 397. Source: Survey Data, 2018

From the table below, relating to age and farm size we find that majority of all ages have land size of five acres and below.

Table 3. Cross tabulation of age and farm size

Age of Respondent in years	**Size of land in acres**				
	Less than 2 acres	2-5 acres	6-10 acres	More than 11 acres	Total
	%	%	%	(%	%
< 25	3	9	2	1	14
26-35	10	11	5	1	27
36-45	6	14	7	6	33
46-55	2	5	3	2	13
Over 55	2	6	3	3	13
Total	23	45	20	13	100

N = 397. Source: Survey Data, 2018

4.2.1 Household Headship and Selected Demographic Characteristics

The four tables below (, 5. 6 and Table 7) cross tabulate the household headship and some selected demographic characteristics. The highest level of education, for female headed households are comparatively like their male counterparts in distribution. The female land ownership at 22% is relatively high in the study area, though the sizes are similar the male heads in size distribution.

Table 4. Gender and highest level of education of household head

Gender of head of household	**Highest level of Education**			
	Primary	Secondary	Tertiary	Total
	%	%	%	%
Female	6	11	6	22
Male	21	32	24	78
Total	27	43	30	100

N = 397. Source: Survey Data, 2018

Table 5. Cross tabulation between gender of household head and land ownership

Gender of head of household	**Land Ownership**		
	Landowner	Tenant	Total
Female	19	3	22
Male	73	6	78
Total	91	9	100

N = 397. Source: Survey Data, 2018

Table 6. Cross tabulation gender of household head and size of land

Gender of Household head	**Size of land in acres**				
	Less than 2 acres (%)	2-5 acres (%)	6-10 acres (%)	More than 11 acres (%)	Total (%)
Female	9	9	3	1	22
Male	13	36	17	12	78
Total	22	45	20	13	100

N = 397. Source: Survey Data, 2018

4.3. Agricultural Extension Services and Technologies

4.3.1. Availability of Agricultural Extension Services

From the study's results, it was found that various extension service providers and services were available. A better part of the respondents, (90.3%) knew about these service providers and 71.3% of them having information on accessing these services. The extension services offered by the County government extension officers were the most available, and which 87% of the respondents often seek. Only 40% of the respondents sought the extension services of the National government and a smaller number sought from cooperative societies. (See table 7). It was noted that though households were aware of a cooperative society, few (31%) of the respondents were members of cooperatives.

Table 7. Awareness and type of agricultural extension service providers in soy and turbo sub counties

Agricultural extension services	Availability (%)
Awareness of AES	
Yes	90.3
No	9.7
Aware of where to find the AES	
Yes	71.3
No	28.7
Service providers	Rank in availability
County government	1 (46%)
National government	2 (21%)
NGOs	3 (14%)
Private Company (seed and/or agrochemical)	3 (14%)
Cooperative Society	4 (5%)

N = 397 Source: Survey Data 2018

On services, majority of the respondents (82%) ranked improvement of crop production as the most available extension package during the year 2018. The service was provided through training and demonstration on high yielding seed varieties, recommended fertilizer and application at 89% better means for weed and pests' control at 90%. Following this is improved dairy production with (77%) reporting receiving information on improvement of breeds, animal feeds and care and management of dairy cows. Ranked third (57%) is availability of poultry extension service and in ranked fourth was training on value addition and market linkages at 48%. Very few (4%) respondents reported to have received extension service on bee keeping. This is summarized in Table 8.

Table 8. Types of agricultural extension services available in the area surveyed

Agricultural extension services	Yes		Ranked
	Frequency	%	Frequency
Improved crop production	320	82	1
Improved dairy	298	77	2
Poultry Keeping	225	57	3
Value addition and market linkages	183	48	4
Bee keeping	17	4	7

N: 397. Source: Survey Data, 2018

4.3.3. Access to Agricultural Extension Services

As depicted in the results of the research, 95% of the respondents confirmed their access to agricultural extension services. 73% of them were present in agricultural extensions training with most of them (53%) having attended once a month. A summary of access indicators is provided in Table 9 below.

Table 9. Indicators of access to agricultural extension services by the surveyed smallholder households

Indicators of access	Frequency	Percentage
Access to agricultural extension services		
Yes	377	95
No	20	5
Attended agricultural extension training		
Yes	290	73
No	107	27
Frequency of attendance in a month		
Once	210	53
Twice	40	10
Thrice	4	1
Occasionally	143	36

N = 397. Source: Survey Data, 2018

4.3.4. Agricultural Extension Service Delivery Method Preference

Respondents have varied preference of extension approaches and methods. The most preferred method of training delivery indicated by respondents was group discussions, (63%). The other approaches in the order of preference include the training and visit approach (58%), and farmer field schools (42%). An equal number (50%) of respondents preferred receiving information through media and farmer meetings. The above summary is shown in Table 10.

Table 10. Agricultural extension service delivery methods preferred by the smallholder farmers

Preferences on AES delivery	Frequency	Percentage
Group discussion and - activities	67	17
Individual visits	79	20
Demonstrations	250	63
Farmer Field School (FFS)	167	42
Training and visit	230	58
Communication channels		
Through media	199	50
Through extension farmers meetings	199	50

N = 397 Source Survey Data 2018

4.3.5. Constraints Hindering Access to Agricultural Extension Services

Respondents ‘assessment of constraints facing their access of agricultural extension services’ show that majority of the respondents (36%) reporting that the extension official did not regularly visit their area while only (7%) had difficulty in finding them

in the office. The factors hindering access to extension agents are summarized in Table 11.

Table 11. Constraint's in accessing extension officers as perceived by the respondents

Factors hindering access to extension officers	Frequency	Percentage
It is difficult to find the extension agent in office	28	7
The extension officer lives out of the village	48	12
Extension officer is always busy	67	17
Lack of means of communication by the smallholder farmer	20	5
The extension officer does not visit our areas regularly	143	36
Smallholder farmer has never tried to find the extension officer	91	23

N = 397. Source Survey Data 2018

4.3.7. Utilization of Agricultural Extension Services

Inquiries regarding application of varied extension services was used to determine the level that AES was utilized. This information includes "seed preparation, fertilizer application, weeding frequency, pesticides and herbicides use, harvesting and storage, spraying livestock, land use planning, farm record keeping and value addition" (Survey Data, 2018). It was observed that all these information were utilized mostly on occasional basis as seen in Table 12.

Table 12. The extent of utilization of agricultural extension services by smallholder farmers

Variable	Level of utilization of AES			
Agricultural extension service package	None %	Low %	Medium %	High %
Seed preparation and sowing	23	18	34	25
Fertilizer application	11	19	46	24
Weeding	10	19	47	24
Pesticide and herbicide use	11	13	53	23
Harvesting and storage	8	27	45	20
Spraying livestock	8	21	35	36
Land use planning	14	35	36	15
Farm record keeping	26	27	28	19
Value addition and marketing	39	25	24	12

N = 397 Source: Survey Data 2018

The findings above reveal that the information with relatively high percentages combined of low and no utilization are farm record keeping (53%) and value addition and marketing advice (64%). On the other hand, there is medium to high utilization of fertilizer application, weeding, pesticides, and herbicide use and livestock spraying.

4.3.8. Perception on Usefulness of Agricultural Extension Services on Improving Agricultural Productivity

The smallholder farmers' perception on usefulness of extension service in providing them information needed for improving their farm productivity was assessed. The findings show that 60% perceive extension service to be effective (successful in producing the desired result, in this case utilization/ change of practice) whereas 76% reported that it is useful (ability to be used practically). However, there was medium to low utilization of AES (50% and 41%) with only a few (7%) having high utilization. The findings are as shown in Table 13.

Table 13. Utilization, effectiveness, and usefulness of agricultural extension services as perceived by the smallholder farmers.

Variable	Frequency	Percentage
Effectiveness of AES		
Effective	237	60
Less effective	160	40
Usefulness of AES training		
Useful	301	76
Somehow useful	96	24
Utilization of AES		
No Utilization	8	2
Low utilization	163	41
Medium utilization	198	50
High utilization	28	7

N = 397 Source: Survey Data 2018

4.3.9. Summary of Key informant Interviews Findings on Availability and Challenges of Agricultural Services in the Study Area

Interviews with the key informants, the Ward Administrators and the Sub County Agricultural Officer confirmed the availability of different options ranging from public sector mainly county agricultural service with each ward having a livestock extension and agricultural extension information. Other players include cooperatives and NGO's and private companies. These players provide extension service related to their missions.

Dairy cooperatives mainly provide dairy related extension while NGOs provide training to farmers as it related to the projects they are implementing. The most common NGO programmes in both Sub counties are farmer dairy productivity improvement training on various aspects such as fodder preservation, improvement of breeds and marketing through facilitation of farmer cooperatives for milk bulking. The private sector providers are mainly fertilizer and agrochemical companies, providing information to farmers.

The agricultural extension models commonly found in the study area include the free public extension services provided when demanded by farmers and through open field days, the partly cost shared provision of extension service where if the farmer partly pays for specialized support and fully commercialized service where farmers pay for the service which is either provided by the private sector or cooperatives.

The public extension service which is available to every smallholder farmer on demand faces challenges insufficient logistical and delays in release of funds affecting timeliness and more so farmers living further away from the sub county headquarters. Other general challenges in the study area are the uncoordinated extension by the

many actors offering extension sometimes with personnel with no background in agricultural extension.

The results of the study are in line with discussions obtained from the main informants who posit that most of the farmers rarely come in contact with the extension service providers regularly. However, it was still asserted that the demand of these services by the farmers was the determinant of the use of extension services. It became paramount for these farmers to take an initiative of attending extension seminars for advice.

4.4. State of Respondents Household Food Security

4.4.1. Household Source of Food

The respondents obtained their food from different sources with the main source being own farm production at 96.9% followed by purchased food (77.9%). Few (16%) sourced foods from relatives and friends while a small number (1.8%) relied on government rations for their food supply. This is summarized in table 14.

Table 14. Main sources of household food

Sources of food	Percentage
Own farm production	96.9
Purchased food	77.9
Supplies from relatives and friends	16.0
Government ration	1.8

N = 397 Source: Survey Data 2018

4.4.2. Food Security Status

The respondent's household food security was measured using information obtained from household's self-assessment of their experiences and behaviour that serve to a certain degree as indicators for household food security.

The results from the household self-assessment on their food security for the past 12 months prior to the field survey showed majority (70%) of them had not experienced food insecurity with a few (19%) experiencing occasionally and often (11%). Table 15 summarizes the findings.

Table 15. Status of food security in Soy and Turbo Sub Counties

Variables	Category of Responses			
	Never %	Rarely %	Occasionally%	Often %
1. "Unable to eat preferred foods due to inadequate resources."	36	34	16	14
2. "Worried that the household would not have enough food"	36	31	25	8
3. "Having to eat a limited variety of foods due to lack of resources"	42	28	20	10
4. "Having to eat a smaller meal than needed because there was not enough food"	43.5	24.7	21.6	10.2

5. "Not having food to eat of any kind because of lack of resources"	44	27	20	9
6. "Going a whole day and night without eating anything because there was not enough food"	48	24	19	9

N = 397 Source: Survey Data 2018

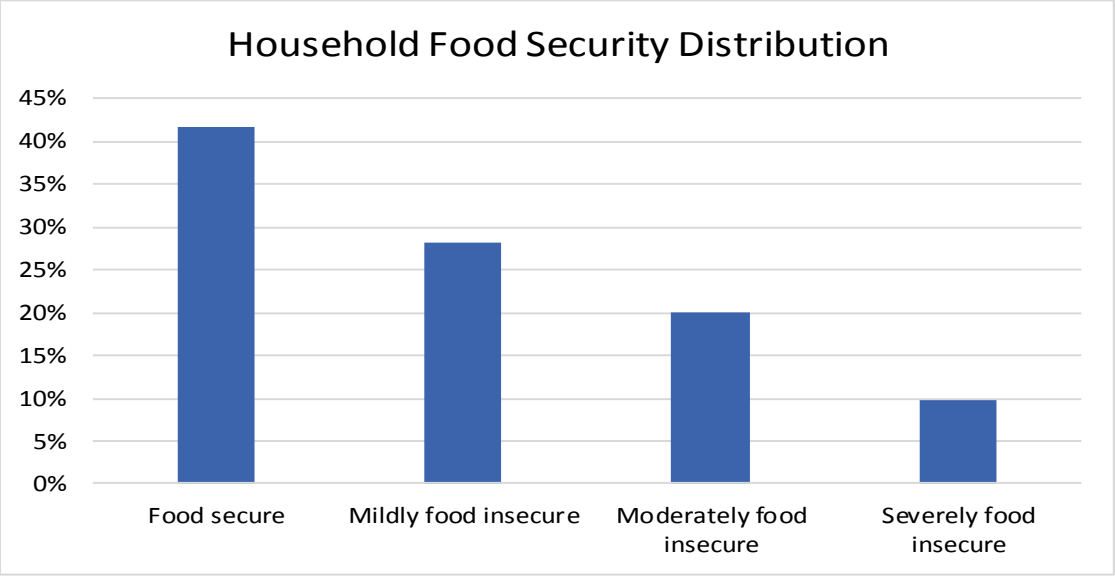

Figure 4: Household Food Security Status

The results above are combined to construct a multidimensional chart showing the respondents' state of the food security. The figure was derived from the taking the average of the percentage of households in a category (Never, Rarely, Occasionally, and often) and dividing by all respondents. The resulting figure is as shown below.

4.4.3. Utilization of Agricultural Extension Service and Household Food Satisfaction

From the results above, it can be asserted that more of the surveyed households (39%) rarely had issues with food security, 31% of them experienced no problems at all and 18% of the households had issues from time to time while (11%) always had problems. Cross tabulation was performed to establish the extent of utilizing extension services and how it is related to the feed security of households.

"A higher percentage of households (19%) with medium level of utilization of agricultural extensions services never experienced any problem in satisfying their household food security 12 months prior to the survey. A small percentage of those who had never utilized (1%) agricultural extensions services always had problems in their household food security needs while (6%) with medium level of utilization reported to always being dissatisfied with their food security" as shown in Table 16.

Table 16. AES utilization and food satisfaction

Utilization of Agricultural Extension Services	Household food security status				
	Never %	Rarely %	Occasionally %	Often %	Total %
No utilization	2	3	1	1	6
Low utilization	11	14	8	4	37
Medium utilization	16	19	8	6	49
High utilization	3	4	1	1	8
Total	31	39	18	11	100

Pearson Chi-Square 4.722 p-value 0.858

N = 397. Source: Survey data 2018

There is not a “statistically significant (p-value=0.858>0.05) relationship between the level of utilization of agricultural extensions services and household food security during the 12 months preceding the study”. (Pearson Chi-Square=4.722).

Among the households surveyed, “89% did not experience food insecurity in the past 12 months before the data collection as compared to the previous year. A higher frequency of households with medium level of utilization (46%) did not have food insecurity. One percent of households with no and high levels of utilizations experienced food insecurity”. As shown in Table 17 there is no link between the level of utilization and household food security.

Table 17. AES utilization and food consumption changes

Agricultural extension utilization	Household food shortage		
	Yes	No	Total
	%	%	%
No utilization	1	5	6
Low utilization	5	32	37
Medium utilization	5	46	50
High utilization	1	6	7
Total	11	89	100

Pearson Chi-Square 1.947 p - value 0.583

N = 397. Source: Survey data 2018

There is not a “statistically significant (p-value=0.583>0.05) relationship between the level of utilization of agricultural extensions services and changes in food consumption”.

Eighty-eight (88%) of the respondents did not experience food shortages. “Thirty two percent of respondents with low utilization and 45% with medium level of utilization of agricultural extensions services did not experience food shortages”. Only 12% of households experienced food shortages across the different levels of utilization as shown in Table 18.

Table 18. AES utilization and food shortage

Agricultural extension utility	“Household experiencing food shortage in the past 12 months prior to the survey”		
	Yes %	No %	Total %
No utilization	1	5	6
Low utilization	5	32	37
Medium utilization	6	45	51
High utilization	1	6	7
Total	12	88%	100

Pearson Chi-Square 1.689 p- value 0.639

N = 397. Source: Survey data 2018

As shown, “there is no significant (p-value=0.639>0.05) relationship between the level of utilization of agricultural extensions services and food shortage.”

4.5 Correlation Analysis

4.5.1 Correlation analysis for household food security and Respondent Demographic Characteristics

Correlation “analysis was performed to determine strength of relationships between food security and demographic factors. The results in Table 19 below show a significant positive relationship between gender of the respondents and marital status

(rho=0.204).” There is also a significant negative relation between gender and age of the respondents and size of farm (rho= -0.105 and -0.203 respectively). This shows that gender, marital status, and age are likely to affect food shortages. Food insecurity increases depending on gender and marital status while it decreases as age of the households increases.

Table 19. Correlation Analysis between Socio-demographic Characteristics and Household food security

Variable	Gender	Age	Marital	Education level	Farm size	Experience food shortage
Gender						
Pearson Correlation	1					
Sig. (2-tailed)						
Age						
Pearson Correlation	-.105*	1				
Sig. (2-tailed)	.036					
Marital						
Pearson Correlation	.204**	.105*	1			
Sig. (2-tailed)	.000	.036				
Education level						
Pearson Correlation	-.018	-.240**	-.025	1		
Sig. (2-tailed)	.717	.000	.621			
Farm size						
Pearson Correlation	-.203**	.232**	-.159**	-.091	1	
Sig. (2-tailed)	.000	.000	.002	.070		
Experienced food shortage						
Pearson Correlation	.027	.026	.061	.018	.018	1
Sig. (2-tailed)	.592	.604	.227	.715	.714	

** “Correlation is significant at 0.01 level (2-tailed)”

* “Correlation is significant at 0.05 level (2-tailed)”

N = 397 Source Survey Data 2018

4.5.2 Correlation Analysis between Farm Size and Farming Experience and Food Security

Correlation analysis was "performed to determine the strength of relationships between household food security and respondent farm size, ownership, and farming experience."

The correlation analysis in Table 20 below shows a significant positive correlation between the type of land ownership and farming experience (rho=0.246). Households who owned land and had more farming years of farming experience are not likely experience food shortages.

Table 20 Correlation analysis of farm size, farming experience and household food security.

Factors	Type of land ownership	Farming experience	Experience food shortage
Type of land ownership			
Pearson Correlation	1	.246**	.055
Sig. (2-tailed)		.000	.274
Farming experience			
Pearson Correlation	.246**	1	.083
Sig. (2-tailed)	.000		.097
Experience food shortage			
Pearson Correlation	.055	.083	1
Sig. (2-tailed)	.274	.097	

** "Correlation is significant at 0.01 level (2-tailed)"

N = 397. Source: Survey data 2018

4.5.3 Correlation between Availability and Access to Agricultural extension services and Food Security.

For the determination of how strong the relationships between "availability and access to agricultural extension services and respondent household food security", correlation analysis was performed.

Table 21 below offers a summary of these correlations. There is a "significant positive relationship between the availability of extension services, attendance of extension training programmes and monthly frequency of attendance" (rho=0 0.200 and 0.108 respectively). Also, there is a "significant negative correlation between availability of extension services and knowledge about its understanding by the households" (rho=-0.237). This shows that "increasing the availability of extension services and attendance to training programmes increases accessibility and therefore contributes to household food security."

Table 21: Correlation analysis availability and access to agricultural extension services and food security

Variables	Food shortage	Availability of Agricultural extension services	Access to Agricultural Extension Service	Attending AES training	Freq. attend train monthly
Food shortage					
Pearson Correlation	1	.043	-.040	.028	.010
Sig. (2-tailed)		.394	.432	.580	.847
Availability of extension services					
Pearson Correlation	.043	1	-.237**	.200**	.108*
Sig. (2-tailed)	.394		.000	.000	.033
Access to AES					
Pearson Correlation	-.040	-.237**	1	-.189**	-.146**
Sig. (2-tailed)	.432	.000		.000	.004
Attend AES training					
Pearson Correlation	.028	.200**	-.189**	1	.268**
Sig. (2-tailed)	.580	.000	.000		.000
Frequency					
Pearson Correlation	.010	.108*	-.146**	.268**	1
Sig. (2-tailed)	.847	.033	.004	.000	

** Correlation is significant at 0.01 level (2-tailed) * Correlation is significant at 0.05 level (2-tailed)

Source: Survey 2018

4.5.4 Correlations between Utilization of Agricultural Extension Services and Respondent Household Food Security

"Correlation analysis was also performed on utilization of extension services and food security to determine the strength of relationships."

Table 22 Pearson correlation analysis on utilization of agricultural extension services and food security

Variables	Food shortage	AES is useful	AES utility
Food shortage			
Pearson Correlation	1		
Sig. (2-tailed)			
AES is useful			
Pearson Correlation	.023	1	
Sig. (2-tailed)	.644		
AES utility			
Pearson Correlation	.039	-.525**	1
Sig. (2-tailed)	.436	.000	

* Correlation is significant at 0.05 level (2-tailed)

Source: Survey Data 2018

The analysis in Table 22 above revealed a "significant positive relation between utilization of agricultural extension services and improvement of household's food security" (rho=0.623). This means that the "utilization of agricultural extension services improves household wellbeing through improved agricultural productivity. There is a statistically significant negative relation between usefulness of the utilization of Agricultural Extension Services and their level of utilization" (rho=-

0.525), meaning that usefulness of Agricultural Extension Services depends on the level of utilization.

4.6. Inferential Results and Test of Hypothesis

This section summarizes results from inferential statistics and the test of study hypotheses. The logistic and ordinal regression models is used to predict the small holder food security based on a set of independent variables.

"Before using the Logistic Regression Model to analyze the collected binary data, the tests suitable to the models were examined. Chi-square and R-square values: Chi-square was used to test the null hypothesis (H0). The logistic regression model achieves a goodness of fit when the Chi-square test statistics are highly significant at 5.0% ($p < 0.05$). In this study, the R-square value of the Cox and Snell test, and the Nagelkerke test were between 0 and 1 which supports the goodness of fit of the model."

4.6.1. Logistic Regressions Results

Influence of Household Demographic Characteristics on Access to Agricultural Services by Smallholder Farmers.

The binary logit regression analysis between the household demographic characteristics and the access to agricultural extension services shows that age is statistically significant at 10% (*p*- value = 0.056), showing that age influences access to agricultural extension service, older heads of households are more likely to access AES compared to younger heads of household. Gender and education level of the household head is statistically significant at 5% (*p*- value = 0.005 and 0.002 respectively). These characteristics though significant are negatively associated with household access to AES, female heads of households are less likely to access

extension services than their male counterparts while education though significant, increase in level of education does not lead to increase in access to AES. Marital status, type of land ownership and farming experience are "positively associated with access to AES but are not statistically significant."

Table 23. T-test analysis between Demographic characteristics and access to agricultural extension services

Access to AES	**Coef.**	**SE**	**t**	**P>|t|**
Age	-.486	.254	-1.91	0.056*
Gender	-.270	.096	-.2.82	0.005**
Marital Status	.085	.105	-0.81	0.419
Education Level	-.249	.080	-.3.10	0.002**
Farm Size	.143	.095	1.51	.131
Type of Land ownership	.341	.331	1.103	0.303

Influence of Household Demographic Characteristics on Smallholder Food Security

The regression analysis between the household demographic characteristics and the household food security as shown Table 25 shows that "age is statistically significant *p*- value = 0.016. and positively associated with household food security, showing that as age of the household heads increases so is their household food security. Marital status of the household head is significant at 0.05," however there is negative association with small holder food security, meaning that marriage increases the chances of a smallholder farming food insecurity. Type of land ownership and farming experience is significant at 10% and is positively associated with food security, land ownership and experiences have a positive influence on the smallholder

food security. Gender of the household head, education level and farm size are not statistically significant.

Table 24. T-test analysis between Demographic characteristics and smallholder food security

Small holder household food security	Coefficient.	SE	t	P>|t|
Age	.108	.004	2.42	0.016**
Gender	.0949	.136	.70	0.487
Marital status	-.204	.086	-2.36	0.019**
Education level	.0101	.042	.38	0.701
Farm size	-.0116	.008	1.40	0.162
Type land ownership	.318	.177	1.80	0.073*
Farming experience	-.0155	.009	-1.66	0.097*
Constant	.142	.446	.032	.749

*Statistical significance at 0.1 level. ** Statistical significance at 0.05 level

N = 397 Source: Survey Data 2018

Influence of Availability, Access, and Utilization of Agricultural extension Services on Household Food Security

In establishing the relationship between the availability, accessibility, and utilization of agricultural service to food security by the surveyed smallholder farmers, awareness of AES, knowledge of where to access the service, frequency of attendance of AES training and utilization of knowledge gained during the interactions were analysed. It was found (table 4.19) that farming households who understood where to

find and how to access agricultural extension services showed to have positive (β=0.197 & 0.420) and statistically significant (p<0.000 & 0.008) relationship with the household food security. Monthly frequency of contact with the agricultural extension service agent shows a negative (β=0.148) and significant relationship with food security.

Table 25 Regression analysis between accessibility and utilization of agricultural extension services and smallholder food security

Small holder household food security	Coef.	SE	z	P>|z|
Aware of availability of AES	0.197	0.043	4.61	0.000***
Aware of how to access AES	0.420	0.157	2.67	0.008**
Attend AES Training	-0.044	0.159	-0.28	0.783
Monthly accessibility of AES	-0.148	0.045	-3.28	0.001***
Utilised knowledge from AES	0.039	0.099	0.39	0.694
Satisfied with the AES	0.177	0.047	3.77	0.000***

*Statistical significance at 0.1 level. ** Statistical significance at 0.05 level
N = 397 Source: Survey Data 2018

4.6.2 Pearson Chi-Square Results

Ordinal regression is used to predict food security given a "set of independent variables. In this study, the food security variable takes the form of ordered response category variable whereas the independent variables are either categorical or continuous. In the output tables below, the variable threshold is used for the intercept term, while the location variable gives the coefficient for the independent variable for the specified link function."

Pearson Chi-Square Regression Analysis between Household Food Security and Demographic Characteristics

The Pearson Chi-square analysis on household security variable frequency of food satisfaction measured on 4-point Likert item and demographic variables, gender, marital status, education, and farm size show that the "Pearson Chi-square statistics is not statistically significant p-value= 0.339>0.05. There is insignificant (p-values>0.05) positive relationship between demographic characteristics and food shortage while gender variable shows inverse relationship". The odds of male headed household to experience food insecurity decreases by 1.9% compared to their female headed counterparts, (β=-0.019). The odds for the married head of household to experience food shortages is 0.39 compared to single, widowed, separated combined (β=0.390). The odds that those who have lower level of education to be exposed to food insecurity is 0.121 as compared to those with higher level of education (β=-0.121). Furthermore, the odds to experience food shortages for those with less than two acres of land is 0.233 as compared to those with greater than two acres, (β=0.233).

$$y = 0.233x_1 + 0.121x_2 + 0.39x_3 - 0.019x_4 + 0.153$$

In conclusion, demographic characteristics like gender, marital status, education level and size of farm influence the state of household food security though not significantly as shown in Table 26.

Table 26. Chi-square relationship between demographic characteristics and household food security

Parameter		Estimate(β)	Sig.
Threshold	[frequency of food satisfaction= 0]	.153	.946
Location	Gender respondent (x_4)	-.019	.981
	Marital status (x_3)	.390	.562
	Education level (x_2)	.121	.700
	Farm size (x_1)	.233	.544

Model Chi-Square = 114.551	Chi-square = .371
Nagelkerke's R^2=0.013	Significance = .339
Cox and Snell's R^2= 0.007	McFadden's R^2=0.009

Source: Survey Data 2018

Pearson Chi-square Analysis between Household Food Security and Household Farming Characteristics

The Pearson Chi-square statistics on household security and two farming characteristics, land ownership and experience is "not significant p-value= 0.341>0.05. The parameter estimates table below summarizes the effect of each predictor. There is insignificant (p-values>0.05) positive relationship between agricultural activities and its effect on food insecurity while farm record keeping shows an inverse relation. The odds of those who owns land to be exposed to food insecurity is 0.555 compared to those who lease (β=-0.555)." The odds that those with farming experience of between one to five years will experience food insecurity is 0.614 as compared to those with more than five years farming experience (β=0.614).

$$y = 0.555x_1 + 0.614x_2 - 0.713.$$

In conclusion, agricultural factors like type of land ownership and farming experience "influence the state of household food security even though not significantly" as seen in Table 27.

Table 27 Pearson Chi-Square Analysis between farming characteristics and household food security

Parameter		**Estimate(β)**	**Sig.**
Threshold	[Household food security = 0]	-.713	.745
Location	Type of land ownership (x_1)	.555	.522
	Farming experience (x_2)	.614	.173
Model Chi-Square = 14.479		Chi-square = .341	
Nagelkerke's R^2=0.017		Significance = .310	
Cox and Snell's R^2= 0.009		McFadden's R2=0.012	

Source: Survey Data, 2018

Pearson Chi-square Analysis between Availability and Access to Agricultural Extension Services and Food Security

The regression on household food security and availability and access to agricultural extension "Pearson chi-square statistic is not significant with a *p*-value= 0.812 > 0.05. The critical chi-square for 1 degree of freedom at 5% level of significance is 3.84." Since the computed chi-square is 0.812, which is less that the critical chi-square, the null hypothesis H_{o1} enhancing availability and accessibility to agricultural extension "improves the food security of smallholder farming households is not rejected. The parameter estimates" in Table 4.21 below "summarizes the effect of each predictor. There is insignificant (p-values>0.05) positive relationship between respondent's households' availability and access to agricultural extension services and food

shortage". The households' attendance of extension training programs and knowledge on where to get extension services shows inverse relationship.

"The odds of availability of extension services are 0.581 as compared to non-availability of these services, (β=-0.581). The odds that those who attend extension training programs will experience food shortages decreases by 14% as compared to those who did not attend, (β=0.139). The odds that those who attend extension training programs once per month will experience food shortages is 0.059 as compared to those who attend twice or thrice per month," (β=0.059).

$$y = 0.581x_1 + 0.213x_2 + -0.139x_3 + 0.059x_4 + 2.017$$

Conclusively, the access to extension services by households has a major impact on the status of their food security, despite not being too major as depicted in Table 28.

Table 28 Chi-square analysis between accessibility to agricultural extension service and household food security

Parameter		**Estimate**	**Sig.**
Threshold	(Household food security= 0)	2.017	.698
Location	Availability of extension services (x_1)	.581	.906
	Understanding access to AES (x_2)	.213	.757
	Attend AE training (x_3)	-.139	.883
	Frequently attend AES	.059	.828

Model Chi-Square = 64.011	Chi-square = .812
Nagelkerke's R^2=0.018	Significance = .371
Cox and Snell's R^2= 0.010	McFadden's R2=0.013

Source: Survey Data, 2018

Ordinal Regression Analysis between Utilization of Agricultural Extension Services and Household Food Security

The Pearson Chi-square statistics from the ordinal regression on "utilization of agricultural extension and food security is not significant (p-value = 0.369>0.05). The computed chi-square is 0.812, which is less that the critical chi-square, the critical chi-square for 1 degree of freedom at 5% level of significance is 3.84, hence the null hypothesis $H_{o2:}$"

Enhanced utilization of agricultural extension services improves the food security of smallholder farming households is not rejected.

The parameter estimates below summarizes the effect of each predictor. "There is insignificant (p-values>0.05) positive relationship between utilization of agricultural extension services and its effect on food shortage while usefulness of the utilization of extension services shows an inverse relation. The odds ratio (β=-0.513) represents the risk of food shortages decreasing by 51.3% for those who view utilization of agricultural extension services as very useful as compared to other households whose thoughts were otherwise. The risk of exposure to food insecurity is 0.650 times for those with no utilization of extension services (β=0.650). Furthermore, the odds of exposure to food shortages are 0.920 for those who rated utilization of extension services helps in improvement of household's wellbeing" (β=-0.920).

$Y = -0.513x_1 + 0.65x_2 + 0.92x_3 + 0.1.81$

Therefore, "the utilization of agricultural extension services will influence the state of household food security even though not significantly" as shown in Table.29.

Table 29. Chi-square relationship between AES utilization and household food security

Parameters		Estimate	Sig.
Threshold	[household food security= 0]	.181	.927
Location	AES attending useful (x_1)	-.513	.334
	AES utility (x_2)	.650	.232
	AES improves wellbeing	.920	.106

Model Chi-Square = 3.148	Chi-square = .369
Nagelkerke's R^2=0.018	Significance = .371
Cox and Snell's R^2= 0.010	McFadden's R^2=0.013

Source: Survey Data, 2018

4.6.3 Hypothesis Testing

The first hypothesis tested the effect of enhanced availability of agricultural extension service on smallholder farmers household food security. The regression on household food security and availability to agricultural extension "Pearson chi-square statistic is not significant with a p-value= 0.812 > 0.05". The critical chi-square for 1 degree of freedom at 5% level of significance is 3.84. With the computed chi-square of 0.812, which is less that the critical chi-square, the null hypothesis Ho_1 enhancing availability and accessibility to agricultural extension improves the food security of smallholder farming households is not rejected.

Though it is expected that agricultural extension service will help increase farm productivity and minimize food insecurity, this is not true in this study, other factors could be contributing to food security. These include socio-economic factors, low use

of technological and environmental factors, limited food production from the low input use.

H_{o2}: Enhancing the accessibility to agricultural extension improves the food security of smallholder farming households. Since the variables: understanding access to extension services, knowing the extension agent, being a member of farmer group, frequent attendance to extension trainings, agricultural extension delivery preferred method and preferred way of getting agricultural information, "are all significant at 1%, we, therefore, reject the null hypothesis that states; Access to agricultural extension services has no significant effect on smallholder farming household food security in Uasin Gishu County."

$Ho_{3:}$ Enhanced utilization of agricultural extension services improves the food security of smallholder farming households. The "Pearson Chi-square statistics from the ordinal regression on utilization of agricultural extension and food security show a not significant (p-value = 0.369>0.05)". The computed chi-square is 0.369 is less that the critical chi-square, the critical chi-square for 1 degree of freedom at 5% level of significance is 3.84, hence the null hypothesis $H_{o2:}$ Enhanced utilization of agricultural extension services improves the food security of smallholder farming households is not rejected. This study focused on the general utilization of agricultural extension services; it may be that farmers choose to utilize some practices/technologies. Adoption of technologies is multidimensional; thus, it is essential to study the effects of multiple technologies as well as control endogenous factors such as household wealth which has a direct link to household food security.

CHAPTER FIVE

DISCUSSIONS

5.1 Introduction

This chapter discusses and synthesises the findings in chapter four. The findings are interpreted in relation to theoretical and conceptual frameworks and relevant studies.

5.2 Household Demographic and Farm Characteristics of Respondents

The demographic and farm characteristics considered for this study included: age, gender of the household head, education, farming experience, farm size and farm ownership. The mean age of the head of household is 38 years, with a range of 20 to 74 years. With only 13% above the age of 55 years, and 41% at the youthful age (below 35 years) this shows that the respondents are within the productive age. A study by Ngele et al., (2015) in neighbouring sub county of Moiben in the same county reported a mean age of 42 years.

Age is a key factor in engagement in farming and general access to information including "access to agricultural extension service and adoption of technologies. The age of the household head has a direct relationship with the farming experience. Farming experience in the study is defined as the time the smallholder farmers has spent in the farming occupation since she/he started making independent production decisions". Sixty-nine of respondents had more than five years farming experience, with the average age of 38 years, these smallholders' farmers have had experience in testing agricultural technologies as disseminated by the AES. Farming experience is a key factor in agricultural production (Muyanga, 2012). Ainembabazi & Mugisha, (2014) in a study an "adoption of technology study in Uganda found that the relationship between adoption of agricultural technologies and farming experience take the form of an inverted shape in bananas, maize, and coffee, suggesting that

farming experience is largely useful in the early stages of adoption, when farmers are still testing the potential benefits. Farmers then abandon the technology if the benefits are smaller than the efforts made especially if the technology demand of labour and larger farm size such as maize".

Landholding sizes are relatively small with 67% of the sampled households owning less than five acres with only 12 % owning more than 11 acres. Muyanga in 2013 on trends on land sizes in Kenya predicted a swift decline of land in the Western highlands of Kenya from the then average 2.6 hectares. This is attributed to the "growing populations densities and ensuing land subdivisions, distress land sales as a result of family financial needs (e.g., education and medical costs) and conversion of agricultural land at close proximity to urban centres to residential plots gradually contributing to declining agricultural land" (Muyanga, 2013). This small land holding has a relationship with the 91% ownership, meaning that the study area is largely occupied by smallholder farmers who are land constrained, with limited land available for renting/leasing out.

In determining the interaction between age and land size, the cross tabulations findings between the two variables shows that majority of respondents across all ages have land size of five acres and below, meaning that age does not determine land size in the study area, however respondents between the age 36-45 years have comparatively smaller land size with 76% of respondents in this age group having less than five acres.

Seventy eight percent of the respondents were married. Married farmers often feel the pressure to produce more to cover for the family and also for sale purposes. This builds the need for more production that results in seeking agricultural information

that could also translate to increased household labor. This study did not confirm the form of ownership whether via inheritance or purchase, A study by the African Women Studies Centre in 2014 found that "only 20.7 per cent of women in Kenya own land compared to 43.8 % of men". The 22% female ownership of land in the study close to the national average. "Land access and ownership is crucial to gain security particularly important for women and girls who are heads of households whether by circumstance or choice." (African Women Studies Centre, 2014).

Formal education in this study was measured by the highest educational qualification attained. With 27% of them having attained primary level of education heads and 73% having secondary and above, we conclude that the respondent had exposure that enables them to know how to seek for and apply information on improved farm practices. With the ability to read, the scope of exposure increases through print media use. Level of education influences access to agricultural knowledge by respondents.

5.3 Availability of Agricultural Extension Services

Ninety one percent of smallholder households interviewed have access to agricultural extension services in both sub counties.

The findings reveal "multiplicity of agricultural extension service providers. The main player is the County Government of Uasin Gishu, whereas others include private sector, NGOs, and cooperatives". This finding concurs with Chowa, Garforth, and Cardey (2013) who confirm that "government led agricultural services are often supplemented by NGOs and the private sector. Varied extension approaches and delivery systems were reported They include farmer field schools, training, and visit (T&V), farmer to farmer and commodity approach in the form of contract farming".

Training and visits accounted for (58%) while 25% represented farmer-to-farmer approach. “It is not clear from this study if the training and visit reported by the beneficiaries has the same features as the one initially conceived and promoted by World Bank which had the extension agent supporting a contact farmer with the expectation that other farmers would learn from them”.

The agricultural officers reported that “the most common approach used is demonstrations through field days. In this approach various technologies are demonstrated in a farm setting” allowing perioding field days for dissemination of the technologies present at the site. However, participation is often low during field days especially among women farmers. In a study that evaluated the “effectiveness of different dissemination pathways in “push-pull” technology in Western Kenya”, Murage et al., (2011) found that “use of field days was the quickest way to communicate technology information followed by farmer-trainers”. This implies that farmers prefer seeing and hearing from their own who have experienced the benefits of the technology.

Another popular approach is “the farmer to farmer, where information is passed from farmer to farmer and reinforcing information from field days. Other delivery system that has been used include farmer field schools, common interest groups, agricultural shows/ trade fairs and exhibitions.” The most preferred method by the smallholder farmers in the study areas was demonstration which allows for hands-on experience. From literature review, we learn from Fischer and Qaim, (2012) that “newer extension approaches often operate through farmer groups, which can not only increase cost-effectiveness but also facilitate mutual learning and sharing of experiences among farmers.”

The findings indicate availability of a range of agricultural technologies with majority of the smallholder reporting higher access to technologies aiming at improving crop production. Among the technologies delivered in crop production extension service include improved seed varieties, fertilizer recommendations, and chemicals for weed and pest management. This is similar to study findings by Loevinsohn et al., (2012) which reports that "the most common areas of technology development and promotion for crops include new varieties and management regimes, soil fertility management and weed and pest management". It is expected that improved seeds and inputs will increase the outputs and reduce the "average cost of production, which in turn results in substantial gains in farm income" (Challa, 2013).

Improved dairy productivity extension service was also available. The main activity being provision of information aiming for increased production through training on breeding especially artificial insemination, feed preservation and general dairy animal care. Other studies report the same technologies as the commonly promoted, a study in Mosop Sub County in the neighbouring County of Nandi report that extension service available to dairy farmers comprise of feeding regimes which include "feed establishment and feed conservation, breeding systems and other technologies such as record keeping, modern milking parlours, among others". This study reported low adoption of the dairy improvement technologies at 30%. Similarly, in this study though the smallholder farmers recognised the availability of the services there was low utilization of the technologies.

Other available technologies from the agricultural extension service were poultry, value addition, market linkages and bee keeping. Poultry mainly included training on

feeds, disease control and housing. Poultry extension is critical, there is rising demand for poultry and eggs influenced by several factors such as population growth and urbanization coupled with the need for smallholder farmers to diversify and adapt to climate change. A study by Ochieng (2013) in Western Kenya reported few farmers, 24.2%, adopting and using the good poultry management practices with many selectively adopting components of the management practices that suit their socio-economic conditions. Beekeeping was the least available AES in the study area.

Though Kenya is agricultural systems is reported to be most commercialised in sub-Saharan Africa by World standards, farmer participation is still low, (Chamberlin, 2013). Findings from this study show slightly less than 50% of the respondents were aware of value addition and market linkages provided as an agricultural extension service. Kembe & Omondi (2016) findings on a study on market access factors in Uasin Gishu report that "type of road and distance to market, access to electricity, access to market conditions, lack of collective organization such as membership to a cooperative" are some of the factors that affect access to markets. The road network in the two sub counties is relatively good with relatively more market centres, therefore this may be factor in low awareness of this service by the extension service providers as households have access to the market.

There was a negative but "significant relationship between education and access to agricultural extension services". The findings by Ainembabazi & J. Mugisha (2012) and Ugochukwu et al., (2018) also find "that education is not a critical factor in accessibility and general adoption of agricultural technologies." This could be attributed to the fact that people with high education level are likely to engage in other

employment that being a full-time farmer and have accessibility to other sources of information for their agricultural activity.

A study by (Bhatta et al. (2008), stated that “agro-vets and farmers’ cooperatives have a propensity to offer quality and timely services to farmers. In addition, NGO staff members had better technical competencies and achieved better results than public extension officials.”

5.4. Accessibility and Utilizations of Agricultural Extension Services

In the examination of “level of accessibility and utilization of agricultural extension services by smallholder farming households. The findings show that smallholder farmers in the study area have high access to agricultural service with 73% having attended agricultural extensions training with most of them (53%)” having attended at least once a month.

This research shares that “agricultural extension involves building capacity of smallholder farmer households in the study area to help them make informed decisions on food security. However, the effectiveness of agricultural extension services is highly dependent on the ability and competence of extension agents to transfer information to the smallholder farmers, and this research focused on establishing the effects of agricultural extension services on access and utilization of agricultural knowledge by smallholder farmers.”

Education is positively associated with increased access and utilization of agricultural extension services. Findings indicated that “all farmers with primary education mentioned to have been using agricultural extension agents”.

and demonstrations in field days as their source of agricultural knowledge. From this observation, it is expected that higher level of education increases the individual's access and utilization of technical information passed on by the extension service providers and have a high probability of engaging in non-farm related employment hence can access other agricultural information outside their farming network.

The findings indicated that "more male than female respondents acquired agricultural extension knowledge for their agricultural activities;" likewise, more male respondents used agricultural extension knowledge to improve agricultural production. This gender disparity is reported in other studies, (Doss et al., 2014; Kiptot et al., 2014; Villarreal 2013), reported that "gender disparities in land access and ownership affects the ability to reach full potential in agriculture especially for women". Some of the barriers to achieving gender equality are existing social and cultural norms which sets outs their gender roles in agriculture and hence their food security (Agarwal 2012).

Limited officers, untimely services and lack of awareness of the service among farming households are some of the issues in extension services. This concurs with Ong'ayo (2017) who reported "lack of facilitation of agricultural extension officers in terms of transport" as the main limitation of the extension officer and affects timeliness and quality of agricultural extension services, all of which hinder farmers' access to the service.

Other challenges facing agricultural extension services include "limited resources by extension service officers coupled with the farmers limited knowledge of the demand-led approach". A study in Wareng district (now Kesses Sub County) by Kipkurgat & Tuigong (2015) in the same County, also noted that farmers had limited information

on available and extent of extension service. Similar studies in Africa "found that a major barrier to extension service availability was lack of transport by extension" (Khaila, et al. 2015 and Mkwambisi et al. 2013). The study revealed that "agricultural extension activities have high impact (66%) on adoption of new technology". Sinkaiye (2005) affirms that "the role of agricultural extension agents is building the capacity of smallholder farmers and helping them make informed decisions to achieve better household food security status."

In addition, "the effectiveness of agricultural extension services is dependent on the efficacy of agricultural extension agents in disseminating information to the smallholder farmers"(AL-Sharafat, Altarawneh and Altahat, 2012) . This implies that "effective agricultural extension is significant towards achieving food security among smallholder farming households." (AL-Sharafat, Altarawneh and Altahat, 2012)

5.5. Smallholder Household Food Security Situation

The World Food Summit held in 1996 defined multidimensionality of food security as "a modified form of food security measurement" this definition has been used in this research. In practice the assessment used several questions were used to assess the food security situation among the respondents' households. These multidimensional questions captured different aspects of food insecurity. This broad spectrum of questions allowed for classification of respondents into different categories of food situations. To avoid the influence of seasonal effects, the state of food security measurement covered the last 12-months prior to the survey."

The responses on the series of the questions enabled the categorization of households into four levels of household food insecurity (access): "food secure, and mild, moderately, and severely food insecure. Households are categorized as increasingly

food insecure as they respond affirmatively to more severe conditions and/or experience those conditions more frequently. A food secure household experiences none of the food insecurity (access) conditions, or just experiences worry, but rarely. A mildly food insecure (access) household worries about not having enough food sometimes or often, and/or is unable to eat preferred foods, and/or eats a more monotonous diet than desired and/or some foods considered undesirable, but only rarely. But it does not cut back on quantity nor experience any of three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating).”

A moderately food insecure household sacrifices quality more frequently, “by eating a monotonous diet or undesirable foods sometimes or often, and/or has started to cut back on quantity by reducing the size of meals or number of meals, rarely or sometimes. But it does not experience any of the three most severe conditions. A severely food insecure household has graduated to cutting back on meal size or number of meals often, and/or experiences any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating), even as infrequently as rarely”.

The food security indicators used for this study were; “whether the household had to go a whole day without food (NOFOOD); eat small meals (SMLMEAL); worried that the household would not have enough food (WORRY); not eat foods they preferred (PREFER) and ate limited variety of food (LIMVAR)”. From the results, it was established that “10% of the households surveyed were food insecure in the 12 months prior to the survey, September 2017 to October 2018. Many households (90%) did not change their consumption patterns in the period with most of them

reporting to have taken three meals even though the meals may not necessarily have been adequate in quality and quantity".

According to the KDHS, (2014), "food insecurity in the county was at 32%, characterized by shortage of food at household level, which is mainly prominent in the months of May to August. Prevalence of stunting is 31.2% while 11.5% of children under-five are underweight" (KDHS, 2014) "attributable to less diet diversification due to overdependence on crops such as maize. The national prevalence of severe food insecurity in the total population was 19% (9.5 million people) between 2016-2018 while the prevalence of moderate to severe food insecurity in the total population was 56.5% (28.1 million people)." (FAO 2019) mainly related to high food prices and income inequalities.

5.5.1 Association between Household Demographic, Farm Characteristics and Food Security

The household demographic characteristics though significant are negatively associated with household access to AES. Age significantly and negatively influenced access to AES. The ordinal regression analysis findings show that higher age and longer farming experience of the household head increases the probability of a household being food secure. Farming experience along with skill acquisition are important for improving farm productivity (Chambo et al., 2007). Other studies showing a positive association, links the farmers farming experience with increase in knowledge and skills on improving farmer's productivity, Agidew (2018) & Kowornu et al., (2012). However, Amaza (2009) gives a different opinion, that farming experience can have positive or negative effect, the positive effect would be up to a

certain period after which the farming experience may have a negative effect especially as the farmer ages.

These results are in line with results from a study in Ethiopia by Agidew & Singh (2018) and another by Bashir et al., (2012) in Pakistan, which reported that "higher age and farming experience of the household head increases the probability of a household being food secure. It goes further to conclude that the higher the age of the household head, the more stable the economy of the household related". In another study by Chiputwa et al., (2011), "age had a positive effect on adoption of farm technologies". It indicated that older farmers had experience about the benefits of technology adoption and therefore are quick to adopt when new technologies are introduced.

More than a third of the households interviewed owned less than five acres of land. Size of the land influences food security. "Size of land can be considered a proxy for wealth-related household variables with a direct link to food security." (Jayne et al. 2016). Study findings in Kihima (2017) in Narok county report that small land holdings lead to low farm yield, low household's food availability and low incomes.

Marital status was statistically positively associated with household food security. The negative association is explained by the fact that marriage increases family size. A study by Bashir et al., (2012) found that an "increase of one member in the household decreases the chances of food security by 31% as this increases the dependency ratio and decreases the chances of food security."

Land ownership is positively associated with food security. Ownership allows farming households to make long-term investments to improve farm productivity such

as application of soil replenishments and crop rotation. A study carried out by Muraoka et al., (2014), in Kenya also came up with similar results. They found a strong positive association between land ownership and food security and that land productivity tended to be lower for leased plots with farmers making little investment towards improving the quality of the farm. Whereas land lease markets can be a solution for poor households to access cultivation spaces, they do not allow rentals for long-term investments as the right to lease solely lies with the landowner.

Copeland and Guertin (2013) assert that "the right to own, control and access land is fundamental to both food security and gender equality. Ownership, control and access to land can ensure that land is used to produce food for household consumption while the surplus can be sold to provide additional income" for use in meeting healthcare and other livelihood needs. For women, property ownership "increases their bargaining power, improves family stability and bolsters household economies. Most international statutes and national constitutions protect gender equality, especially with regard to land and other property rights, as well as education and general food security." (Copeland and Guertin, 2013)

5.5.2 Association between Availability, Access and Utilization of Agricultural Extension Services and Smallholder Food Security

From the inferential analysis, it is "observed that those with no utilization of extension services are 65% likely to be exposed to food insecurity, while the risk of food insecurity for those who reported extension services being useful decreases by 51.3% compared to those who think otherwise. These results are similar with other studies that have reported extension services, though not significant, influence the state of household food security."

Studies have mixed results on the impact of extension and improved productivity. They reckon that "extension impacts are difficult to show because of attribution issues. There are many factors that affect farmer's agricultural performance leading to difficulty in quantifying the cause and effect" (Anderson, 2007). Birkhaeuser et al. (1991) review of extension studies found that "36 studies out of 48 showed significantly positive effects on knowledge, adoption, and productivity."

This study showed an "insignificant relationship between availability, access and utilization of agricultural extension and respondent household food security." "Generally, almost all smallholder farmers involved in the study required and acquired agricultural extension knowledge related to different agricultural activities. They required capacity and knowledge for value addition to their agricultural produce. Most smallholder farmers appreciated the fact that the usage of agricultural knowledge increased agricultural production thus improving their livelihoods. It was also evident that smallholder farmers are able to evaluate extension services based on adequacy, availability, and timeliness."

It is acknowledged that "other multidimensional factors such as household demographics, high prices of agricultural inputs, diminishing land resources coupled with poor agricultural practices among others affect food security" (Wachira, 2014 & Kumba, 2015).

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the conclusions drawn from the findings of the study and the recommendations on how the findings obtained can be applied to improve agricultural extension for improved food security among smallholder farmers.

6.2 Conclusion

With the limited knowledge on the "nature and availability, accessibility and utilization of agricultural extension services and household food security among small holder farmers in Uasin Gishu," the study not only sought to establish the status food security among small holder farming households, it also established the association between "household demographic characteristics, availability, accessibility and utilization of agricultural extension services and household food security" among small holder farmers.

The household self- assessment of their food security between August 2017-July 2018 (12 months prior to the field survey) shows that only 11% reported to have faced food insecurity, a similar percnatge of household experiences food security at the national level.. On the association with household demographic characteristics, the findings show mixed results, while there are positive relationships between some respondent demographics specifically land size and ownership, others such as gender and marital status indicate a negative relationship with household food security.

The smallholder farmers interviewed have general understanding about the availability of the agricultural extension service, with some of them having accessed the services through attendance of agricultural dissemination event such as field days

and trade affairs. However, the utilization of the knowledge in changing their agricultural practises is medium. Agricultural extension availability, access and utilization indicate an insignificant positive relationship to household food security.

Agricultural extension services like improved crop production, dairy improvement, market linkages, poultry and bee keeping information are all available and provided mainly by the County Government of Uasin Gishu. Even with the presence of extension services, few farming households' access and utilise the extension information offered. From the study, the researcher observes that application of some of the extension methods are perceived to be effective by smallholder farmers in the study area. For instance, regular farm visit is crucial for dissemination of extension knowledge and should be encouraged. However, visits should be meaningful and have a purpose in order to have a positive result. In order, for agricultural extension to achieve results on the household food security of farmers and farming households at large, there is a need for pluralistic agricultural extension services that apply varied methods to reach the diverse types of farming households including use of local community-based agents.

6.3 Recommendations

Arising from the study objectives, the findings and conclusion, the research makes the following recommendations:

To overcome the current the low utilization of AES, the study recommends a model that allows for adaptive AES. This implies that in "addition to gradual advances in technology improvements, continuous retraining of experienced farmers is essential for them to keep updating their farming experiences and to increase the adoption of improved agricultural technologies. This is particularly important in the framework of designing and operationalising effective policies for widening the adoption of new and modern agricultural technologies (AES). "A robust, efficient and effective extension system should be able disseminate and communicate messages that are clear, tailored to the varied needs of the audiences and locally relevant."

Adoption goes beyond simple awareness; farmers should be allowed to try to "make modifications to match specific on-farm circumstances and receive support during the trial or when questions arise. This initial adoption stage requires trust and familiarity in who and how messages are delivered which requires intensive and ongoing interactions between the extension worker and the farmers." This interaction is even more necessary in times when new concepts such as climate-smart and climate technology adoption are being introduced, which are new concepts and may take long to comprehend. A trusted extension worker who understands the farmers' realities would be best suited to deliver this for adoption and behaviour change to occur. A proposal to bridge the existing gaps and challenges in extension service would be strengthening last mile presence of AES via community-based extension agents.

The "Ministry of education, collaboration with the County governments, should consider re-introducing agriculture as a subject to be taught right away from primary schools as a way of creating awareness among its citizens who will be future farmers the methods to be used to improve crop yields". The government, "through the Ministry of agriculture, should increase funding for agricultural training programmes to enable the County agricultural officers to equip the training centres with the physical training facilities, as this will be one of the ways of motivating the farmers to attend the training programmes."

6.3.1. Recommendations for Practice: The Community -Based Extension Service Agents (CESA)

To avoid the generalist agricultural extension services, which sometime fails to consider the heterogenous and complex biophysical, and socio- economic conditions of smallholder farmers, the study proposes community-based extension service agents (CESA) who shall serve as the last mile extension service contact at the village with linkages to Ward Agricultural Officers (WAOs), and other extension service providers.

The CESA will be network of self-employed individuals identified from the community based on a pre-agreed criterion such a level of education, residency in the community and of good reputation. The selection should be participatory for support and community acceptance of the CESA's as legitimate actors. These CESAs will have a link to the various agencies providing extension services like, government, private sector and NGOs both in crop and livestock production. These actors will train, equip and supervise the CESA on their different specialties. The CESA model has the potential to increase access particularly where there is high demand and low

access. They can also reduce any social cultural (gender, age and language) barriers. The CESA's can reduce inequalities in access to agricultural information by bringing information, services, and agricultural supplies closer to smallholder farmers rather than requiring farmers to visit agricultural extension officers hence reducing cost of travel and saving time.

Furthermore, use of technology can provide a cost-effective approach to provide knowledge to the CESA's and to improve information management. Borrowing from experiences in community health, the CESA's can influence behaviour change towards higher adoption of good practices and/or new crop varieties and prepare smallholder farmers to adapt to shocks and stresses arising from climate change.
In addition, they can keep records on household food production and facilitate follow-up services.

Acknowledging that the recruitment and retention of the CESA's will be determined by the compensation and sense of worthiness, this could be overcome by provision of a range of services, as agro vets and aggregators agents charging a fee for services and other financial incentives. The proposed AES delivery model is illustrated in Figure 5.

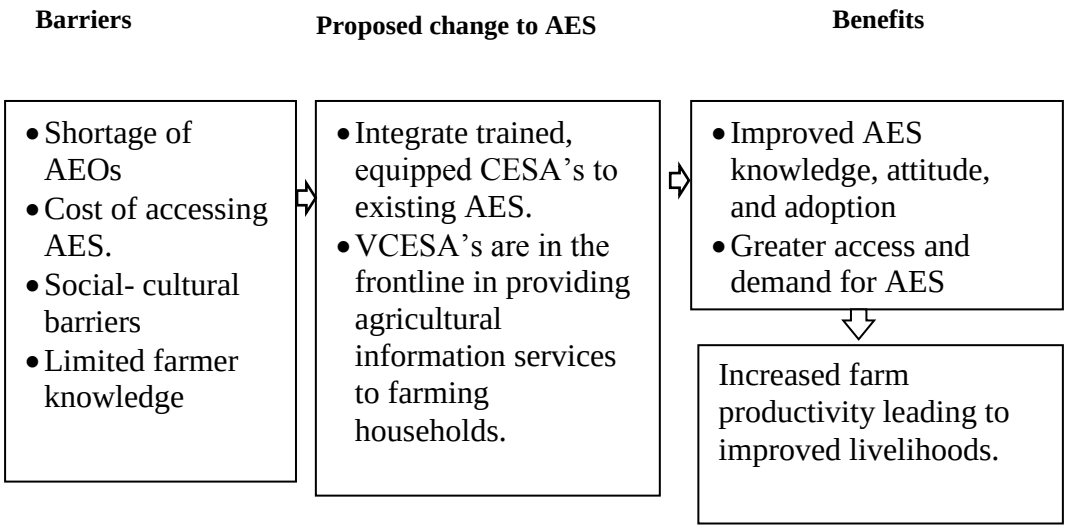

Figure 5. Proposed Agricultural Extension Delivery Model

Agricultural system strengthening can create an environment of entrepreneurship, empowering smallholder farmers to solve their own problems and reposition government and other development actors as facilitators rather than drivers of change.

Farmers should be involved in research, allowing them to set research priorities, to influence the agenda, and to contribute their indigenous knowledge. This ensures that interventions address their needs. On the service front, the importance of service providers cannot be gainsaid, they can strengthen farmers through resource facilitation- logistical support and continuous training- reaching out to the farmers and improving their delivery of extension service.

This information on the significance of cooperatives and farmers groups in household food security is very important, cooperatives and groups ensure that there are economies of scale in input purchasing, collective marketing of farm produce and provision of a platform to reach many farmers. From this study, the researcher makes a recommendation on development and strengthening of policies and interventions encouraging the participation of farmers in groups and cooperatives as well as development of strategies to support the growth of cooperatives. In view of the unexpected active membership of respondents in cooperatives in the study, there is need to strengthen the farmer cooperatives in the area to make them attractive to the farming households. Increasing participation in farming cooperatives will make it easy to organize demand for and access to agricultural service.

Food security can only be enhanced in the study area and other areas by enhancing knowledge on farming techniques and suitable farming methods. It can also be achieved by encouraging farmers to diversify their livelihoods and to complement

their farming with other non-farm activities in response to the changing climatic conditions.

6.3.2. Recommendation for Sustainable Agricultural Extension Services for Food Security

Based on the research findings, for a sustainable agricultural extension service that can contribute to food security, the following are the suggestions:

a) To enhance the effectiveness of agricultural extension services that recognise the need for including sustainability into agricultural extension services. If household food security is to be achieved, farmers resilience to climate change Embracing sustainable agricultural methods is one way of reducing farmers dependence on artificial inputs thus less vulnerability to market and climate changes.

b) To increase access and utilization, extension service providers should involve all members of the family. Providing information to all adults in household increases joint decision-making, increases knowledge retention and greater uptake.

c) To increase availability. The county should increase investment in agricultural extension service, this is through additional personnel, enhanced their training in emerging technologies and issues including climate change as well as enhancing the competence and motivation of the existing ones.

d) To enhance the household food security status, the agricultural extension services should integrate of food security and nutrition messages into agricultural extension to maximise the positive role that agriculture plays in food security.

e) To promote youth in agriculture given an aging farming population, promote youth initiatives including access to agricultural services and finance to develop their capacity. Facilitate their access to land and other resources to enable them to engage in agriculture.

f) To make use of developments in the information communication technologies, embracing use of information technology and other emerging farmer facing approaches such as use of extension call centres which has the potential to cut the costs of extension. The world is moving towards a digital economy, big data and artificial intelligence, digital systems such as automation, robotics is used to offer mechanised and remote extension service. Digital finance is increasing financial inclusion in many regions thus facilitating micro-entrepreneurship. E-commerce platforms are linking smallholder farmers with national and global markets. Data is very important and dictates what kind of support and advice farmers require, therefore the country should invest in data management, analysis and dissemination of information to make decisions that will increase food security.

6.3.3. Recommendation for Policy

For enhanced adoption of agricultural extension services to achieve food security, the government should not only invest in the supply side (the extension service providers) but also understand the farmers' needs to ensure effectiveness and efficiency in the use of limited agricultural services.

With the changes in climate and emerging challenges in smallholder farming, policy interventions are required to push for diversification of livelihoods in the rural areas. Agricultural policy should consider other factors related to household food security

beyond own production and take into consideration other non-farm work to increase household incomes and ensure food security for smallholder farmers. This could include policy measures to build household assets in financial and non-farm factors such as education and infrastructure. This requires concerted efforts across many stakeholders for a coordinated and integrated approach to build the resilience of smallholder farmers.

6.4. Areas for Further Research

The research proposes further research in the following areas;

The food security status was measured for a specific point in time (12 months preceding the survey), it does not consider the variability of the seasons over the years. Therefore, a study that measures the food security periodically can capture the varying food security and its relationship with the agricultural cycle.

The study was limited to examining the approaches used and their accessibility but did not go in-depth to analyse the extent of contact, analysis of extension personnel capacity and facilities that are available to implement the extension service. This is a suggestion for further research.

Further research could also examine the process of how extension service is delivered and assessment of farmer learning and behaviour change, aimed at proposing more efficient and effective approaches to today's farmer.

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APPENDIXES

Appendix I. Introduction Letter

To: TO WHOM IT MAY CONCERN

Date: 3rd July 2018

RE: Information on PhD Data Collection Exercise by Caroline Toroitich

Ms. Caroline Toroitich (Admission Number AGR/PhD/2013/13) is a PhD student at the School of Agriculture and Biotechnology in the University of Eldoret. She is carrying out a survey on **"Examining the Nexus between Agricultural Extension Services and Food Security among Small-Holder Farming Households in Uasin Gishu County, Kenya".** This study aims at examining how availability, access and utilization of agricultural extension services affect smallholder farming household's food security. The student is required to collect data from a sample of small holder households in of Sugoi, Kaptebee and Ngenyilel in Turbo Sub County and Soy, Kipsomba and Barsombe in Soy Sub County

The purpose of this letter is to introduce the student and inform you that she will be seeking to interview with some County Officers at the Sub County and Ward Level. Please be assured that names of interviewees will not be revealed in the resultant research report. If you have any further inquiries, questions or concerns about this study, please feel free to contact the principal investigator on mobile number indicated below.

Please provide her with the support she may need. Do not hesitate to contact us in case of any questions.

Sincerely,

Caroline Toroitich

PhD Student

University of Eldoret

Appendix II. Research Assistant Introductory Letter

Dear Respondent,

Ms. Caroline Toroitich (principal investigator) is a PhD student at the University of Eldoret. Department of Agricultural Extension and Rural Development. She is carrying out a research on "Access **and Utilization of Agricultural Extension Services by Smallholder Farmers' and the link to Household Food Security in Uasin Gishu County, Kenya".** The purpose of the letter is to introduce the survey and inform you that the bearer of this letter has been appointed by the principal investigator as a research assistant in the study.

I kindly request for 30-45 minutes of your time to respond to some questions in the questionnaire. However, feel free to end the interview at any time you choose, also you should not feel obligated to answer any question that you prefer not to. The research assistant will be filling in the information on the tablet.

I appreciate your willingness to share your experiences and time. If you have any further inquiries and questions regarding this study, please feel free to contact the principal investigator on the mobile number below.

Thank you.

Caroline Toroitich

Principal Investigator

Mobile no. 0722506165

Appendix III. Household Survey Questionnaire

SECTION I: DEMOGRAPHIC INFORMATION

(Kindly tick where appropriate)

1. Kindly indicate your gender.

   a. Male [ ]

   b. Female [ ]

   a. 15-19 years [ ]

   b. 20-25 years [ ]

   c. 26-30 years [ ]

   d. 31-35 years [ ]

   e. 35-40 years [ ]

   f. 40 years and above [ ]

2. What is your age (in years?

3. Please indicate your marital status?

   a. Unmarried [ ]

   b. Married [ ]

   c. Widow/Widower [ ]

   d. Divorced [ ]

   e. Separated (Living separately [ ]

4. Please indicate your highest level of education.

   f. Illiterate [ ]

   g. Primary School [ ]

   h. Secondary School [ ]

   i. Certificate [ ]

   j. Diploma [ ]

k. Degree [ ]

l. Postgraduate [ ]

5. What is the gender of the household head?

a. Male [ ]

b. Female [ ]

6. How did you become the head of the household?

a) Inherited [ ] b) Marriage [ ]

c) Widow [ ] d) Child [ ]

e) Divorced/Separated [ ] f) Migration [ ]

i. Death [ ] h) Sickness [ ]

i) Disability [ ]

7. What is your relationship with the head of the household?

a) Self [ ]

b) Spouse [ ]

c) Parent [ ]

d) Child [ ]

e) Other Kin [ ]

f) Other (Specify)…….

8. What is the size of your farm?

a) Less than 2 acres [ ]

b) 2-5 acres [ ]

c) 6-10 acres [ ]

d) 11-20 acres [ ]

e) More than 20 acres [ ]

f) Other ----------

9. What is the type of your farming land ownership?

   a) Farm Owner [ ]

   b) Tenant [ ]

   c) If you are a tenant, what is the kind of tenancy?

      (i) Fixed tenant [ ]

      (ii) Sharecropping [ ]

10. How many years have you spent in conducting farming activities?

   a) 1-5 years [ ]

   b) 6-10 years [ ]

   c) 11-15 years [ ]

   d) 16-20 years [ ]

   e) Over 21 years [ ]

SECTION II: EXISTING AGRICULTURAL EXTENSION SERVICES

11. Available agricultural extension services

(i) What is your understanding of access to Agricultural extension services?

   a) I have no idea what access to agricultural extension services are. [ ]

   b) I have some understanding about agricultural extension services [ ]

   c) I understand very well what agricultural extension services [ ]

(ii) Are agricultural extension services available in your area?

a) Yes

b) No

12. What were the major agricultural extension services available in the area in 2017?

	Agricultural extension information	Yes	No
1	Improved crop production		
1.1	*High yielding seeds*		
1.2	*Fertilizer application*		
1.3	*Weeds, Pest and Disease control*		
1.4	*Others (specify)*		
2	Improved dairy		
2.1	*Breeding*		
2.2	*Feed establishment and conservation*		
2.3	*Animal disease control*		
2.4	*Zero grazing*		
2.5	*Others (specify)*		
3	Improvement of market linkages		
3.1	*Value Addition*		
3.2	*Linkage to markets*		
3.3	*Others (specify)*		
4	Poultry production		
4.1	*New Breeds*		
4.2	*Poultry Feeding*		
4.3	*Poultry Housing*		
4.4	*Others (specify)*		
5	Bee keeping		

13. Extension Service Providers

(i) Do you know the extension agent in your area?

a) Yes [ ]

b) No [ ]

c) ii) If your answer above is Yes rank the following agricultural extension service providers in your area whereby 1-Never, 2-Rare, 3-Don't know, 4- often, 5-Very often

	Agricultural extension service providers	**Rank in frequency**
1	National government agents	
2	County Government Officers	
3	NGOs (specify)	
4	Cooperative society	
5	Private company (specify)	

SECTION III: ACCESS TO AGRICULTURAL EXTENSION SERVICES

14. Accessibility to the Agricultural Extension Services

(i) Do you have access to extension services?

a) Yes [ ]

b) No [ ]

(ii) Do you know where you can get agricultural extension services or farm assistance/advice about your crops and livestock in your area?

a) Yes [ ]

b) No [ ]

(iii) If the answer is yes, on question 5 above, please specify where you get assistance about your crops and livestock_____

(iv) Who attends the extension training or programmes in your family?

a) Father [ ]

b) Mother [ ]

c) Both (a & b) [ ]

d) Any member of the family [ ]

e) All members of the family [ ]

f) Alternate (one at a time) [ ]

(v) How often do you attend agricultural extension trainings in a month?

a) Once [ ]

b) Twice [ ]

c) Thrice [ ]

d) Other_____

(vi) How did you first hear about agricultural extension training programs in your area?

a) Through village meetings [ ]

b) Visited at home by extension agent [ ]

c) Visited at home by farmer leader [ ]

d) Through media [ ]

e) From a friend [ ]

f) Other_____

(vii) What are some of the constraints facing existing agricultural extension services? Rank these constraints on a scale of 1 to 5 in this order: 1-Never, 2-Rare, 3-Don't know, 4- often, 5-Very often

	Constraints facing Extension services	**Rank in order of importance**
	Few officers	
	Not timely	
	Poor quality	
	Expensive	
	Low level of awareness	
	Biasness towards progressive farmers	

(viii) Are you a member of any farmers' group in your area?

a) Yes [ ]

b) No [ ]

(ix) Do you believe that agricultural extension agents help farmers to improve their crop production/yields or better livestock?

a) Yes [ ]

b) No [ ]

15. Agricultural Extension Service Delivery System Preferences

(i) What is your preferred method of training during the delivery of agricultural extension services?

a) Demonstration with hands on experience [ ]

b) Group discussion and group activities [ ]

c) Individual visits [ ]

d) Problem solving activities [ ]

e) Lecture [ ]

f) Other----------

(ii) Which agricultural extension approaches do you like the most during delivery of agricultural extension service?

a) Farmer Field School (FFS) [ ]

b) Training and visit [ ]

c) Farmer to farmer [ ]

d) Contract farming [ ]

e) Other----------

(iii) What is your preferred way of getting agricultural information regarding the crops and livestock that you produce?

a) Through media (radio, television, newspaper) [ ]

b) Through phone [ ]

c) Through extension farmers meetings [ ]

d) From friends [ ]

e) Other ----------

(iv) Have you had a chance to give feedback to an agricultural extension agent about the delivery of extension training program?

a) Yes [ ]

b) No [ ]

(v) What factors hinder communicating with extension agents in your area?

a) Difficult to find the office [ ]

b) Lives out of the village [ ]

c) Has many appointments to make [ ]

d) I don't have a phone to call [ ]

e) Doesn't visit my area regularly [ ]

f) I have never tried to find him/her in person [ ]

g) Other----------

(vi) The statements below focus on Access to Agricultural extension services and are scaled on a five-point Likert scale. Tick as appropriate. (SA- Strongly agree, A- Agree, N- Neutral, D- Disagree, SD- Strongly disagree)

Statements on Agriculture Extension Activities	**SA**	**A**	**N**	**D**	**SD**
i. Participating in extension education program helps to increase my income from the farm.					
ii. Lessons taught can easily be applied in my daily field activities.					
iii. Participating in extension education program helps in improving way of farming/productivity					
iv. I like to attend the extension trainings because the extension agent provides continuous support to help me apply and implement the information.					

(vii) a) Membership in agricultural cooperative societies

	Agricultural cooperative society	**Yes**	**No**
i.	Is there an agricultural cooperative in your village or area?		
ii.	Are you a member in the agricultural cooperative?		
iii.	Do any of your neighbors have cooperative membership?		
iv.	Do any of your friends have cooperative membership?		

v.	Do any of your relatives have cooperative membership?		
vi.	Does the cooperative provide you with production inputs?		
vii.	Does the cooperative collectively purchase the inputs for the members?		
viii.	Does the cooperative control your production behaviors?		
ix.	Do you think that the agricultural services provided by the cooperative are more effective than government provided agricultural services)?		
x.	Do you think that the services provided by agricultural cooperatives are useful?		

(viii) (a) How many years have you been a cooperative member? (years)……

(b) How much do you have to pay for the annual membership fee? (Kshs/year) …….

(c) In which aspect do you think that the cooperative plays the most important role to your farming practice?

i. Technical guidance [ ]
ii. Providing marketing information [ ]
iii. Providing services for transportation [ ]
iv. Dividing up returns [ ]
v. Other [ ]

What is the reason for not choosing the cooperative membership?

i. Local cooperative is not available [ ]
ii. The dividends are low [ ]

iii. Farming condition is lower [ ]

iv. I am used to the traditional farming [ ]

v. Others [ ]

SECTION IV: UTILIZATION OF EXTENSION SERVICES

16. Farmers Perception on the Utilization of Agricultural Extension Services

(i) How useful are the agricultural extension training programs you have attended?

a. Very Useful [ ]

b. Useful [ ]

c. I don't know [ ]

d. Somehow useful [ ]

e. Not useful [ ]

(ii) Generally, how would you rate the agricultural extension programs in your area in helping to improve farming households' wellbeing through agricultural production?

a. Very effective [ ]

b. Effective [ ]

c. Fair [ ]

d. Less effective [ ]

(iii) Have you utilized the agricultural extension services offered through trainings?

a) No Utilization [ ]

b) Low Utilization [ ]

c) Medium Utilization [ ]

d) High Utilization [ ]

(iv) Do what level have you used the following agricultural extension trainings in your farming activities?

Agricultural extension service	**Utilization of Agricultural Extension services offered**			
	Never	**Rarely**	**Occasionally**	**Often**
Improved crop production				
High yielding seeds				
Fertilizer application				
Weeds, Pest and Disease control				
Others (specify)				
Improved dairy				
Breeding				
Feed establishment and conservation				
Animal disease control				
Zero grazing				
Others (specify)				
Improvement of market linkages				
Value Addition				
Linkage to markets				
Others (specify)				
Poultry production				
New Breeds				
Poultry Feeding				
Poultry Housing				
Others (specify)				
Bee keeping				

(v) The statements below focus on utilization of agricultural extension services on a five-point Likert scale (**Where: SA -Strongly Agree; A-Agree; N-Neutral; D- Disagree & SD- Strongly Disagree).** Mark as appropriate.

Statements on utilization of agricultural extension services	**SA**	**A**	**N**	**D**	**SD**
The extension agent provides good ideas that help me in improving my crop and livestock production.					
The Agricultural extension agent is readily available (can easily be reached) to help famers implement the new farming ideas					
The training is provided at times when we can apply it in the field					
The extension agent is usually well-prepared during extension training program					
The extension agent has training materials (such as facilities for demonstration) needed for the extension education program					
The government plays an important role in helping farmers through the extension service.					
The extension agents are friendly and easily approachable regarding my farm problems					
The extension system (through extension agents) offers what you really need					

17. How have you benefited from the agricultural extension training you have attended? ……

    ……..

18. What advice would you give to improve the training and utilization of the agricultural extension services? ……

    .....

    ……

SECTION VI: STATE OF HOUSEHOLD FOOD SECURITY

19. "What are the sources of food for this holding (circle appropriate code)?"
    i. Own farm production
    ii. Purchased food
    iii. Government rations
    iv. Supplies from relatives/friends
    v. Other (Specify
20. The "food that (I/we) bought just didn't last, and (I/we) didn't have money to get more." Was that often, sometimes, or never true for (you/your household) in the last 12 months?
    i. Often true
    ii. Sometimes true
    iii. Never true
    iv. Don't know
21. (I/we) "couldn't afford to eat balanced meals." Was that often, sometimes, or never true for (you/your household) in the last 12 months?"
    i. Often true
    ii. Sometimes true

iii. Never true

iv. Don’t know

22. “In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?”

    i. Yes

    ii. No

23. “In the last 12 months, were you every hungry but didn't eat because there wasn't enough money for food?”

    i. Yes

    ii. No

24. “In the last 12 months], were you ever hungry but didn't eat because you couldn't afford enough food?”

    i. Yes

    ii. No

    iii. Don’t know

25. “In the last 12 months], did {you/you or other adults in your household} ever not eat for a whole day because there wasn't enough money for food?”

    i. Yes

    ii. No

    iii. Don’t know

26. Household behavior food security self-assessment

Household food security	**How frequent?**			
	Never	**Rarely**	**Occasionally**	**Often**
In 2017, “were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?”				
In 2017, “did you worry that your household would not have enough food?”				
In 2017, “were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?”				
In 2017, “did you or any household member have to eat a limited variety of foods due to a lack of resources”				
In 2017, “did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?”				
In 2017, “was there ever no food to eat of any kind in your household because of lack of resources to get food?”				
In 2017, “did you or any household member go a whole day and night without eating anything because there was not enough food?”				

27. Food sources of the household

The questions below collect data on sources used by the household to obtain food. What are the sources of food for this household? Of the ones indicated in the table, which do you regard as most important?1, 2, 3, 4 or 5 with one being the most important.

Source of food		**Write code**
1	Own farm production	
2	Purchased food	
3	Supplies from relatives/friends	
4	Government rations	
5	Other (Specify)	

28. To "address product and seasonal variations in food sources used by the household," fill in the table below that shows product and seasonal variations. Use the source codes above1, 2, 3, 4 or 5 with one being the most important.

Product	**Main source used**		
	Season 1	**Season 2**	**Season 3**
Staples			
Maize			
Rice			
Wheat			
Animal and Dairy Protein			
Meat			
Poultry			
Milk			
Plant protein			
Beans			

29. Food consumption practices

a. "Number of meals the household normally has per day |__|"

b. "Number of days the household consumed meat last week |__|"

c. "How often did the household have problems in satisfying the food needs of the household last year? |__|"

Codes: 1 = Never 2 = Seldom 3 = Sometimes 4 = Always 5 = Other (specify)

d. "Did the household change its food consumption over the past 12 months compared to the previous year? Yes = 1; No = 2"

e. "If yes, what changes have taken place?"

List in order of importance: (*Codes: 1 = Never 2 = Seldom 3 = Sometimes 4 = Always 5 = Other (specify)*

f.).

Type of changes (code)	Code
"Increased number of meals taken per day"	
"Increased consumption of staple foods (such as rice, flour, sorghum, potatoes and cassava,)"	
"Increased consumption of legumes and vegetables"	
"Increased consumption of animal and milk products (such as meat, poultry, fish, eggs and dairy products)"	
Decreased "number of meals taken per day"	
Decreased "consumption of staple foods"	
Decreased "consumption of legumes and vegetables"	
Decreased "consumption of animal and milk products"	
Other (specify)	

Food Shortages

a) "Has the household experienced any food shortages over the past 12 months? Yes = 1; No = 2"

b) "If yes, what were the main reason(s) for these food shortages?"

List in order of importance (Reason 1 = most important reason)

Main reasons for food shortages	Ranking of reasons
Decline in own farm production because of drought	
Decline in own farm production because of pests and diseases	
Decline in own farm production because of labour constraints	
Decline in own farm production because of time constraints	
Decline in own farm production because of soil degradation	
Decline in own farm production because of low quality of agricultural inputs used	
Lack of funds to purchase food	
Decline in government food supplies	
Decline in food supplies from friends and relatives	
Decline in remittances received from relatives and friends	
Increase of food prices	
Unemployment of household member(s)	
Increase of household expenditures due to Illness/death of household member(s)	
Other (specify)	

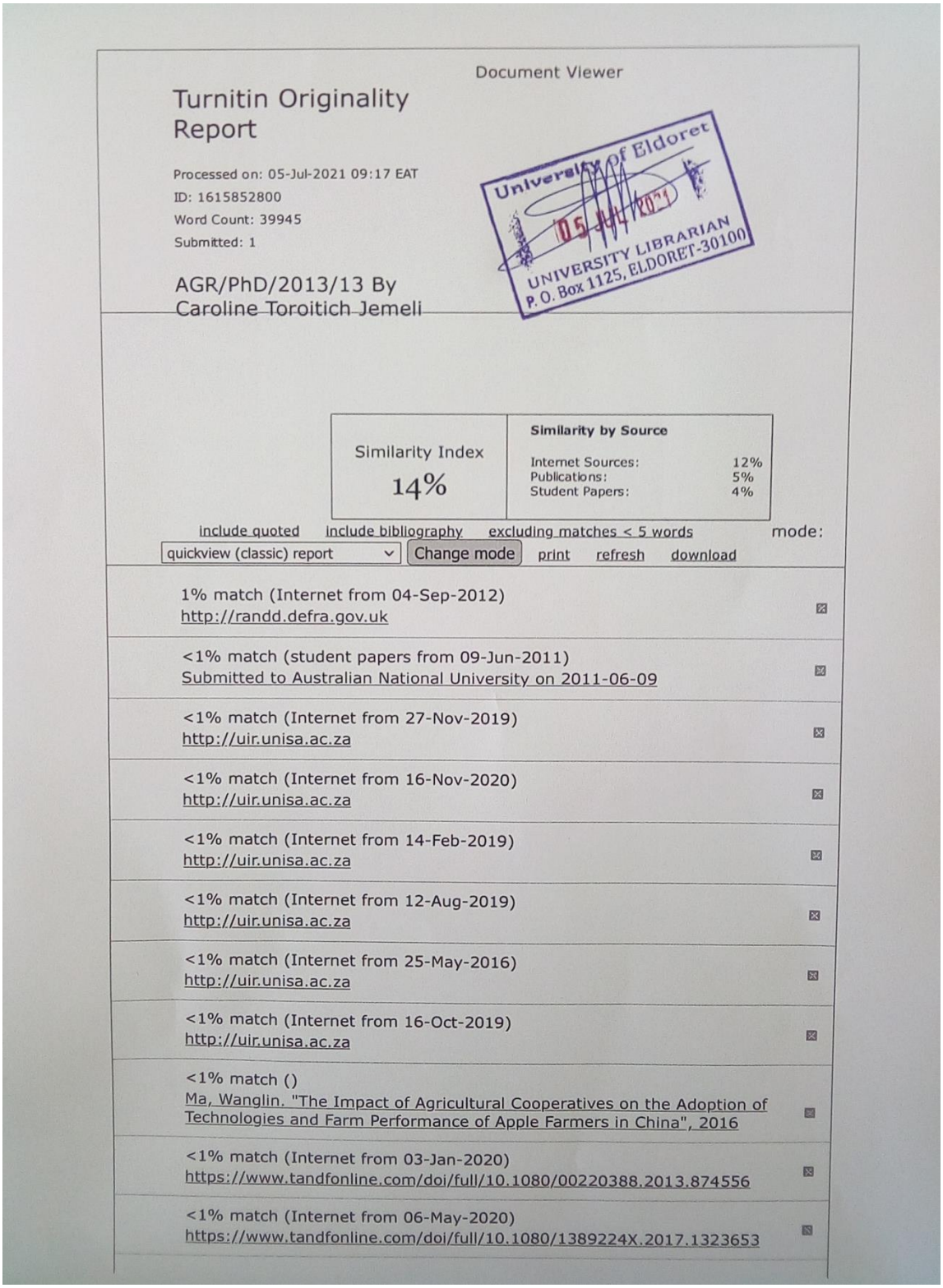
Thank you for your response.

Appendix IV: Additional Data

Table 30 Membership in agricultural cooperative societies

Questions on Membership to Cooperative Society	**Yes**	**No0.0**
Is there an agricultural cooperative in your village or area?	262(65.66%)	83(20.8%)
Are you a member to an agricultural cooperative?	295(73.93%)	96(24.06%)
"Do any of your neighbours have cooperative membership?"	124(31.08%)	269(67.42%)
"Do any of your friends have cooperative membership?"	233(58.4%)	156(39.1%)
"Do any of your relatives have cooperative membership?"	249(62.41%)	135(33.83%)
"Does the cooperative provide you with production inputs?"	258(64.66%)	128(32.08%)
"Does the cooperative collectively purchase the inputs for the members?"	153(38.35%)	232(58.15%)
"Does the cooperative control your production behaviors?"	185(46.37%)	198(49.62%)
"Do you think that the agricultural services provided by the cooperative are more effective than government provided agricultural services)?"	118(29.57%)	270(67.67%)
"Do you think that the services provided by agricultural cooperatives are useful?"	261(65.41%)	126(31.58%)

Appendix V: Similarity Report



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