EFFECTIVENESS OF AGRICULTURAL EXTENSION HUMAN-WILDLIFE CONFLICT MITIGATION STRATEGIES ON HUMAN-WILDLIFE CONFLICT AMONG SMALLHOLDER AGRO-PASTORALISTS IN LAIKIPIA COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

DECLARATION

I hereby declare that this thesis is my original work and that it has not been presented in part or any other form for an award of a diploma or degree in any University.

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RECOMMENDATION

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DEDICATION

The results of this academic work is dedicated to my loving wife, Gladys Gesare for her invaluable support, love, sacrifice and understanding during my study and academic pursuit. I extend the same to my children Brightson, Joy and Purity. I also dedicate it to my late father, Julius Nyamwamu Ateng‟a and mother, Joyce Gesare for their care and instilling the attitude and virtue of hard work, commitment and scholarship in me. Lastly, to my elder sister Ludia, brothers Paul and Tom for their inspiration and continued encouragement.

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ABSTRACT

The agriculture sector in Kenya is critical in the achievement of food security, employment creation and provision of raw materials for agro-industries. The sector is affected by various challenges that impact negatively on its performance. Human-wildlife conflict is one of the pressing challenges farmers in Laikipia County are experiencing despite agricultural extension promoting various mitigation strategies. Available evidence showed that information on the effectiveness of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) on human-wildlife conflict was inadequate or poorly documented. Consequently, it had been difficult for government agencies and stakeholders to develop effective human wildlife conflict mitigation strategies. This study sought to establish the effectiveness of AEHWCMS on human-wildlife conflict among smallholder agro- pastoralists. A cross-sectional survey research design was used where Simple Random Sampling was used to select 203 respondents and purposive sampling used to select further 10 respondents. Primary data was collected using semi-structured questionnaires while secondary data were collected using a document review guide. Primary data was analyzed using mean, frequencies and percentages. Effectiveness of AEHWCMS was measured through farmers" and extension agents" ratings of the effectiveness of the strategies on a 5- point Likert scale after observation for at least 4 years of use. The study established that farmers adopted various AEHWCMS such as digging trenches, growing unpalatable crops and live fences and their adoption was affected by farmers" socio-demographic characteristics, especially age, gender, education and income level. Further, human wildlife conflicts in Laikipia County were on an increasing trend between 2012 and 2015 probably due to the low effectiveness and sustainability rates of AEHWCMS, with the effectiveness and sustainability rates for some being as low as ≤11.76% and 15% respectively. A compensation scheme is 23% effective while translocation of wildlife is 25% effective as a human wildlife conflict coping strategy. This study also found that collaboration between agricultural extension and Kenya Wildlife Service in promoting human wildlife conflict mitigation strategies is 37% adequate. It was concluded that AEHWCMS were not adequately effective in mitigating human-wildlife conflict among smallholder agro- pastoralists. It was recommended that effective and sustainable human wildlife conflict mitigation and coping strategies be developed and promoted by extension agents among farmers. The mitigation strategies should be gender-friendly, youth-friendly and affordable. Agriculture extension and wildlife conservation policies should be clear on partnership so as to promote effectiveness and sustainability of AEHWCMS.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

AEAS	Agricultural Extension Acquisition System
AEDS	Agricultural Extension Delivery System
AEHWCMS	Agricultural Extension Human Wildlife Conflict Mitigation Strategies
AGRA	Alliance for a Green Revolution in Africa
ASAL	Arid and Semi-Arid Land
ASL	Above Sea Level
CBO	Community-Based Organization
CFA	Community Forest Association
CWCCC	County Wildlife Conservation and Compensation Committee
CWS	Community Wildlife Service
DWCC	District Wildlife Compensation Committee
ERSWEC	Economic Recovery Strategy for Wealth and Employment Creation
FAO	Food and Agricultural Organization
FBO	Faith-Based Organization
GDP	Gross Domestic Product
G o K	Government of Kenya
Ha	Hectares
HWC	Human-Wildlife Conflict
HWCCS	Human Wildlife Conflict Coping Strategies
IFAD	International Fund for Agricultural Development
KALRO	Kenya Agriculture & Livestock Research Organization
KFS	Kenya Forest Service
KIEA	Kenya Institute of Economic Affairs
KIILA	Kenya International Institute of Legal Affairs
KNBS	Kenya National Bureau of Statistics
KWS	Kenya Wildlife Service
LWF	Laikipia Wildlife Forum
MENR	Ministry of Environment and Natural Resources
MFW	Ministry of Forestry and Wildlife
MoALF	Ministry of Agriculture, Livestock & Fisheries
MoARD	Ministry of Agriculture & Rural Development
MoLPP	Ministry of Land and Physical Planning

MoPND	Ministry of Planning and National Development
NACOSTI	National Council of Science, Technology & Innovation
NAEP	National Agriculture Extension Policy
NADAS	National Agricultural Advisory Services
NALEP	National Agriculture & Livestock Extension Program
NASEP	National Agriculture Sector Extension Policy
NGOs	Non-Governmental Organizations
RFA	Rain Forest Alliance
RoK	Republic of Kenya
SDG	Sustainable Development Goal
SFG	Space for Giants
SPSS	Statistical Package for Social Sciences
SRA	Strategy for Revitalization of Agriculture
SRS	Simple Random Sampling
SSA	Sub Saharan Africa
TCA	Tsavo Conservation Area
TLT	Tree is Life Trust
T&V	Training & Visit
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
USA	United States of America
USAID	United States Agency for International Development
WCS	Wildlife Conservation Society

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

The global agriculture sector is important for economic growth and employment creation. It employs over two billion people and contributes about 30% to the world's Gross Domestic Product (GDP) (Hanson, 2013). While enhancing food security and employment creation in Africa, the agricultural sector promotes economic growth (Alliance for a Green Revolution in Africa (AGRA), 2013; Hoffman & O'Riain 2012). The agriculture sector employs 65% of African workforce and is a source of 40% of the total GDP (Huho & Kosonei, 2013; World Bank, 2008). The sector is the largest employer in developing countries, with its growth significantly increasing income generation and poverty reduction (Asenso-Okyere & Jemaneh, 2012; World Bank, 2012). It is therefore significant in achieving Sustainable Development Goal (SDG) 1, which aims at reducing the level of poverty in the world (United Nations, 2015). In Kenya, agriculture is a source of food, income and employment and it accounts for 65% of the total national export, 18% of formal and 70% of informal employment (Muriu & Biwott, 2013). Since agriculture contributes 26% of the national GDP directly and 25% indirectly, it is considered to be the backbone of the national economy (Government of Kenya (GoK), 2010).

Despite the important role played by the agriculture sector in economic development, food security and employment creation, smallholder farmers in different parts of the world experience various challenges which include poor land quality that is degraded and less productive due to effects of climate change such as floods, drought, reduced water supply and diseases (Curtis, 2013; Fre & Tesfergasis, 2013). Farmers in Africa experience problems of inadequate extension services and effects of wildlife menace (Lamarque et al., 2009). Farmers in Kenya, including Laikipia County experience the problem of insecurity and human-wildlife conflict (GoK, 2010; GoK, 2012a; MFW, 2012). Human-wildlife conflict is a phenomenon which is experienced in different parts of the world in which wildlife and people compete for limited resources and also share boundaries (Eniang, Ijeomah, Okeyoyin & Uwatt, 2011; Musimbi, 2013). Human wildlife conflict manifests as injury or death of livestock or even people, loss of crops, damage to property and also disease transmission. Despite the potential negative effects of wildlife conservation, it is an important resource because it is a base for the tourism industry which generated 5% of global GDP and 7% of

the world‟s employment opportunities in 2011 (GoK, 2008; United Nations Conference on Trade and Development (UNCTAD), 2013). In Kenya, the tourism industry is identified as one of the growth engines for the national economy because it contributes 13% to the economy, 12% of GDP and 19% of the total wage employment (Vernon, 2010; Wanyonyi, 2012).

The trend of human-wildlife conflict in many regions of the world has intensified over the recent decades due to increase in human population and expansion of agricultural activities (Food and Agricultural Organization (FAO), 2015). In Africa, conflicts between people and wildlife have been increasing due to competition for limited natural resources (Hocking & Humle, 2009). For instance, crop damage caused by wildlife in Slovenia has increased since 1993 while in Cameroon, human-wildlife conflict is expected to increase in unprotected wildlife areas due to expansion of industrial plantations (Eyebe, Dkamela & Endomana, 2012). In Uganda, crop damage by wildlife is likely to increase in future due to government support for a shift from subsistence to cash crop farming (Eniang et al., 2011). In response to the human wildlife conflict, agricultural extension promotes various agricultural extension human-wildlife conflict mitigation strategies. It involves assisting farmers to analyze their production problems and becoming aware of them, identifying and using the opportunities available for improvement (Muyanga & Jayne, 2006). Through agricultural extension, farmers are educated on farming technologies aimed at improving agricultural production and productivity (Anaeto et al., 2012). Agricultural extension also promotes sustainable use of natural resources, including human-wildlife conflict mitigation, food security and improvement of livelihoods (Kidanemariam et al., 2013). In Kenya, the Ministry of Agriculture, Livestock and Fisheries (MoA, L & F) is dominant in the provision of public agricultural extension although other service providers such as the Kenya Wildlife Service (KWS) and Kenya Forest Service are also involved.

Farmers respond to human-wildlife conflict by using different agricultural extension human wildlife conflict mitigation strategies. They use barriers such as live fences, digging trenches round the farm or erect a buffer of unpalatable crops (Treves, 2007). In Mozambique, farmers grow crops such as chili that are unpalatable to wildlife to serve as barriers on their farms (Anderson & Parieda, 2005). Agricultural extension service also promotes other mitigation strategies such as growing live fences using mauritius thorn, sisal or kai apple (Parker, Osborn, Hoare & Niskanen, 2007). The strategies used also include growing crops that have

2

spikes against birds, hanging colonized bee hives against elephants and buffaloes, and digging trenches along the farm boundary to prevent wildlife entry, especially by elephants (Graham & Ochieng, 2010). In Kenya, the MoA, L & F and KWS separately provide extension services aimed at human-wildlife conflict mitigation. This is achieved through the promotion of growing of live fences, using mauritius thorn and kai apples, digging trenches round the farm to stop wildlife entry and growing unpalatable crops such as chili and pyrethrum (KWS, 2013; GoK, 2010). The services deployed by agricultural extension also promotes human wildlife conflict mitigation strategies such as bitter and spiked varieties of sorghum against birds, integration of unpalatable crops in a crop rotation program, growing fodder and growing sunflower whose heads face down against birds. These strategies can be used either singly or in combination depending on the wildlife species involved.

Further, governments in various countries such as India, China, Mozambique and Zimbabwe promote various human-wildlife conflict mitigation strategies through governance. The governments establish compensation schemes with the aim of covering a portion of losses caused by wildlife (Roundeau & Bulte, 2007). Such compensation initiatives compensate farmers for crop and livestock or even human injury or death (Lamarque et al., 2009). Such compensation schemes are found in Asian countries such as India and China and African countries such as Ghana, Mozambique and Zimbabwe (Parker et al., 2007; Roundeau & Bulte, 2007). Compensation for loss or damage is based on an exhaustive assessment valued at prevailing market prices. A compensation scheme was introduced in Kenya, implemented for some years, suspended and later re-introduced (Lamarque et al., 2009; MFW, 2011). Some countries such as India and Namibia translocate wild animals with the aim of reducing human-wildlife conflicts (Parker et al., 2007; Lamarque et al., 2009). The Kenya government also translocates wildlife, for instance, eleven elephants were translocated between the year 2000 and 2001 from Laikipia County to Meru National Park (Graham et al., 2009a).

However, limited information which was also poorly documented was available on the effectiveness of the mitigation strategies promoted through governance and policy and the collaborative activities undertaken between agricultural extension and the KWS in mitigating human wildlife conflict among smallholder agro-pastoralists in Laikipia County. Further, limited information existed and was poorly documented on the agricultural extension human wildlife conflict mitigation strategies adopted by smallholder agro-pastoralists, their effectiveness and sustainability. Additionally, limited information was available and poorly

documented on socio-demographic factors affecting adoption of the agricultural extension human wildlife conflict mitigation strategies, the trend of human-wildlife conflict among smallholder agro-pastoralists in Kenya, including in areas of Laikipia County.

During the implementation of community development programs through Community Wildlife Service (CWS), Kenya Wildlife Service (KWS) also offers some agricultural extension services. This is a strategy which promotes active community participation in wildlife conservation outside protected areas (KWS, 2016). Through the CWS the KWS undertakes community education and provision of agricultural extension specially to enable farmers to protect crops and livestock against attack, destruction or injury by wildlife (KWS, 2016). In addition, KWS promotes human-wildlife conflict mitigation strategies such construction of trenches, planting unpalatable crops such as chili and live fences using kai apples or mauritius thorn. Despite efforts by the Ministry of Agriculture, Livestock and Fisheries and the KWS in promoting human-wildlife conflict mitigation strategies among smallholder farmers in Laikipia County, farmers still experience the conflict. This is aggravated by human settlement and use of wildlife habitats for farming, resulting from lack of a land use policy (Ministry of Land and Physical Planning (MoLPP), 2016). This results in human settlement and agricultural activities being allowed in forest areas, unprotected wildlife habitats and areas bordering forests, such as Rumuruti Forest.

Further, wildlife conservation is practiced in areas not gazetted or protected as wildlife habitats such as Rumuruti Forest, resulting in human-wildlife conflict. This scenario depicts lack of synergy and coordination among various government departments. This is especially the case for the Kenya Forest Service, MoLPP and the MoA, L & F in the use of natural resources and provision of agricultural extension services. Lack of a national land use policy to guide the use of land as wildlife habitats, land bordering wildlife habitats or unprotected and non-gazetted wildlife habitats, could be contributing to the occurrence of human-wildlife conflict. It could also be affecting the agricultural extension human wildlife conflict mitigation strategies used by smallholder agro-pastoralists, their effectiveness and sustainability. Limited information was available and was also poorly documented on the trend of human-wildlife conflict, the effectiveness of human wildlife conflict coping strategies promoted by the government and how KWS collaborates with MoA, L & F in providing agricultural extension on human-wildlife conflict mitigation. Additionally, limited information was available and was poorly documented on the agricultural extension human

wildlife conflict mitigation strategies adopted and their effectiveness and sustainability. Further, there was inadequate information that was also poorly documented on the level of implementation of collaborative activities carried out by agricultural extension stakeholders during the promotion of human wildlife conflict mitigation strategies among smallholder agro-pastoralists in Kenya, Laikipia County inclusive.

1.2 Statement of the Problem

Human-wildlife conflict (HWC) is a problem experienced by farmers in various parts of Kenya which have wildlife habitats such as in Laikipia County. Generally, the conflict manifests as wildlife damage to crops, injuring or killing livestock and even people leading to loss of economic gain or even life. Human-wildlife conflict in the County was on the increase. This was the case despite a number of measures available to address it and also farmers receiving and probably using advice about various agricultural extension human wildlife conflict mitigation strategies from extension service providers. These strategies include planting of crops that are unpalatable to wildlife (such as chili) to prevent damage from wildlife, digging trenches to prevent wildlife from accessing crops, livestock and people. They also include using natural barriers (such as sisal, mauritius thorn or cactus) to protect crops, livestock and people from wildlife and using crops that have hairs or spikes to control damage from birds. Information on the Agricultural Extension Human Wildlife Conflict Mitigation Strategies used by smallholder farmers in Laikipia County and their effectiveness was scanty and inadequately documented. This had contributed to making it difficult for the relevant government agencies and other stakeholders to formulate and promote innovative mitigation strategies which were effective among smallholder farmers. This study avails the information to farmers, extension service providers and other stakeholders to enable them plan better how to reduce the negative effects of human-wildlife conflict in the area.

1.3 Purpose of the Study

The study sought to establish the effectiveness of Agricultural Extension Human Wildlife Conflict Mitigation Strategies in reducing human-wildlife conflict among smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County. This information can be used by farmers and other stakeholders in the agriculture sector to develop innovative and appropriate mitigation strategies so as to reduce human-wildlife conflict and loss of economic gain among smallholder farmers.

1.4 Objectives of the Study

The objectives of this study were to determine:

i)   The Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) adopted among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya''s Laikipia County.

ii)   The socio-demographic factors affecting adoption of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya''s Laikipia County.

iii)   The trend of human-wildlife conflict among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya''s Laikipia County.

iv)   The effectiveness of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) used among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya''s Laikipia County.

v)   The effectiveness of Human Wildlife Conflict Coping Strategies promoted through governance among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya''s Laikipia County.

vi)   The sustainability of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) used among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya''s Laikipia County.

vii)   The extent of collaboration between Agricultural Extension and Kenya Wildlife Service in promoting Human Wildlife Conflict Mitigation Strategies among smallholder agro-pastoralists bordering Rumuruti Forest bordering Rumuruti Forest in Kenya''s Laikipia County.

1.5 Research Questions

The study sought to answer the following research questions:

i)   What were the Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) adopted among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya''s Laikipia County?

ii) What were the socio-demographic factors that affected adoption of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya''s Laikipia Count?

iii) What was the trend of human-wildlife conflict among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya''s Laikipia County?

iv) How effective were the Agricultural Extension Human Wildlife Conflict Mitigation Strategies used among smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County?

v) How effective were the Human Wildlife Conflict Coping Strategies promoted through governance among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya's Laikipia County?

vi) How sustainable were Agricultural Extension Human Wildlife Conflict Mitigation Strategies used among smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County?

vii) To what extent was there collaboration between Agricultural Extension and the Kenya Wildlife Service in promoting Human Wildlife Conflict Mitigation Strategies among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya's Laikipia County?

1.6 Significance of the Study

This study was designed to establish the effectiveness and sustainability of Agricultural Extension Wildlife Mitigation Strategies (AEHWCMS) among smallholder agro-pastoralists in Laikipia County region of Kenya. The findings can be useful to farmers, extension service providers, researchers and policy makers. Farmers can use the information generated to determine ways of saving lives and also choose the farming enterprises that are less susceptible to wildlife attack for adoption. Researchers and extension practitioners will use the information to develop mitigation strategies that are effective and sustainable. Researchers will also acquire a new body of knowledge on the effective and sustainable AEHWCMS. Policy makers will use the results in decision-making and formulation of the national agricultural extension policy. Wildlife management organizations can use the information to identify effective mitigation strategies for promotion among smallholder farmers. The information can also be used by wildlife conservation stakeholders in informing their collaboration with agricultural extension stakeholders in a bid to enhance the effectiveness of AEHWCMS and HWCCS promoted among smallholder farmers in Laikipia County so as to save lives.

1.7 Scope of the Study

This study focused on determining the effectiveness of agricultural extension human wildlife conflict mitigation strategies used by smallholder agro-pastoralists who had experienced in mitigating human wildlife conflict experienced between the years 2012 and 2015 in Laikipia

County. This was achieved by collecting data on the agricultural extension human wildlife conflict mitigation strategies adopted by smallholder agro-pastoralists in four years, as from 2012 to 2015 and counting the number of farmers who had used each of the strategy. To determine the socio-demographic factors affecting adoption of AEHWCMS, the number of farmers falling within different gender, age, level of formal education and income was counted. Determining the trend of human wildlife conflicts involved counting the number of incidents being experienced each month of the year to know the time of the year when the conflicts are many and require a lot of attention in terms of finance and personnel.

To determine the effectiveness and sustainability of AEHWCMS adopted and the human wildlife conflict coping strategies promoted through governance, ratings by farmers and their extension agents on the effectiveness and sustainability of each of these strategies were used. Data generated will be used in recommending strategies to improve the effective human wildlife conflict mitigation strategies and also suggest alternative ones in case where the strategies are not effective or sustainable. Further, the number of farmers who reported the existence of various mitigation strategies was counted. This study also looked into the extent of collaboration between agricultural extension and KWS in promoting human wildlife conflict mitigation strategies. This involved using rating by extension agents on the degree of collaboration between agricultural extension and KWS. The data generated can be used to recommend strategies for strengthening collaboration or justify the need for recommending collaboration if there was no any. The study focused on smallholder agro-pastoralists because they comprised majority of farmers in Laikipia County.

1.8 Limitations of the Study
The following were the limitations of the study:
   i) A few of the smallholder agro-pastoralists were illiterate. This posed a challenge in the administration of questionnaires because they were written in the English language of which the respondents could not read. This was overcome by using individuals who were competent in both the vernacular of the respondents and English language to serve as interpreters of the questionnaire items. Interpretation ensured that the respondents understood the questionnaire items before they could respond to them.
   ii) Some of the farmers chosen had not kept accurate records of the data required for the four years about hectares of crop damage, number of livestock and people injured or

even killed. To overcome this challenge, approximate estimations were therefore used as an average of the intended values.

1.9 Assumptions of the Study

The study made the following assumptions:

i) The smallholder agro-pastoralists provided possible honest data on the trend of human-wildlife conflict and damage caused by wildlife attack on their farms. It was assumed that the respondents clearly understood the questions as asked by the researcher and therefore gave honest, valid and reliable responses.

ii) All the smallholder agro-pastoralists in Laikipia County had adopted at least one of the wildlife mitigation strategies promoted by public agricultural extension on their farms. They therefore had the information being sought by this study.

iii) All the respondents bordering Rumuruti Forest cooperated during this study and provided the data required. Cooperation of the respondents meant that the respondents willingly provided the information that was being sought by this study.

1.10 Definitions of Terms

For the purpose of this study, the following definitions of terms were adopted:

Adoption means the start to use a particular method (Hornby, 2010). In this study, the term adoption meant the acceptance and usage of the agricultural extension-based human-wildlife conflict mitigation strategies by smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County for at least two years.

Agricultural Extension is a system for exchanging information and transferring skills between farmers, extension workers and researchers so as to assist farmers in identifying agricultural production problems and adopt appropriate technologies (Abegunde & Ogunsumi, 2011). The information disseminated may comprise advice, awareness creation and skill development and education. In this study agricultural extension referred to the system for exchanging information and skills about human- wildlife conflict mitigation between agro-pastoralists in Laikipia County and agricultural extension service providers. This system of exchanging information and skills was aimed at determining the effect of human-wildlife conflict on agricultural production and promoting appropriate, effective and sustainable agricultural extension human wildlife conflict mitigation strategies.

Agro-pastoralism is defined as a production system which is practiced in semi-arid parts where livestock farming is practiced alongside crop farming or as a farming system characterized by a mix of crop and livestock production system (Jalloh, 2012; Kamau et al., 2008). In this study, smallholder agro-pastoralists referred to small-scale combination of crop and livestock production in marginal areas of Laikipia County.

Cope is defined as accepting or bearing with something although it is painful or unpleasant (Hornby, 2010). It involves dealing successfully with something unpleasant or a difficult situation. In this study, a human wildlife conflict coping strategy referred to an activity which enables a farmer to bear with a human wildlife conflict situation.

Effectiveness refers to the capability of producing an intended or wanted result (Hornby, 2010). In this study, effectiveness referred to the capability to reduce human-wildlife conflict incidents. Therefore, effectiveness of Agricultural Extension Wildlife Mitigation Strategies (AEHWCMS) referred to the capability of the AEHWCMS to reduce the human-wildlife conflict among smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County. Effectiveness was measured by adopting the rating of effectiveness on a 5-point Likert scale by farmers and their extension agents

in the study area who had used the AEHWCMS for at least four years on their farms and made observation. The AEHWCMS were considered effective when the hectares of crops damaged, number of livestock injured or killed or number of humans injured or killed was reduced by at least 10%. This could involve the use of a single mitigation strategy or in combination, during the four-year period of use, which was from the year 2012 to 2015. The values in the year 2012 were taken as the baseline.

Human-Wildlife Conflict is a situation which exists when the needs and behavior of wildlife impact negatively on the goals of human beings (Le Bel et al., 2011). It can also be defined as a situation existing when wildlife requirements encroach on human requirements with costs to residents and wild animals (FAO, 2009). In this study, the term human-wildlife conflict referred to the destruction of crops and attack of livestock and people by wildlife; invasion of wildlife habitats by people and death of wildlife and even people through wildlife-transmitted diseases.

Mitigation refers to the act of making something less harmful (Hornby, 2010). In this study, mitigation referred to the act of reducing the amount of crop damage, number of livestock or people injured or killed and even incidences of disease transmission by wildlife.

Protected area is an area of land or sea specifically set aside for the maintenance of biological diversity, natural or associated cultural resources and is managed through legal means (United Republic of Tanzania, 2013). In this study the term referred to an area of land set aside legally for use in wildlife conservation and it is fenced.

Sustainability means the ability of being upheld or maintained (Hornby, 2010). A human-wildlife conflict mitigation strategy is sustainable if it is administered by the local community itself (Le Bel et al., 2011). In this study, sustainability meant the extent to which the smallholder agro-pastoralists in Laikipia County could successfully implement the Agricultural Extension Wildlife Mitigation Strategies (AEWMS) using their own resources without external support. Sustainability was measured by adopting the rating of sustainability on a 5-point Likert scale by farmers and their extension agents in the study area who had used the AEHWCMS for at least four years on their farms.

Trend means the general direction in which a situation is changing or developing (Hornby, 2010). In this study the term trend referred to either an increase or decrease of the human-wildlife conflict incidences over four years, among smallholder agro-pastoralists in Laikipia County.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents literature on the importance of agriculture, socio-demographic factors affecting agricultural technology adoption, concept of human wildlife conflict and its global trend, typology of human wildlife conflict, collaboration between agricultural extension and KWS in human wildlife conflict mitigation; human wildlife conflict coping strategies promoted through governance, the role of agricultural extension in human wildlife conflict mitigation , human wildlife conflict mitigation strategies adopted, their effectiveness and sustainability, agricultural extension and KWS policies in human wildlife conflict mitigation, the theoretical and conceptual framework.

2.2 Importance of the Agriculture Sector in the World

The agricultural sector is very critical in the growth of global economies, where it employs more than two billion people besides contributing about 30% of the global GDP (Hanson, 2013). In Africa, the agricultural sector is critical in the achievement of food security, employment creation and promotion of economic growth (Alliance for a Green Revolution in Africa, AGRA, 2013; Hoffman & O‟Riain, 2012). The sector is also a source of income and employment for Africans, especially the poor (Ncube, Elkheshen, Lyeka & Beileh, 2012). The agricultural sector also provides opportunities for economic development and poverty reduction especially in the rural areas of Sub Saharan African countries (International Fund for Agricultural Development, IFAD, 2010; Shaffnit-Chatterjee, 2014). Furthermore, the agriculture sector is the largest employer in developing countries, and its growth significantly increases income generation and also reduces poverty (Asenso-Okyere & Jemaneh, 2012; World Bank, 2012). Consequently, the agricultural sector is considered very important in achieving Sustainable Development Goal 1, which seeks to reduce the level of poverty in the world (United Nations, UN, 2015).

The agriculture sector contributes about 26% of the GDP directly and 25% indirectly to the Kenya‟s economy (GoK, 2010). The sector is therefore considered the backbone of the economy. For instance, in the year 2010, the sector grew at 6.3%, from negative 2.9%, translating to GDP growth from 2.6% to 5.6% during the same period (KNBS, 2010). Additionally, the growth of the national economy is positively correlated to agricultural growth and development. This was evidenced by an average growth rate of 6% in agricultural growth, resulting in a growth rate of 7% to the national economy in the first two decades after

independence (GoK, 2012b). Further, since independence, Kenya has heavily relied on the agricultural sector for economic growth, employment creation and generation of foreign exchange.

Smallholder farmers in different parts of the world experience various challenges such poor quality land (degraded and less productive) and effects of climate change such as floods, drought, diseases and reduced water supply (Curtis, 2013; Fre & Tesfergasis, 2013). Small-scale farmers in Africa also face various challenges such as inadequate extension services and effects of human wildlife conflicts (Lamarque et al., 2009). The small-scale farmers in Sub Saharan Africa are also affected by insecurity of land tenure, human wildlife conflicts and effects of climate change (Schaffnit-Chatterjee, 2014). Whereas farmers in other parts of Kenya experience low adoption of agricultural technology and heavy crop losses to disease and pests, smallholder farmers in Laikipia County also face challenges such as social insecurity and human wildlife conflicts (GoK, 2010; GoK, 2012a; MFW, 2012). The challenges experienced by smallholder farmers could result in reduced agricultural productivity and also undermine household food security (Bruinsma, 2009). Human wildlife conflicts being severe challenges affecting smallholder agro-pastoralists in Laikipia County, they reduce agricultural productivity, production and household food security. This scenario can be severe if the Agricultural Extension Human Wildlife Conflict Mitigation Strategies used by the smallholder farmers are not effective against the targeted wildlife.

2.3 The Concept of Human-Wildlife Conflict and its Global Trend

Human-wildlife conflict is a phenomenon experienced throughout the world in areas where people and wildlife share and compete for limited resources and also share boundaries (Eniang et al., 2012; Musimbi, 2013). The conflict arises mainly from loss, degradation and fragmentation of wildlife habitats through human activities such as expansion of agricultural activities (Otieno & Hassan, 2013). Competition between growing human population and wildlife for limited resources results in a conflict. For instance, the transformation of forests and other ecosystems into agricultural land or urban areas resulting from an increase in demand for land, food production and raw materials leads to loss of wildlife habitats, culminating in a conflict situation. Effects of human-wildlife conflict range from injury to death of livestock or humans, loss of crops, damaged infrastructure and disease transmission (to humans or wildlife). It may also include school absenteeism of children to guard crops at home or being too scared to walk to school. It also includes reduced farm productivity for

farmers who spend more time guarding their crops, and other social costs such as stress (FAO, 2015). Injury or death of people may occur when they are in or near waterways, when travelling, fishing or fetching water, while protecting crops and water against wildlife (especially at night) or when people encounter injured animals. Fear of wildlife restricts people‟s freedom of movement and access to resources. This situation can induce high levels of stress and feelings of insecurity among people. Road accidents caused by wildlife and bird-aircraft collisions occur worldwide and can result in livestock or human injury or even death. For instance, in America about 29,000 deers are killed annually after colliding with automobiles (Musimbi, 2013).

Despite the potential negative effects of wildlife, it is an important resource because it forms the base for the tourism industry in different parts of the world. The industry generated 5% of global GDP and 7% of world employment opportunities in 2011 (GoK, 2008; UNCTAD, 2013). The industry contributed USD 1 trillion to the world economy in 2008, and is ranked as the 4th largest in the world (Honey & Gilpin, 2009). In Kenya, the government identifies the tourism industry as one of the growth engines for the national economy (Wanyonyi, 2012). This is because it contributes about 13% to the economy, 12% of GDP and 19% of the total wage employment (Vernon, 2010). The tourism industry also contributes significantly to the growth of both the local and national economy. This is evidenced by its generation of more than 10% of the total formal employment and about 25% GDP in the 2005/2006 financial year (Laikipia Wildlife Forum (LWF), 2012). The sector is therefore considered as a key driver for economic development as envisaged in the national development plan called „Vision 2030‟. Although wildlife plays an important role in national economic development through the tourism industry, its interaction with people results in a human-wildlife conflict situation (GoK, 2012a; MFW, 2012).

The trend of human-wildlife conflict in different parts of the world keeps on fluctuating. In many regions of the world, conflicts have intensified over the recent decades due to an increase in human population growth and expansion of agricultural activities (FAO, 2015). Over the last four decades, wildlife habitats in the world have shrunk drastically due to human encroachment (Mbugua, 2012). Further, in Alberta, Canada, between 1992 and 1996, wolves killed 2,806 livestock while in Idaho, Montana and Wyoming (USA), between 1987 and 2001, wolves killed 728 livestock (cattle and sheep) (Musimbi, 2013). Crop damage caused by wildlife in Slovenia has increased since 1993 to date. Human wildlife conflicts are

increasing as human populations expand into Africa"s forests (Sharman, 2013). As human populations continue to grow, encroachment on wildlife habitats become inevitable thus the human-wildlife conflict. In Africa, conflicts between humans and wildlife have been increasing due to competition for resources such as food and water or attack on humans by wildlife (Hockings & Humle, 2009). For instance, the area East of Khutse Game Reserve and South of Central Kalahari Game Reserve in Botswana"s South experiences severe human- wildlife conflict with farmers sustaining losses of up to 20% of their livestock to wildlife annually (Kesch, 2014). In Nigeria, crop damage is up to 98% and is projected to increase as more people crowd the limited land (Eniang et al., 2011). And, in Cameroon, human-wildlife conflict is expected to increase in unprotected wildlife areas due to expansion of industrial plantations (Eyebe et al., 2012).

In 2004, about 28.4 ha of crop were destroyed by wildlife in Campo-maan area of Cameroon while in 2006 wildlife destroyed 65% of maize, ground nuts, cow pea and cotton area in Tomboro District, Cameroon. Crop damage by wildlife is likely to increase in future in Uganda due to government support for shifts from subsistence farming to cash crop farming which requires much land (Eniang et al., 2011). It is also estimated that in Tanzania, 200 people are killed by wildlife annually whereas crop damage has greatly increased as from the start of a new millennium (Johanson, 2010). For example, in the year 2000, about 687 tones of crop was damaged, 1,023 in the year 2001 and 1,053 tones in the year 2002 in Liwale District of Tanzania. In the Tsavo East National Park, in the year 2005, wildlife killed 6 people and 2 in 2006, the number of injured people dropped from 5 to 0, while the incidences of crop attack reduced from 51 to 46 in the same period (Otieno & Hassan, 2013). This showed that the trend of human-wildlife conflict fluctuates a great deal, especially in non- protected wildlife habitats where wildlife freely moves into the adjacent farmland. Globally, generally there is a declining trend of human-wildlife conflict as depicted by the lower wildlife attack incidences, acreage of crop damaged or the number of livestock or even people injured or killed. This could be attributed probably, to the use of effective human wildlife conflict mitigation strategies by farmers although there was limited documented evidence. Further, there was limited information which was also inadequately documented on the trend of human-wildlife conflict among smallholder agro-pastoralists in Laikipia County. Availability of this information could help in determining the months when farmers experience the most serious problem so that a recommendation can be made to put in place more efforts for countering the conflicts.

2.4 Typology of Human-Wildlife Conflict among Smallholder Farmers

Human-wildlife conflicts manifest themselves in different ways in areas where they occur in different parts of the world. For instance, in North America, bears raid dustbins in National Parks and edges of towns, wildlife disturbs and wakes up residents as well as cause disorder on the streets (Lamarque et al., 2009). Wildlife attack also causes damage to property such as storage bins, destroy assets such as water points, where people collect water from (Eyebe et al., 2012). In Lwangwa valley of Zambia, wildlife destroyed many stores of fruit masawu (Parker et al., 2007). The other properties also destroyed by wildlife included fences and water installations. For example, in the Chobe National Park of Botswana, wildlife damaged water pipes to access water during the dry season and also destroyed fences round a wildlife ranch in Low Veld of Zimbabwe in 1999. Wildlife attack also destroys various infrastructure, water storage, pipes, pumps and reservoirs in the rural areas of Kenya (Bond, Davis, Nott, Nott & Stuart-Hill, 2006).

Wild animals also destroy crops when they attack farms, especially the farms near wildlife habitats. For instance, in Europe, crops are destroyed by wild boar, wild rabbit and wooden pea while in Australia crops are destroyed by Kangaroos (Lamaque et al., 2009). Crop damage is a common form of human-wildlife conflict in rural areas of Africa (Nyangoma, 2010). Crop damage is the most common form of human-wildlife conflict in the African continent where it is caused by birds, rodents, buffaloes, elephants, antelopes, bush-pigs and hippopotamuses. Crop destruction also occurs in Cameroon, where up-to 28.4ha of crops grown were destroyed in the Camp- maan in 2004, while in 2006 about 65% of crops grown (maize, cotton, ground nuts and cowpea) were destroyed in Tomboro District. In Kenya, wildlife also destroys crops (Lauren-Bond, 2013). Wildlife destroys food crops grown for subsistence use (maize, millet and vegetables) and also cash crops grown for sale (cotton, tobacco, fruits and vegetables) (Bond et al., 2006). Crop damage by wild animals is common in areas outside wildlife habitats and farms adjacent wildlife habitats. For instance, wildlife move from the Tsavo Conservation Area (TCA) into neighboring land in search of feed and in the process they destroy crops (Makindi, Mutinda Olekaikai, Olelebo & Aboud, 2014). Wild animals also destroy approximately 68.4% of farm produce within the TCA. The wild animals also destroy food crops in stores (Lauren-Bond, 2013). Damage to stored food by wildlife following a harvest is the most disruptive human wildlife conflict to farmers. This is because a lot of damage can be done in a short period on concentrated food source than when the crop is in the field. Furthermore, a crop damaged in the field can be replaced by

replanting while food in stores cannot be replaced until the next planting season (Parker et al., 2007).

Attack by wild animals can also lead to livestock injury or even death (Parker et al., 2007). In Asia, especially India, wildlife such as Tiger, leopard, lions attack livestock especially pigs, cattle and sheep (Lamaque et al., 2009). In African countries wildlife attacks livestock. For instance, in Cameroon, wildlife such as Hyenas, Civets and Lions attack livestock and domestic animals (Eyebe et al., 2012). For instance, around the Jukumu Wildlife Management Area (JWMA) of Tanzania, fifty-three cows were killed and forty-one injured by crocodiles in one year (Lamaque et al., 2009). Further, in the areas neighboring Sengwa Wildlife Research Area (SWRA), in Zimbabwe, two hundred and forty-one livestock were killed by wildlife between 1993 and 1996. Livestock are either injured or killed through wildlife attack of farms in Kenya (Lauren-Bond, 2013). In the areas adjoining Tsavo National Park in Kenya, a total of three hundred and twelve attacks by wild animals led to death of four hundred and thirty-three livestock. Within the Tsavo Conservation Area, wild animals move from their habitats into the neighboring farms to search for water and feed, and thus injure and kill livestock (Makindi et al., 2014).

Wildlife attack can also lead to human injury or even death (Eyebe et al., 2012; Parker et al, 2007). They also pose a threat to human life (Graham et al., 2010). In the US, about five thousand people are injured while four hundred and fifteen people are killed through wildlife-related incidents annually (Musimbi, 2013). In the period between 1996 and 1997, wildlife killed eleven people around Kruger National Park in South Africa, while seventy people were killed in Cabo Delgado Province between the years 2001 and 2002 (over 18 months) (Lamarque et al., 2009). Additionally, in Tanzania, in the period between 1990 and 2004, five hundred and sixty-three people were killed and three hundred and eight injured. A further twenty-eight were killed and fifty-seven injured in the Jukum Wildlife Management Area of Tanzania. People are also injured or even killed by wildlife attacks in Kenya (Bond, 2014). For instance, within the Tsavo Conservation Area of Kenya, more than two hundred people were killed in seven years, while ten people were killed in five years in the Kakum Conservation Area. Wildlife invasion on farms also can transmit diseases to livestock or people, such as rabies (Lamarque et al., 2009). Within the Goza Province of Mozambique, two hundred and twenty-eight cows died of theilleriosis they contracted from buffaloes. In Kenya, wildlife also transmit diseases, for instance in the Tsavo Conservation Area of Kenya,

wildlife transmit diseases or disease-causing parasites to livestock. However, limited information was available and was poorly documented on the nature of human wildlife conflict among smallholder agro-pastoralists in Laikipia County.

Human-wildlife conflict is a problem affecting farmers in various parts of the world and it is caused by a wide range of wild animals such as mammals, birds and insects (Nyangoma, 2010). Various species of wild animals are responsible for human-wildlife conflict in different parts of the world where it is experienced. In Asia, especially Northern India, monkeys are notorious in destroying crops while deers are common in Northern America where they attack dustbins (Lamarque et al., 2009). Deers cause collisions with automobiles, thus injuring people. Wolves kill domestic animals in Canada, attack and injure livestock in the US. Wild boar, wild rabbits and hare destroy crops in Europe while wild rabbits destroy crops and pasture in Australia. In Asian countries, tigers, leopard, lions and snow leopard attack livestock, with elephants being the major source of human-wildlife conflict by attacking livestock such as cattle and pigs (Lamarque et al., 2009; Graham et al., 2010).

Human-wildlife conflict is prevalent in Africa where large numbers of big mammals such as elephants and lions roam freely in marginal rangelands and protected areas (Makindi et al., 2014). Further, a wide variety of vertebrates such as rodents, birds, antelopes, buffaloes, hippopotamuses, bush pigs and elephants cause conflict with the farming communities in Africa (Musimbi, 2013). For instance, in Cameroon along the Banyang-Mbo region, crop damage is caused by elephants and buffaloes, compelling farmers to abandon the fields when the damage is quite high (Rose, 2002). Additionally, most crop damage by elephants in the Southern Ghana and around Liwonde National Park in Malawi occurs during the rainy season. Elephant crop damage peaks occur during the flowering or ripening stages of crops. Crop damage by elephants has a temporal pattern which is linked to seasonal declines in the availability of wild foods, especially high quality wild grasses (Le Bel et al., 2011).

In Cameroon, elephants are the most common large animals that destroy various crops such as millet and also destroy farm structures such as granaries. The conflicts are more pronounced at the peripheries of wildlife habitats, especially along migration routes of elephants (Eyebe et al., 2012). Conflicts also occur both in dry and rainy seasons but intensify when water gets scarce. Elephants are considered the main wild animal involved in crop destruction in Cameroon and occurs throughout the year. Elephants are recognized as the greatest threat to African farmers and especially peasant farmers who are unable to deal with

the problem of elephant attack and damage themselves (Parker et al., 2007; Lamarque et al., 2009). In particular, elephants are the most notorious wild animals in Zimbabwe, South Africa and Mozambique (Hoare, 2012). They were responsible for about 39% of the human-wildlife conflict cases reported in Mozambique between 2006 and 2010 (Le Bel et al., 2011). In Kenya, an elephant is one of the major wild animals that are a problem to farmers (Lauren-Bond, 2013). An elephant is a problem to crop farmers and pastoralists because it destroys crops (Graham & Ochieng, 2008; Graham et al., 2010). Elephants also destroy infrastructure such as water pipes and granaries and also compromises the physical safety of people, including causing injury or even death. Elephants destroy crops regularly and are very destructive (Lauren-Bond, 2013).

The other wild animal that is a problem to farmers is the lion. In Africa, lions roam freely in marginal rangelands and gazetted habitats for wild animals (Makindi et al., 2014). Lions eat cattle and goats and may also eat people (Parker et al., 2007). In Cameroon, lions attack livestock and they are also killed by people (Eyebe et al., 2012). Lions kill people in Mozambique. For instance, 70 people were killed in Cabo Delgado province of Mozambique in a period of 18 months (between 2001 and 2002) (Lamarque et al., 2009). Lions were responsible for 10% of human-wildlife conflict cases reported between 2006 and 2010 (Le Bel et al., 2011). Lions also injured 308 people and killed 563 in Tanzania between 1990 and 2004 and the Lions killed 11 people near Kruger National Park in South Africa between 1996 and 1997 (Lamarque et al., 2009). Over a period of four years on two neighboring arid land and ranches adjoining Tsavo East National Park in Kenya, a total of 312 attacks by wild animals resulted in the death of 433 heads of livestock with lions being responsible for 86% of the attacks (Musimbi, 2013). About 26% of farmers in the Tsavo Conservation Area report that lions visit their farms especially during the dry season (Makindi et al., 2014).

In Africa, crocodiles are responsible for more human deaths (Lamarque et al., 2009). Crocodiles are responsible for 29% of the human-wildlife conflict cases reported in Mozambique between 2006 and 2010 (Le Bel et al., 2011). From the year 1999 to 2004, crocodiles killed at least 28 people and injured 57 others in the Jukumu Wildlife Management Area, Selous Game Reserve of Tanzania (Lamarque et al., 2009; Musimbi, 2013). Further, in the Jukumu Wildlife Management Area of Tanzania, crocodiles injured 41 cows and killed 53 cows in one year (Lamarque et al., 2009). Vertebrates such as hippos also come into conflict with farming communities in Africa (Parker et al., 2007; Lamarque et al., 2009). Hippos kill

or injure livestock and people as they move around at night such that people living nearby often get scared to travel after darkness falls. Further, hippos were responsible for more human deaths than any other wild animal in the 1970s (Lamarque et al., 2009; Musimbi, 2013). In Mozambique, hippos damage crops at localized places (Kate, 2012). For instance, between 2006 and 2010, hippos were responsible for 16% of the human-wildlife conflict cases reported in Mozambique (Le Bel et al., 2011). Hippos also destroy boats in Cameroon (Eyebe et al., 2012).

Hyenas are also one of the greatest threats to humans. They are responsible for majority of the human-wildlife conflicts in Africa (Musimbi, 2013). They may eat people and their livestock (Parker et al., 2007). In Mozambique hyenas eat goats (Kate, 2012). Hyenas commonly attack domestic animals in Cameroon (Eyebe et al., 2012). Hyenas are one of the major problem animals where they attack goats and sheep in Kenya (Macclennan, Groom & Frank, 2009; Bond, 2014). For example, Hyenas were responsible for about 14% of the 312 attacks over a period of four years in the areas bordering Tsavo East National Park in Kenya (Makindi et al., 2014). In the Tsavo Conservation Area of Kenya, 61% of farmers reported that hyenas visit their farms or living areas. They frequently visit farms throughout the year in search of food, water and salts.

A wide variety of vertebrates such as buffaloes are also a source of human-wildlife conflict in Africa (Lamarque et al., 2009). Wild animals such as buffaloes come into conflict with farming communities in Africa (Parker et al., 2007). For example, along the Banyang-Mbo region in Cameroon, crop damage by a buffalo was seasonal, occurring mainly during the rainy season (Rose, 2002). Crop damage mostly occurs along the sanctuary edges, since farming fields are closer to the sanctuary edges. Buffaloes mostly destroy crops and also transmit livestock diseases such as Foot and Mouth Disease (FMD) and theilleriosis (Parker et al., 2007; Eyebe et al., 2012; Kate, 2012). Buffaloes also transmit anthrax to livestock (Musimbi, 2013). In the Goza province of Mozambique, 228 cattle died of anthrax after contracting the disease from buffaloes. Buffaloes also use the same water holes as people and when animals are present, people may be too scared to use them. Buffaloes are also a source of human-wildlife conflict in Kenya. For instance, in the Tsavo Conservation Area, about 71% of farmers reported that buffaloes visit their farms or living areas (Makindi et al., 2014). The farmers identified food as the main reason for which wild animals move into community

farms. Buffaloes leave the TCA to look for water, which may be scarce during the dry seasons of the year.

Baboons, apes and monkeys also attack food crops such as maize, fruits, tobacco and wheat in Africa (Lamarque et al., 2009; Eyebe et al., 2012). In Zimbabwe, baboons and monkeys are problem animals to farmers (Kate, 2012). On the Gokwe Communal land, next to Sengwa Wildlife Reserve Area in Zimbabwe, baboons were involved in killing 241 livestock between January 1993 and June 1996 (Lamarque et al., 2009). Along the Tsavo Conservation Area in Kenya, up to 91% of farmers reported that monkeys visit their farms while about 83% reported that baboons visit their farms or their living areas (Makindi et al., 2014). Monkeys and baboons frequent farms throughout the year in search of food water and salts. Further, monkeys and baboons inflict wounds on dogs and intimidate people, especially women in towns when scavenging for food (Lamarque et al., 2009). A wide variety of vertebrates such as birds come into conflict with farming communities in Africa (Parker et al., 2007; Lamarque et al., 2009; Musimbi, 2013). For instance, quelea birds are a problem to wheat farmers in Mozambique (Kate, 2012). Birds also destroy seeds from sorghum and millet crop (Parker et al., 2007).

A wide variety of vertebrates such as rodents come into conflict, creating the human-wildlife conflict with farmers in Africa (Parkert et al., 2007; Musimbi, 2013). In Cameroon, along the Banyang-Mbo area, majority of crop damage is caused by large rodents such as cane rats (Rose, 2002). Porcupines and hedgehog attack crops in Cameroon (Eyebe et al., 2012). Majority of crop damage is caused by large rodents such as cane rats (Rose, 2002). The other vertebrate pests which come into conflict with farmers in Africa include the antelope and warthog (Parker et al., 2007; Hoare, 2012). Among African farmers bush pigs destroy potatoes and ground nuts. The bush pigs are a problem to farmers in Mozambique (Kate, 2012). Other wild animals attack farms causing crop damage and also injuring or killing livestock. They include boars, wild rabbits and leopards. Boars and wild rabbits destroy crops in Europe and Australia while leopards kill livestock in Capetown, South Africa (Lamarque et al., 2009). In Kenya, the other wild animals that are a problem to farmers include wild dog, leopard, zebra and squirrel (Lauren-Bond, 2013; Bond, 2014). In different parts of the world, a wide range of insects also attack crops while using them as food (Nyangoma, 2010). For instance, along the Banyang-Mbo in Cameroon, grasshoppers cause major crop damage (Rose, 2002). However, limited information was adequately documented and could be shared

on the types of human-wildlife conflicts prevalent among smallholder agro-pastoralists in Laikipia County and was poorly shared with agricultural extension. Unavailability of such information could be contributing to an increase in trend of human-wildlife conflict through promotion and adoption of mitigation strategies that are not effective on human wildlife conflict among smallholder farmers in Laikipia County. This could also be leading to allocation of inadequate resources towards promoting human-wildlife conflict mitigation strategies.

2.5 Effectiveness and Sustainability of Mitigation Strategies Adopted by Farmers in Kenya

Human-wildlife conflicts are experienced in various parts of the globe in areas where people and wildlife share and compete for limited resources and also share boundaries (Eniang et al., 2011; Musimbi, 2013). The conflicts occur either when the needs and behavior of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact on the needs of wildlife (Madden, 2004). These conflicts could result when wildlife damages crops, injures or kills domesticated animals, threaten or even kill people. They also arise when a wild animal attacks livestock or damages crops, when an individual or community seeks to kill wildlife or when a person retaliates against the authorities in charge of conserving wildlife and its habitat.

Farmers in various parts of the world who experience human-wildlife conflict respond differently to wildlife invasion of their farms by using the skills and knowledge provided through agricultural extension. Agricultural extension is the provision of agriculture-related knowledge to farmers with the aim of increasing their ability to improve farm productivity (Anaeto et al., 2012; Peterman, Behrman, & Quisumbling, 2011). It educates farmers to enhance adoption of farming technologies (Anderson et al., 2008; Zivkovic, Jelic & Rajic, 2009). As a way of increasing agricultural productivity, agricultural extension seeks to solve problems facing farmers through empowerment by providing them with knowledge and skills including skills and knowledge on mitigation of human-wildlife conflict. Agricultural extension also promotes various human-wildlife conflict mitigation strategies such as growing of crops that are unpalatable to wildlife such as chili. This can be achieved by growing chili as the main crop, where chili is grown in a pure stand or as a buffer crop. This involves growing of about two to three lines of chili around a crop that is more susceptible to wildlife attack such that as the wild animal seeks to feed on the main crop, it is repelled by the unpleasant chili which serves as a buffer (Hocking & Humle, 2009). In some African

countries, chili crop is grown round a main crop where it serves as a barrier against wild animal in accessing a crop field (Anderson & Parieda, 2005). In some parts of Kenya, chili crop is grown as a mitigation strategy against attack by wild animals (Graham et al., 2010).

Trenches measuring two meters deep and two meters wide are dug and are either covered or uncovered. In Asian countries such as China and India, trenches are dug along boundaries of wildlife habitats or around water points and have been successful in mitigating attack by wild animals especially elephants (Parker, Osborn, Hoare, & Niskanen, 2007). Trenches have to be wide and deep enough to ensure that wild animal cannot step over it or jump. In some places, the trenches are filled with pointed sticks to deter wild animals from crossing. In India, shallow trenches overlain with branches and leaves have been used successfully. When an animal treads upon the leaves it yields as the substrate gives in and fears that it will plunge into a pit, therefore withdraws. The trench is thirty centimeters deep but wide enough to prevent an adult elephant from stepping over it and the covering must be well maintained otherwise, the strategy will not be useful. Trenches are used in Yunnan province in China to control wild animals such as elephants. Trenches are also used in African countries to keep off elephants from farms with significant success (Lamarque et al., 2009). For instance, on the Southern boundary of Queen Elizabeth National Park, Uganda, an elephant-proof trench was constructed measuring two meter deep, two meters wide with earth soil banked up half a meter from a trench"s edge (Parker et al., 2007). This trench was effective in keeping elephants out of the farm. However, trenches require large investments of labor or mechanical digging equipment and intensive maintenance and they encourage soil erosion (Treves, 2007).

Additionally, some wild animals such elephants can fill trenches by kicking soil from edges into the trench, then crossing. Trenches are constructed around the farm to prevent wildlife from accessing the farm, livestock and humans (Parker et al., 2007). The other mitigation strategies promoted include growing natural barriers such as spiny cacti such as Opuntia and Agave species. These hedges are low-cost and effective against both carnivores and ungulates but grow slowly and therefore taking long time to establish. Further, these plants often spread uncontrollably, they are too patchy to form a cohesive barrier and furthermore, their thorns are not strong enough to deter some wild animals such as baboons and elephants (Parker et al., 2007; Lamarque et al., 2009). For instance, in Uganda, smallholder farmers use natural barriers such as live fences to mitigate wildlife invasion of their farms (Kate, 2012; Wallace

& Hill, 2007). Digging of trenches is considered 25% effective in mitigating human-wildlife conflict among small-scale farmers in Tsavo Conservation Area (Makindi et al., 2014).

A plant called mauritius thorn (*Caesalpinia decapetala*) can be grown around the farm to prevent entry of wild animals. The plant is planted in various places in Africa to serve as a natural barrier against wild animals (Parker et al., 2007). However, the plant is very invasive and requires regular maintenance, trimming and training, all which are labor-intensive. They can also be eaten by some wild animals. Other mitigation strategies recommended through agricultural extension include growing of crops with spikes or hairs such as varieties of sorghum, to prevent damage by wildlife such as birds of quelea species. In some African countries such as Kenya, farms are protected using African honey bees. It involves placing bee hives on the edge of crop fields, hung at least three meters above the ground or incorporating hives into a simple fence (Hoare, 2012). Just as wild animals come into contact with the bee hives, bees are disturbed and therefore come out and sting the wild animals. Additionally, wild animals such as elephants are repelled by the buzzing sound produced by bees (Karidozo & Osborn, 2007; Graham et al., 2010). The wild animals especially elephants retreat from the source of buzzing sound or make alarm calls (King, Douglas-Hamilton, & Fritz-Vollrath, 2011). In Zimbabwe, there was avoidance of hives placed on elephant paths. The use of Kenya bee hives is considered to be the new solution to human-elephant conflict. This mitigation strategy can be used against both small and large wild animals. Through advice from agricultural extension, farmers respond to human-wildlife conflict by using different agricultural extension mitigation strategies. This shows that after smallholder farmers receive advice from extension service providers about agricultural extension human- wildlife conflict mitigation strategies, they could use different agricultural extension human wildlife conflict mitigation strategies on their farms.

Despite small-scale farmers using various wildlife extension mitigation strategies, they still experience significant degrees of human-wildlife conflict. This could mean that the extension mitigation strategies used are either not effective or not sustainable. The small-scale farmers therefore use non-extension human wildlife conflict mitigation strategies against attack by wild animals. Farmers guard their farms in various ways. In East Africa, it involves monitoring herds and actively defending a farm where human herders ward off attacking animals (WWF-SARPO, 2005). Herders scare away wild animals such as lions, hyenas and cheetahs using various weapons such as spears, knives or firearms. Fear of people dissuades

wild animals from causing damage. For instance, elephants in the area around Kakum Conservation Area (KCA) in Ghana avoid farms that are guarded by people (Lamarque et al., 2009). In East Africa human herders are effective in warding off wild animals such as lions, hyenas and cheetahs by scaring them away using weapons such as spears, knives and firearms.

Guard animals can be used to provide an alternative to a herder monitoring a flock. To be successful, the guard animal must bond with the animals they are to guard and the bonding combined with guard animals" natural aggression towards attacking animals makes the guarding animals effective in protecting livestock (WWF-SARPO, 2005). Dogs can be effective in protecting homesteads and livestock from attack by wild animals and especially when trained to alert people on the presence of wild animals rather than chasing them away. Farmers in North America guard their farms using dogs which are left alone to safeguard livestock whereas in North Asia and Europe dogs are used together with humans for guarding (Parker et al., 2007). Herder dogs are dogs which are used to accompany livestock daily during grazing. The dogs to be used for herding livestock must be introduced to the livestock they are expected to herd when they are young and be allowed to grow with the livestock. Guarding is practiced by farmers in India where they effectively and successfully protect their crops at night using guard dogs against black bears, and cheetahs, although less effective on wolves and grizzly bears. In Namibia, between 1994 and November 2001, domestic dogs accompanying herds in 117 farms showed that guard dogs can reduce livestock losses.

In Cameroon, chasing of wild animals is practiced. Crop fields or herds are guarded and any wild animal approaching the farms is spotted and chased away through making noise, throwing stones and wooden sticks, lighting wooden sticks around the farm and also guarding using flashlights (WWF-SARPO, 2005). However, chasing wild animals is time-consuming and sometimes risky because occasionally it has led to fatal accidents while at the same time, the children who guard crops and livestock lose time meant for attending school. Further, in Northern Kenya, guarding by people accompanied by shepherd dogs was linked to lower rates of lion attacks on cattle (Parker et al., 2007). Donkeys can also be used as guard animals, for instance, both dogs and donkeys are used in Namibia and Botswana to accompany livestock. The donkeys have been successful in reducing human-wildlife conflict incidents especially where cheetah and spotted hyena are concerned (WWF-SARPO, 2005). In Kenya, one or two donkeys per herd of cattle are used to guard a herd against lions.

Donkeys are used as guard livestock because they are naturally more alert and aware of attacking animals, they are not afraid and will fight the wild animals and chase them away even by biting and kicking.

Guarding can be modified by use of watchtowers constructed at half a kilometer interval to provide vantage points built round cultivated fields to increase a farmer's chances of being alerted of the presence of potentially harmful wild animals before they cause damage (Hoare, 2012). This method requires that farmers cooperate among themselves in managing the watchtowers by probably developing a duty roster, although in most cases women and children guard crops (Kate, 2012). Baboons and Chimpanzees are fearful of adult men than women and children. Alternatively, specifically constituted teams can act as guards as is the case in Kakum in Ghana where community scouts are used to provide vigilance and also promote community-based wild animal control in an area of high human-elephant conflict. The vigilante method is used in African countries such as Zimbabwe, Mozambique and Zambia (WWF-SARPO, 2005). Vigilante method can also be achieved by using alarm systems using a network of cowbells or metal tins filled with stones and connected along a length of twine. This approach can be effective in mitigating human-wildlife conflict and help the farmer in avoiding the farmer having to stay alert all night long. However, some wild animals especially baboons show less fear to simple vigilance and therefore make the strategy less effective. Guarding is effective in mitigating attack by non-climbing wild animal, especially elephants, buffalo and wild pigs (Kate, 2012). However, guarding requires additional human labor especially at night and it is time-consuming. Furthermore, guarding using dogs requires that people are present for the strategy to be effective. Additionally, some wild animals such as baboons are quick to adapt to measures taken against them and are quick to find weaknesses in guarding of crops.

Farmers light fire as a mitigation strategy against attack by wild animals. Fires are lit on boundaries of crop fields or burning sticks can be carried out by farmers (Parker et al., 2007). Fire can be kept burning throughout the night in those areas where wild animals attack more frequently (WWF-SARPO, 2005). Plastic and rubber may also be burnt to produce a noxious smoke, and the fire may be left burning all night even when farmers are not present in the farm (Parker et al., 2007). These strategies are not harmful and therefore some wild animals such as elephants habituate to them over time of use, thus making the strategies less effective. Noise-making can also be used as a mitigating strategy against human-wildlife conflict for

instance through beating drums and tins, „cracking‟ whips, yelling and whistling to move wild animals such as elephants away from a farm (Parker et al., 2007). Noise-making can be achieved by using devices such as firecrackers, local bangers or explosives made from gun-powder, fertilizer or empty barrels (WWF-SARPO, 2005).

Non-electric fencing can be used as a human-wildlife conflict mitigation strategy which involves fences built with wooden or steel poles being driven vertically into the ground (Parker et al., 2007). Heavy gauge wire or cable is strung between the poles drawn tight. Strong non-electric fences are used in different parts of Africa and Asia to restrict wild animals such as elephants from accessing farms to cause damage. Although these fences are effective, they are expensive to erect and also require large amounts of labor for maintenance (Lamarque et al., 2009). Fencing is a successful strategy in limiting non-climbing animals such as elephants, buffalo and wild pigs from entering farms or homesteads. Strand wire fences made of steel wire and droppers strung between metal poles, occasionally with lower section of netting will keep out smaller wild animals.

Elephant dung, cow dung or any plant material can be mixed with ground chili and then compressed into a brick which is then dried in the sun (WWF-SARPO, 200). When these chili bricks are placed at embers of a fire at the edges of crop fields or along invasion and burnt, they produce a noxious smoke which is a deterrent to wild animals, especially elephants (Hoare, 2012). If the prevailing breeze is consistent and the brick burns for three to four hours, the smoke can deter wild animals from invading a farm. However, chili alone is not an effective deterrent against wild animals and therefore farmers must supplement these efforts (Parker et al., 2007). For instance, hanging cow bells or equipment that can produce sound on a chili fence to alert farmers of a wild animal contacting the string barrier (Hoare, 2012). A modification of this strategy involves having sisal strung between two bush-cut poles or existing trees surrounding a growing crop. Only one or two strands of oiled sisal string placed at a height of one and half meter above the ground having intermittently placed cloth squares soaked in chili oil to enhance the smell. Sisal ropes or barks can be run from tree to tree or set up three meters long poles placed thirty meters apart, then pieces of white cloth attached to the twine at five meters intervals. This is done in conjunction with grease and hot pepper oil, which is then applied on the twine to act as a water-proofing media and in effect cause irritation to any wild animal such as an elephant when it comes into contact with the fence.

Chili aerosol has also been used in North America and Zimbabwe to prevent attack by elephants and being wind-dependent, it is difficult to control the direction of flow besides being expensive (Parker et al., 2007). Chili sprays can be used in areas where wild animals have become habituated to other simpler mitigation strategies, necessitating the use of locally produced sprays (WWF-SARPO, 2005). In the Tsavo Conservation Area (TCA) of Kenya, small-scale farmers use various mitigation strategies such as making noise using objects, especially metallic objects, use of scare crows, burn hot pepper to produce noxious smoke and light fire to scare away wild animals (Makindi et al., 2014). The small-scale farmers also burn rubber or cow dung to produce noxious smoke, use dogs to guard their farms and also guard farms using arrows and spears. Reviewed literature showed that farmers in Kenya use various human wildlife conflict mitigation strategies. However, limited information was available and was inadequately documented on the Agricultural Extension Human Wildlife Conflict Mitigation Strategies adopted, their effectiveness and sustainability among smallholder farmers in Laikipia County. Availability of this information can help in recommending strategies for improving the effectiveness and sustainability of those adopted or recommend alternative AEHWCMS.

2.6 Socio-Demographic Factors Affecting Farmers' Agricultural Technology Adoption

There are various social and demographic factors which can affect adoption of agricultural technologies and innovation such as age, gender, level of education and level of income of a farmer. During this study, selected social and demographic factors which affect adoption of agricultural technologies were focused and are discussed below.

2.6.1 Effect of A Farmer's Education Level on Adoption of Agricultural Technologies

Education level of a farmer refers to the number of years spent in formal schooling, which therefore measures the cumulative number of years a farmer has undertaken formal schooling (Kabanyoro et al., 2013). The education level of a farmer positively influences adoption of an agricultural technology by a farmer. For instance, a one-year increase in the average education level raises the level of agricultural output per capita by about 4%. This is because education increases a farmer"s willingness to adopt a new agricultural technology. For instance, education equips a farmer with understanding and knowledge which is necessary for technology adoption (GoK, 2007). Further, a skilled labor-force is more complementary to the introduction and effective utilization of new agricultural technologies such as human

28

wildlife conflict mitigation strategies. Educated farmers have a higher productive capacity and earn higher incomes (Bradshaw, Castallino & Diop, 2013).

Adoption of agricultural technologies by farmers is positively correlated to the education level of a farmer. This is because education improves a farmer"s ability to access and process information, thus improve on-farm activities (Baffoe-Asarel, Danqu & Annor-Frempong, 2013). Further, education increases the ease of adopting improved agricultural technologies by increasing a farmer"s acceptance of the improved technology. A literate population is an asset which provides skilled labor-force, thus reducing the cost of farm operations. Additionally, a higher education level is critical in improving economic growth and competitiveness since education can generate sustainable economic growth (Holland, Liadze, Rienzo & Wilkinson, 2013). Further, education enhances agricultural productivity, resulting from an educated labor-force which is better at creating, adopting and implementing improved agricultural technologies.

A higher level of education improves the quality of agricultural productivity. This is supported by the fact that primary and secondary levels of education have a higher level of productivity while university level of education enhances innovation (Garcia, Guanawan & Jreij, 2013). Further, a higher level of education fosters adoption of improved agricultural ideas and household economic growth. Additionally, a higher level of education makes a farmer more productive besides cultivating in her knowledge and life skills. A primary level of education positively influences economic growth than secondary level of education. This is because primary level education skills have an immediate effect on labor productivity. On the other hand, a higher level of education increases the probability of deciding and understanding information necessary for making innovation decisions (AGRA, 2014). Thus, farmers who have at least a primary level of education are likely to readily accept and adopt an improved agricultural technology such as the Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS). This will result in reduced human wildlife conflicts. This shows that education level of a farmer affects adoption of agricultural technologies. However, limited information was available and was inadequately documented on the effect of education level of smallholder farmers" adoption of AEHWCMS in Laikipia County. Lack of this information led to extension agents" promotion of human wildlife conflict mitigation strategies that were not effective. Availability of this information can help in determining whether farmers" education level affects adoption of improved agricultural

technologies and thereby recommend efforts to be put in place with the aim of enhancing adoption.

2.6.2 Effect of A Farmer's Age on Adoption of Agricultural Technologies

The age of a farmer positively influences adoption of an agricultural technology (Baffoe-Asarel et al., 2013). For instance, young farmers are more innovative and willing to adopt improved technologies whereas older farmers tend to avoid adopting the improved technologies because they associate the improved technologies with some difficulty. Since older farmers have undergone reduced cognitive ability to learn, they tend to avoid situations they perceive as being cognitively demanding such as improved agricultural technologies. This implies that the age of a farmer is positively correlated to technology adoption. Further, the advancement in age of a farmer negatively influences the decision to adopt an agricultural technology (Gbegah & Akubuilo, 2013). This is because older farmers are less risk-averse and less flexible than younger farmers and therefore less likely to adopt improved technologies, including Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS).

Adoption of an improved agricultural technology is negatively affected by the age of a farmer. For instance, a farmer aged over sixty-five years or is middle-aged is less likely to adopt an improved technology compared to a farmer aged thirty-five or below (Glass & Li, 2010). In some cases, the age of a farmer positively influences agricultural technology adoption. This is because it is generally assumed that older farmers have more farming experience and knowledge which they use to understand the benefits of improved agricultural technologies (Gbegah & Akubuilo, 2013; Kabanyoro et al., 2013). Older farmers can evaluate an improved agricultural technology better than young farmers. Further, as a farmer grows old she becomes more skillful and knowledgeable through learning by doing. However, this trend attenuates as she reaches middle age and her physical strength starts to decline.

This shows that the age of a farmer significantly influences agricultural technology adoption. Although younger farmers are likely to adopt improved agricultural technologies, older farmers are likely to adopt improved technologies and through use of their accumulated knowledge and experience choose the effective technologies especially the AEHWCMS. However, limited information was available and poorly documented on the influence of farmers" age on adoption of agricultural extension human wildlife conflict mitigation strategies among smallholder agro-pastoralists in Laikipia County. As a result, extension

agents were promoting human wildlife conflict mitigation strategies that were not appropriate for smallholder farmers of various ages. Availability of this information helped in determining the effect of age on adoption of agricultural technologies and therefore recommend for efforts to be put in place with the aim of enhancing adoption.

2.6.3 Effect of A Farmer's Level of Income on Adoption of Agricultural Technologies

Agricultural technology adoption is positively influenced by a farmer"s level of income (Namwata, Lwelemira & Mzirai, 2010). A high level of income facilitates a farmer"s ease of access to new agricultural technologies (Al-Ghaith, Sanzogni & Sandhu, 2010). Further, farmers with high incomes are less risk-averse, have more access to information and resources and therefore more likely to adopt improved technologies. Farmers having high incomes can easily adopt improved agricultural technologies (Gbegah & Akubuiolo, 2013). This shows that the level of income influences a farmer"s acceptance and adoption of an improved agricultural technology by determining her ability to pay for a technology because adoption requires a large initial resource investment. Since income enables a farmer to purchase initial inputs, it positively and significantly influences agricultural technology adoption.

This means that smallholder farmers whose income is relatively low cannot afford to purchase inputs required to initiate improved agricultural technologies, including the AEHWCMS. The farmers will also not afford effective human wildlife conflict mitigation strategies, probably because they will be perceived as being expensive and thereby continue experiencing significant degrees of human wildlife conflicts. However, limited information was available and poorly documented on the effect of farmers" level of income on adoption of agricultural extension human wildlife conflict mitigation strategies among smallholder agro-pastoralists in Laikipia County. Therefore, extension agents were promoting human wildlife conflict mitigation strategies that are not suitable for smallholder farmers of various levels of income. Availability of this information helped in determining how the level of income affects adoption of agricultural technology and thus recommends strategies for improving adoption of technologies by farmers of various income levels.

2.6.4 Effect of A Farmer's Gender on Adoption of Agricultural Technologies

Both men and women participate in farming activities and make significant contribution in agricultural development in different parts of the world. For instance, women make about 35-50% contribution to agriculture in Asia, 50-60% in SSA, 40% in Southern Africa and 50% in

East Africa (FAO, 2011). Although women make a significant contribution in agricultural development, they face various challenges which limit their achievement of optimal agricultural production (Njuki & Sanginga, 2013). The challenges include limited access to land and credit facilities, inadequate marketing information and limited ownership of production resources (Adekunle, 2013; Kroma, 2013). For instance, globally, more men than women own land in SSA, and women constitute about 15% of agricultural land owners (FAO, 2011). In Kenya, women own about 5% of land (Kroma, 2013). Land ownership determines eligibility for access to other productive resources such as agricultural credit. Women farmers are therefore less likely to purchase farm inputs such as fertilizer, improved seed, equipment and machinery (Njuki & Muller, 2013). Increasing women"s access to productive resources to match those accessed by men could increase farm yields by about 25% and consequently increase agricultural output by about 3.3%.

Since men control access to critical productive resources such as land, they are considered as the main decision makers in crop and livestock production (Bernier et al., 2013). Men also control access to farm productive assets such as farm machinery. Consequently, women find it difficult to implement the knowledge gained through extension training because they must seek approval from their male partners which may not be forthcoming (Farnworth, Fone-Sundell, Nzioki, Shivutse & Davis, 2013). This implies that men and women can engage in different crop and livestock production enterprises and also adopt agricultural technologies based on the level of control and access to productive resources. Further, the income earned by men and women is different. The mean income earned by men is three times higher than that earned by women, although a higher percentage of women than men provide farm labor (GoK, 2011). Since men acquire and control more productive resources than women, they earn more income (Namwata et al., 2010). An increase in income enables farmers to acquire farm inputs which are necessary for agricultural technology adoption. Further, gender inequality affects access to agricultural credit, farm inputs and extension services (Seguino & Were, 2013). This means that male farmers who have relatively more access to agricultural credit, farm inputs and agricultural extension services are more likely to adopt improved agricultural technologies, unlike females.

Men and females have different levels of access to agricultural extension services (Anandajayasekeram, Puskur, Sindu, & Hoekstra, 2008). Most women farmers (62%) do not attend agricultural extension trainings although they manage most farms (Manfre et al.,

2013). Further, women farmers are not targeted by agricultural extension programs. For instance, in Kenya, extension agents target men as the main farmers yet they do not attend training for agriculture thus creating a gap between those receiving agricultural information and those implementing it (Farnworth et al., 2013). This is because men attend trainings but do not implement what they have learnt. In addition, the selection criteria for farmers to attend agricultural trainings using land size owned, literacy level and ability to purchase inputs decreases chances for female participation (Manfre et al., 2013). Additionally, even if women participate in agricultural trainings, they may not implement the knowledge and skills they learn because they lack the decision-making authority and resources. The gender of a farmer especially, the household head influences the decision whether or not to adopt a new agricultural innovation (Gbegah & Akubuilo, 2013). For instance, in Africa, women‟s less access to productive resources (land, labor, money) undermines their ability to implement labor-intensive agricultural innovations. Thus, men adopt agricultural technologies more than women because men have more access and control to productive resources than women. Increasing women‟s access to productive resources to match those of men could increase farm yields by about 20-30% and consequently increase agricultural output in developing countries by about 2.5 to 4.0%.

This shows that the gender of a farmer positively and significantly affects the potential to access, accept and adopt an agricultural technology, including the human-wildlife conflict mitigation strategies. This could mean that male farmers experience high levels of human-wildlife conflict than female farmers. This could be attributed to the fact that men are not the major source of farm labor although they receive major agricultural training by extension service providers. In contrast, females who are the major source of farm labor do not participate in most agricultural trainings offered by extension service providers. Further, the few female farmers who attend trainings do not implement the knowledge and skills acquired because they are not the principal decision makers in their households. Consequently, farmers in most households could be adopting agricultural extension human wildlife conflict mitigation strategies that are not effective and therefore continue experiencing high degrees of human-wildlife conflict. However, limited information was available and was poorly documented on the effect of gender on the adoption of agricultural extension human wildlife conflict mitigation strategies among smallholder agro-pastoralists in Laikipia County. As a result, extension agents were promoting human wildlife conflict mitigation strategies that are not appropriate for smallholder farmers of various gender groups. Availability of this

information could help in determining the human wildlife conflict mitigation strategies adopted by the various gender and recommend for their improvement with the aim of enhancing adoption.

2.7 Human Wildlife Conflict Coping Strategies Promoted through Governance

Human-wildlife conflict is a phenomenon which occurs in different parts of the world especially in areas where farming activities are undertaken in areas neighboring wildlife habitats. As a response, wildlife conservation organizations such as Kenya Wildlife Service promote various human-wildlife conflict coping strategies such as giving monetary compensation to farmers, insurance and incentive programs, voluntary relocation and translocation of wildlife. These strategies do not require significant input from agricultural extension. This study sought to determine the effectiveness of these human wildlife conflict coping strategies on human wildlife conflict among smallholder agro-pastoralists in Laikipia County.

2.7.1 Monetary Compensation of Claims for Farmers' Losses Caused by Wildlife

Governments of some countries such as India, China, Mozambique and Zimbabwe and the wildlife conservation organizations in different parts of the world establish schemes whereby farmers are given money to cover a portion of the losses caused by wildlife (Roundeau & Bulte, 2007). Initiatives which are aimed at compensating farmers for the losses caused by wildlife attack on livestock, humans or crop damage are popular among both private and public organizations. They are formed with the aim of promoting conservation of wild animals such as elephants, rhinos and lions in Africa, snow leopards, tigers and antelopes in India and East Asia. Since human-wildlife conflict cause significant economic costs to farmers, therefore, compensation is made to farmers with the aim of alleviating further conflicts. Making compensation involves governments offsetting a portion of the cost of a conflict incident through either cash or „in kind" payment directly to farmers (Parker et al., 2007). It may also involve making monetary payment to the affected individuals or giving them licenses to exploit natural resources, allowing them to hunt wild animals and collect firewood, timber and fodder from inside wildlife habitats. Compensation of a damage or loss caused by wildlife is based on an exhaustive assessment valued at prevailing market price in a given country.

Financial compensation is considered to be a more practical solution to losses caused by wildlife (MFW, 2011). The major benefit attributed to compensation is that it increases

tolerance of wildlife and promotes more positive attitudes and support for wildlife conservation among people living adjacent wildlife habitats (Musimbi, 2013). Compensation schemes are implemented in Asian countries such as India and China (Roundeau & Bulte, 2007). Payment of compensation in the event of a loss is usually confined to specific category of loss, such as human death or livestock death as a result of wildlife attack such as elephants or hyena (Lamarque et al., 2009). Compensation is paid out with the aim of increasing tolerance levels to damages among the communities affected so as to prevent them from taking actions that are harmful to wildlife for example, hunting and killing wild animals. Compensation schemes are used in African countries such as Mozambique, Ghana and Zimbabwe. However, the demand for compensation is often higher than what governments can afford to provide. Furthermore, the efficiency of the compensation schemes is often affected by corruption and funds being inadequate.

Although compensation programs are established for good intentions, they can lead to disastrous effects. For instance, compensation that is costly for financing agencies can lead to reduced wildlife populations and a fall in local people"s welfare (Roundeau & Bulte, 2007). This is because compensation can distort commodity prices and consequently increase returns to agriculture which then encourages agricultural expansion even to areas that are more vulnerable to wildlife attack. Furthermore, the quantity of crops damaged by wildlife is estimated and its value assessed at the prevailing market price. In Africa, compensation programs run by governments pay only a fraction of the losses caused by wildlife, with the compensation being based on observed market prices. However, it may be difficult to predict what the value of crops will be in the absence of damage since trying to do so may appear arbitrary to farmers and therefore erode their confidence and trust in the compensation system.

The monetary compensation scheme has been tried in different countries but has never been successful, due to various reasons. First, compensation is unable to decrease the degree of conflict because the real problem is not being addressed. It looks like nothing is being done to decrease the likelihood of wildlife attack (Hoare, 2012). Compensation reduces the interest for self-defense among farmers. This aggravates the scale of damage, and this cannot address the unquantifiable opportunity costs borne by people who are affected by the threat of wild animals. Compensation is expensive, cumbersome and slow to administer because of the need to train assessors covering a large area, which also has financial implications, and once

started, it has no end point. A compensation program is open to abuse and corruption through bogus claims, inflated and intentional cultivation on places where crops can be attacked and damaged. Additionally, since funds are not adequate to cover all compensation claims, payment of compensation to only some victims can cause resentment among recipients. Furthermore, the value of payment is eroded by inflation and the meager pay-outs cause resentment among recipients. These reasons make monetary compensation to be considered as a flawed concept since it only addresses symptoms and not the real causes of human- wildlife conflict.

Compensation programs have been used in African countries such as Rwanda, Botswana, Uganda, Burkina Faso, Zimbabwe, Ghana and Mozambique (Lamarque et al., 2009). However, most African countries do not pay compensation to farmers for losses caused through attacks by wild animals because they argue that the compensation schemes do not significantly reduce human-wildlife conflict. They therefore need to be modernized, to make them less bureaucratic, more realistic, more reactive and transparent. For instance, a compensation scheme piloted in Zimbabwe was abandoned when the number of claims quadrupled in the second year of implementation. In Mozambique, before compensation is made for damages caused by wild animals, assessment is done by a specific committee. In the year 1991, each one of the one hundred and twenty-seven farmers whose crop was damaged received USD 40 (an equivalent of 350kg bag of millet).

However, when the government of Mozambique paid compensation to farmers for damages caused by wild animals in the area neighboring Maputo Special Reserve in form of food products, crop damage just continued to increase. This happened until crop damage reached a level where the government faced difficulties obtaining sufficient food for use in compensation. The compensation program was therefore abandoned. The compensation schemes used in Asian countries such as in India are not regarded effective because the process of making claim and verification and also approval procedures are bureaucratic. This results in a small proportion of up to only 11% of all claims being paid (Roundeau & Bulte, 2007). Further, reimbursement of claims takes relatively a long period of time, of up to 6 months before being paid, even when the losses are undervalued. Additionally, approximately, only 5% claims of the total livestock lost through injury and deaths are paid while only 14% of crop damage is paid. The long duration taken in processing and paying out claims and the costs involved in making the claims discourages farmers from making claims.

In China, about 10% of claims are paid out to pastoralists whose crops are destroyed by wild animals (Roundeau & Bulte, 2007). In the Sub Saharan Africa countries, compensation schemes for losses caused by wild animals exist although few are considered effective. Compensation programs in Uganda are unaffordable since despite making out payments, crop damage has been escalating (Hoare, 2012).

A compensation program was introduced and implemented in Kenya with good results, although it was suspended in the year 1989, when it was regarded unworkable (Lamarque et al., 2009). This was because it neither replaced nor paid out compensation for installations destroyed by wild animals. Later, the scheme was re-introduced but again became problematic because the government had not provided for reimbursement of crop and livestock losses, repair or replacement of any property destroyed by wildlife (MFW, 2011). A compensation of USD 400 could be made to a family concerned for loss of human life or injury and was regarded inadequate to cover funeral expenses or even hospital bills. This amount of compensation also disregarded the impact of human-wildlife conflict on dependent children who drop out of school due to lack of money to pay fees (WWF-SARPO, 2005; Lamarque et al., 2009). The compensation scheme also disregards the impact of monetary payment for crop damage, livestock and personal loss resulting from human-wildlife conflict. These compensation schemes were therefore considered unsustainable because they entirely relied on financial budgetary allocation by the government and therefore did not encourage community members to protect their property and co-exist with wildlife.

Further, in Kenya, compensation may be applied for in response to human injury or death caused by wild animals as set out in the Wildlife Act (Conservation & Management), Chapter 376, Section 62 of the Laws of Kenya. According to this law, as from 1st July 2006, up to 2012, a maximum of fifty thousand shillings (50,000 KES) and two hundred thousand shillings (200,000 KES), was to be paid for human injury and human death respectively (GoK, 2009; KWS, 2012; GoK, 2013a, & c). The financial compensation sought to address the visible direct impacts of wild animal attack incidents in order to increase human tolerance for wild animals (Barua, Bhagwat & Jadhaw, 2013). However, community members regarded putting the value of human life at two hundred thousand shillings as being low. Compensation paid out to farmers was set by the government on the rates, assessment and payment claims determined by the District Wildlife Compensation Committees (DWCCs)

(MFW, 2011; KWS, 2012). It was paid only for human injury or death, not including destruction of crops, livestock or property destroyed by wild animals.

A new wildlife conservation policy was enacted in Kenya in the year 2013. The new Wildlife Conservation and Management Act of 2013 which came into force as from January 2014 allows the formation of a County Wildlife Conservation and Compensation Committees (CWCCCs) whose responsibility is to review and recommend claims for compensation (GoK, 2013a & c). The claims result from loss of livestock or people"s life or damage of crops as a result of attack by wild animals. The committee verifies a claim made by a farmer and then recommends to the cabinet secretary who shall consider the cases and then pay five million shillings for human death. Two million shillings are paid for permanent disability and at least two million for any other injury, depending on the extent of injury. The law allows any person who suffers a loss or damage to crops, livestock or property resulting from attack by wild animals to submit a claim to the County Wildlife Conservation Compensation Committees for consideration. After review of claims made by a farmer, an award and compensation are made, valued at a prevailing market price. However, no compensation is made in cases where the owner of livestock, crop or any other property failed to protect her crops, livestock or property against damage or destruction by wildlife (GoK, 2013a, c & d).

For a farmer in Kenya to receive compensation for a claim launched after wild animals damage their crops, injure or kill their livestock or even people, the correct procedure must be followed. The procedure in seeking compensation as per the Wildlife Compensation and Management Act of No. 47 of 2013 requires that once an incident of attack has occurred, a farmer should report to KWS offices within 48 hours and make effort to preserve the evidence of attack by filling either Form A or Form B (Appendix E & F) (GoK, 2013a, c & d). Upon receiving the claim form, an assessor is dispatched by KWS to the site of the incident to undertake assessment so as to indicate the extent and amount of damage sustained. An assessor is expected to present a report to the farmer and also to the County Wildlife Conservation and Compensation Committee (CWCCC). A claimant is supposed to provide proof of death, body injury of livestock or people or loss or damage to crops by providing an Identification Card (ID) or birth certificate. She should also provide a death certificate, medical report of the person injured (P3), claim form (either Form A or B) and a report from an assessor and evidence of ownership of land where livestock or human life loss or crop damage occurred. Upon the County Wildlife Conservation and Compensation Committee

(CWCCC) receiving a report from an assessor, the committee verifies a claim of loss or damage of crop or livestock injury or death and makes payment which varies depending on the assessment report within 60 days of receiving a claim.

On the other hand, on receiving a claim for human injury or death, the committee (CWCCC) shall within thirty days of receiving the report from an assessor verify the claim and make its recommendation to the Cabinet Secretary in charge of the Ministry of Environment and Natural Resources (MENR), where Kenya Wildlife Service is housed (GoK, 2013c & d). Upon receipt of CWCCC recommendations, the Cabinet Secretary is expected to make payment of the claim, of five million for human death, three million for injury resulting to permanent disability and two million for any other body injury within 30 days. Compensation for either human or livestock injury or death and damage to crops is calculated based on the actual loss or damage that has occurred. A claim shall not be compensated if the owner is considered not to have taken reasonable measures to protect her crops, livestock or thought that she used the crop as a lure to wild animals. Further, no compensation is made for injury, death or loss of property in a gazetted wildlife habitat. Therefore, where payment is made for a claim for livestock injury or death, the injury or death have resulted directly from an attack by wild animals and the carcass of the livestock being claimed for must be available during assessment by a Kenya Wildlife Service officer.

In most cases, compensation will be obtained only for loss of life or personal injuries and no compensation is claimable when the human injury or even death occurs during unlawful actions by the person concerned or during normal wildlife utilization activities such as hunting (Makindi et al., 2014). The major benefit attributed to compensation schemes is that they increase tolerance of wildlife and promote positive attitudes and support for conservation among people who live closer to wildlife habitats (Musimbi, 2013). However, communities regard the process of claiming and making compensation to be slow. Additionally, some farmers report that when wild animals attack their farms and feed on crops, they do not receive any compensation from the government even when all crops have been lost (Bond, 2014). Other farmers consider the compensation paid out to farmers for injury or loss of human life to be insufficient or not commensurate to the loss suffered (Makindi et al., 2014). Furthermore, it is unfair not to compensate individual losses and damage to property such as livestock attack and crop damage. The reviewed literature showed that farmers in Kenya are aware of the availability of compensation schemes against

losses caused by wildlife. However, limited information was available and was also poorly documented on the effectiveness of compensation schemes in coping with human-wildlife conflict among smallholder agro-pastoralists in Laikipia County. Additionally, limited information was available on farmers" knowledge of the correct procedure for seeking compensation against losses caused by wildlife attack. Availability of such information could help in putting in place measures to improve the effectiveness of the compensation schemes or recommend alternative strategies of coping with human wildlife conflicts. This can help to save the huge financial resources allocated and used for compensating losses resulting from human wildlife conflicts.

2.7.2 Incentive Programs

Incentive programs are based on subsidies which are aimed at offsetting the cost of conservation and adoption of conservation-friendly practices which create tolerance towards wild animals through the exchange of benefits derived from wild animals (WWF-SARPO,

2005). They may also involve giving out licenses to farmers who are neighbors to wildlife habitats to exploit natural resources through tourism, hunting or collecting fuel-wood, timber, mushroom and fodder among others. In Zimbabwe, crocodile eggs are collected from the wild by communities and sold to private crocodile farms. In Mozambique, local communities receive about twenty per cent of the income obtained from exploitation of wildlife resources through tourism and hunting (Lamarque et al., 2009). The approach of sharing benefits provides tangible benefits to land owners as a way of recognizing the role they play in hosting wild animals on their land and meeting the costs of conserving the wildlife. Further, through the tourism industry, job opportunities are created which in turn compensates the cost of maintaining wildlife. All these efforts are aimed at changing local people"s negative perception of wildlife conservation.

The incentive program was implemented successfully in India and significantly reduced forage overlap among livestock and wild herbivores through clearance of an area of five hundred hectares from human use and livestock grazing (WWF-SARPO, 2005). In turn, community members received financial benefits for loss of grazing areas and land. During implementation of this program in Mongolia, pastoralists were not permitted to poach snow leopards, thereby losing some income. The lost income was offset by granting permission for sale of wooden handicrafts. The benefits derived from wildlife conservation can also take the form of community development projects such as construction of school buildings,

construction of hospitals, capacity-building and training of community members and also cash payment to households (Parker et al., 2007).

The Kenya Wildlife Service implements a program aimed at sharing revenue generated from visiting wildlife conservation areas especially parks, with rural communities that are living in areas neighboring the parks. This strategy is meant for encouraging the community to participate in mitigating human-wildlife conflict and wildlife conservation (Makindi et al., 2014). The money obtained from tourism is then used to fund local community development projects such as the construction of hospitals, classrooms for schools, water supply and hospital infrastructure. Although such development projects target the people affected by wildlife conservation, they do not actually reduce the amount of crop destroyed or number or livestock injured or killed. They rather, attempt to offset the damages by providing positive benefits to communities that suffer from human-wildlife conflict (Parker et al., 2007; Musimbi, 2013). It is therefore not a direct solution to human-wildlife conflict but it attempts to reduce enmity with wildlife. Although the literature reviewed indicated that farmers in Kenya are aware of the incentive programs offered to farmers susceptible to human wildlife conflict, inadequate information was documented on the effectiveness of the use of incentives in coping with human-wildlife conflicts among small-holder agro-pastoralists in Laikipia County. Lack of such information could be contributing to the promotion of activities which aggravate the occurrence of human wildlife conflicts. Availability of such information could be used to recommend strategies for improving the effectiveness of incentives or recommend alternatives strategies for coping with human wildlife conflict.

2.7.3 Translocation of Wild Animals

The translocation technique involves removal of wild animals from an area considered a high conflict area and moving them to an area that is considered as low risk or a new site (Parker et al., 2007). Translocation may be the best and practical approach in cases where territorial vacancies are available or may also be done as a way of sale of live animals to privately owned wildlife reserves (Lamarque et al., 2009). This technique may be used as a pre-emptive action taken before human-wildlife conflict occurs. It works well when wild animals that require being isolated have a high population density and therefore need to be reduced through relocation of some individuals. The relocation approach was used in Northern India when the presence of rhesus monkeys became a nuisance to community members through

biting, stealing and destroying property such as house furnishings, telephone antennae, gardens and electric poles.

When some of the monkeys were moved to a different semi-natural forest, their population reduced and consequently reduced the human-wildlife conflict that was being experienced in that area (Lamarque et al., 2009). For some years after the relocation of the monkeys, their population remained low and therefore in a way resolved the problem of human-wildlife conflict. Translocation of wild animals is also practiced in Namibia (Republic of Namibia). The same approach was used in South Africa and Kenya where elephants were tranquillized and then transported to a new location, resulting in a reduced situation of human-wildlife conflict. A total of eleven elephants were translocated between the year 2000 and 2001 from Laikipia County to Meru National Park (Graham et al., 2009a). Although reviewed literature showed that farmers in Laikipia County were aware of translocation of wildlife, inadequate information was documented on its effectiveness in coping with human wildlife conflict among smallholder agro-pastoralists in Laikipia County. Availability of this information can be used to recommend ways of improving its effectiveness or recommend alternative human wildlife conflict coping strategies.

2.7.4 Land Use Planning

This human-wildlife conflict mitigation strategy involves accommodating the needs of a people and those of wild animals and the community-based wildlife conservation in a way in which benefits return to rural communities (Parker et al., 2007). Implementation of this mitigation strategy is aimed separating agricultural activities through zoning of separate areas for agricultural activities and wild animal conservation. It can also be achieved through the development of buffer zones at the edges of wildlife corridors, thereby separating agricultural activities and wild animals within a landscape. Consequently, this helps in solving the cause of human-wildlife conflict and reducing the potential of its occurrence in the long-term. This results from the avoidance of growing food crops within the range of wild animals. However, such complex interactions require political will and larger timeframes for them to be implemented. Consequently, in order to reduce the impact of human-wildlife conflict on rural communities in the meantime, short-term mitigation strategies should be combined with community-based mitigation strategies. However, limited information was available and was poorly documented on adoption and effectiveness of the land-use planning approach in coping with human-wildlife conflict among small-scale agro-pastoralists in Laikipia County.

Availability of information about effectiveness of land use planning as a strategy for coping with human wildlife conflict can help in recommending ways of enhancing its effectiveness or alternative human wildlife conflict coping strategies.

2.7.5 Community Insurance Programs

Livestock and crops can be covered against the risk of attack by wild animals through payment of a premium share of insurance by community members and the local government agencies. Then rural people can be allowed to take a minimum annual cost which is refunded in the event of crop and livestock loss (WWF-SARPO, 2005). Local insurance programs have shown great promise in Namibia where revenues generated from wildlife are used to offset losses individual farmers incur. This is common, especially among conservancy owners who contribute to the insurance kitty (Parker et al., 2007). An insurance scheme has been implemented in India successfully (WWF-SARPO, 2005). It involved community members making monthly contributions to the insurance scheme. Then they received compensation which was proportional to the total number of livestock killed and the amount of money contributed to the insurance fund within a year"s period. Individual community members contribute towards the insurance program by paying premiums for insurance against damage to crops, loss of livestock or personal injury or even death. However, reviewed literature showed that limited information was available and was poorly documented on farmers" awareness and willingness to use community insurance schemes for coping with human wildlife conflict. Further, limited information was available and poorly documented on the effectiveness of community insurance schemes in coping with human-wildlife conflict among smallholder agro-pastoralists in Laikipia County. Availability of such information can help in improving the effectiveness of insurance schemes or recommend other human wildlife conflict coping strategies and also save the huge financial resources used for insuring against losses resulting from human wildlife conflicts.

2.8 Collaboration between KWS and Agricultural Extension in HWC Mitigation

Kenya Wildlife Service is a corporate body established by an Act of Parliament mandated to conserve and manage wildlife habitats and wildlife conservation areas such as forests, game reserves, national parks and conservancies (GoK, 2013a & c). It also manages human-wildlife through implementation of various approaches aimed at changing attitudes of affected communities to wildlife and conservation institutions (Makindi et al., 2014). The main functions of Kenya Wildlife Service include provision of wildlife conservation

education and extension services, creation of public awareness and support of wildlife conservation policies (GoK, 2013c). In an effort to offer education about the conservation of wild animals, benefits and mitigation of human-wildlife conflict, wildlife conservation personnel visit individual community members and train them. The personnel also organize short courses for community members where they train, sensitize and educate them. Education of community members also involve organizing community barazas and exchange visits to wildlife conservation areas for community member to learn how wild animals are conserved and the benefits that can be accrued. Community education initiatives also include educating community members using mass media and sensitization programs. They also include trainings about wildlife conservation strategies and also human-wildlife conflict mitigation strategies by organizations involved in the conservation of wild animals. All these efforts are geared towards instilling a sense of ownership and responsibility of wildlife resources, a process that is continuous. Kenya Wildlife Service also promotes positive interaction between people and animals through the physical and financial support given towards the conservation of wild animals.

In its efforts to mitigate human-wildlife conflict, Kenya Wildlife Service promotes various community-based initiatives which include education and awareness creation (KWS, 2016). These efforts are aimed at stimulating the local people to participate in the conservation of wild animals, so that they can derive benefits from the same venture. As an awareness creation approach, Kenya Wildlife Service promotes participation of local people and inclusive learning aspects which are important in wildlife conservation. Local communities are encouraged to access knowledge, both about conservation resources and conservation strategies (LWF, 2012). In all these situations, conservation education is given emphasis. For instance, using an interactive drama has been found to be effective in generating public understanding of wildlife conservation programs (Graham, Nyumba, Kahiro, Mutugi & Adams, 2009b). This is attributed to its ability to break barriers of literacy and create opportunities to discuss complex and controversial issues in an open and safe environment. However, educating communities and creating awareness on the importance of wildlife conservation is considered about 21% effective in mitigating human-wildlife conflict among smallholder farmers in Kenya (Makindi et al., 2014).

Kenya Wildlife Service also promotes various human-wildlife conflict mitigation strategies such as construction of moats, construction of trenches, growing of crops that are unpalatable

to wild animals and growing of natural fences (KWS, 2016). A moat is a deep wide channel dug round a castle and filled with water to make it more difficult for animals to cross and attack. They can be dug in the space between a farm and wildlife habitat to deter a wild animal from crossing over from its habitat to a farm. Knowledge and skill about moat construction is provided to community members through training by KWS personnel. Kenya Wildlife Service personnel also train community members on the construction and maintenance of trenches along farm areas bordering wildlife habitats, with the aim of deterring movement of wild animals such as elephants and hippopotamus from their habitats into the farm. Additionally, the KWS gives seeds for Mauritius thorn and seedlings of Kai apples, cactus and sisal to community members bordering wildlife habitats and also trains and educates them on how to establish and maintain them.

Agricultural extension as a form of out of school education educates and trains farmers on various agricultural technologies, including human-wildlife conflict mitigation strategies. Through agricultural extension, farmers are educated and trained on farming technologies with the aim of improving agricultural production and productivity (Anaeto et al., 2012). Farmer education enhances adoption of agricultural technologies (Anderson, 2008; Zivkovic et al., 2009). Further, agricultural extension equips rural people with skills and knowledge needed to improve their livelihood and well-being (Davis, 2008; Samir et al., 2013). Agricultural extension services are provided both in developed countries such as New Zealand, Japan, Australia, Canada and United States and also in developing countries such as Serbia (Zivkovic et al., 2009). At initiation, the main aim of agricultural extension was to transfer agricultural information and technologies from central research stations to farmers, with the aim of increasing agricultural productivity and production in the interest of achieving national food security (CGIAR. 2013; Kidanemariam et al., 2013). Consequently, agricultural extension strategies basically focused on increasing production of food crops through provision of training and information and improving access to input and support services (Anandajayasekeram et al., 2008). In contrast, modern agricultural extension is aimed at shifting from basically increasing agricultural productivity as the main goal to a wider and comprehensive goal of achieving sustainable natural resource management (Swanson, 2008; Kidanemariam et al., 2013).

Further, initially, agricultural extension was offered mainly by the Ministry of Agriculture (Swanson, 2008; Swanson & Rajalahti, 2010). Modern agricultural extension in African

countries such as Kenya is pluralistic, involving many different providers although dominated by public extension service under the Ministry of Agriculture (Anaeto et al., 2012; Davis, 2008). Modern extension and advisory services promotes interaction among farmers and other rural actors such as Community-Based Organisations, private sector, research institutions, education centers and various government departments (Davis, 2008). Adoption of modern agricultural ideas and technologies enhances achievement of agricultural development goals (Laoubi, Boudi, & Yamao, 2010).

Rural people live in geographical spaces that are dominated by farms, forests, water, coastal zones, mountains or deserts (FAO, 2013). For rural development to be realized, rural communities should be supported to manage their own natural resources more effectively. Agricultural extension therefore being a public good educates community members about community natural resource management approaches (Christoplos, 2010). In Zimbabwe, agricultural extension service implements community development projects such as CAMPFIRE, with the aim of mitigating human-wildlife conflict while empowering local communities (Bond, 2006; Gandiwa, Heitkonig, Lokhorst, Prins & Leeuwis, 2013). Community development projects are also implemented in other African countries such as Zambia and Botswana (Mbaiwa, 2005; Richardson, Fernandez, Tshirley & Tembo, 2012).

Extension service in Kenya is provided by public, private, Community-Based Organisation and Farmer-Based Organisation (Swanson, 2008; MoA, 2009). Its main aim is to increase crop production and productivity. One of the core functions of agricultural extension in Kenya is to promote conservation of natural resources and also promote sustainable environment and natural resource management. This is because they form a basis for agriculture (GoK, 2012a). This is achieved through imparting knowledge on good agricultural practices on water catchment, soil and water conservation, wetland utilization and community-based natural resource management. This also includes human-wildlife conflict mitigation through promotion of mitigation strategies. The human-wildlife conflict mitigation strategies promoted by agricultural extension include avoidance of farming on wildlife corridors, avoidance of farming adjacent wildlife habitats, growing of crops that are unpalatable to wildlife, establishment of live fence, planting heavily attacked crop beyond a suitable wildlife habitat and agro-forestry practices (Parker et al., 2007; Hocking & Humle,
2009; GoK, 2012a; Hoare, 2012; Mc Guinnes & Tailor, 2014). In Laikipia County, public extension promotes various human-wildlife conflict mitigation strategies such as growing of

crops that are unpalatable to wildlife, growing of natural fences, digging trenches and growing of buffer crops (GoK, 2013b). Extension Service also promotes community-based natural resource management practices such as forest conservation, farm forestry, fodder crop production, fruit crop production and woodlot production, all aimed at human-wildlife conflict mitigation.

Agricultural extension in Kenya, including areas in Laikipia County, provide extension service about human-wildlife conflict mitigation strategies and also involve a wide spectrum of actors and practitioners in the industry. Similarly, as Kenya Wildlife Service offers some extension services aimed at mitigation of human-wildlife conflict it is expected to involve various stakeholders. It is therefore evident that both the agricultural extension policy and the Kenya Wildlife Service policy support partnership and collaboration during implementation of their mandated activities, which also includes provision of extension services and community education. However, reviewed literature did not indicate the extent of collaboration during promotion and implementation of human wildlife conflict mitigation strategies among smallholder farmers in Laikipia County. This implies that the aspect of collaboration and partnership is not being implemented although policy guidelines exist. Failure to collaborate as stipulated in both the agricultural extension policy and the KWS policy guidelines could be negatively affecting the effectiveness of human wildlife conflict mitigation strategies adopted by the smallholder agro-pastoralists in Laikipia County. It could also lead to duplication of functions and responsibilities, resulting in inefficiency in the use of both financial, material and human resources.

2.9 The Role of Agricultural Extension in Kenya in Human-Wildlife Conflict Mitigation
Agricultural extension entails the transfer of agricultural technologies to rural farmers for application on their farms so as to improve their farm productivity and standard of living (Munyanga & Jayne, 2006). It is the assistance given to farmers so as to enable them to identify and analyze their production problems and consequently become aware of the opportunities available for improvement. It is also regarded as a form of out of school education which assists farmers through educational procedures, in improving their farming methods   and technologies. It also promotes adoption of agricultural technologies. Agricultural extension is an important source of agricultural information because it disseminates new and improved agricultural technologies and also serves as a bridge between researchers and farmers (Margono & Sugimoto, 2011).

Through agricultural extension, farmers are trained and educated on various farming technologies with the aim of improving productivity and production (Anaeto et al., 2012). Further, modern agricultural extension promotes interaction among farmers, the private sector, research institutions, education institutions and agricultural organisations (Davis & Kroma, 2013). Agricultural extension also promotes sustainable utilization of natural resources, including human wildlife conflict mitigation, food security and improved livelihoods (Kidanemariam et al., 2013). However, limited information was available and was poorly documented on the effectiveness of agricultural extension human wildlife conflict mitigation strategies among smallholder farmers in Laikipia County.

Human wildlife conflict is a challenge that significantly affects agricultural production and productivity especially for smallholder farmers. In response, agricultural extension, which is provided by various players in the agriculture sector such as Rain Forest Alliance and Kenya Wildlife Service although dominated by public extension seeks to assist smallholder farmers in mitigating human wildlife conflict. This is achieved through promotion of various Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) such as growing of live fences (using sisal, cactus and Mauritius thorn) and expected adoption of the strategies by farmers (Parker et al., 2007). The other AEHWCMS promoted include digging trenches round the farm to prevent wildlife from entering the farm and growing crops that are unpalatable to wildlife, such as hot pepper, ginger and pyrethrum. In Uganda, agricultural extension promotes avoidance of farming on wildlife corridors and adjacent wildlife habitats and also growing crops that are less susceptible to wildlife attack such as onions (Hoare, 2012; Hocking & Humle, 2009). However, limited information was available on the AEHWCMS adopted and their effectiveness among smallholder farmers.

In Kenya, agricultural extension also promotes various Agricultural Extension Human Wildlife Conflict Mitigation Strategies such as growing of crops that are unpalatable to wildlife (such as hot pepper) against elephants and some sorghum varieties against birds to prevent damage. Agricultural extension also promotes digging of trenches round the farm to deny wildlife such as hippopotamus access to the farm. The strategies promoted also include growing of live fence using sisal, cactus, Kai apple or Mauritius thorn against buffalo, monkey and elephants. The mitigation strategies also include growing of crops that have spikes such as some varieties of sorghum against birds (Quelea quelea & Weaver bird), guarding the farm using livestock such as donkeys and African honey bees against elephants

48

and buffaloes (Graham et al., 2010). The AEHWCMS can either be used singly or in combination with others depending on the species of wildlife targeted. Although literature shows that agricultural extension can play a significant role in human wildlife conflict mitigation, little information was available and documented on the effectiveness of human wildlife conflict mitigation strategies promoted by agricultural extension among smallholder farmers in Laikpia County. Consequently, agricultural extension could be promoting human wildlife conflict mitigation strategies which are not effective. Availability of the information can be used to recommend strategies of improving the effectiveness of agricultural extension human wildlife conflict mitigation strategies or alternative human wildlife conflict mitigation strategies.

2.10 Contribution of Agricultural Extension and KWS Policies in HWC Mitigation

Agricultural extension as a form of out-of-school education system disseminates agricultural technologies to farmers with the aim of helping them to solve agricultural problems. Many countries have developed different types of agricultural education systems which have been categorized as „Agricultural Extension Delivery System‟ (AEDS), and the „Agricultural Extension Acquisition System‟ (AEAS) (Kibet, Omunyin & Muchiri, 2005; Naswem, Daudu & Ejembi, 2008). The AEDS implies that there is a body of knowledge, information and technology that are accessible to the extension agency that it makes available to farmers who need them. This is typical of Ministry-based extension (conventional agricultural extension model). It involves public extension workers, who implement extension programs that are fixed by the government and are centralized from its headquarters with the extension agency driving the process. On the other hand, AEAS involves a group of organized farmers who can reach beyond their village to acquire information and other inputs considered desirable. Here, farm organization is involved in the recruitment and dismissal of an extension agent who facilitates and advises group members. In Kenya, the conventional agricultural extension model is common where the Ministry of Agriculture extension agents have information, knowledge and technologies that they disseminate to farmers.

For effective agricultural extension service delivery, a national policy framework is a fundamental concern. This because the policy will indicate the national agricultural development priorities and outline the organizational structures necessary to implement the priorities. It will also indicate the corresponding institutional linkages and the extent and nature of commitment that encourages farmers to support the policy. In Britain, immediately

after the world war when there was urgent need to increase agricultural production, an agricultural Act was promulgated. Consequently, the National Agricultural Advisory Services (NADAS) was formed to provide extension services so as to boost agricultural production through technology adoption (Naswem et al., 2008). However, countries in Central Asia have no national policy framework for developing agricultural extension services. In Nigeria, agricultural extension was introduced by the colonial government (1861-1950) and there was no policy or goal statement on agricultural extension. During the colonial period, the colonial government designed extension services for the benefit of the British economy. The post-colonial government inherited the agricultural extension structure from the colonial government. Later, the extension policy was determined by the World Bank, with the adoption of the Training and Visit (T & V) approach.

In its efforts to revamp the agriculture sector and reverse the negative trend in extension service delivery, the Ministry of Agriculture and Rural Development (MoARD) of Kenya developed the National Agricultural Extension Policy (NAEP) (Kibet et al., 2005; Lopokoiyit, 2012). This policy was implemented from the year 2001 to 2011 under the National Agriculture and Livestock Extension Program (NALEP). This policy led to the introduction of the pluralistic model of extension, with the government leading in facilitating other actors in the provision of extension services. Its aim was to guide and harmonize management and delivery of extension services in the country (Kibet et al., 2005; GoK, 2001). This policy advocated for demand-driven extension services and involvement of other players in agricultural extension service delivery. The NAEP was further re-defined through the Strategy for Revitalization of Agriculture (SRA) as part of Economic Recovery for Wealth and Employment Creation (ERSWEC). The aim of ERSWEC was to modernize agriculture and promote partnerships and accountability for efficient extension services. This could result in increased production, improved research and extension services, food security, higher incomes, with the overall goal of economic development and poverty alleviation (Lopokoiyit, 2012). Through implementation of these agricultural extension policies, human wildlife conflict mitigation strategies promoted could be expected to be effective. However, limited information was available on the effectiveness of agricultural extension human wildlife conflict mitigation strategies promoted through NAEP on human wildlife conflict among smallholder farmers.

Despite the government's efforts to promote NAEP, many stakeholders did not embrace this policy framework as expected (GoK, 2012a). This was attributed to various reasons such as lack of a widely accepted institution to coordinate and harmonize inputs from various sectors, organizations and programs. Further, there was lack of multi-skilled extension agents, resulting in piece-meal extension service delivery to clients who faced multiple problems. Consequently, the government initiated the review of NAEP and its implementation, producing, the National Agricultural Sector Extension Policy (NASEP) (GoK, 2012a). This is a sector-wide policy which involves the Ministry of Agriculture, Livestock & Fisheries Development and the Ministry of Cooperative Development and Marketing. Implementation of this policy started in the year 2011. This policy aims at guiding and harmonizing the management and delivery of extension services. It is meant to broaden the extension service content and service delivery to cover an entire value chain (GoK, 2012a). It also advocates for demand-driven and pluralistic extension service. Implementation of NASEP could be expected to promote effective agricultural extension human wildlife conflict mitigation strategies on human wildlife conflict among smallholder farmers.

In African countries, agricultural extension is provided by various stakeholders, who include public, private and Non-Governmental Organizations (AGRA, 2013; Christoplos, 2010). In Kenya, the agricultural extension service is also provided by diverse players although the Ministry of Agriculture, Livestock and Fisheries Development (MoA, L & F) is the major government extension service provider. Other extension service providers include parastatals such as Kenya Agriculture & Livestock Research Organization (KALRO), which develops technologies and innovations then disseminates them to farmers. Private commercial companies such as agro-chemical companies offer agricultural extension services through farm input merchants (stockists) and farmer demonstrations. They also use agricultural extension service as a marketing strategy for their agricultural technologies. Private non- commercial companies such as Non-Governmental Organizations (NGOs), Faith-Based Organizations (FBOs) and Community-Based Organizations (CBOs) also provide agricultural extension services (Kazbekov & Qureshi, 2011). In Laikipia County agricultural extension service providers include the Kenya Wildlife Service (KWS) (GoK, 2013b; USAID, 2013). Agricultural extension service providers also promote sustainable natural resource use, which also includes human-wildlife conflict mitigation. However, limited information was available on the effectiveness of the agricultural extension human wildlife conflict mitigation strategies promoted through NASEP on human wildlife conflicts among smallholder farmers.

The mandate of Kenya Wildlife Service (KWS) is to conserve and manage wildlife on behalf of the country. Kenya Wildlife Service implements a program called Community Wildlife Service (CWS), a strategy which promotes active community participation in wildlife conservation outside protected areas (GoK, 2012c; KWS, 2016). Through CWS, KWS undertakes community education and provision of extension services. It also provides services to farmers and ranchers to enable them protect crops and livestock against attack and destruction by wildlife. The KWS also creates partnerships in wildlife conservation organizations and protects people and property from injury and damage by wildlife (GoK, 2012c; KWS, 2016). Therefore, KWS promotes positive human-wildlife interaction and encourages community support for wildlife conservation. In addition, the KWS promotes various human-wildlife conflict mitigation strategies such as building of moats, construction of trenches and planting of natural fences such as Kai apples and growing of unpalatable crops such as chili, ginger, onion among others. However, limited information was documented on the effectiveness of human wildlife conflict mitigation strategies promoted through the KWS policy on human wildlife conflict among smallholder farmers.

Land presents an important resource for economic life of majority of people in Kenya. The biggest challenge that Kenya as a country is facing is how to balance the satisfaction of human livelihood needs and sustainable use of resources for posterity. However, land use continues to be addressed through uncoordinated legal and policy framework (Ministry of Land and Physical Planning, (MoLPP) 2016). For instance, human settlement and agricultural activities are allowed in forest areas and areas bordering forests such as Rumuruti Forest. Further, wildlife is conserved in areas that are not gazetted or protected as wildlife habitats. This shows that there are incompatible land uses, a situation which has resulted in land use conflicts including human-wildlife conflict. This is caused by lack of a land use policy in Kenya. For instance, forests play a critical function in agriculture, livestock, wildlife conservation and tourism sectors. Therefore, to achieve sustainable forest management and conservation, policies that promote cross-sectoral linkage and synergy between the forest sector and other related sectors are necessary. Consequently, the Forest Act 2005 was enacted and implemented as from 2007to 2014 (Government of Kenya (GoK), 2014). The Forest Act (2005) permitted the conversion of forest land to other uses such as agriculture. Furthemore, rapidly increasing population, demand for fuel wood, poverty and demand for grazing land compelled rural people to resort to poor land use practices. This scenario necessitated the review of the Forest Act (2005) in 2014. The Revised Forest Act (2014) promotes farm

forestry. This policy further allows Kenya Forest Service to provide forestry extension services to farmers, especially those bordering wildlife habitats.

On the other hand, Kenya is rich in natural resources which include a vast array of wildlife, which contributes directly and indirectly to local and national economy through revenue generation and wealth creation (Ministry of Forestry and Wildlife, 2012).However, much of the wildlife occurs outside gazetted areas, on lands owned by communities and individuals, thus increasing possibilities for the occurrence of human-wildlife conflict. This happens despite the existing wildlife conservation policy which emphasizes wildlife conservation only in gazetted areas. However, this does not reduce human-wildlife conflict in areas not gazette and areas bordering gazetted wildlife areas. This is because of various reasons such as rapid change of tenure and land use in wildlife rangelands from communal to private ownership and the associated land sub-division for uses such as agriculture which interferes with wildlife corridors (Government of Kenya (GoK), 2014). There is also destruction of wildlife habitats due to rapidly increasing human population, poverty and demand for fuel wood. Land tenure practices and illegal allocation of wildlife habitats to individuals cause apathy by local communities towards wildlife. Conservation of wildlife in forests which are not gazetted or fenced as wildlife habitats is also practiced.

Further, change of land use and erection of boundaries in wildlife habitat areas has resulted in human-wildlife conflict. In addition, there is lack of a national land use policy in Kenya which should guide agricultural activities on land bordering wildlife habitats, human settlement and wildlife conservation (MoLPP, 2016; GoK, 2014). Such a scenario shows that there is lack of coordination and synergy among various government departments. These include Kenya Forest Service, Kenya Wildlife Service, Ministry of Land and Physical Planning and the Ministry of Agriculture, Livestock and Fisheries Development, in the management of natural resources, land use management and provision of agricultural extension services. This leads to incompatible land uses for instance farming activities on forest land and wildlife conservation on unfenced or areas not gazetted as wildlife habitats (MoLPP, 2016). This results in a scenario which could reduce the effectiveness of human wildlife conflict mitigation strategies among farmers. This phenomenon was also observed in Laikipia County and could be contributing to the occurrence of human-wildlife conflicts. Limited information was available and poorly documented on how activities of agriculture sector stakeholders affect the effectiveness and sustainability of agricultural extension human

wildlife conflict mitigation strategies among smallholder agro-pastoralists in Laikipia County. Availability of the information can be used to recommend strategies for improving the activities which enhance effectiveness and sustainability of human wildlife conflict mitigation strategies or recommend alternative activities.

2.11 Theoretical Framework

This study was informed by the conflict theory and the functionalist theory. The conflict theory was propounded by Karl Marx while Herbert Spencer and Robert Merton proposed the functionalist theory. The term conflict refers to a deliberate attempt to oppose, resist or coerce the will of another individual or others (Rummel, 1980; Starr, 1980). It is a social process in which individuals or groups strive to meet their ends by directly challenging the antagonist by violence or threat of violence. During a conflict situation, individuals seek to obtain rewards by eliminating or weakening its competitors. Usually, conflicts arise from a clash in interests held by individuals due to their difference or incompatibility. Hammer (2007) conceives a conflict as a disagreement between individuals over goals and values. A social or group conflict occurs when two or more individuals oppose each other in social interactions. This happens reciprocally while exerting social power in an effort to achieve scarce or incompatible goals and prevent the opponent from attaining them. Farrington and Chertok (1993) opine that competition for resources result in conflicts by ensuring that only the strongest of a species survive. A conflict occurs when individuals are motivated to pursue their interests, needs, goals and resources that they consider important and desirable. Unequal distribution of the scarce resources in a society increases the chances for a conflict (Adu- Febri, 2012).

The conflict theory claims that a society is in a state of perpetual conflict due to competition for limited resources. This theory further holds the view that social order is maintained through domination and power instead of consensus and conformity. A society is composed of different groups which are competing for power and resources. Conflict leads to continuously changing relations within the existing social structure and the transformation of the social system. The functional theory views society as a complex system whose parts work together with the aim of promoting solidarity and stability. A society is viewed as a system of interconnected parts that are working together in harmony so as to maintain a state of balance and social equilibrium for the whole society (Mooney, 2007). A society is regarded as a structurally integrated whole. This implies that social institutions perform important functions

for the society to exist. The functionalist theory emphasizes interconnectedness of society by focusing on how each part influences and is influenced by other parts. Thus, elements of a society are functional if they contribute to social stability and dysfunctional if they disrupt social stability (Ritzer, 2007).

The conflict and functionalist theories are important in this study. The conflict theory is important because it provides insight into the possible causes of conflict in society. In particular, it shows that a conflict is caused by competition for limited natural resources to satisfy their needs, goals and interests which are different and incompatible. As individuals compete, some get injured or even die with only the strongest surviving. As individuals seek to achieve these goals and satisfy their interests, needs and interests, they scramble to access and use the limited natural resources. This means that always there shall be conflict due to competition for the limited natural resources, aimed at meeting incompatible needs, goals and interests among members of society. On the other hand, the functionalist theory informs this study through an explanation that a society is a social system made up of different interconnected parts. For the social system to function well and benefit its members, each part of the social system must perform its function well, resulting in social stability and equilibrium. However, if one element of the social system is dysfunctional, then the whole social system becomes dysfunctional. The whole system will be affected resulting in instability and lack of equilibrium. This implies that a society will always be unstable and deficient of equilibrium whenever at least one of its elements is not functioning well since its parts are interconnected. Furthermore, the individual elements of a society work together towards a harmonious whole society.

In Laikipia County, farmers, wildlife, forests, rivers, KWS, Ministry of Agriculture, Livestock and Fisheries Development, CBOs and NGOs have a role to play for the maintenance of balance and social equilibrium. If a member of society is dysfunctional, then social stability and equilibrium is disrupted. For instance, if forests are dysfunctional or depleted and do not meet the requirements for wildlife‟s survival then wildlife will move out of the forest in search of pasture and water. Similarly, if land is scarce due to rapid human population increase, humans encroach on forests in search of agricultural land. This will destabilize the forest ecosystem, resulting in human-wildlife conflict. A conflict theory informs this study by showing that wildlife in Laikipia County and people will be in conflict due to their pursuit and exploitation of scarce resources to meet their needs. In Laikipia

County, wildlife and humans reciprocally compete for the scarce resources within the environment to meet their life"s needs, resulting in human-wildlife conflict. The conflict between wildlife and humans as they compete for limited resources results in ecosystem change, injury or even death of humans and displacement of wildlife. On the other hand, the functional theory shows that the Laikipia County ecosystem will be unstable because of the competition for scarce resources. The competition arises from the differences in needs and interests between people and wildlife, resulting in a human-wildlife conflict.

2.12 Conceptual Framework

The conceptual framework used in this study was developed from the reviewed literature. The conceptual model helps the reader to understand the proposed relationship between the variables of study (Mugenda & Mugenda, 2003; Mugenda, 2008). The conceptual model for this study is as shown in Figure 1. The independent variable in this study was the Agricultural Extension Wildlife Mitigation Strategies (AEHWCMS) used by smallholder agro-pastoralists. They include planting of crops that are unpalatable (such as pepper) to prevent damage from wildlife and digging of trenches round the farm to prevent wildlife from accessing the farm. The other strategies include using live fences (such as sisal, cactus & Mauritius thorn) and using crops with spikes to control damage by birds. The dependent variable was the effectiveness of AEHWCMS in mitigating human-wildlife conflict among smallholder farmers as influenced by various factors. These include farmers" attitudes and perceptions towards the AEHWCMS, farmers" skill and knowledge regarding the use and management of AEHWCMS and the species of wildlife on which the mitigation strategy is used. Other factors include climatic conditions of an area, amount of labor required to start and manage the AEHWCMS, the economic value or gains of a mitigating strategy, the cost and availability of inputs for initiating and managing the AEHWCMS.

The moderator variables which affect the effect of the independent variable on the dependent variable include farmers" age, gender, education level, household income and the farm size. The effect of the moderator variable on the effectiveness of AEHWCMS was controlled by building the moderator variables into the study and also holding them constant. The conceptual model showed that AEHWCMS were effective in mitigating the human-wildlife conflict but their effectiveness was affected by farmers" attitudes and knowledge, species of wildlife targeted, climatic conditions, and economic value of a strategy, cost and availability of inputs to initiate and manage AEHWCMS. The effectiveness of AEHWCMS was

measured using the rating of effectiveness of the AEHWCMS adopted and the human wildlife conflict mitigation strategies promoted through policy and governance by farmers as a percentage change in the number of livestock injured or killed and the number of livestock infected by wildlife-transmitted diseases. It was also measured as a percentage change in the number of hectares of crops damaged by wildlife, number of humans injured or killed and the number of farmers‟ complaints reported to Kenya Wildlife Service by farmers.

Independent Variables	Moderator Variables	Dependent Variable

Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS):

- Planting crops that are not palatable to wildlife (e.g. chili) to prevent damage from wildlife
- Digging ditches to prevent wildlife from accessing crops, livestock and humans
- Growing live fences (e.g. sisal or cactus fence) to protect crops, livestock and humans from wildlife
- Growing crops with spikes to control damage from birds

i) Farmer's Age, Gender, Education level and Household Income
ii) Farm Size

Effectivenessof AEHWCMS in mitigating Human-Wildlife Conflict (HWC) measured as annual percentage change in:

- Number of livestock injured or killed by wildlife
- Number of acres of crops damaged by wildlife
- Number of people injured or killed by wildlife
- Number of farmer's complaints reported to KWS

Figure A: Conceptual framework showing the Relationship between the AEHWCMS and their effectiveness in mitigating human-wildlife conflict.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a discussion of the research methodology that was used to achieve the study objectives. It contains a description of the research design, description of the study area and target population. It also discusses sampling procedures and sample size, instrumentation, data collection and data analysis procedures and a summary of data analysis techniques.

3.2 Research Design

This study used a cross-sectional survey research design. During a cross-sectional survey a sample is selected from a defined population and contacted at a single point in time to determine the prevalence of the outcome of interest in a given population (Dadonie, Zagminas & Berzanskyte, 2013). The cross-sectional survey was selected because it could determine the frequency of an attribute under study in a defined population at a particular point in time. Additionally, it was suitable for investigating individuals" behavior that could best be understood by observing them within their natural setting (Simon & Goes, 2013). A survey facilitates an examination of the real world and a description of relationships existing between variables under study (Fox, Hunn & Mathers, 2007; Kothari, 2008). It was also used to collect large amounts of quantitative data from one or more variables of the target population. Non-participant observation was also used to collect primary data. Document review through review of reports was also used to collect secondary data on socio- demographic factors affecting adoption of agricultural technologies and the agricultural extension human wildlife conflict mitigation strategies adopted. Further, documents were reviewed on the trend of human-wildlife conflict, collaborative activities between agricultural extension and the Kenya Wildlife Service and the human-wildlife conflict mitigation strategies promoted through policy and governance.

3.3 Location of the Study

The study was done in Laikipia County, among smallholder agro-pastoralists who border Rumuruti Forest. Rumuruti Forest is not a gazetted wildlife habitat which is 6,217 ha in size and hosts various wildlife such as colobus monkey, bush buck, buffalo, dikdik, elephants, butterflies and several species of birds (Ministry of Forestry & Wildlife (MFW), 2012). The other wildlife found in Laikipia County include the lion, leopard, rhinoceros, gazelle, impala, eland, zebra and the African wild dog (GoK, 2013b). The area bordering Rumuruti Forest area is multi-tribal, occupied by the Kalenjin, Kikuyu, Samburu and Turkana communities

(Ministry of Forestry & Wildlife, 2012). Laikipia County is about 9,700km^2 in size; it is located in North-Central Kenya at an altitude of 1,700-2,000metersabove sea level, North West of Mount Kenya, North East of the Aberdare highland, West of the Rift Valley and South of Samburu (Laikipia Wildlife Forum, 2012; Maximilian, William & Kahiro, 2011). Laikipia County is not a gazetted wildlife area although it holds the second highest wildlife population in Kenya (Graham & Ochieng, 2008; Maximilian et al., 2011). Laikipia County is semi-arid, receives bimodal rainfall (range of 400-1,500 mm), and most of its soil is either clayey loam or clayey sand (GoK, 2013b). The major source of livelihood for most households in Laikipia County is farming of maize and beans, rearing of dairy and beef cattle, camels and sheep and minimal production of horticultural crops under irrigation (GoK,

2013b). The land use patterns in Laikipia County include pastoralism, mixed farming, ranching, agro-pastoralism and marginal mixed farming. Laikipia County has a poverty index of about 43.5% with food poverty of about 39% (KNBS, 2010). Laikipia County was chosen for this study because it is an ASAL area with the second highest wildlife population in Kenya. Additionally, the county has forest areas which are not protected or gazetted as wildlife habitats although they host large wildlife populations. The County also hosts Rumuruti forest and Marmanet forests which hold large populations of wildlife although they are not fully fenced or gazetted as wildlife habitats.

3.4 Population of the Study

The population for this study consisted of the smallholder agro-pastoralists bordering wildlife habitats in Laikipia County while the accessible population comprised the smallholder agro-pastoralists bordering Rumuruti Forest. The accessible population hailed from Rumuruti, Igwamiti, Marmanet and Salama wards in Laikipia County. There were about 35,640 households within the four wards (KNBS, 2010), which form the Rumuruti Forest catchment area. However, there were 500 households within at least one kilometer distance from Rumuruti Forest boundary, throughout the entire forest area. The one kilometer was chosen because it was assumed that households within this distance were the most susceptible to wildlife attack. The study focused on smallholder farmers because they comprised majority of farmers in Laikipia County. These households formed the sample frame for this study. The households grow different crops and keep various livestock for subsistence use. The accessible population of 400 which consisted of households previously affected by wildlife invasion was compiled from records at the agricultural, chief and Kenya Wildlife Service offices inSalama, Marmanet, Igwamiti and Rumuruti Wards of Laikipia County. In addition,

public extension service providers deployed within Rumuruti, Salama, Marmanet and Igwamiti wards were involved in the study because these areas border Rumuruti Forest. The extension service providers were 27 in number and 10 of them were involved in the study because they promote the agricultural extension human-wildlife conflict mitigation strategies, which were of interest in this study.

3.5 Sampling Procedure and Sample Size

This section discusses the sampling procedure and the process of determining the sample size that was utilized in this study.

3.5.1 Sampling Procedure

Simple Random Sampling was used to select the smallholder agro-pastoralists from each of the Igwamiti, Salama, Marmanet and Rumuruti wards. This ensured that the sample had the same characteristics as respondents for this study and also that the sample had the same characteristics as the population as recommended by Kothari (2008). In a randomly selected sample, each member in the entire population has an equal chance of being included in the sample (Fox et al., 2007; Maina, 2012). The farmer respondents (203) were proportionately sampled from Igwamiti, Marmanet, Salama and Rumuruti wards in Laikipia County where Rumuruti Forest is physically located. This was aimed at obtaining a relatively equal representation from each of the wards bordering Rumuruti Forest because farmers in those wards are more susceptible to human wildlife conflict. About one quarter (25%) of the farmer respondents were obtained from each of the wards as shown in Table 1.

Table 1

Respondents per Ward in the Study Area

Ward	Farmers		Technical Staff		
	Sample	Proportion (%)	In-post	sample	Proportion (%)
Igwamiti	51	25.12	9	3	33.33
Rumuruti	51	25.12	5	2	22.22
Marmanet	51	25.12	11	4	36.36
Salama	50	24.64	2	1	0.50
Total	203	100	27	10	37.03

A further ten (10) extension agents in the selected wards where farmer respondents were obtained from were also sampled for the administration of a questionnaire because they promote extension mitigation strategies and also work closely with farmers. Since they

formed a key element in determining the effectiveness of the mitigation strategies, they were therefore identified through purposive sampling.

A table of random numbers was used as a guide in performing the simple random sampling procedure. This involved assigning the accessible population, which was the sampling frame, numbers 1 to 400. A starting point was randomly selected on a table of random numbers having 5 digits. The first 3 digits of the random numbers on the table of random numbers were used. This was because the accessible population (400) had three digits. Movement was made down the column while selecting numbers that fell between 1 and 400. Numbers that recurred or were bigger than 400 were excluded from the selection. There the farmers assigned those numbers were picked for data collection until a total of 203 respondents were selected.

3.5.2 Sample Size

Glenn (1992) developed a formula and table that can be used as a guide for determining sample size (S) needed relative to a known population (N). This is consistent with the specified confidence level and the designated level of accuracy, as shown by the amount of sampling error that can be tolerated (Lunenburg, 2008). The sample size (S) was obtained from a finite population (N) by adopting the pre-determined values in a published table (Appendix K). This study utilized proportional sampling where 51 households were selected from each of the Rumuruti, Salama, Marmanet and Igwamiti wards so as to have an adequate representation from all the four wards bordering Rumuruti Forest. The approximate total number of smallholder agro-pastoralists targeted was 500 who had previously been affected by wildlife attack between 2012 and 2015. However, since the total number of accessible smallholder agro-pastoralist households was 400, only 203 were sampled. This was above the recommended sample size of 201, based on the accessible population at a confidence of 95% (ά=0.05) as recommended by Glenn (1992) (Appendix K). In addition, 10 out of a total of 27 public extension service providers serving in Salama, Marmanet, Igwamiti and Rumuruti wards were involved in the study.

3.6 Instrumentation

For this study, two semi-structured questionnaires, one for farmers and another for public extension service providers and a document review guide were used for data collection.

3.6.1 Semi-structured Questionnaires

Semi-structured questionnaires (Appendix A and B) were developed by the researcher under the guidance of Egerton University supervisors and used to collect primary data. A questionnaire is a collection of a series of questions designed to elicit information, filled by the sampled respondents (Awaisu, 2013). A questionnaire was chosen for this study because it was suitable for collecting data from the sample which was widely scattered and the study population was literate and large. The questionnaire for farmers had a total of twenty questions. It contained questions on general personal information of the respondent, the trend of human-wildlife conflict and the different types of mitigation strategies and their effectiveness. The questionnaire for extension service providers had sixteen items. It contained questions on personal information of the respondent, different types of mitigation strategies and their effectiveness. During data collection, the sampled respondents were expected to tick on the chosen alternative or write on the blank spaces provided for closed- ended and open-ended questions respectively. The questionnaire for farmers was used to collect qualitative and quantitative primary data from smallholder agro-pastoralist household heads bordering the Rumuruti wildlife habitat in Laikipia County. The questionnaire for extension service providers was used to collect both qualitative and quantitative primary data from the extension service providers deployed in the areas bordering Rumuruti Forest. Questionnaire items were used to collect data for addressing specific study objectives and answer the respective research questions.

3.6.2 A Document Review Guide

A document review guide (Appendix C) was developed by the researcher and used to collect secondary data. Secondary data collection involved reviewing of annual reports as from year 2012 to 2015, at the Sub-County and County offices in Laikipia and the national Kenya Wildlife Service head-quarter offices using a document review guide. This involved a critical examination of recorded information related to agricultural extension and human-wildlife conflict and recording the source and the information obtained. Data for year 2012 served as a baseline on adopted strategies and the trend of human-wildlife conflict. Further, both qualitative and quantitative secondary data was collected through a review of documents at agriculture and livestock offices.

3.6.3 Validity

Whereas Lunenburg (2008) and Fox et al. (2007), define validity as the degree to which a data collection instrument measures what it purports to measure, Bui (2009) defines it as the extent to which the instrument measures what it is intended to measure. Meredith et al. (2007) also argue that test validity is the degree to which evidence and theory support the interpretation of test scores entailed by the proposed uses of the tests. In this study, built-in validation items were used to validate the questionnaire and determine whether respondents were consistent in their responses. The appropriateness and representation of the content in the questionnaires was determined by ensuring that all characteristics are measured as indicated in the study objectives, as recommended by Borg and Gall (1983) and Wiersma (1995). In addition, discussions were held with five Agricultural Education and Extension experts of Egerton University to assess content validity of the questionnaire items as recommended by Lunenburg (2008). They also checked on the general appearance of the items in the instrument and ensured the achievement of optimum face validity. This ensured that the questionnaire items measured what they were intended to measure in the study objectives. It also ensured that the format, length and clarity of terms used were appropriate. The questionnaires were also validated through pilot-testing them on respondents who were similar in characteristics to the study population. Based on the comments offered, appropriate adjustments were made on the questionnaires. The document review guide was validated by five agricultural extension experts from Agricultural Education and Extension department of Egerton University. The validation of the questionnaires and document review guide ensured that they captured the data sought in the questionnaires and documents reviewed respectively. This information included the trend of human-wildlife conflict, mitigation strategies used and their effectiveness in the world, Africa, Kenya and in Laikipia County.

3.6.4 Reliability

Lunenburg (2008) defines reliability of a data collection instrument as the degree to which the instrument consistently measures what it is measuring while Bui (2009) and Fox et al. (2007) define it as the extent to which an instrument consistently measures what it is intended to measure. Meredith et al. (2007), also defines test reliability as the degree to which a measurement error is absent from the scores yielded by a test. During this study, reliability of the farmer"s questionnaire was estimated through piloting using 30 smallholder agro-pastoralists bordering Maasai Mara game reserve in Narok County. The reliability of the extension staff"s questionnaire was piloted on five extension staff deployed in the Naroosura

ward which neighbors Maasi Mara Game Reserve. Farmers in Maasai Mara were used because they border an unprotected wildlife habitat just as farmers in Laikipia County border Rumuruti Forest which is not protected. Wildlife therefore easily move out of Maasai Mara just as they do from Rumuruti Forest to the neighboring farmland, thus causing human wildlife conflict.

The internal consistency technique was used in estimating the reliability of the questionnaire, while a Cronbach"s reliability coefficient was used to determine the internal consistency of questionnaire items. The Cronbach"s coefficient method was chosen because it could be used after administering research instruments only once and could also assess both multi-response questionnaire items (Meredith et al., 2007). The following formula by Well and Wollack (2003) was used in calculating Cronbach"s coefficient: $ά = k ÷ (1- Σ^k_{i-k} p_i(1-p)†σ^2_x]$, where: k is the number of items in the questionnaire, pi is the item difficulty, represented by the proportion of respondents who answer a given questionnaire item correctly, and$σ^2_x$ is the sample variance for the total score in the questionnaire items. The findings of the pilot-testing exercise were used to revise questionnaire items until a reliability co-efficient of ά =0.89 and
0.86 were achieved for farmer"s and extension staff"s questionnaire respectively. This was above the recommended minimum reliability level of a Cronbach"s reliability coefficient of ά =0.70 and above, at a confidence level of 0.05.

3.7 Data Collection Procedure

Before data collection, the researcher acquired a research permit from the National Commission for Science, Technology and Innovation (NACOSTI), through Graduate School of Egerton University. Preliminary visits were made to area Assistant Chiefs" offices. During these visits, a list of agro-pastoralist farmers settled on or bordering wildlife habitat were prepared. A total of 203 farmers" names and contacts were prepared. This was followed by introductory visits to Agricultural and Kenya Wildlife Service offices to create awareness to staff about the intended study. The area Chiefs in collaboration with the Ward Agricultural Officers prepared a list of farmers who were later involved in the study and a plan on the area to be surveyed discussed. The identified farmers were then later invited by Ward Agricultural Officers, Assistant Chiefs for a meeting on designated places for administration of the questionnaire by the researcher. Further, visits were made to the Sub County Agricultural Officer Laikipia West Sub County. During these visits, awareness of the intended study was created and a list of the extension staff deployed in Rumuruti, Igwamiti, Marmanet and

Salama Wards was prepared. These staffs were then invited to designated places on agreed dates. The researcher did introductions by explaining the objectives of the study then distributed copies of the questionnaire which was written in English to the staff who then responded to the questions. Since the extension staffs were competent in English, the questionnaire items did not require translation into vernacular.

For collection of data from farmers, Ward Agricultural Extension Officers and Area Chiefs served as guides in locating the sampled farmers and mobilizing them to agreed central places. The farmer respondents were met face-to-face, by the researcher and an introduction done by the area Chief. The researcher explained the purpose of the study to the farmers then sought consent to collect the data. After consent was granted, then the researcher assured the farmers of the confidentiality of the information they were to provide. The researcher then administered the semi-structured questionnaire for farmers on the household heads of sampled agro-pastoral farmers in form of an interview during meetings. The questionnaire was written in English language although not all the respondents were literate. Therefore, agricultural extension officers and chiefs who were competent in English and the local languages particularly Kalenjin, Kikuyu, Samburu and Turkana helped in translating the questionnaire items to vernacular. This ensured that respondents understood the questionnaire items and therefore gave reliable responses. Primary data was collected through administration of the questionnaire on 203 agro-pastoralists who were sampled by the researcher. Further primary data was collected from public extension service providers using a questionnaire designed for them.

A document review guide was also used to collect secondary data. This involved reviewing of annual reports as from the year 2012 to 2015 at the Sub-County, County in Laikipia and national Kenya Wildlife Service head-quarter offices and also agriculture and livestock offices. Crop damage assessment and livestock injury or death reports were also reviewed at the County and Sub-County agricultural offices using a document review guide. During review of secondary data sources, documents were recorded alongside the information being sought from each. This process continued until all accessible documents which contained information about the socio-demographic factors affecting adoption of agricultural technologies were reviewed. The information and data collected also included trends of human-wildlife conflict, human-wildlife conflict mitigation strategies promoted by agricultural extension and the agricultural extension and Kenya Wildlife Service policy. It

also included mitigation strategies used by farmers, those promoted through policy and governance and their effectiveness in various parts of the world, including Laikipia County.

3.8 Data Analysis

Based on the objectives of the study, the data collected data was analyzed at a confidence level of ά=0.05 set apriori. This was because the sample size used in this study had been calculated based on a 0.05 level of significance. Data was coded and analyzed using Statistical Package for Social Sciences (SPSS) version 21.Descriptive statistics were used to analyze both the primary qualitative and quantitative data for the respective study objectives as shown in Table 1. Table 1 shows the research objective, independent and dependent variables and the statistical method of analyzing data collected for dependent variables for respective objectives. The collected qualitative primary data was grouped into broad themes and then converted into frequency counts and the resultant data was expressed as percent, mean and mode. Quantitative data was also converted into frequencies, mean and mode. In particular, the mean values of hectares of crop damage and number of livestock injured or killed as from 2012 to 2015 were used in determining the trend of human-wildlife conflict. Frequency counts, mean and mode values of farmers using AEHWCMS over the study period was used to determine the mitigation strategies adopted by farmers, their effectiveness and sustainability. It also included socio-demographic factors affecting adoption of AEHWCMS and the factors affecting effectiveness and sustainability of agricultural extension human wildlife conflict mitigation strategies and the coping strategies promoted through governance. The frequency counts of farmers and extension staff and their respective mean values based on their ranking of AEHWCMS were used to determine the effectiveness and sustainability of AEHWCMS. The frequency counts were also converted into percentage to determine the relative proportions of respondents per each rank of effectiveness and sustainability of the mitigation and coping strategies.

Table 2

Data Analysis Summary

	Research Objectives	Independent Variable	Dependent Variable	Analysis Method
i)	To determine the Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) adopted among smallholder agro-pastoralists bordering Rumuruti Forest	AEHWCMS	Adoption of AEHWCMS in mitigating HWC	mean; mode; percent; frequency
ii)	To determine the socio-demographic factors affecting adoption of (AEHWCMS) among smallholder agro-pastoralists bordering Rumuruti Forest	Socio-demographic factors	Adoption of AEHWCMS in mitigating HWC	mean; mode; percent; frequency
iii)	To determine the trend of human-wildlife conflict among smallholder agro-pastoralists bordering Rumuruti Forest	AEHWCMS	Trend of AEHWCMS in mitigating HWC	mean; mode; percent; frequency
iv)	To determine the effectiveness of AEHWCMS used among smallholder agro-pastoralists bordering Rumuruti Forest	AEHWCMS	Effectiveness of AEHWCMS	mean; mode; percent; frequency
v)	To determine the effectiveness of HWCCS promoted through governance among smallholder agro-pastoralists bordering Rumuruti Forest	HWCCMS	Effectiveness of HWCCMS on HWC	mean; mode; percent; frequency
vi)	To determine the sustainability of AEHWCMS used among smallholder agro-pastoralists bordering Rumuruti Forest	AEHWCMS	Sustainability of AEHWCMS	mean; mode; percent; frequency
vii)	To determine the extent of collaboration between Agricultural Extension and Kenya Wildlife Service in promoting HWCMS among smallholder agro-pastoralists bordering Rumuruti Forest.	collaboration	Extent of collaboration between Agricultural Extension and KWS	mean; mode; percent; frequency

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and discussion of the study. This is done in light of the trend of human-wildlife conflict, agricultural extension mitigation strategies used and the effectiveness of the mitigation strategies used by smallholder agro-pastoralists in Laikipia County. The section starts with the results and discussion based on the objectives of the study. The data collected were analyzed using descriptive statistics, in particular the mean, mode, frequency and percentage.

4.2 The AEHWCMS Adopted by Farmers in Laikipia County

The first objective of the study was to determine the Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) adopted by the smallholder agro-pastoralists in the target area. In answering this objective, the study generated the following results which are summarized in Table 3. The major wildlife that are a problem to farmers in Laikipia County include monkeys, elephants, buffaloes, Zebra, squirrels, birds, hyena, antelope, impala and gazelle. To mitigate the effect of wildlife attacks, agricultural extension promotes various strategies among smallholder farmers in Laikipia County. This is achieved through training and demonstration on mitigation strategies such as digging of trenches, growing of crops that are unpalatable to wildlife and growing fodder. The other mitigation strategies promoted include growing early maturing crops such as potatoes, crop rotation, growing live fences using plants such as Mauritius thorn, cactus or sisal and growing of spiked crops such as wheat among others. This study established that smallholder agro-pastoralists in Laikipia County use various mitigation strategies as summarized in Table 3.

Table 3

Adoption of Agricultural Extension Human Wildlife Conflict Mitigation Strategies

Strategy	Farmers Using (%)	Wildlife involved	Crop protected
Growing unpalatable crops	0.90 (n=2)	Monkey	Maize, potato, banana, sweet potato
	10.41 (n=21)	Elephant	Maize, potato, wheat, beans
	8.14 (n=17)	Zebra	Beans, peas, brassicas
	8.60 (n=18)	Gazelle	Legumes, grasses
Growing live fence	10.86 (n=22)	Monkey	Maize, potato, banana
	12.67 (n=26)	Elephant	Beans, peas
	11.76 (n=24)	Buffalo	Brassicas, grasses
	9.95 (n=20)	Zebra	
	10.40 (n=21)	Antelope, Gazelle	
	10.40 (n=21)	Hyena	Goats, sheep, cattle, lambs, kids
Digging trenches (2M X 2M X 2M)	12.22 (n=25)	Elephant	Maize, beans, potato, wheat
	9.50 (n=19)	Hippopotamus	
Dressing seeds with pesticide	0.45 (n=1)	Squirrel	Maize, beans, fruit
Optimal plant population	0.45 (n=1)	Porcupine	Beans, potato, maize
Hairy or spiked crops	8.41 (n=17)	Weaver/ quelea birds	Wheat, sorghum, sunflower
Resistant crop varieties	9.50 (n=19)	Weaver/ quelea birds	Bean, sunflower, sorghum
Synchronized cropping	0.9 (n=2)	birds	Wheat, sorghum, sunflower, maize
Intercropping	0.45 (n=1)	birds	Maize, sunflower, sorghum
Growing fodder	0.45 (n=1)	elephant	Maize, beans

The strategies include growing unpalatable crops such as beans, pyrethrum and sunflower (8.6%), and chili against monkeys (9.0%). Farmers (10.41%) grow unpalatable crops such as sunflower, chili, pyrethrum, tobacco and onion either as buffer crop (round the main crop) or as main crop against elephant. The smallholder farmers (10.86%) grow live fence such as Mauritius thorn and kai apples against monkeys, elephants (12.67%) and buffalo (11.76%). Farmers also dig trenches (2M X 2M X 2M) round the farm to prevent wildlife from accessing the farm. The smallholder farmers (8.14%) also grow hairy or spiked crops such as sunflower and wheat and soya bean varieties that choke and repel birds. Only a small proportion (9.05%) of farmers grows resistant crop varieties. First, this includes the farmers who grow sunflower varieties that are resistant to bird attack, such as those which are black and yellow at the center of the head, thus acting as an eye. It also includes the farmers who grow sunflower varieties whose heads face down, thus making it difficult for birds to attach to the head to feed on seeds. Lastly, it also includes farmers who grow maize varieties that have tightly covered cobs or husks to make it difficult for the birds to feed on seeds especially at the milk and soft dough stage. This study reveals that a small proportion (≤12.2%) of smallholder agro-pastoralists in Laikipia County have adopted the agricultural extension mitigation strategies. This shows that farmers in Likipia County use various agricultural extension human wildlife conflict mitigation strategies.

Further, results showed that most farmers (76%) use more than one mitigation strategy concurrently. The farmers also use the mitigation strategies against more than one species of wildlife species to protect more than one crop and more than one species of livestock. For instance, live fence in form of Mauritius thorn and growing of unpalatable crops such as sunflower and pepper is used to mitigate various species of wildlife, to protect different types of crops and livestock. These findings agree with other studies which show that in African countries, small-scale farmers grown unpalatable crops such as red chili to mitigate wildlife such as elephants (Hocking & Humle, 2009; King, Douglas-Hamilto & Fritz-Vollrath, 2011). The findings also agree with a study in Queen Elizabeth Park Area (QEPA) which found that a mitigation strategy which is multipurpose is readily adopted by farmers for example red chili which serves as a mitigation strategy and as a source of income (Babaasa, Akampulira & Bitaribo, 2013). Further, live fences are used in Kibale and Bwindi areas of Uganda against elephants, baboons, bush-pigs and gorillas while trenches are also used against elephants, buffaloes and bush-pigs in Kibale and QEPA regions.

This study established that smallholder agro-pastoralists in Laikipia County also use various non-agricultural extension wildlife mitigation strategies as shown in Table 4.

Table 4

Non-extension Mitigation Strategies Used by Farmers

Strategy	Farmers using (%)	Wildlife involved	Crop/ Livestock Protected
Lighting fire	45.3 (n=92)	Monkey; elephant;	Legumes; cereals; fruits
Scaring/guarding	53.7 (n=109)	buffalo; zebra; antelope	vegetables; bananas
		porcupine; squirrel	

Results showed that more than half (53.7%) of the farmers use the scaring away of wildlife strategy while about an average proportion (45.3%) use the lighting fire strategy. The scaring away strategy is achieved by people physically guarding only and sometimes guarding in the company of dogs and chasing away the wildlife from their farms. It is also achieved by making loud noises through shouting or beating objects or erecting scare crows on a crop field. Guarding is done by local communities who sometimes hire labor for guarding. It involves shouting, banging objects, throwing sticks or stones to scare away wildlife. These results agree with findings in Mozambique which showed that farmers scare wildlife away from their farms (Anderson & Parieda, 2005). Findings from the Tsavo Conservation Area (TCA) show that farmers make loud noises or use scare crows against wildlife attack (Makindi et al., 2014). Results from this study also concur with the findings in Mozambique and the Tsavo Conservation Area (TCA) which showed that farmers light fire to mitigate human-wildlife conflict. The farmers also burn materials that produce offensive smell such as old tyres and cow dung to repel wildlife from the farm.

4.3 Farmers' Socio-demographic Factors Affecting Adoption of AEHWMS

This section presents the descriptive parameters of farmer respondents" socio-demographic characteristics which affect adoption of agricultural extension human wildlife conflict mitigation strategies. The socio-demographic characteristics that were of interest in this study were the gender, age, level of formal education and household income. Farmers were selected because they were the principal respondents since they were expected to adopt the agricultural extension human-wildlife conflict mitigation strategies promoted by extension service providers. They were therefore very critical in determining the effectiveness of the

agricultural extension human-wildlife conflict mitigation strategies. Descriptions are presented in form of tables and figures showing frequencies and percentages of the respective parameters.

The second objective of the study was to determine socio-demographic factors affecting adoption of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) among smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County. In answering this objective, the study generated the following results which are summarized in Figures A, B, C, D and E.

4.3.1 Effect of Farmers' Gender on Adoption of AEHWCMS in Laikipia County

A total of 203 small-scale maize farmers previously affected by human-wildlife conflict were involved in the study through administration of a questionnaire. This study established that more than half (61 %) males participate in farming activities than females (39%) as shown in Figure B.
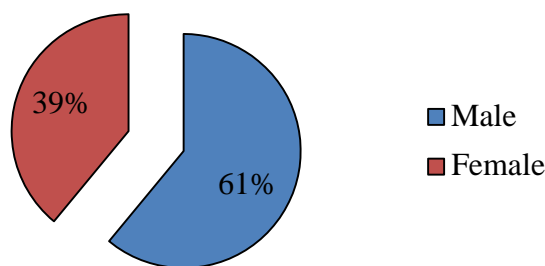
Figure B: Farmers'' distribution by gender

This could mean that most households in Laikipia County are headed by males. This might also mean that agriculture in Laikipia County is dominated by men, more especially pastoralists. This disagrees with Kiura (2011) who found that more women (75%) than men participate in farming through the provision of farm labor. Furthermore, women play a significant role within the smallholder system where they produce food crops (IFAD & UNEP, 2013). Women in developing countries are involved in various farming activities such as planting, weeding, harvesting, threshing and winnowing of farm produce, as well as processing, storage and marketing (Adekunle, 2013). Women play a significant contribution in the agricultural labor-force and agricultural activities, which are estimated to produce up to

80% of the food (FAO, 2011). The World Bank (2012) also found that addressing gender inequalities and empowering women is vital in improving food and nutrition security. This implies that if women acquire the knowledge and skill required in mitigating the human-wildlife conflict, they are likely to implement it since they carry most of the farming activities. Empowerment of female farmers is likely to improve the effectiveness of the mitigation strategies. Anandajayasekaram et al (2008) had also observed that men and women have different levels of access to agricultural extension services from which they benefit in different ways. A farmer's gender significantly affects the adoption rate of agricultural technologies. Thus, increasing women's access to extension will empower farmers and this could significantly contribute to the effectiveness of Agricultural Extension Human Wildlife Conflict Mitigation Strategies.

4.3.2 Effect of Farmers' Age on Adoption of AEHWCMS in Laikipia County

In presenting information about the age of farmers in Laikipia County, a bar graph was used, which shows the age in years on the x-axis and the proportion of farmers in each age in percentage on the y-axis. Regarding the age of farmers, this study established that of the 203 farmers, 23% were aged 40 years and below while 77% were aged 41 years and above (Figure C).
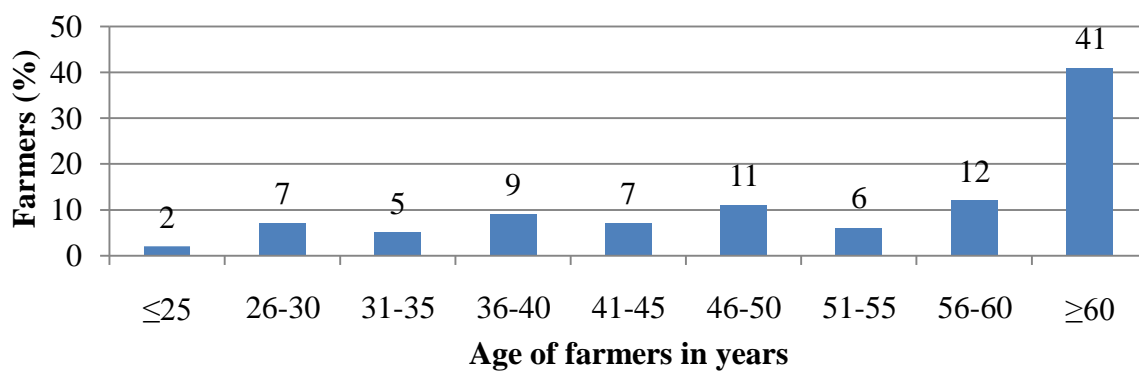
Figure C: Farmers' distribution by age

This meant that over three quarters of the farmers were aging, since the youth involved in agriculture were few. This implies that agricultural activities in Laikipia County are undertaken by an aging population and that the youth have shunned agriculture. This negatively affected the nature of farming activities and the agricultural technologies adopted by the farmers. This concurs with Anandajayasekaram et al (2008) who observed that the performance in agricultural activities is affected by the age of a farmer. Since humans

become less active with increase in age, farmers who have advanced in age are not likely to repeatedly implement some agricultural extension human wildlife conflict mitigation strategies. This is because the strategies are labor-intensive and also require regular maintenance while farmers would have become less active. This is likely to negatively affect the sustainability of mitigation strategies especially by the small-scale farmers who rely mostly on manual labor. Failure to maintain the agricultural extension human wildlife conflict mitigation strategies will lower their effectiveness.

4.3.3 Effect of Farmers' Education on Adoption of AEHWCMS in Laikipia County

To present information on the education level of farmers in Laikipia County, a bar graph was plotted having education level on the x-axis and the proportion of farmers per each education level in percentage, on the y-axis. In regard to the highest education level of farmers in Laikipia County, this study found that about 28% of the respondents had no formal education, more than half (72%) had at least primary education, 64% had up to secondary education while only 70% had up to tertiary education (Figure D). This could mean that farmers in

Laikipia County are literate and at least have basic education.
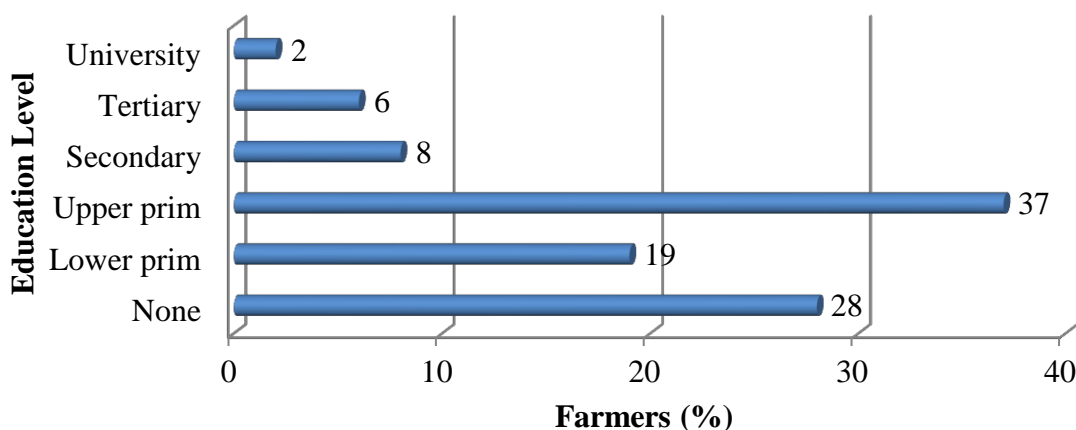
Figure D: Farmers" highest education level

Involvement of a literate and educated population in training could increase their understanding of the subject matter thus increase their adoption of agricultural innovations and technologies. This is consistent with KIPPRA (2009) and Nyagaka, Obare, Omiti & Nguyo (2010) who found that an educated labor-force easily understands, interprets new information and adopts improved agricultural technologies. This is because technology adoption by farmers is positively correlated to the education level of a farmer. This is also in agreement with the findings by Anandajayasekaram et al (2008) who found that the

75

educational status of a farmer affects her agricultural performance. Education and training of a farmer facilitates good performance and sharpens skills of the farmers, which in turn enhances adoption of agricultural technologies. Literate farmers are skeptical of new ideas and are able to evaluate available agricultural information on improved agricultural technologies and make informed decisions (Mcharo, 2013). Education also improves a farmers" ability to access and process agricultural information and use it in improving on- farm activities (Baffoe-Asarel et al., 2013). Education level affects a family member"s ability to access and use agricultural information (Babu, Glendenning, Asenso-Okyere & Govindarajan, 2012). Further, education positively changes the perceptions of a farmer since if she is more educated, she is likely to accept and most probably adopt improved agricultural technologies (Tiruneh, Yigezu & Bishaw, 2015). This shows that adequate levels of education by farmers can speed up the rate of adoption of agricultural innovations. Thus, most smallholder farmers in Laikipia County may not innovatively adopt agricultural extension human-wildlife conflict mitigation strategies since they have a low level of formal education.

Education is productivity-enhancing (Holland et al., 2013). Additionally, an educated labor-force is better at creating, implementing and adapting new technology, thereby generating growth. A one year increase in average education raises the level of output per capita by between 3-6% or raises the rate of potential agricultural growth by just over 1% per annum. The number of years of schooling by a farmer positively influences the probability of the farmer"s adoption of an agricultural technology (Gregory & Sewando, 2013). Education is important for economic growth since higher levels of education attainment lead to a more skilled and productive workforce who produces more effectively and produces a higher quality of services (International Labor Office (ILO), 2010). This results in economic growth and a rise in the standard of living. Educated farmers seek and obtain agricultural information about improved agricultural practices (Mcharo, 2013). Literate farmers are skeptical of new ideas and can evaluate agricultural information on improved agricultural technologies and make better decisions.

This could mean that the low education status of the farmers in Laikipia County could be affecting their agricultural technology adoption and productivity. This is because the acceptance and adoption of an agricultural innovation highly depends upon the literacy and understanding levels of the farming community. This could be true because educated farmers

are likely to grasp the concepts of modern farming and technical agriculture. They understand, assimilate, accept and use the agricultural technology conveyed on to them by the extension agent. Therefore, the smallholder farmers in Laikipia County who are educated are expected to be receptive to the agricultural technologies disseminated by extension agents. They are also expected to grasp the agricultural knowledge and skills and use them correctly. This will improve the effectiveness of the agricultural extension human wildlife conflict mitigation strategies promoted among the smallholder farmers in Laikipia County.

4.3.4 Effect of Farmers' Income Level on Adoption of AEHWCMS in Laikipia County

To present information on the income level of farmers in Laikipia County, a bar graph was used. The bar graph had annual income levels on the x-axis while proportion of farmers, in percentage, falling in each level of income on the y-xis. In this study, a farmer earning an average of at least 60,000 shillings or less annually was considered a low-income earner, one earning between 60,000 and 120,000 shillings was considered medium and the one earning more than 120,000 shillings was considered a high income earner. Results of this study found that more than half (51%) of the small-scale farmers in Laikipia County are poor, earning 60,000 shillings or less annually. Only about 30% earning at least 60,000 or more and only 19% earning 120,000 shillings or more (Figure E).
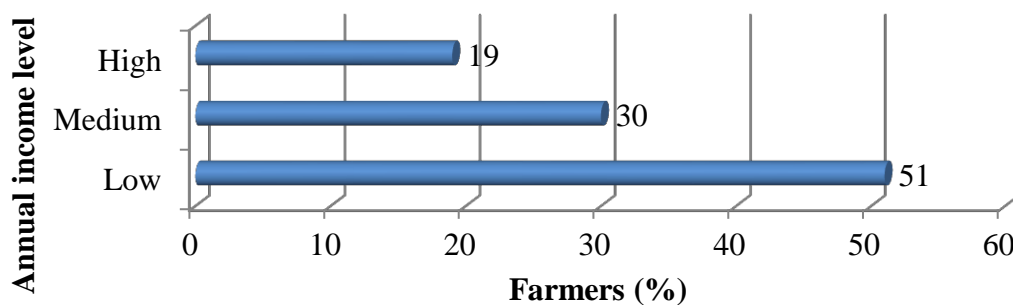
Figure E: Farmers" annual income level

This means that most farmers in Laikipia County are of low economic status. This could be affecting the human wildlife conflict mitigation strategies they use. This is because if farmers cannot afford the inputs required to initiate and manage the mitigation strategies then their use and effectiveness will be reduced. This agrees with an observation made by Seguino and Were (2013) that low levels of income limits access to agricultural technologies. Babu et al. (2013) also found that the income level of a farmer negatively affects her ability to access and use agricultural information. Kabanyoro et al. (2013) adds that a farmer"s financial resources

and marketing services available will affect her adoption of agricultural technologies. Limited access to credit and information on marketing systems limits a farmer from achieving optimal production and agricultural development (Njuki & Sanginga, 2013). This condition could be hindering smallholder farmers" adoption of agricultural extension human wildlife conflict mitigation technologies and therefore reducing their effectiveness. This agrees with findings by Baig and Aldosari (2013) that even if farmers are willing to adopt an agricultural technology, failure to afford the essential inputs negatively affects its adoption. Further, farmers with higher incomes are able to buy the required inputs and this facilitates knowledge transfer to them (Mcharo, 2013). This shows that farmers with higher levels of income are able to purchase the required inputs compared to those with low income. Thus, farmers with high income are likely to adopt new agricultural innovations and technologies. This case also applies for the adoption of agricultural extension human wildlife conflict mitigation strategies by smallholder agro-pastoralists in Laikipia County, Kenya. Farmers having higher levels of income can to purchase inputs for the agricultural extension human wildlife conflict mitigation strategies and most probably maintain them, thus improving their effectiveness.

4.4 Trend of Human Wildlife Conflicts among Agro-pastoralists in Laikipia County

The third objective of this study was to determine the trend of human-wildlife conflicts among smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County. To provide the answer to this objective, results that were generated by this study are summarized in Figures F, G, H and I and Tables 5, 6, 7, 8, 9 and 10.

To present information on the trend of human-wildlife conflict among smallholder agro-pastoralists in Laikipia County a bar graph was plotted, showing the month during which the conflict occurs on the x-axis while the number of human wildlife conflict incidences was plotted on the y-axis. The bars were further denoted by the year so as to compare the number of human wildlife conflict incidences for every month in a year for a period of four years. A line graph was also used to show the trend of human wildlife conflicts. Months were plotted on the x-axis and number of human wildlife conflict incidences on the y-axis. The line graphs were plotted using different colors for four years, as from 2012 to 2015, so as to show the annual trend of human wildlife conflicts and also to make a comparison during the four years. The results of this study showed that invasions of farms by wild animals were at the lowest in the month of February and highest in the months of August and September. This implies that during these months, invasions start and increase progressively until they reach the peak in

the months of August and September then start to decline progressively until they reach the lowest in the month of February (Figure F).
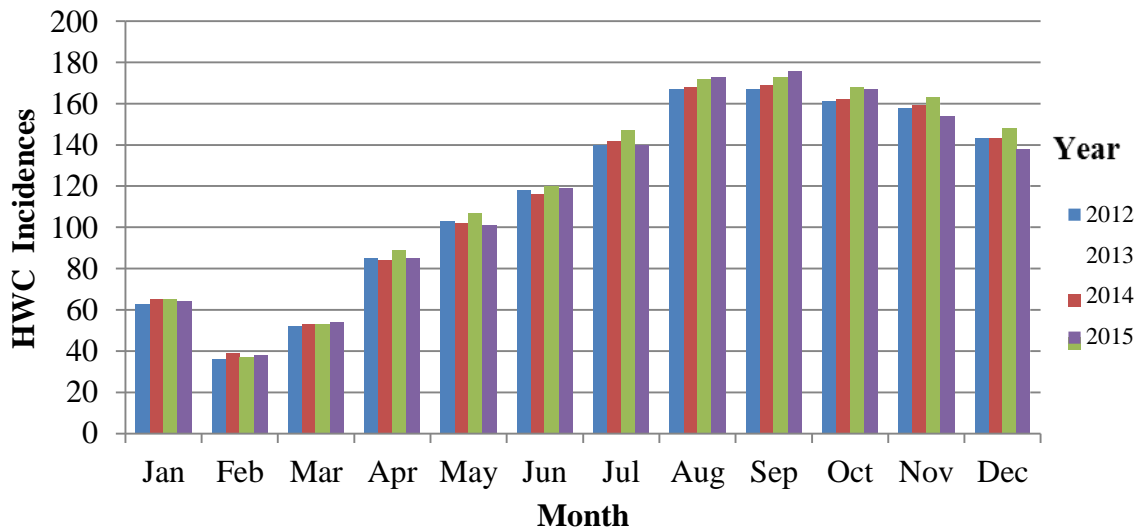
Figure F: Monthly incidents of human-wildlife conflict

This means that human-wildlife conflicts are at the lowest during the fallow season when there are no crops in the field, they increase as planting season starts and progressively increase as the crop grows until maturity. Then as harvesting starts, wildlife attack incidences start declining progressively. These findings show that the trend of human-wildlife conflicts in Laikipia County matches with that in Mozambique. In Mozambique, attacks by wild animals are distributed throughout the year; they occur the year round although most of them occur in the July- September period, followed by March, April, June and October Months, with most incidences occurring during the dry and rainy seasons (Le Bel et al., 2011). The trend of human-wildlife conflicts in Laikipia County also matches with that in Cameroon where it occurs all the year round, during both the dry and rainy seasons (Eyebe et al., 2012). However, it is more pronounced during the dry season because of water scarcity. In Kenya, attacks by wild animals is accentuated during the dry season thus heightening conflicts between wild animals and pastoralists over access to watering points as well as competition for grazing land (Lee & Graham, 2006). Further, this study also found that human-wildlife conflict incidences are fewer during the early months of the year when there is no crop on the farm and increase progressively as planting starts, as the crop grows until the harvesting period. This trend is maintained in a period of four years as shown in Figure G.
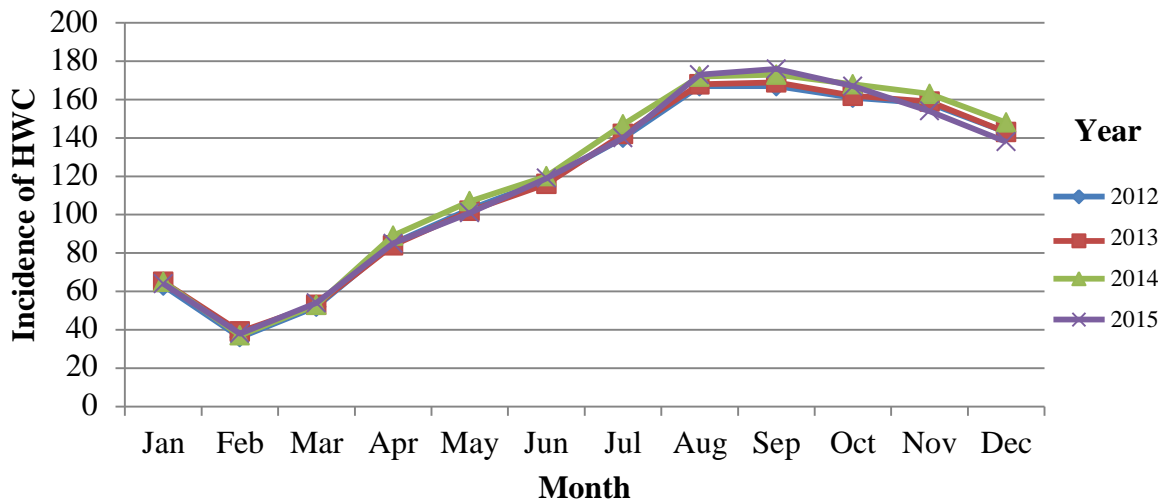
Figure G: Annual trend of human-wildlife conflict

This study also established that there was an increase in crop damage for most crops grown in Laikipia County. For instance, crop damage for maize rose from 67.51% in 2012 to 69.23% in 2015, 67.08% in 2012 to 69.96% in 2015 for potatoes. Banana crop damage increased from 75.90% in 2012 to 79.08 in 2015, while the damage for pepper increased from 46.25% in 2012 to 51.43% in 2015 (Table 5).

Table 5

Extent of Crop Damage by Wildlife in Laikipia County

Crop	Average crop damage/ha (%)				
	2012	2013	2014	2015	Average
Maize	67.51 (n=167)	68.92 (n=174)	70.27 (n=187)	69.23 (n=182)	68.48
Beans	69. 76 (n=145)	67.26 (n=150)	67.04 (n=160)	68.13 (n=158)	68.05
Potatoes	67.08 (n=124)	68.57 (n=128)	71.78 (n=132)	69.96 (n=132)	69.35
Dolichos	55.71 (n=7)	77.86 (n=7)	68.75 (n=8)	54.00 (n=10)	64.08
Vegetables	71.13 (n=64)	71.80 (n=66)	74.40 (n=68)	75.07 (n=68)	73.10
Sorghum	60.29 (n=14)	52.31 (n=13)	57.50 (n=14)	60.00 (n=8)	57.53
Wheat	67.50 (n=14)	67.25 (n=25)	56.44 (n=16)	56.77 (n=17)	61.99
Orange	51.00 (n=201)	43.25 (n=20)	57.48 (n=23)	50.53 (n=19)	50.57
Pepper	46.25 (n=8)	50.00 (n=6)	48.57 (n=7)	51.43 (n=7)	49.06
Banana	75.90 (n=38)	77.21 (n=38)	79.85 (n=39)	79.08 (n=38)	78.01
Passion fruit	62.50 (n=6)	59.17 (n=6)	59.17 (n=6)	84.17 (n=6)	66.25
Avocado	66.52 (n=29)	63.36 (n=31)	68.06 (n=35)	69.38 (n=32)	66.83

This means that there was an increasing trend of crop damage among smallholder farmers in Laikipia County. Further, results of the study showed that there was no significant decline in the average crop damage among farmers in Laikipia County over a period of four years of using the AEHWCMS (Table 6).

Table 6

Average Crop Damage per ha among Farmers

Year	Average crop damage/ ha (%)	Variance
2012	48.39 (n=259)	0.00
2013	48.67 (n=260)	0.29
2014	56.57 (n=302)	7.90
2015	57.00 (n=304)	0.43

Instead, there was an increase in crop damage, with the highest damage increase (7.9%) being experienced in 2014. This means that the agricultural extension human wildlife conflict mitigation strategies used by smallholder agro-pastoralists were not effective on wildlife that damaged the crops grown in Laikipia County.

This study also found that various wild animals such as elephants, monkey, zebra, hippos and weaver birds attack and destroy various crops such as maize, potatoes, legumes, wheat among others grown by farmers in Laikipia County as shown in Table 7.

Table 7

Wildlife Destroying Crops in Laikipia County

Crop Destroyed	Wild Animal
Maize	Elephant, bird, gazelle, antelope, buffalo, Hippo
Legumes	Monkey, elephant
Potatoes	Elephant, monkey
Vegetable	Buffalo, elephant, monkey
Sorghum	Bird, elephant, hippo, gazelle, zebra, antelope
Wheat	Bird, buffalo, hippo

The smallholder farmers in Laikipia County reported that various wildlife species such as the elephant, monkey, buffalo and birds are responsible for destruction of their crops, as shown in Table 8.

Table 8

Wildlife Responsible for Crop Damage in Laikipia County

Wildlife Species	Proportion of Farmers (%)
Elephant	95 (n=193)
Monkey	87 (n=1770
Buffalo	76 (n=155)
Gazelle/antelope	72 (n=147)
Hippopotamus	16 (n=33)
Birds	73 (n=149)
Zebra	67 (n=136)
Porcupine	42 (n=86)
Squirrels	38 (n=78
Hyena	57 (n=116)

Elephants destroy various crops such as maize, potato, wheat, legumes, vegetables and even sorghum. A very high proportion of farmers (95%) in Laikipia County reported that Elephants are the most frequent and destructive wild animal and it destroys many varieties of crops. They therefore cause the greatest threat to rural life and livelihood. This agrees with findings from Zimbabwe, Mozambique and South Africa which indicated that Elephants are the most notorious wild animals and are most destructive (Lamarque et al., 2009; Hoare, 2012). Additionally, in the Tsavo Conservation Area of Kenya, 97% of farmers reported that Elephants invade their farms (Makindi et al., 2014). Elephants destroy millet in Cameroon (Eyebe et al., 2012).

In Kenya, Elephants are a problem to crop farmers where they frequently attack crops and also destroy infrastructure (Graham et al., 2010; Lauren-Bond, 2014). Conflict between farmers and elephants are more pronounced at the peripheries of wildlife habitats and also along migration routes (Eyebe et al., 2012). They occur both during the dry and rainy seasons. This was also the case for Laikipia County farmers. For many subsistence farmers and pastoralists, elephant attacks also lead to constraints in the performance of the general day to day human activities such as collection of firewood or water, travelling to school and loss of time because of farm guarding (Lee & Graham, 2006). Farmers in Laikipia County also experience these challenges posed by elephant invasion on their farms. The high

proportion of farmers in Laikipia County reporting attacks by elephants means that almost all the farmers in the County are vulnerable and are affected by elephant invasions.

The other wild animal that causes significant crop damage in Laikipia County is the monkey which destroys crops such as maize, potatoes, bananas and sweet potatoes. A very high number of farmers (87%) reported that monkeys invade their farms and destroy crops. This situation matches with that in the Tsavo Conservation Area in Kenya where 91% farmers reported that monkeys visit their farms or the living area (Makindi et al., 2014). Monkeys visit farms throughout the year to seek food and water. This study established that in Laikipia County, monkeys mostly attack food crops such as maize, bananas and sweet potatoes. These results also agree with results which showed that in Africa, monkeys and baboons attack and feed on food crops such as maize, wheat and fruits (Lamarque et al., 2009). The high proportion of farmers in Laikipia County who reported that monkeys attack their farms means that monkeys are indeed a problem to the farmers. A similar situation is being experienced in Zimbabwe where baboons and monkeys are a problem to farmers because of attacking and destroying their crops (Kate, 2012).

Most farmers (76%) in Laikipia County reported that buffaloes invade their farms and destroy crops such as those of the brassica (cabbages, kales) and grass family (maize, sorghum, wheat, nappier grass). The high number of farmers affected by buffalo attack means that these wild animals are problematic to almost all the farmers in Laikipia County. During a study in the Tsavo Conservation Area in Kenya about 71% of farmers also reported that buffaloes visit their farms in search of food and therefore damage their crops (Makindi et al., 2014). Buffaloes visit farms during both the dry and rainy season in search of water and food. Buffaloes also use the same water sources as humans, and when they are there people are usually scared to also use them. Consequently, buffaloes are among those wild animals which pose the greatest threat to humans and are responsible for majority of human-wildlife conflict (Lamarque et al., 2009). In Cameroon, buffaloes destroy crops, for instance, in areas along the Banyang-Mbo region since farming fields are closer to the Banyang-Mbo sanctuary (Rose, 2002; Eyebe et al., 2012).

About 72% of farmers in Laikipia County reported that Gazelles and antelopes invade their farms and destroy legumes, grasses and brassicas. This means that most farmers in Laikipia County experience the problem of attack by antelopes and gazelles. This agrees with reports indicating that in African countries such as Cameroon, antelopes and gazelles are problematic

to farmers (Parker et al., 2007; Hoare, 2012). A small proportion (16%) of farmers in Laikipia County reported that a hippopotamus is a problem to them. The results also agree with other findings which show that hippos damage crops at localized areas and also destroy infrastructure such as boats in Mozambique (Kate, 2012). Further, hippos conflict with farmers in Africa and are responsible for about 16% cases of human-wildlife conflict (Parker et al., 2007; Lamarque et al., 2009; Le Bel et al., 2011). Up to 73% of farmers in Laikipia County experience destruction of their crops such as wheat, sorghum, sunflower, maize and beans by birds. This concurs with reports showing that in African countries such as Mozambique, birds such as quelea species come into conflict with farming activities through destruction of crops (Lamarque et al., 2009; Kate, 2012; Musimbi, 2013). Birds utilize cultivated crops as sources of their food, for example by feeding on sorghum and millet seeds (Parker et al., 2007; Nyangoma, 2010). Some farmers (67%) reported that zebra destroy their crops such as legumes, brassicas and grasses. This agrees with other reports which indicated that zebra causes crop destruction among farmers in other parts of Kenya (Lauren-Bond, 2013). Further, rodents also feed on crops grown by farmers in Laikipia County.

About 42% of farmers and 38% of farmers reported that porcupines and squirrels respectively damage their crops especially legumes, maize and fruits. A variety of rodents damage crops in African countries such as in Cameroon along the Banyang-Mbo sanctuary crops are destroyed by cane rats (Rose, 2002; Parker et al., 2007; Musimbi, 2013). Rodents such as porcupines and hedgehog attack crops in Cameroon (Eyebe et al., 2012). The high proportion of wild animals invading farms in Laikipia County imply that the mitigation strategies used by the smallholder farmers are not effective. The smallholder farmers will therefore continue experiencing high degrees of human-wildlife conflict thus, heavy crop losses. Further, the high damage of major food crops, particularly maize, beans, potatoes, vegetables, sorghum and wheat mean that this will affect household food security for the smallholders in Laikipia County.

To show the trend of livestock and people injured in Laikipia County in the years 2012 to 2015, a line graph was used. On the line graph, the years from 2012 to 2015 were plotted on the x-axis while the number of livestock and people injured were plotted on the y-axis. Results on the graph showed that the number of goats injured by wildlife decreased from a high of 170 in 2013 to 94 in 2014, the number of sheep injured decreased sharply from 95 in 2012 to 24 in 2015. The number of cattle injured significantly decreased from 17 in 2012 to

12 in 2015, while the number of people injured in the same period decreased from 31 in 2012 to 20 in 2015 (Figure H).
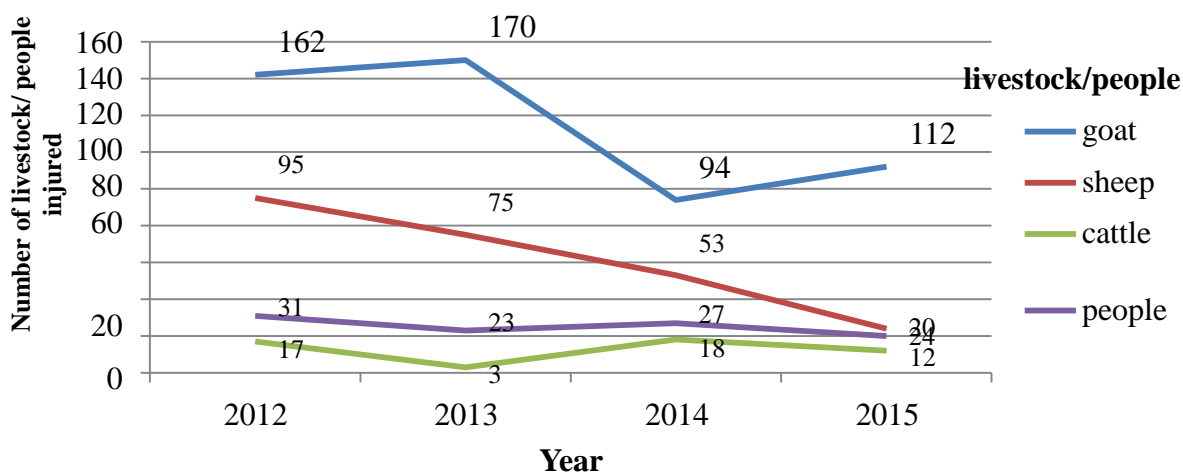
Figure H: Trend of livestock and people injured

Results on Figure H show that there was a significant decline in the number of livestock and people injured as from the year 2012 to 2015. The decline was sharp particularly for sheep, followed by people, cattle and lastly the goats. This could imply that either the agricultural extension human wildlife conflict mitigation strategies or any other human wildlife conflict mitigation strategies used by the smallholder agro-pastoralists in Laikipia are effective against wildlife that attack sheep. The effectiveness of these strategies then declines for the wildlife which attack people, cattle and goats.

Livestock and people in Laikipia County are attacked by various wild animals such as elephant, monkey, hippo, hyena and leopard and injure or kill people and various livestock species such as goats, sheep and cattle as shown in Table 9.

Table 9

Wildlife Attacking Livestock and People in Laikipia County

Livestock /people attacked	Wild animal involved
Goat	Hyena, leopard, wild dog
Sheep	Hyena, wild dog
Cattle	Hyena, wild dog, leopard
Poultry	Wild dog, hyena
Humans	Elephant, hyena, leopard, wild dog, monkey

Farmers in Laikipia County reported that various species of wildlife are responsible for attack of livestock and even people, leading to injury or even death as summarized in Table 10.

Table 10

Wildlife Responsible for Livestock and Human Attack

Wildlife Species	Proportion of Farmers (%)
Hyena	57 (n=116)
Hippopotamus	16 (n=33)
Elephant	91 (n=185)
Buffalo	65 (n=132)
Monkey	89 (n=181)

About 57% of agro-pastoralists in Laikipia County reported that hyenas visit their farms and attack people and various livestock species such as goats, sheep, cattle and poultry. The high proportion of farmers in Laikipia County experiencing invasions by the hyena means that the wild animal is a big problem to the farmers. This situation is also experienced by farmers in the Tsavo Conservation Area in Kenya where 61% of the small-scale farmers reported that the hyena invade their farms (Makindi et al., 2014). Hyenas frequently visit farms and living areas throughout the year in search of food and water, and therefore attack livestock and people. In African countries such as Cameroon, hyenas present a great threat to humans and are responsible for a high degree of human-wildlife conflicts (Eyebe et al., 2012). Hyenas commonly attack livestock such as goats, cattle, domestic animals and people (Parker et al., 2007; Kate, 2012). In Kenya, hyenas are one of the major wild animals which are problematic to farmers because they attack livestock such as sheep and goats and even people (Macclennan et al., 2009; Bond, 2014). For instance, hyenas were responsible for about 14% of the 312 attacks which killed 433 heads of livestock in the areas adjoining Tsavo East National Park in Kenya over a period of four years.

About 16% of the smallholder agro-pastoralists in Laikipia County reported that hippopotamus invade their farms and attack livestock and even people. Findings of this study agree with those in Mozambique showing that between 2006 and 2010, hippos were responsible for 16% of the human-wildlife conflict cases reported (Le Bel et al., 2011). In Africa, various vertebrates such as hippos come into conflict with farming activities (Parker et al., 2007; Lamarque et al., 2009). Furthermore, hippos were responsible for more human

deaths in Africa than any other animal in the 1970s (Lamarque et al., 2009; Musimbi, 2013). Hippos injure or kill livestock and people especially when they move around at night such that people living nearby to their habitat often get scared to travel after darkness falls (Parker et al., 2007).

In Laikipia County, most farmers (91%) reported that elephants attack their farms, frequently in a year. These findings concur with those obtained in the Tsavo Conservation Area which showed that 97% of farmers experience invasion by elephants (Makindi et al., 2014). Elephants attack and injure or even kill livestock and people, and therefore pose a great threat to small-scale farmers in Africa who cannot manage elephant invasions on their own (Lamarque et al., 2009). For instance, in Mozambique, elephants were responsible for up to
39% of all the human-wildlife conflict cases reported between 2006 and 2010 (Le Bel et al., 2011). Elephants are considered to be the most problematic wild animal among farmers in Zimbabwe, Mozambique and South Africa because of the frequent attacks and great damage it causes after attack (Hoare, 2012). Elephants invade farms in both the dry and rainy seasons, although they attack more frequently during the dry season, when there is water scarcity and reduced vegetation. Elephant invasion results in livestock and human injury and even death and also destruction of property (Musimbi, 2013). In Kenya, elephants attack farms regularly, injure or kill livestock and people in addition to destroying property (Bond, 2014).

A high number (65%) of small-scale farmers in Laikipia County experience attack by buffaloes, frequently in a year. This agrees with a research in the Tsavo Conservation Area where 71% farmers reported that buffaloes visit their farms regularly (Makindi et al., 2014). Further, in Africa, buffaloes use the same water sources as people therefore scaring people when they are at the water sources. Buffaloes are therefore considered a great threat to people and therefore a major source of human-wildlife conflicts (Lamarque et al., 2009). Buffaloes can also transmit livestock diseases such as anthrax (Musimbi, 2013). For instance, buffaloes transmitted anthrax to 228 cattle in the Goza province of Mozambique. Buffaloes also spread theilleriosis and Foot and Mouth Disease (FMD) (Kate, 2012). Monkeys also invade farms in Laikipia County, with most (89%) farmers reporting the problem of monkeys on their farms. This also concurs with a study in the Tsavo Conservation Area where 91% farmers reported of monkey attacks and a further 83% reported of baboon attacks (Makindi et al., 2014). Monkeys and baboons frequently visit farms throughout the year in search of food and water.

In some African Countries such as Zimbabwe, monkeys and baboons are serious problems to farmers where they kill livestock, domestic animals and threaten people (Kate, 2012). For instance, on the Gokwe communal land, next to Sengwa Wildlife Research Area in Zimbabwe, baboons were involved in killing 241 livestock between 1993 and 1996 (Lamarque et al., 2009). Additionally, in Africa baboons injure and inflict wounds on dogs and also intimidate people especially women when scavenging for food. Other wild animals such as leopards can attack and injure or even kill livestock or people. For instance, in Cape Town region of South Africa, leopards injure and also kill sheep (Lamarque et al., 2009). In Kenya leopards are a problem to pastoralists because they attack and injure or kill livestock and people (Bond, 2014). Since various species of wild animals attacked livestock and people and therefore caused human-wildlife conflicts in Laikipia County, pastoralists needed to use various mitigation strategies which were suitable for each species of wild animal. Consequently, the declining trend in the number of both livestock and humans injured by wildlife mean that the wildlife mitigation strategies used by smallholder agro-pastoralists were effective against wild animals which attack livestock and humans in Laikipia County.

To further show the trend of human wildlife conflict in Laikipia County, a line graph was plotted having years on the x-axis and the number of livestock or people killed on the y-axis. This graph showed that the number of sheep killed by wildlife in Laikipia County declined from 227 in 2012 to 110 in 2015 while the number of goats killed increased from 107 in 2012 to 139 in 2015. The number of cattle killed by wildlife increased from 15 in 2012 to 38 in 2015 while the people killed increased from 4 to 6 in the same period (Figure I).
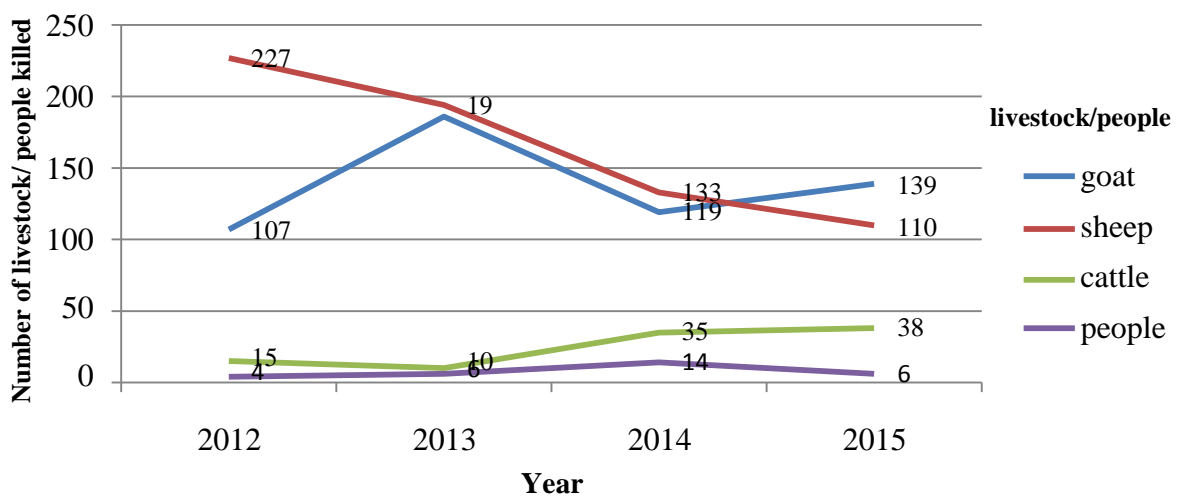
Figure I: Trend of livestock and people killed

This means that there was a general increasing trend of livestock and human deaths arising from attacks by wild animals among smallholder agro-pastoralists in Laikipia County. This could therefore imply that the agricultural extension human wildlife conflict mitigation strategies used by smallholder agro-pastoralists were not effective against the wild animals which attack goats, cattle and people. In contrast, the mitigation strategies used were effective against wildlife that attack sheep. This also implies that generally, the trend of livestock and human deaths will still remain high because the human wildlife conflict mitigation strategies used by smallholder agro-pastoralists in Laikipia County are not effective against wild animals which attack livestock. The agro-pastoralists will therefore continuing experiencing high livestock losses through attacks by wild animals.

4.5 Effectiveness of Mitigation Strategies Adopted by Farmers in Laikipia County

The fourth objective of the study was to determine effectiveness of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) used among smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County. To provide answers to this objective, the study generated the following results which are summarized in Figure J and Tables 9, 10, 11 and 12.

In this study effectiveness referred to the capability of the Agricultural Extension Wildlife Mitigation Strategies (AEHWCMS) to significantly reduce human-wildlife conflict among smallholder agro-pastoralists. Therefore, the Agricultural Extension Human Wildlife Conflict Mitigation Strategies were considered effective if they reduced the conflict by at least 10%. Effectiveness of the mitigation strategies was measured by using ratings by farmers who had used each strategy on a five-point Likert scale which involved not effective, marginally effective, effective, very effective and very very effective. A very very effective mitigation strategy was assigned 1 while the strategy that is not effective was assigned 5. The farmers and extension staff used the same scale to rate the effectiveness of each agricultural extension human wildlife conflict mitigation strategy. Extension staff used the same scale as farmers because they train and demonstrate to farmers on the mitigation strategies and also monitor the use of the strategies by farmers. A sum of the ratings by farmers who had used a particular strategy plus extension agents" rating of the strategy based on the effectiveness criteria produced an estimate of effectiveness rate. Based on the effectiveness rate, this study found that the AEHWCMS used by smallholder farmers in Laikipia County vary in the degree of effectiveness although it was generally low, as shown in Table 11.

Table 11

Rate of Effectiveness of AEHWCMS used by Farmers

Strategy	Targeted Wildlife	Effectiveness (%)
Unpalatable crops	Monkey	30.00 (n=61)
	Elephant	25.00 (n=51)
	Zebra	31.58 (n=65)
	Antelope, impala	25.00 (n=51)
	Weaver, quelea bird	34.60 (n=71)
Growing a live fence	Elephant	25.00 (n=51)
	Buffalo	23.07 (n=47)
	Zebra	27.27 (n=55)
	Antelope, impala	26.09 (n=53)
	Hyena	30.43 (n=63)
Growing fodder	Elephant	30.00 (n=62)
Seed dressing	Squirrel	45.00 (n=91)
Digging trenches	Hippo	28.57 (n=59)
Hairy or spiked crop variety	Quelea/weaver bird	11.76 (n=24)
Resistant crop varieties	Quelea/weaver bird	33.33 (n=70)
Synchronized cropping	birds	50.00 (n=102)
Intercropping	birds	100.00 (n=203)

For instance, growing unpalatable crops such as sunflower, beans, pyrethrum and chili against monkeys is 30% effective. Growing tobacco, onion, macadamia and chili against elephants is 25% effective, while growing pyrethrum and sunflower against zebra is 31.58% effective. Growing buffer sorghum against quelea quelea birds and weaver birds is 34.6% effective. Chili can be grown either as the main crop or as 2-3 lines round the main crop to form a buffer. Growing live fences using mauritius thorn or kai apples against elephants, buffalo, zebra, antelope and hyena is about 30% effective. Growing of resistant crop varieties is only up to 33.3% effective. Further, digging trenches round the farm to form a barrier is 33.33% effective. This implies that the AEHWCMS are not effective as shown by the low degrees of effectiveness. Therefore, the smallholder agro-pastoralists in Laikipia County are likely to experience significant crop and livestock losses resulting from wildlife attacks. For

instance, there was no significant decrease in maize, bean, potato and sorghum crop damaged by wildlife as shown in Table 12.

Table 12

Crop Damage by Wildlife in Laikipia County

Crop	Average crop damage/ ha (%)			
	2012	2013	2014	2015
Maize	67.51 (n=167)	68.92 (n=174)	70.27 (n=187)	69.23 (n=182)
Beans	69. 76 (n=145)	67.26 (n=150)	67.04 (n=160)	68.13 (n=158)
Potatoes	67.08 (n=124)	68.57 (n=128)	71.78 (n=132)	69.96 (n=132)
Dolichos	55.71 (n=7)	77.86 (n=7)	68.75 (n=8)	54.00 (n=10)
Vegetables	71.13 (n=64)	71.80 (n=66)	74.40 (n=68)	75.07 (n=68)
Sorghum	60.29 (n=14)	52.31 (n=13)	57.50 (n=14)	60.00 (n=8)
Wheat	67.50 (n=14)	67.25 (n=25)	56.44 (n=16)	56.77 (n=17)
Orange	51.00 (n=201)	43.25 (n=20)	57.48 (n=23)	50.53 (n=19)
Pepper	46.25 (n=8)	50.00 (n=6)	48.57 (n=7)	51.43 (n=7)
Banana	75.90 (n=38)	77.21 (n=38)	79.85 (n=39)	79.08 (n=38)
Passion fruit	62.50 (n=6)	59.17 (n=6)	59.17 (n=6)	84.17 (n=6)
Avocado	66.52 (n=29)	63.36 (n=31)	68.06 (n=35)	69.38 (n=32)

This could imply that the mitigation strategies used by smallholder farmers in Laikipia County are not effective, thus the relatively high rates of crop damage experienced. This means that the mitigation strategies used by the smallholder farmers are not effective against wildlife that damage crops grown in Laikipia County. These mitigation strategies include growing spiked sorghum, sunflower and wheat, digging trenches, growing live fences using mauritius thorn and growing unpalatable crops such as pepper. These findings disagree with other findings which indicate that live fences can effectively mitigate human-wildlife conflict by restraining wildlife, by acting as barriers to wildlife movement (Tiruneh et al., 2015). The findings of this study also differ with a study in Uganda which established that trenches effectively deterred wildlife when applied in the flat areas of Kibale and Queen Elizabeth Park Area (QEPA) in Uganda and along the contours in the volcanoes of Rwanda (Babaasa et al., 2013). This study also established that, there was a significant decline (29.15%) in the

total number of livestock injured and those injured between 2013 and 2014 and a further decline (3.76%) between 2014 and 2015 (Table 13).

Table 13

Number of Livestock Injured and Killed by Wildlife Annually

Livestock	Average number of livestock injured/killed			
	2012	2013	2014	2015
Goats				
Injured	162	170	94	112
Killed	107	186	119	139
Sheep				
Injured	95	75	53	24
Killed	227	194	133	110
Cattle				
Injured	17	3	18	12
Killed	15	10	35	38
Total	623	638	452	435

This could mean that the mitigation strategies used by smallholder farmers such as growing Mauritius thorn are effective against wildlife such as hyena that attack livestock reared in Laikipia County, especially sheep. These results agree with a study in the Greater Virunga Landscape (GVL) in Uganda which found that live fences such as growing mauritius thorn are effective against baboons, gorilla and bush-pigs (Andama, 2009; Babaasa et al., 2013). However, a mauritius thorn fence will only be effective if planted in three rows, 30cm apart, when branches are layered and intertwined to form an animal-proof barrier. The low effectiveness of the mitigation strategies used by smallholder farmers in Laikipia County could mean that the farmers will continue experiencing significant human-wildlife conflict. The wild animals responsible for human-wildlife conflict in Laikipia County include elephant, hyena, zebra, birds, monkey and gazelle.

Findings of this study also showed that the non-extension mitigation strategies used by smallholder farmers in Laikipia County vary in the degree of effectiveness (Table 14).

Table 14

Effectiveness of Non-extension Mitigation Strategies Used by Farmers

Strategy	Wildlife involved	Effectiveness (%)
Lighting fire	Monkey, elephant, zebra, antelope,	36.2
Scaring/guarding	porcupine, squirrel, hippopotamus	33.6

For instance lighting of fire was 36.2% effective while scaring was 33.6% effective. Chasing which involves herding and scaring through drumming and sounding tins is also used in Bwindi, Uganda, Virunga and Democratic Republic of Congo, effectively against gorillas, elephants and baboons (Babaasa et al., 2013). Results of this study differ with findings which showed that guarding is effective especially against buffalo, elephant and primates in the GVL region. However, a comparison between extension mitigation strategies and non- extension mitigation strategies show that the latter have slightly higher effectiveness indices than the former. But generally the extension mitigation strategies and the non-extension mitigation strategies used by smallholder farmers in Laikipia County have low (≤36%) effectiveness indices. This means that farmers will continue experiencing significant crop losses and a number of livestock injured or killed resulting from wildlife attack.

In determining the effectiveness of agricultural extension human wildlife conflict mitigation strategies, information on factors reducing the effectiveness of AEHWCMS was collected. A bar graph was used to present the factors affecting the effectiveness of AEHWCMS by plotting the factors on the x-axis and the proportion of farmers affected per each factor plotted on the y-axis. This study established that the effectiveness of Agricultural Extension Human Wildlife Conflict Mitigation Strategies used by smallholder farmers in Laikipia County is affected by an overlap of various factors. These factors include farmers" attitude towards AEHWCMS, farm size, system of land tenure, climatic conditions, availability of planting materials, availability of market for produce and unavailability of planting materials for AEHWCMS as summarized in Figure J.
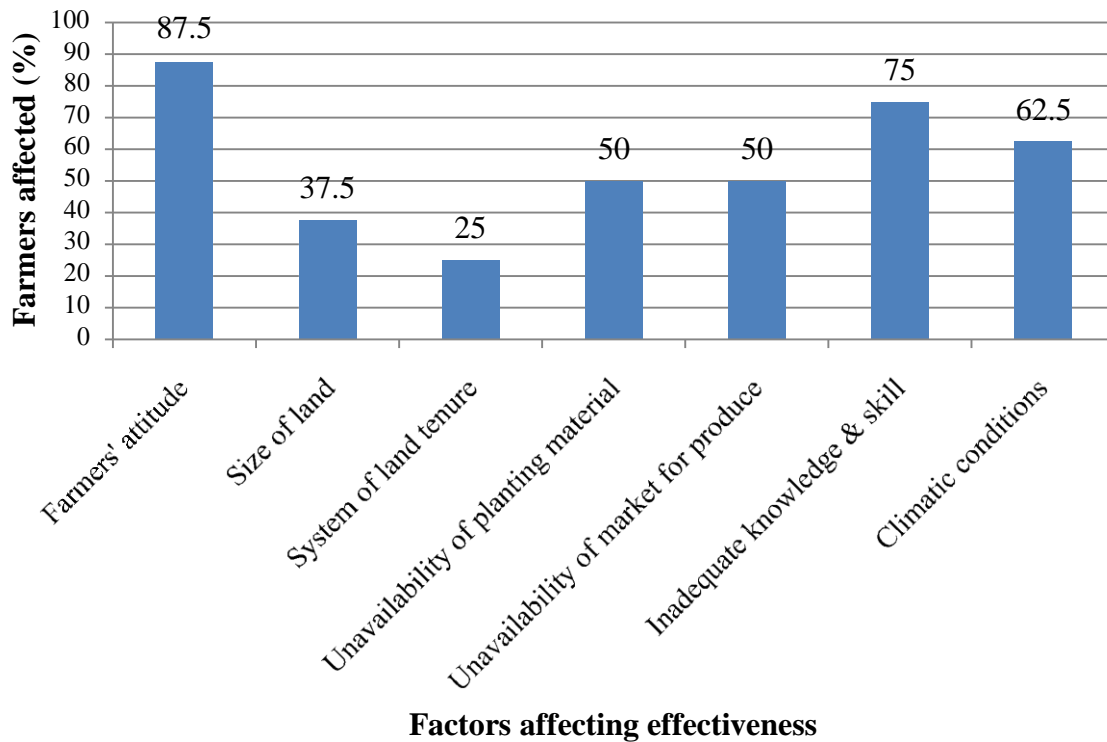
Figure J: Factors affecting effectiveness of AEHWCMS

About 87.5% of farmers are affected by their attitude towards AEHWCMS. For example, most farmers grow maize, even if it is heavily damaged by wildlife. This discourages them from deciding on the use of a particular human wildlife conflict mitigation strategy. Most of the farmers reported that they do not like using the AEHWCMS. The farmers also reported that they prefer few crops such as maize, beans, potatoes and vegetables. They are therefore not willing to try growing other crops especially those that are less susceptible to wildlife attack such as pepper, tobacco, pyrethrum or sunflower. The farmers have also not been convinced that some crops such as pepper or tobacco cannot be fed on by wildlife such as elephants. They therefore continue growing crops they prefer such as maize thus remain susceptible to wildlife attack. This showed that they have a negative attitude towards AEHWCMS. A further 50% of farmers who grow sorghum that is less susceptible to wildlife attack have not taken it as a main crop but just grow it for subsistence use. Further, since farms in Laikipia County are small in size, farmers feel that growing crops such as pepper which is not a staple food crop is a misuse of their land resources. Farmers may also fail to follow the recommendations given by extension agents on the use of the mitigation strategies. For example in growing 3 lines of chili round the main crop to act as a repellant, growing three lines of mauritius thorn 30cm apart, layering and intertwining it and also regularly

pruning it. Thus, farmers" attitude towards AEHWCMS lowers the effectiveness of the human wildlife conflict mitigation strategies.

The system of land tenure affects the effectiveness of AEHWCMS among 50% of smallholder farmers in Laikipia County. The farmers reported that since they use either leased or land owned among several sons for farming, plants such as sisal, cactus and mauritius thorn are not suitable. This is because they take longer than three years to grow and fully establish an effective barrier against wild animals. Therefore, these plants cannot be used by farmers who lease land for periods shorter than three years. And if they do not grow these plants then they will not mitigate wildlife attack. Consequently, farmers bordering wildlife habitats need to share the responsibility of establishing and maintaining a mitigation strategy. This agrees with Babaasa et al. (2013) who found that cooperation and collective response among farmers is required from those affected. This is especially given that farmers who border wildlife habitats have small land holdings. Unavailability of planting materials for AEHWCMS such as kai apple, teflosia and mauritius thorn affects 50% of the smallholder farmers. This lowers effectiveness of the mitigation strategies used by the farmers, thus increase susceptibility to human-wildlife conflict. For example, seed for mauritius thorn is only available at Kenya Forest Research Institute (KEFRI) and is expensive. Seeds for tobacco, pepper and sunflower varieties that are suited for arid areas are not readily available to smallholder farmers in Laikipia County. This scenario affects the use of the AEHWCMS by smallholder farmers, thus affect the effectiveness of the strategies.

Unavailability of a ready market for produce from unpalatable crops affects 50% of farmers in using AEHWCMS. Lack of a ready market for tobacco and chili discourages farmers from growing them. Furthermore, the produce cannot be consumed at household level in their forms immediately after harvest. Farmers therefore opt for other crops such as maize and beans. This contributes to the susceptibility of households to wildlife attack. For instance, pyrethrum is not palatable to wildlife such as elephants, monkeys and buffalo but farmers in Laikipia County do not readily grow it due to a collapsed pyrethrum industry in Kenya. Growing of pepper is not economical for commercial production, compounded by lack of varieties that are suited for arid areas such as Laikipia County. Seed for sunflower varieties that are best suited for processing because of being rich in the oil content and are preferred by processors are readily available in the market. Farmers therefore grow the varieties they can easily sell. The same is the case for sorghum where farmers grow the white varieties such as

„gadam‟ which they can easily sell even if they are more susceptible to bird attack and not the red varieties which are less susceptible.

Most crops that are unpalatable to wildlife are not economically viable in Laikipia County and this discourages farmers from growing them, thus reduceing their effectiveness. Consequently, farmers remain vulnerable to wildlife attack. This finding agrees with another research in Kabale area in Uganda which established that if there are no benefits to individuals and the community by using a given wildlife mitigation strategy then they will not adopt and maintain it (Babaasa et al., 2013). Further, unpalatable crops can only be effective as mitigating strategies if the cultivar is grown in an area that is large enough to reduce attractiveness of crops beyond it and the crop must be profitable. However, the small land holdings by farmers in Laikipia County limit them from growing unpalatable crops in large acreages thus reducing their effectiveness as wildlife mitigation strategies.

Inadequate knowledge and skill on the available AEHWCMS and their use affects 75% of smallholder farmers in Laikipia County. The farmers lack knowledge on the crops that are unpalatable to wildlife for example monkeys and birds. Farmers also lack knowledge on mitigation strategies suitable against elephants since they damage crops that they do not eat by trampling on them. Famers also lack adequate knowledge on the propagation of mauritius thorn especially seed storage, pre-germination and establishment. This may lead to low germination percentage resulting in poor vegetation cover. Further, farmers‟ inadequate knowledge on timing of crop establishment for example pepper, tobacco and mauritius thorn will affect its growth and development. These results concur with the findings of another study which established that farmers in Kibale and GVL have inadequate knowledge about the human wildlife conflict mitigation strategies to use (Babaasa et al., 2013). Further, inadequate education and sensitization lowers understanding of a human wildlife conflict and its solution. For instance, poor maintenance of live fences along borders of farms or wildlife habitats results in permeability of the fence leading to intense human wildlife conflicts (Chaminuka, 2010). This reduces the effectiveness of AEHWCMS amongst smallholder farmers. Consequently farmers will continue to experience significant degrees of crop damage and livestock attacks.

The climatic conditions in Laikipia County which is characterized by arid and semi-arid conditions affect 62.5% of smallholder farmers in the use of AEHWCMS. For instance, there are no unpalatable crop varieties for crops such as pepper, sunflower, tobacco and pyrethrum

suited for arid and semi-arid conditions. Pepper, sunflower and tobacco being warm climate crops cannot perform well in arid conditions and therefore be effective as human wildlife conflict mitigating strategy. Further, the poor performance of these crops in Laikipia County climatic conditions discourages farmers from growing them. They abandon them, thus become vulnerable to wildlife attack. In addition, there are no mauritius thorn and kai apple varieties that are suited for the arid and semi-arid conditions. Kai apple and mauritius thorn shed foliage during the dry season, thereby allowing wildlife to penetrate and attack farms. The two species of plants also grow slowly, taking longer time to establish and be effective as mitigation strategies. Further, damage of fences by wildlife is highest during the dry season and without prompt and constant maintenance, the fence cannot be effective in mitigating human-wildlife conflict (Kristina, Bauer & Loveridge, 2012). Furthermore, for many wildlife species such as lions and leopards, effectiveness of fences is highly dependent on their maintenance (Ferguson, Adam & Jori, 2012; Kesch, 2014). Therefore climatic conditions in Laikipia County lowers the effectiveness of mitigation strategies used by farmers, hence they continue experiencing wildlife attacks. These finding concur with another research which established that the effectiveness of live fences highly depends on ecological aspects of the surrounding (Babaasa et al., 2013).

4.6 The Conflict Coping Strategies Promoted in Laikipia County through Governance
The fifth objective of the study was to determine the effectiveness of human wildlife conflict coping strategies promoted through governance among smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County. In answering this objective, the study generated the following results which are summarized in Figure K, and Tables 15, 16, 17 and 18. This study established that the various human wildlife conflict coping strategies promoted through governance are not effective. In determining the effectiveness of a compensation scheme and translocation of wildlife in coping with human wildlife conflict, farmers ranked the degree of effectiveness on a five-point Likert scale which involved not effective, marginally effective, effective, very effective and very very effective. A very very effective coping strategy was assigned 1 while the strategy that is not effective was assigned 5. For compensation schemes in addition to ranking, farmers gave reasons why they did not consider a compensation scheme an effective human wildlife conflict coping strategy.

4.6.1 Monetary Compensation of Claims Launched by Farmers

For farmers to seek compensation, they are supposed to launch claims after a human wildlife conflict incident following the procedure as stipulated by the Wildlife Conservation and Management Act Number 47 of 2013 (GoK, 2013a & d). This study found that compensation schemes are about 23% effective in coping with human wildlife conflicts, as summarized in Table 15.

Table 15

Effectiveness of a Compensation Scheme

Variable	Effectiveness (%)
Effective	23 (n=47)
Not effective	77 (n=156)

This implies that even if farmers receive compensation, they will significantly suffer the loss caused by wildlife attack. This is because of its low rate of effectiveness as a strategy for coping with human wildlife conflict. This study also found that only a small proportion of farmers (38%) in Laikipia County follow the right procedure in claiming and seeking compensation for either, crop damage, livestock and human injury or even death as summarized in Table 16.

Table 16

Proportion of Farmers in Laikipia County Claiming Compensation

Variable	Farmers (%)
Farmers claiming compensation using correct procedure	38 (n=77)
Farmers claiming compensation, not using correct procedure	62 (n=126)

This means that most farmers in Laikipia County will not receive compensation after wild animals attack their farms because they do not follow the right procedure and do not meet the requirements as set out by the Wildlife Conservation and Management Act of 2013. For instance, farmers may fail to report the incident to Kenya Wildlife Service office within 48 hours after its occurrence. They may also fail to provide a land title deed for the farm where crop damage occurred or even fail to preserve evidence of happening until after assessment.

To illustrate the fact that a farmer is eligible for compensation after launching a claim for compensation, the farmer affected by wildlife attack and her livestock or people injured or even killed must submit a report to the correct recipient, who is the Kenya Wildlife Service. A bar graph was used by plotting the recipient of the report on the x-axis and the proportion of farmers submitting the report to various recipients in percentage, on the y-axis. This study found that some farmers in Laikipia County do not report incidents to the Kenya Wildlife Service as required by law, to initiate the process of seeking compensation as shown in Figure K.
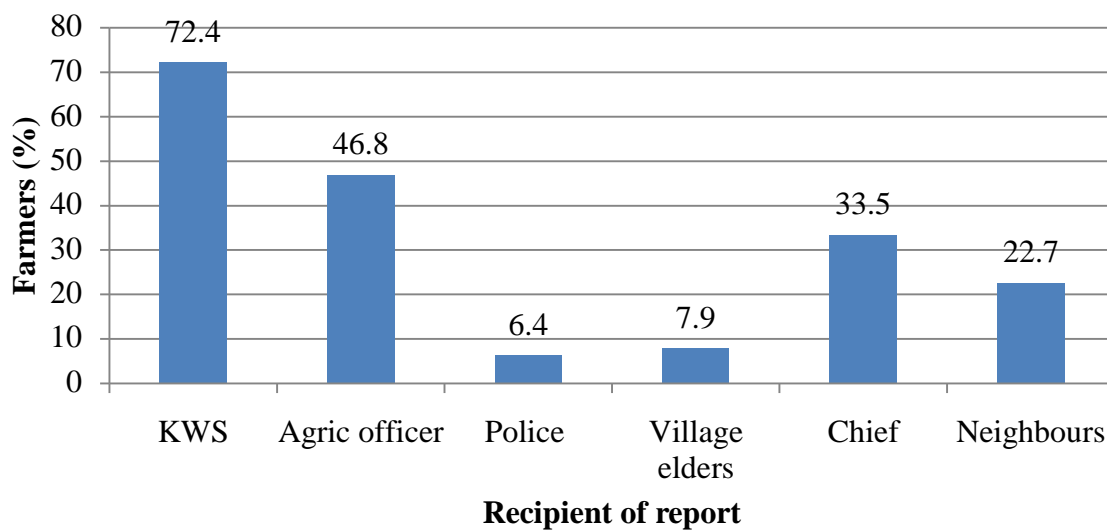
Figure K: Recipients of wildlife attack report

Once wild animals invade farms and destroy crops, injure or kill livestock and even people, farmers are expected to report the incidents to the relevant authorities for them to assess the extent of damage so that the farmer can be compensated. Results of this study showed that most (72.4%) farmers in Laikipia County visit Kenya Wildlife Service offices to report the incidents while a significant proportion (46.8%) report to agricultural extension officers. This means that Kenya Wildlife Service is the major recipient of information about an attack by wild animals for the farmers in Laikipia County, followed by agriculture extension officers then the area chief. However, this could be because KWS is mandated to conserve and manage wildlife in the country.

Thus, farmers visit Kenya Wildlife Service offices to report attacks and seek compensation for any damage or loss caused by wild animals besides moving away the animals in cases where they are physically present on the farm. On the other hand, the farmers who visit agricultural extension offices could be seeking relief food, crop production inputs and even

compensation for the damage caused by wild animals. Some farmers may also seek advice on the wildlife mitigation strategies. A significant proportion of farmers (33.5%) visit the area chief. This may not be for advice on human wildlife conflict mitigation strategies but as a formality in the procedure for seeking compensation and also to seek security since the area chief is in charge of general security in her area of jurisdiction. Further, a chief can mobilize community members to chase away wild animals in cases where they are physically present on the farm.

Results of this study also showed that some farmers (27.6%) do not report wildlife attack incidents to KWS offices as required by the Wildlife Conservation and Management Act of 2014. The Act requires that the affected farmer should report the incident within 48 hours after it occurs to KWS personnel (GoK, 2013a & c). This would allow assessors to move to the site of the incident to assess the extent of damage or loss and prepare a report which will be used in compensating the farmer. Since a significant proportion (27.6%) of farmers does not report to KWS offices, their claims do not qualify for compensation. This implies that most farmers in Laikipia County do not know the correct procedure of launching claims and seeking compensation for damages and losses caused by wild animals. Consequently, a farmer is likely to resent or even develop a negative attitude towards the conservation of wild animals, a situation that can aggravate human-wildlife conflicts.

This study also found that for the study period (2012 to 2015), all farmers (100%) in Laikipia County who had launched claims had not received any form of compensation. This was after wild animals attacked their farms and either destroyed their crops, injured or killed their livestock or even people. This was despite most (≥72.4%) farmers having launched claims seeking compensation (Figure K). Farmers in Laikipia County therefore, had different perceptions towards the monetary compensation scheme run by the Kenya Wildlife Service (Table 17).

Table 17

Farmers" Perception towards Compensation Scheme

Perception	Farmers (%)
Compensation process is slow	76 (n=155)
Compensation process is cumbersome	81 (n=165)
Seeking compensation is a waste of time	88 (n=179)
Compensation process lacks transparency	73 (n=148)
Compensation award is inadequate	86 (n=174)

Among the smallholder farmers in Laikipia County who had claimed compensation for damages and losses caused by wildlife attack on their farms, most (88%) of them consider that the exercise is a waste of time. This could be attributed to failure by the government to compensate claims by farmers for claims launched for the last five years. The same farmers could be involved in a repeat attack by wild animals. This scenario matches with other findings where farmers in Kenya reported that they do not receive any financial compensation from the government even when their entire crop has been destroyed by wild animals (Lauren-Bond, 2013). Some African countries do not pay out compensation for damages caused by wild animals because they argue that compensation does not reduce human-wildlife conflicts (Lamarque et al., 2009). It is unfair not to compensate an individual after their property has been damaged. This could be the reason why some farmers (27.6%) in Laikipia County did not initiate the process of seeking compensation. However, in Sub Saharan Africa, compensation schemes exist although they are not effective.

Majority of farmers (86%) consider the amount of money paid out for successful claims as inadequate. For instance, paying out USD 40 to a family whose family member has been killed is not enough to cater for funeral expenses and hospital bills and also meet the daily needs of the dependants left by especially if she was the sole bread earner. Further, the amount of money paid out is not enough to cater for school fees for the dependent children who may drop out of school due to lack of funds to pay school fees. Further, the amount of money (50,000 KES or 2- 3 million KES) paid out for human injury of up to permanent injury is not commensurate with the loss suffered. This agrees with a report from Tsavo Conservation Area where farmers consider the amount of money paid out after attacks by wild animals to be un-proportional to the loss suffered (Makindi et al., 2014).

Most farmers (81%) in Laikipia County reported that the process of claiming compensation after attack by wild animals is cumbersome. These findings also agree with a study done in the Tsavo Conservation Area of Kenya where farmers reported that the procedure for compensation is cumbersome (Makindi et al., 2014). This was associated with the filling of forms A and B (Appendix E & F) which involves visiting different government offices such as chief"s office, agricultural office, police office, a hospital and the Kenya Wildlife Service offices more than once. These results concur with those in the Sub Saharan Africa where farmers reported that the process of seeking compensation is bureaucratic (Lamarque at al., 2009; Hoare, 2012). In developing countries, the process of compensating claims is characterized by heavy bureaucracy (Roundeau & Bulte, 2007). The long process of claiming compensation and the long time (of two years or even more) taken before compensation is received discourages farmers from even making a claim itself. For instance, in Kenya, the process of compensating claims by farmers after wildlife attack farms delays and takes long (Makindi et al., 2014). This scenario can discourage a farmer from launching a claim.

Most farmers (76%) in Laikipia County consider the process of claiming compensation after wild animals attack their farms to be slow. The findings agree with reports from farmers in Africa that the process of seeking compensation is slow to administer (Hoare, 2012). This could be attributed by the failure by the government to pay compensation for claims sought by farmers for a long period, of two or even more years. Farmers in other parts of Kenya who are affected by wildlife attack also consider the process of receiving compensation after launching claims to be slow (Bond, 2014). Claiming compensation by farmers is also prone to corruption. This was shown by farmers (73%) in Laikipia County who reported that the process of claiming and receiving compensation lacks transparency. This matches with farmers" reports from different parts of the world which show that compensation of claims after attacks by wild animals is open to considerable abuse or corruption (Hoare, 2012). This is because sometimes bogus claims can be made, claims can be inflated or farmers can deliberately cultivate on areas most prone to wildlife attack so that they can be compensated after attack. For instance, compensation of claims to farmers by the government of Kenya was abandoned in 1989 due to corruption (Bond, 2014). Further, compensation schemes in developing countries have been abandoned due to fraud and corruption by both scheme administrators and claimants (Roundeau & Bulte, 2007).

Findings of this study therefore show that monetary compensation of claims to farmers is not effective in coping with human-wildlife conflict among smallholder farmers in Laikipia County. This was supported by the various reasons given by farmers, such as the compensation process being slow, inadequate, cumbersome and marred with corruption. Farmers may not therefore seek to be compensated and instead will resent. For instance, in Zimbabwe a compensation scheme was abandoned after two years of implementation when the number of claims quadrupled (Lamarque et al., 2009). In the year 2005, the government of Mozambique paid compensation to farmers adjacent Maputo Special Reserve but crop damage still continued in such a way that the government had difficulty in providing compensation. A compensation scheme was implemented in Kenya with promising results until 1989 when it became unworkable and therefore was suspended. This implies that compensating farmers for the loss of crops or livestock as a result of attack by wild animals is not an effective and sustainable strategy in coping with human-wildlife conflict among smallholder farmers in Laikipia County. Furthermore, compensation schemes deal with the effect of a human wildlife conflict and not the root cause.

4.6.2 Translocation of Wild Animals

This study established that translocation of wild animals from Laikipia County is 25% effective in coping with human wildlife conflict among smallholder farmers as shown in Table 18.

Table 18

Effectiveness of Translocation of Wildlife

Degree of effectiveness	Effectiveness (%)
Effective	25 (n=51)
Not effective	75 (n=152)

These findings agree with findings from a study done in the Tsavo Conservation Area where small-scale farmers reported that translocation of wild animals as a strategy for coping with human-wildlife conflict is 20% effective (Makindi et al., 2014). For instance, only eleven elephants were translocated between the years 2000 and 2001 from Laikipia County to Meru National Park (Graham et al., 2009). This means that other wild animals were left within the wildlife habitat in Laikipia County. The low rating of the effectiveness of translocation as a coping strategy could be because farmers had never experienced translocation of wild

animals being practiced. It could also be because translocation involves only the most problematic wild animals. Therefore, farmers in Laikipia County still consider themselves much vulnerable to attack by the wild animals remaining in the habitat after others are translocated. Since translocation of wild animals had not been undertaken in Laikipia County for more than a decade, translocation is therefore not considered by smallholder farmers as an effective strategy for coping with human-wildlife conflict.

4.7 Sustainability of AEHWCMS Adopted by Farmers in Laikipia County

The sixth objective was to determine the sustainability of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) used by smallholder agro-pastoralists bordering Rumuruti Forest. To answer this objective, the study produced results shown in Table 19, 20 and 21. In this study, sustainability referred to the ability of smallholder agro-pastoralists to successfully administer the AEHWCMS using their own resources without relying on external resources. Sustainability of AEHWCMS was measured through ranking by farmers who had used each mitigation strategy at least for two years, on a five-point Likert scale which included not sustainable, marginally sustainable, sustainable, very sustainable and very very sustainable. A very very sustainable mitigation strategy was assigned 1 while a strategy which is not sustainable was assigned 5. This was summed up with public extension agents" rating of the strategies on the same scale since they train the farmers, demonstrate and monitor farmers" use of the strategies on their farms. A sum of the rankings of each strategy on the sustainability criteria produced a sustainability rating. This study found that AEHWCMS have low sustainability rates which vary among the mitigation strategies. For instance, growing of mauritius thorn as a live fence against monkeys is 29.4% sustainable and digging trenches round the farm against elephants is 15.4% sustainable. Growing spiked sunflower, sorghum and wheat varieties against birds is 25% sustainable (Table 19).

Table 19

Sustainability of Mitigation Strategies Adopted by Farmers

Strategy	Target Wildlife	Sustainability (%)
Growing unpalatable crops	Monkey	66.70 (n=13)
	Elephant	66.70 (n=13)
	Zebra	66.70 (n=13)
	Antelope	66.70 (n=13)
	Quelea/weaver bird	100.00 (n=5)
Growing live fence	Elephant/buffalo/hyena	29.40 (n=7)
	Zebra/antelope	29.40 (n=7)
Growing fodder	elephant	100.00 (n=5)
Digging trenches	Elephant/hippo/gazelle/impala	15.40 (n=4)
Seed dressing	squirrel	100.00 (n=5)
Spiked/hairy crop variety	birds	25.00 (n=5)
Growing resistant crops	birds	47.20 (n=3)
Synchronized cropping	birds	25.00 (n=3)

The low sustainability rates of most AEHWCMS imply that smallholder agro-pastoralists in Laikipia County use mitigation strategies that are not sustainable. Consequently, the smallholder farmers will continue to experience a significant degree of human-wildlife conflict. This study also found that the non-extension mitigation strategies used by smallholder farmers also have low sustainability rates as shown in Table 20.

Table 20

Sustainability of Non-extension Mitigation Strategies Used by Farmers

Strategy	Sustainability (%)
Lighting fire	0.00
Scaring	12.50

For instance, lighting fire is totally (0.0%) not sustainable while scaring is about 12.5% sustainable. This study found that generally, both the agricultural extension human wildlife conflict mitigation strategies and the non-extension mitigation strategies have low sustainability rates. This could mean that the smallholder farmers in Laikipia County use

wildlife mitigation strategies that are not sustainable. They will therefore continue experiencing significant crop losses and number of livestock injured or killed. The low sustainability indices could be attributed to various factors, some of which are discussed below.

This study established that the low sustainability rates of the agricultural extension human wildlife conflict mitigation strategies could be caused by a number of factors. For instance 46.31% of farmers are affected by having inadequate knowledge which could be about the effective human wildlife conflict mitigation strategies, source of planting materials or knowledge and skill on how to use the mitigation strategy. For example farmers do not know the crops which are unpalatable to elephants or even the varieties of unpalatable crops suited for the climatic conditions in Laikipia County. A further 12.81% of farmers consider the AEHWCMS to be unsustainable because of lack of inputs such as planting materials. For instance the farmers in Laikipia County reported that seed for unpalatable crops such as chili is unavailable (Table 21).

Table 21

Factors Affecting Sustainability of Mitigation Strategies

Factor	Farmers (%)
Danger posed by a strategy	0.01 (n=2)
Farm size	0.01 (n=2)
High cost of implementation	10.84 (n=22)
Ineffective mitigation strategies	4.43 (n=9)
Lack of knowledge	46.31 (n=94)
Lack of inputs such as seed	12.81 (n=26)
Climatic conditions of an area	1.48 (n=3)
Lack of market for unpalatable crops	1.48 (n=3)
Type of land ownership	0.01 (n=1)
Religion of a farmer	0.01 (n=1)

For instance trenches cannot be excavated on small pieces of land, furthermore their excavation is expensive. There is lack of planting materials for unpalatable crops such as chili especially those suited to the climatic conditions in Laikipia County. Further, mitigation strategies such as mauritius thorn cannot be established on leased or leased land. This means

that lack of knowledge by farmers, lack of inputs and the high cost of implementing the mitigation strategies are causes of reducing the sustainability of wildlife mitigation strategies among smallholder agro-pastoralists in Laikipia County. These findings agree with a research report that showed that availability of inputs such as seed and other equipment deters adoption and reduces sustainability of a mitigation strategy for example in using red chili (Baabasa et al., 2013). Further, if the cost of inputs for initiating a mitigating strategy is high it will not be adopted by small-scale farmers. The high cost of the inputs also reduces the sustainability of the mitigation strategy. Lack of knowledge and skill about the use of a mitigation strategy reduces its effectiveness and sustainability. In addition, farmers will invest and implement sustainable mitigation strategies if they expect the investment to be profitable, and if they have the right education, information and motivation.

4.8 Extent of Collaboration in Promoting HWCMS in Laikipia County

The seventh objective of this study was to determine the extent of collaboration between Agricultural Extension and Kenya Wildlife Service in promoting Human Wildlife Conflict Mitigation Strategies among smallholder agro-pastoralists bordering Rumuruti Forest in Laikipia County. To answer this objective, the study generated results which are summarized in Table 22 and 23. This study found that the partnership and collaboration between Kenya Wildlife Service and public agricultural extension providers during promotion of human wildlife conflict mitigation strategies is inadequate (63%) (Table 22).

Table 22

Extent of Collaboration between Agricultural Extension and KWS

Variable	Collaboration (%)
Adequate collaboration	37 (n=4)
Inadequate collaboration	63 (n=6)

The low rate of collaboration and partnership means that in most cases KWS and the public agriculture extension service providers operate with minimal involvement of the other as they promote human wildlife conflict mitigation strategies among farmers in Laikipia County. This could be contributing to the low effectiveness of AEHWCMS. Consequently, farmers experience intense human wildlife conflicts. The low rate of adequacy in collaboration means that in some activities the two organizations collaborate well and poorly in others. This scenario was supported by further results which showed that there is 20% partnership during

provision of extension services, 60% during planning and implementation of community projects, 80% during crop assessment and 30% during promotion of human wildlife conflict mitigation strategies (Table 23).

Table 23

Areas of Partnership by KWS and Agricultural Extension

Variable	Partnership (%)
Provision of extension service	20 (n=2)
Planning and implementation of projects	60 (n=6)
Crop/livestock damage assessment	80 (n=8)
Promotion of human wildlife conflict mitigation strategies	30 (n=3)

Agricultural extension and KWS collaborate during crop assessment after wild animals destroy crops or assessment of livestock injured or killed. The extension staff and the KWS staff work together in the preparation of the report to help a farmer launch a claim for compensation. There is also collaboration during a Participatory Rural Appraisal (PRA) towards planning and implementing human wildlife conflict mitigation strategies, especially electric fencing. This was witnessed during the construction of the Ol Pejeta electric fence in Ramuria Division, Laikipia County when KWS involved agricultural extension staff during the PRA. Further, after a human wildlife conflict incidence, some farmers report to the agricultural extension staff to seek help for either chasing away the animal from their farms or compensation for the damage caused by the wild animal. The extension staff then, informs the KWS staff who takes action.

In addition, during community mobilization towards implementing human wildlife conflict coping strategies such as hospitals, agricultural extension staffs also participate. For instance, agricultural extension staff participated in community mobilization towards construction of Manguo Primary School by KWS. Agricultural extension staff and KWS staff also consult each other about the human wildlife conflict mitigation or coping strategies to promote. They also collaborate during barazas to educate farmers or create awareness on the coping or mitigation strategies to use during frequent wildlife attacks and also when a wildlife animal is present on the farm. This shows that agricultural extension and KWS collaborate during promotion and implementation of human wildlife conflict and coping strategies. However, due to the inadequate extent of collaboration and partnership in promoting and implementing

human-wildlife conflict mitigation strategies, the AEHWCMS have low effectiveness. This implies that the smallholder agro-pastoralists will continue experiencing significant degrees of human-wildlife conflict despite agricultural extension and Kenya Wildlife Service utilizing large amounts of resources are used to mitigate the conflict.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter gives a summary, conclusions, recommendations of the study and suggestions for further research. The conclusions and recommendations made were based on the findings, for possible intervention by various stakeholders in the agriculture sector. Briefly discussed is the introductory part of the study, literature review, research design, population of study, sampling procedures, data collection and analysis procedures. The final part is the summary of findings, conclusions and recommendations. Findings and recommendations are important because they show the knowledge gap filled by this study while recommendations for further research are based on the gaps identified after making conclusions of this study.

5.2 Summary of the Study

This study sought to establish the effectiveness of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) on human wildlife conflict among smallholder agro-pastoralists bordering Rumuruti Forest in Kenya‟s Laikipia County. This was achieved by collecting data on the AEHWCMS adopted by the smallholder agro-pastoralists in Laikipia County and ranking them in terms of effectiveness in reducing crop damage, livestock or human injury or even death. To achieve this purpose, questionnaires were administered on 203 smallholder agro-pastoralists and their 10 extension staff. Face and content validity of the questionnaires were estimated through discussions with five experts and two supervisors from the Agricultural Education and Extension Department of Egerton University. Reliability of the questionnaires was estimated by pilot-testing using 30 smallholder agro-pastoralists and bordering Maasai Mara Game Reserve in Narok County and their 5 agricultural extension staff. The internal consistency technique was used to calculate the reliability co-efficient. A reliability co-efficient of α=0.89 and α=0.86 for farmers‟ and agricultural extension staff‟s questionnaire respectively were accepted. The researcher administered the questionnaire on the farmers and agricultural extension staff and analyzed the data collected using SPSS version 21. Secondary data were collected through document review using a document review guide.

The first objective was to determine the AEHWCMS adopted by smallholder agro-pastoralists. Results of this study showed that ≤8.60% of farmers grow unpalatable crops, ≤12.67% grow live fences, ≤12.22% dig trenches, ≤8.41% grow crops with hairs or spikes

and ≤9.50% grow crops such as maize varieties that are resistant to bird damage. Farmers also use other strategies such as scaring away (53.70%) and lighting fire (45.30%). Most farmers (76.00%) use more than one mitigation strategy against more than one species of wildlife concurrently.

Objective two was to determine the socio-demographic factors affecting adoption of Agricultural Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS). To achieve this objective gender, age, education level and income level of farmers were considered. This study established that more males (61%) than females (39%) are engaged in farming in Laikipia County. It also means that most farmers in Laikipia County are males, implying that they are major decision makers in most households in Laikipia County. This means that the effectiveness of AEHWCMS adopted on the farm is affected by gender of farmers since men are major decision makers in most households although women are the major source of farm labor. This study also found that majority of farmers (77%) in Laikipia County are aged 41 years and above, with the minority of farmers (23%) being aged 41 years and below. This means that in Laikipia County agriculture is dominated by an aging population and that youth have shunned agriculture. This implies that the effectiveness of AEHWCMS used is affected by the age of farmers.

The study also revealed that an average population of farmers (46%) had only up to primary level of education, while a significant proportion (28%) had no formal education. This shows that majority of farmers (74%) had at least primary education or no formal education. This means that most farmers in Laikpia County are of a low education status. This implies that adoption and effectiveness of AEHWCMS is affected by the education level of a farmer. This research also established that more than half of farmers (51%) in Laikipia County were poor because they earn an average income of less than 60,000 shillings annually, with only 30% earning between 60,000 and 120,000 shillings annually. This means that most smallholder farmers in Laikipia County earn low income and therefore cannot afford the inputs required to initiate and maintain most AEHWCMS. This lowers the adoption and effectiveness of AEHWCMS among smallholder agro-pastoralists in Laikipia County.

Objective three sought to determine the trend of human wildlife conflict among smallholder agro-pastoralists. Results showed that there was an increasing trend of human wildlife conflicts among smallholder agro-pastoralists in Laikipia County. For instance, the hectarage of maize crop destroyed increased from 67.05% in 2012 to 69.23% in 2015 while the

hectarage for potato crop destroyed increased from 67.08% in 2012 to 69.96% in 2015. Additionally, the number of goats killed by wildlife increased from 107 in 2012 to 139 in 2015 and the number of cattle killed increased from 4 to 6 in the same period.

Objective four sought to determine the effectiveness of AEHWCMS adopted by smallholder agro-pastoralists in Laikipia County. Effectiveness of the AEHWCMS was determined by ranking of the strategies by farmers who had used them for at least 2 years and their extension agents on a 5-point Likert scale. This study found that growing of unpalatable crops was ≤34% effective, live fences were ≤30% effective, digging trenches 28.51% effective, growing crops having spikes 11.76% effective and growing resistant crop varieties 33.33% effective. The low rates of effectiveness were attributed to various reasons such as farmers" negative attitude towards growing unpalatable crops and small landholdings. They also include unavailability of ready market for unpalatable crops and farmers" inadequate knowledge and skill about unpalatable crop varieties agro-ecologically suited to climatic conditions in Laikipia County.

Objective five sought to determine the effectiveness of human wildlife conflict coping strategies promoted through governance on human wildlife conflict in Laikipia County. Effectiveness of the HWCCS was determined by ranking of the strategies by farmers and their extension agents on a 5-point Likert scale. This study established that translocation of wildlife is 25% effective while compensation schemes are 23% effective. Additionally, 100% of farmers in Laikipia County reported that although they had launched claim after wildlife invaded their farms and destroyed crops, injured or killed livestock or even people, they had never received any form of compensation in a period of four years, as from 2012 to 2015. This shows that these strategies are not effective in coping with human wildlife conflicts.

Objective six sought to determine the sustainability of human wildlife conflict mitigating strategies among smallholder farmers in Laikipia County. Sustainability was measured through ranking of the AEHWCMS by farmers who had used the strategies on their farms and their extension agents, on a 5-point Likert scale. This study found that the sustainability of AEHWCMS vary from as low as 15% for digging trenches, 25% for growing spiked crops, 29.4% growing live fence to 66.7% for growing of unpalatable crops. However, the sustainability rate varies depending on the mitigation strategy and the wild animal targeted.

Objective seven sought to determine the extent of collaboration between agricultural extension and Kenya Wildlife Service during the promotion of human wildlife conflict mitigating strategies in Laikipia County. This study established that the extent of collaboration between agricultural extension and KWS was about 37% adequate. The low rate of partnership and collaboration could be lowering the effectiveness of the human wildlife conflict mitigation strategies promoted among the smallholder farmers in Laikipia County.

5.3 Conclusions

Based on the results of this study, the following conclusions were made:

i) Low proportions of smallholder farmers adopt each of the various AEHWCMS such as digging trenches, growing unpalatable crops, growing spiked crops, growing live fences and resistant crop varieties on their farms. This could be due to inadequate knowledge and skill about AEHWCMS, unaffordable inputs for AEHWCMS and lack of agro-ecologically suited unpalatable crops. Further, farmers have a negative attitude towards the use of unpalatable crops as a human wildlife conflict mitigation strategy.

ii) Socio-demographic factors, particularly gender, age, level of education and income level of farmers significantly affects the effectiveness of AEHWCMS adopted among smallholder agro-pastoralists in Laikipia County. This is because most farmers are advanced in age, have low education level and on average, earn low income annually.

iii) The trend of human wildlife conflicts among smallholder agro-pastoralists in Laikipia County is on an increase, from the early months of the year to the end of the year, annually. This could be attributed to the low effectiveness of AEHWCMS adopted.

iv) The AEHWCMS adopted by smallholder agro-pastoralists in Laikipia County do not adequately mitigate the increasing trend of human wildlife conflicts because they have low rates of effectiveness, some as low as ≤11.76%. This could be due to inadequate farmers" knowledge and skill on establishment and maintenance of AEHWCMS, inputs of some strategies being unaffordable and unavailable, farmers" low education level and advancement in age.

v) The human wildlife conflict coping strategies promoted through governance have low rates of effectiveness, as low as 23% effective. They are not effective in making farmers cope with human wildlife conflicts because they tend to address

consequences of the conflicts and not their root causes. Further, these strategies are top-down in nature and therefore farmer involvement is minimal and inadequate.

vi) Most AEHWCMS adopted by smallholder farmers in Laikipia County have low sustainability rates besides having low effectiveness rates for mitigating human wildlife conflicts. Some of the AEHWCMS have as low as 15% sustainability rates. Therefore, smallholder farmers in Laikipia County will continue experiencing significant degrees of human wildlife conflicts.

vii) The collaboration between Agricultural extension and KWS is not adequate during planning and implementation of human wildlife conflict mitigation activities. The collaboration is as low as 37% adequate. In some instances the collaboration is adequate and in some cases it is inadequate. For instance, they do not adequately collaborate during implementation of human wildlife conflict coping projects such as hospitals and schools and farmer education or provision of extension service. However, they collaborate adequately during assessment of crop, livestock and infrastructure damage after wildlife attack.

5.4 Recommendations of the Study

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

i) Extension service providers in Kenya should identify and promote effective and sustainable Agriculture Extension Human Wildlife Conflict Mitigation Strategies (AEHWCMS) among smallholder farmers. This can improve adoption rates of the AEHWCMS and consequently reduce human wildlife conflict incidences among farmers in Laikipia County. The extension agents should also set up demonstrations aimed at convincing farmers that the AEHWCMS are effective, so as to improve adoption.

ii) The Ministry of Agriculture and agriculture sector stakeholders should develop and promote youth and gender-friendly Agriculture Extension Human Wildlife Conflict Mitigation Strategies. These AEHWCMS should also be affordable and attractive to youth and smallholder farmers so as to improve their adoption and effectiveness. For example, varieties of chili that are agro-ecologically suited, fast in growth and marketable can be grown on a commercial scale. They can also develop sorghum varieties that are unpalatable to birds, are hairy and suitable to the brewing industry. Farmers can then be trained, offered soft loans and

encouraged to form cooperatives for bulk buying of inputs and marketing of the farm produce.

iii) Agricultural extension and agriculture stakeholders should promote effective and sustainable AEHWCMS such unpalatable crop varieties, so as to enhance adoption by smallholder farmers. This will help in reversing the increasing trend of human wildlife conflicts among smallholder farmers in Laikipia County.

iv) The Ministry of Agriculture and the KWS should promote farmer-based human wildlife conflict coping strategies such as crop, livestock or even human insurance schemes. This will enhance ownership, sustainability and effectiveness in coping with human wildlife conflicts. The community-based human wildlife conflict coping strategies will encourage farmers to identify the root causes of the conflict and help them to seek effective solutions.

v) The Ministry of Agriculture and KWS should formulate agricultural extension and wildlife conservation policies that promote and are clear on collaboration and partnerships. Strengthening collaboration will facilitate development of effective and sustainable human wildlife conflict mitigation and coping strategies thus reduce human wildlife conflicts especially among smallholder farmers.

5.5 Recommendations for Further Research

Based on the findings of this study and building on the existing research, it is hereby recommended that further research be undertaken in the following areas:

i) Effectiveness of AEHWCMS on human-wildlife conflict among smallholder farmers neighboring unprotected wildlife habitats in other Counties hosting wildlife in Kenya.

ii) Sustainability of human-wildlife conflict mitigation strategies adopted by smallholder farmers bordering wildlife habitats in other Counties Kenya.

iii) The extent of influence of inadequate collaboration between agricultural extension and Kenya Wildlife Service on the severity of human-wildlife conflict in other Counties in Kenya.

iv) The effectiveness of human-wildlife conflict mitigation strategies promoted by the Kenya government through governance in other Counties.

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APPENDIX A

FARMERS' QUESTIONNAIRE ON EFFECTIVENESS OF AGRICULTURAL EXTENSION WILDLIFE MITIGATION STRATEGIES

Dear Respondent,

This questionnaire seeks to collect data for determining the effectiveness of agricultural extension wildlife mitigation strategies in mitigating human-wildlife conflict among smallholder agro-pastoralists from 2012 to 2015. The information you provide will help in formulating policies, identifying and developing strategies to reduce human-wildlife conflict and will be kept confidential. Your cooperation will be highly appreciated.

Instructions

Answer all the questions in the spaces provided or Tick (√) as appropriate.

SECTION A: RESPONDENT'S PERSONAL DATA

1. Gender: Male ☐ Female

2. Age : Below 25yrs ☐ 36-40yrs ☐ 51-55yrs ☐

   26-30yrs ☐ 41- 45 yrs ☐ 56-60yrs ☐

   31-35yrs ☐ 46-50yrs ☐ Above 60 yrs ☐

3. Highest education level:

   None ☐ Upper Primary ☐ Tertiary ☐

   Lower Primary ☐ Secondary ☐ University ☐

4. Average household income for one year:

   Low (Less than ksh. 60,000) ☐ High (more than ksh.120, 000) ☐

   Medium (ksh. 60,000-120,000) ☐

5. Approximate farm size in acres……………………………………………………………

SECTION B: INFORMATION RELATED TO HUMAN-WILDLIFE CONFLICT

6. Indicate your sources of information on human-wildlife conflict mitigation strategies………………………………………………………………………………………

   ………………………………………………………………………………………

   ………………………………………………………………………………………

7. Estimate the effect of wildlife attack on your household in the last four years by filling Table 1.

   Table 1

Effect of Wildlife Attack

Effect of wildlife attack	Year				Total
	2012	2013	2014	2015	
a) On goats					
i. Total number of goats					
ii. Number injured					
iii. Total number of deaths					
b) On sheep					
i. Total number					
ii. Number injured					
iii. Number of deaths					
c) Cattle (cows+bulls)					
i. Total number					
ii. Number injured					
iii. Number of deaths					
Total					
d) Humans					Remarks
i. Total per household					
ii. Number injured					
iii. Number of deaths					
e) Others: (please specify)					Total
f) Total number of invasions					

8. Indicate in Table 2 the species of livestock that is attacked by the wildlife shown.

Table 2

Species of Livestock Attacked

Wildlife	Livestock
Elephant	
buffalo	
Hyena	
Others (specify)	

9. Indicate the number (from the key provided) that signifies the extent of crop damage in a year by completing Table 3.

Key:

5=very low

4 =low

3 =medium

2=high

1=very high

Table 3

Extent of Crop Damage in a Year

Stage of growth	Extent of damage			
	2012	2013	2014	2015
i. Seedling				
ii. Intermediate				
iii. Mature				

10. Indicate in Table 4, the month or months in which wildlife attacked your farm. (Use √).

Table 4

Month of Wildlife Attack

Year	Month											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug	Sep	Oct	Nov.	Dec.
2012												
2013												
2014												
2015												

11. Indicate in Table 5 the crop that is damaged by the wildlife shown.

Table 5
Crop Damaged by Wildlife

Wildlife	Crop
Elephant	
birds	
buffalo	
porcupine	
hyena	
gazelle	
monkey	
Others (specify)	

12. Estimate in Table 6, the (%) of the crop damaged by wildlife out of the total acreage of each crop in a year.

Table 6
Per Cent of Crop Damage

Crop	Year			
	2012	2013	2014	2015
	%	%	%	%
i. Maize				
ii. Beans				
iii. Dolichos (Njahi)				
iv. Irish Potatoes				
v. Vegetables				
vi. Sorghum				
vii. Wheat				

viii.	Orange tree				
ix.	Pepper				
x.	Tomatoes				
xi.	Others: (please specify)				

13. Indicate in Table 7 the mitigation strategy you use against the wildlife shown.

Table 7

Mitigation Strategy Used

Wildlife	strategy
Elephant	
birds	
buffalo	
porcupine	
hyena	
gazelle	
monkey	
zebra	
Others (specify)	

14. Indicate in Table 8 the strategy you use on your farm to reduce the number of wildlife attacks. Tick as appropriate (Use √).

Table 8

Strategy forReducing Wildlife Attacks

Strategy		Year			
		2012	2013	2014	2015
i.	Planting unpalatable crops e.g chili(pepper), ginger				
ii.	Digging trenches/ditches				
iii.	Growing sisal				

iv. Growing cactus				
v. Growing mauritius thorn				
vi. Growing crops with spikes				
vii. Growing fodder				
viii. Growing fruit trees				
ix. Growing woodlot				
x. Growing crops that mature early to escape attack				
Others: (please specify)				

15. Rank in Table 9 the strategies you use to reduce wildlife attacks on your farm using the criteria provided.

Criteria:

1= Very very effective

2= Very effective

3= Effective

4= Marginally effective

5= Not effective

Table 9

Effectiveness of Wildlife Mitigation Strategies

Strategy	Effectiveness
i. Planting unpalatable crops e.g chili	
ii. Digging trenches/ditches	
iii. Growing sisal	
iv. Growing cactus	
v. Growing mauritius thorn	
vi. Growing crops with spikes e.g	
vii. Growing fodder e.g	
viii. Growing fruits. e.g	
ix. Growing woodlot	

x. wildlife translocation	
xi. government incentives provided	
xii. electric fence	
xiii. relocation of farmers	
xiv. monetary compensation	
xv. community insurance	
Others: (please specify)	

16. In Table 10, indicate the mitigation strategy you have benefited from

Table 10 (use √)

Mitigation Strategy implemented by KWS

Strategy	
Electric fence	
Monetary compensation	
Translocation of wildlife	
Giving incentives	
relocation of people	
Community insurance	
Land use planning	

17. In Table 11, indicate two factors affecting the effectiveness of each of the following strategies

Table 11

Factors Affecting Effectiveness of Strategies

Strategy	Factors
Monetary compensation	
Relocation of people	
Translocation of wildlife	
Community insurance	
Electric fence	
Land use planning	
Receiving incentives	

18. In Table 12, indicate using a tick (√) the activities implemented jointly by Kenya Wildlife Service and Agricultural Extension

Table 12

Activities jointly Implemented by KWS and Agricultural Extension

Activity	Mark (√)
Provision of extension services	
Project implementation	
Crop/livestock/infrastructure damage assessment	
Promotion ofhuman wildlife conflict mitigation strategies	
Others:	

SECTION C: GENERAL INFORMATION

19. State two major challenges you face in adopting Agricultural Extension Wildlife Mitigation Strategies on your farm.

    …………………………………………………………………………………………………

    …………………………………………………………………………………………………

20. Give two major recommendations on what the Ministry of Agriculture, Livestock and Fisheries Development should do to reduce wildlife attacks on crops, livestock and humans.

    …………………………………………………………………………………………………

    …………………………………………………………………………………………………

21. Give two major recommendations on what the County Government should do to prevent wildlife attackson your farm.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

THANKS FOR YOUR COOPERATION.

APPENDIX B

EXTENSION AGENTS' QUESTIONNAIRE ON EFFECTIVENESS OF AGRICULTURAL EXTENSION WILDLIFE MITIGATION STRATEGIES

Dear Respondent,

This questionnaire seeks to collect data for determining the effectiveness of agricultural extension wildlife mitigation strategies in mitigating human-wildlife conflict among smallholder agro-pastoralists from 2012 to 2015. The information you provide will help in identifying and developing strategies to reduce human-wildlife conflict and will be kept confidential. Your cooperation will be highly appreciated.

Instructions

Answer all the questions in the spaces provided or Tick (√) as appropriate.

SECTION A: RESPONDENT'S PERSONAL DATA

1. Gender: Male   ☐   Female

2. Age :   26-30 yrs   ☐   41-45yrs   ☐   56-60 yrs   ☐

            31-36yrs   ☐   46- 50 yrs   ☐   Above60yrs   ☐

            36-40yrs   ☐   51-55yrs   ☐

3. Highest education level:

Secondary ☐   Diploma ☐ 2nd degree (Msc/MA) ☐

Certificate ☐ 1st Degree ☐ 3rd degree (Phd)   ☐

SECTION B: INFORMATION RELATED TO HUMAN-WILDLIFE CONFLICT

4. Indicate in Table 1 the wildlife that invade farms and the crop they damage

Table 1

Crop Damaged by Wildlife

Wildlife	Crop
Elephant	
Hare	
gazelle	
Dik dik	
porcupine	
squirrel	
buffalo	

Monkey	
Others; (please specify)	

5. Indicate in Table 2 the livestock attacked by the wildlife shown.

   Table 2

   Livestock Attacked by Wildlife

Wildlife	Livestock
Elephant	
lion	
leopard	
mongoose	
Squirrel	
Others:	

6. Indicate the number (from the key provided) that signifies the extent of crop damage in a year by completing Table 3.

Key:

5=very low

4 =low

3 =medium

2=high

1=very high

Table 3

Extent of Crop Damage in a Year

Stage of growth	Extent of damage			
	2012	2013	2014	2015
i. Seedling				
ii. Intermediate				
iii. Mature				

7. Indicate in Table 4 the month or months in which wildlife attacked your farm. (Use √).

Table 4

Month of Wildlife Attack

Year	Month											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug	Sep	Oct	Nov.	Dec.
2012												
2013												
2014												
2015												

8. Estimate in Table 5, the (%) of the crop damaged by wildlife out of the total acreage of each crop in a year.

Table 5
Percent of Crop Damage

Crop	Year			
	2012	2013	2014	2015
	%	%	%	%
Maize				
Beans				
Dolichos (Njahi)				
Irish Potatoes				
Vegetables				
Sorghum				
Wheat				
Orange tree				
Pepper				
Tomatoes				
Others: (please specify)				

9. Indicate in Table 6, the mitigation strategy used against the wildlife shown.

Table 6: Mitigation Strategy Used

Wildlife	Strategy
Elephant	
Birds	

Buffalo	
Porcupine	
Hyena	
Gazelle	
Monkey	
zebra	
Others (please specify)	

10. Indicate in Table 7 the strategies farmers use on their farms to reduce the number of wildlife attacks. Tick as appropriate (Use √).

Table 7

Strategy for Reducing Wildlife Attacks

Strategy	Year			
	2012	2013	2014	2015
i. Planting unpalatable crops e.g chili (pepper), ginger				
ii. Digging trenches/ditches				
iii. Growing sisal				
iv. Growing cactus				
v. Growing mauritius thorn				
vi. Growing crops with spikes				
vii. Growing fodder				
viii. Growing fruit trees				
ix. Growing woodlot				
x. Growing crops that mature early to escape attack				
Others: (please specify)				

11. Rank in Table 8, the mitigation strategies farmers use to reduce wildlife attacks on their farms, using the criteria provided.

Criteria:

1= Very very effective

2= Very effective

3= Effective

4= Marginally effective

5= Not effective

Table 8

Effectiveness of Wildlife Mitigation Strategies

Strategy	Effectiveness
i. Planting unpalatable crops e.g chili	
ii. Digging trenches/ditches	
iii. Growing sisal	
iv. Growing cactus	
v. Growing mauritius thorn	
vi. Growing crops with spikes	
vii. Growing fodder	
viii. Growing fruits	
ix. Growing woodlot	
x. translocation of wildlife	
xi. government incentives	
xii. relocation of farmers	
xiii. monetary compensation	
xiv. community insurance	
xv. electric fence	
Others: (please specify)	

12. Indicate in Table 9the mitigation strategies agricultural extension and Kenya Wildlife
Service jointly implement in Laikipia County (use √)

Table 9

Mitigation strategy jointly implemented by KWS and agricultural extension

Strategy	Mark (√)
i. Live fence	
ii. Digging trenches	
iii. Promotion of unpalatable crops	
iv. Bee hive technology	

v. Growing crops having spikes	
Others (specify)	

14 In Table 10, indicate using a tick (√) the activities implemented jointly by Kenya Wildlife Service and Agricultural Extension

Table 10

Activities jointly Implemented by KWS and Agricultural Extension

Activity	Mark (√)
Provision of extension services	
Project implementation	
Crop/livestock/infrastructure damage assessment	
Promotion of human wildlife conflict mitigation strategies	
Others:	

SECTION C: GENERAL INFORMATION

13. State two major challenges farmers face in adopting Agricultural Extension Wildlife Mitigation Strategies on their farms.

………………………………………………………………………………………………

………………………………………………………………………………………………

14. Give two major recommendations on what the Ministry of Agriculture, Livestock and Fisheries Development should do to reduce wildlife attacks on crops, livestock and humans.

………………………………………………………………………………………………

………………………………………………………………………………………………

15. Give two major recommendations on what the County Government should do to prevent wildlife attacks on farms.

………………………………………………………………………………………………

………………………………………………………………………………………………

THANK YOU FOR THE COOPERATION

APPENDIX C

DOCUMENT REVIEW GUIDE

S/No	Document	Information looked for
1	Evaluation of Agricultural Extension and Delivery Services in Southwest Nigeria. International Journal of Agriscience, 1 (4), 581-591. 2011 (185).	-Promoted agricultural extension wildlife extension mitigation strategies (AEHWCMS) -Adopted AEHWCMS
2	The Role of Extension Officers and Extension Services. In: The Development of Agriculture in Nigeria. Wudpecker Journal of Agricultural Research, 1 (6), 180-185	-Promoted agricultural extension wildlife extension mitigation strategies (AEHWCMS) -Adopted AEHWCMS
3	Concepts and Practices in Agricultural Extension in Developing Countries: A Sourcebook	-Promoted agricultural extension wildlife extension mitigation strategies (AEHWCMS) -Adopted AEHWCMS
4	Strategies to Mitigate Human-Wildlife Conflicts-Mozambique Wildlife Management. Working Paper no. 8	Human-wildlife conflict mitigation strategies Effectiveness of mitigation strategies
5	Agricultural Advisory Services: Background Paper for the World Development Report, 2008	-Promoted agricultural extension wildlife extension mitigation strategies -Adopted AEHWCMS
6	Farmers" Perceptions of the Impact of Wildlife on Small-scale Cacao Cultivation in Cameroon. African Primates, 7 (1), 27-34.	Manifestation of human-wildlife conflict Trend of human-wildlife conflict
7	A Holistic Approach to Natural Resource Conflict: the Case of Laikipia County, Kenya. Journal of Rural Studies, 34.	Human-wildlife conflict mitigation strategies Mitigation strategies adopted
8	Mobilizing the Potential of Rural and Agricultural Extension. FAO of the United Nations and the Global Forum for Rural Advisory Services	-Promoted agricultural extension wildlife extension mitigation strategies -Adopted AEHWCMS
9	Research on Agricultural Extension Systems: What Have We Learnt and Where Do We Go From Here? Workshop Organized by the CGIAR Research Program on Policies, Institutions and Markets. October 15-16	Promoted agricultural extension wildlife extension mitigation strategies (AEHWCMS) Adopted AEHWCMS
10	Extension and Advisory Services for Facilitating Sharing of Agricultural Innovations. In: Alliance for a Green Revolution in Africa. Agriculture Status Report: Focus on Staple Crops	Promoted agricultural extension wildlife extension mitigation strategies (AEHWCMS) Adopted AEHWCMS
11	Human-Wildlife Conflict Worldwide: Collection of Case Studies, Analysis of Management Strategies and Good Practices. South Africa: 1-34	Human-wildlife conflict mitigation strategies Adopted and effectiveness and sustainability of mitigation strategies
12	Assessment of Human-Wildlife Conflicts in Filinga Range of Gashaka Gumti National Park, Nigeria. Publication of Nasarawa State	Trend of human-wildlife conflict Human-wildlife conflict mitigation

	University, Keffi, PAT, 7 (1), 15-35	strategies
13	Overview of Human-Wildlife Conflict in Cameroon. Poverty and Conservation Learning Group Discussion Paper No. 05.	-Trend of human-wildlife conflict -Human-wildlife conflict mitigation strategies
14	Human Wildlife Conflict in Africa-Causes, Consequences and Management Strategies. FAO Forestry paper 157	-Trend of human-wildlife conflict -Human-wildlife conflict mitigation strategies
15	Agricultural Extension Services System in Nepal Pulchowk,	Agricultural Extension Wildlife Mitigation Strategies
16	CAMPFIRE and Human-Wildlife Conflicts in Local Communities Bordering Northern Gonarezhou National Park, Zimbabwe. Ecology and Society, 18 (4), 7.http://dx.doi. org /10.h‟5751/Es-05817-180407	Trend of human-wildlife conflict Human-wildlife conflict mitigation strategies Effectiveness of mitigation strategies
17	Agricultural Sector Development Strategy (ASDS) 2010–2020	Agricultural Extension Wildlife Mitigation Strategies promoted
18	National Agricultural Sector Extension Policy (NASEP).	Agricultural Extension Wildlife Mitigation Strategies promoted
19	Laikipia County: First County Integrated Development Plan 2013-2017	Agricultural Extension Wildlife Mitigation Strategies promoted
20	Coexistence in a Land Use Mosaic? Land Use, Risk and Elephant Ecology in Laikipia District, Kenya	Trend of human-wildlife conflict Effectiveness/ sustainability of strategies HWC mitigation strategies adopted
21	Uptake and Performance of Farm-based Measures for Reducing Crop Raiding by Elephants, Loxodonta Africana, among Farms in Laikipia District, Kenya. Oryx, 42.	-Trend of human-wildlife conflict -HWC mitigation strategies used -Effective HWC mitigation strategies
22	The Use of Community Drama in the Mitigation of Human-Elephant Conflict, Laikipia, Kenya. Laikipia Elephant Project,	HWC mitigation strategies used Effective and sustainability of HWC mitigation strategies
23	The Use of Electric Fences to Reduce Human-Elephant Conflict: ACase Study of the Ol-Pejeta Conservancy, Laikipia District, Kenya. Working Paper 1.	HWC mitigation strategies used Effective HWC mitigation strategies
24	Mobile Phone Communication in Effective Elephant-conflict Management in Laikipia County, Kenya. Oryx, 46 (01), 137-144.	HWC mitigation strategies used Effective HWC mitigation strategies
25	Elephants, Safety Nets and Agrarian Culture: Understanding Human-Wildlife Conflict and Rural Livelihoods around Chobe National Park, Botswana. Journal of Political Ecology, 20	Manifestation of HWC Trend of HWC HWC mitigation strategies
26	Solving Problems and Resolving Conflict Using the Inter-cultural Conflict Style Model and Inventory	HWC mitigation strategies used Effective HWC mitigation strategies
27	Community, Lions, Livestock and Monkey: Spatial and Social Analysis of Attitudes to Wildlife and the Conservation Value of Tourism in a Human-Carnivore Conflict in	-Manifestation of HWC -Trend of HWC -HWC mitigation strategies used

	Botswana; Biological conservation, 142, 2718-2725.	-Effective HWC mitigation strategies
28	Crop Protection and Conflict Mitigation: Reducing the Cost of Living alongside Non-Human Primates. Biodiversity and Conservation, 21, 2569-2587.	HWC mitigation strategies used

Effective / sustainability of HWC mitigation strategies |
| 29 | Lessons from 15 years of Human-Elephant Conflict Mitigation. Management Consideration involving Biological, Physical and Governance Issues in Africa. | HWC mitigation strategies used

Effective HWC mitigation strategies |
| 30 | Best Practice Guidelines for the Prevention and Mitigation of Conflict between Humans and Great Apes. Gland, Switzerland. IUCN/SSC Primate Specialist Group | HWC mitigation strategies used

Effectiveness of HWC |
| 31 | Monkey Management: Using Spatial Ecology to Understand the Extent and Severity of Human-Baboon-Conflict in the Cape Pennisula, South Africa. Ecology and Society, 17 (13). | HWC mitigation strategies used

Effective / sustainability of HWC mitigation strategies |
| 32 | Human-Elephant Conflict Trials in Zimbabwe: Can bees deter Elephants from Raiding Crops? In: Walpole, M. & Linkie, M. (eds). Proceedings of a Symposium on Mitigating Human-Elephant Conflict: Case Studies from Africa and Asia. Cambridge, UK. Pp.29-36. ISBN: 9781903703267. | HWC mitigation strategies used

Effective HWC mitigation strategies

Sustainable HWC mitigation strategies |
| 33 | Possible Strategies/Practices in Reducing Wild Animal (Primate).Crop Raids in Unprotected Areas in Hoima, District, Uganda | -HWC mitigation strategies used
-Effective HWC mitigation strategies
-Sustainable HWC mitigation strategies |
| 34 | Kenya Wildlife Conservation Project USAID & Kenya. Retrieved on http://www.kws.go.ke. | Extension service providers

HWC mitigation strategies promoted |
| 35 | The Wildlife Conservation and Management Act, 2013 | HWC mitigation strategies promoted |
| 36 | Bee Hive Fences are Effective Deterrents for Crop Raiding Elephants. Field Trials in Northern Kenya. African Journal of Ecology, 49 (4), 431-439. | Effective HWC mitigation strategies

Sustainable HWC mitigation strategies |
| 37 | Human-wildlife Conflict in Senkele Swayne‟s Hartebeast Sanctuary, Ethiopia. Journal of Experimental Biology and Agricultural Sciences, 1, (1). | Effective HWC mitigation strategies

Sustainable HWC mitigation strategies |
| 38 | A Wildlife Conservation Strategy for Laikipia County (2012-2030). First Edition. | Effective HWC mitigation strategies

Sustainable HWC mitigation strategies |
| 39 | Human-wildlife Conflict in Africa: Causes, Consequences and Management Strategies. FAO, Forestry Paper 157 | -Trend of HWC
-Effective HWC mitigation strategies
-Sustainable HWC mitigation strategies |

40	Human (in) Security of the Livestock Crop-wildlife Nexus: The Case of Laikipia County, Kenya. IFRO PhD Thesis	-Trend of HWC -Effective HWC mitigation strategies -Sustainable HWC mitigation strategies
41	Human Wildlife Conflicts in Southern Africa: Riding the Whirl Wind in Mozambique and in Zimbabwe, the Importance of Biological Interactions in the Study of Biodiversity	Trend of HWC Effective HWC mitigation strategies Sustainable HWC mitigation strategies
42	The Growing Conflict between Humans and Wildlife: Law and Policy as Contributing and Mitigating Factors. Journal of International Wildlife Law and Policy, 11.	-Trend of HWC -Effective HWC mitigation strategies -Sustainable HWC mitigation strategies
43	Human-wildlife Conflicts: Causes and Mitigation Measures in Tsavo Conservation Area, Kenya. International Journal of Science and Research (IJSR), 3, (6).	-Trend of HWC -Effective HWC mitigation strategies -Sustainable HWC mitigation strategies
44	Mobile Phone Communication in Effective Human Elephant-Conflict Management in Laikipia County. Nanyuki, Kenya. International Oryx; the International Journal of Conservation.	Trend of HWC Effective HWC mitigation strategies Sustainable HWC mitigation strategies
45	Farmers" Perceptions and Actions to Decrease Crop Raiding by Forest Dwelling Primates around Rwandan Forest Fragment, Human Dimensions of Wildlife: An International Journal, 19 (2), 179-190.	Trend of HWC Effective HWC mitigation strategies Sustainable HWC mitigation strategies
46	Crop-Raiding of Mango Fruits, Mangifera indica, by Mantled Bowlers (Alouatta pollata) in the Refugio de vida Silvestre Curu, Costa Rica. American Journal of Physical Anthropology. Suppl. 46: 153	Trend of HWC Effective HWC mitigation strategies Sustainable HWC mitigation strategies
47	Wildlife Conservation Education. The George Wright Forum, 29 (1), 59-66.	-Trend of HWC -Effective HWC mitigation strategies
48	Human-wildlife Conflicts: Emerging Challenges and Opportunities. Human-Wildlife Interactions. Paper 24.	-Trend of HWC -Effective HWC mitigation strategies -Sustainable HWC mitigation strategies
49	The National Wildlife Conservation and Management Policy, 2012	-Trend of HWC -Effective HWC mitigation strategies
50	Identifying the Economic and Social Impacts of Crop Raiding by Non-Human Primates on Local Livelihoods, in Mount Rungwe, South West, Tanzania. Folia Primatological, 79	Effective HWC mitigation strategies Sustainable HWC mitigation strategies
51	Factors Influencing Human-wildlife Conflict in Communities around the Park: A Case of Lake Nakuru National Park, Kenya. Masters" thesis	Effective HWC mitigation strategies Sustainable HWC mitigation strategies
52	Human-elephant Conflict Mitigation: A Training Course for Community-Based Approaches in Africa. Trainer"s Manual. Elephant Pepper Development Trust,	Effective HWC mitigation strategies Sustainable HWC mitigation strategies

	Livingtone, Zambia and IUCN/SSC AfESG	
53	Exploring Human-Non Human Primate Interface in Sulawesi, Indonesia: American Journal of Primatology, 71, 1-7.	Effective HWC mitigation strategies Sustainable HWC mitigation strategies
54	Agricultural Extension and Advisory services in Algeria at Crossroads: Pressing Problems and Innovative Solutions. IV International Symposium, Agrosym.10.7251/ AGSY13031343A	AEHWCMS promoted Effective HWC mitigation strategies Sustainable HWC mitigation strategies
55	Effectiveness of Solar Blinkers as a Means of Crop Protection from Wild Boar Damage. Crop Protection, 30, 1216-1222.	Effective HWC mitigation strategies Sustainable HWC mitigation strategies
56	Opportunities and Challenges Facing Small-scale Cattle Farmers Living adjacent to Kruger National Park, Limpopo. Journal of Emerging Trends in Economics and Management Sciences (JETEMS), 5 (1).	Trend of HWC Effective HWC mitigation strategies Sustainable HWC mitigation strategies
57	Space for Giants Annual Report	Extension service providers
58	The Development of Primate Raiding: Implications for Management and Conservation. International Journal of Primatology, 31, 133-156.	Effective HWC mitigation strategies Sustainable HWC mitigation strategies
59	Global review of Good Agricultural Extension and Advisory Service Practices.	AEHWCMS promoted
60	Strengthening Agricultural Extension and Advisory Service Systems: Procedures for Assessing, Transforming and Evaluating Extension Systems. Agriculture and Rural Development Discussion Paper 45	AEHWCMS promoted Agricultural extension policy Effective HWC mitigation strategies
61	Effectiveness of Crop Protection Methods against Wildlife Damage: A Case Study of two Villages in Bardia National Park, Nepal. Crop Protection, 29, 1297-1304.	Effective HWC mitigation strategies Sustainable HWC mitigation strategies
62	The Impact of Human-Wildlife Conflict on Human Lives and Livelihoods. Pp. 86-106.	-Trend of HWC -Effective HWC mitigation strategies -Sustainable HWC mitigation strategies
63	Balancing the Needs of People and Wildlife: When Wildlife Damage Crops and Prey on Livestock.	Trend of HWC Manifestation of hwc HWC mitigation strategies
64	Final Performance Evaluation Report for Community-Based Natural Resource Management and Biodiversity, implemented by Laikipia Wildlife Forum.	Effective HWC mitigation strategies Sustainable HWC mitigation strategies
65	The Kenya Wildlife Service in the 21st Century: Protecting Globally Significant Areas and Resources; Historical Factors that Shaped Wildlife Conservation in Kenya. The George Wright Forum, 29 (1), 21-29.	Effective HWC mitigation strategies Sustainable HWC mitigation strategies Manifestation of hwc

66	Development of Techniques to Reduce Farmer-Wildlife Conflict Associated with Crop-Raiding in Masindi District, Uganda. The Rufford Maurice Laing Foundation.	Effective HWC mitigation strategies Sustainable HWC mitigation strategies
67	Mitigating Human-elephant Conflict: Case Studies from Africa and Asia.	Effective HWC mitigation strategies Sustainable HWC mitigation strategies

APPENDIX D

GEOGRAPHICAL LOCATION OF RUMURUTI FOREST IN LAIKIPIA COUNTY
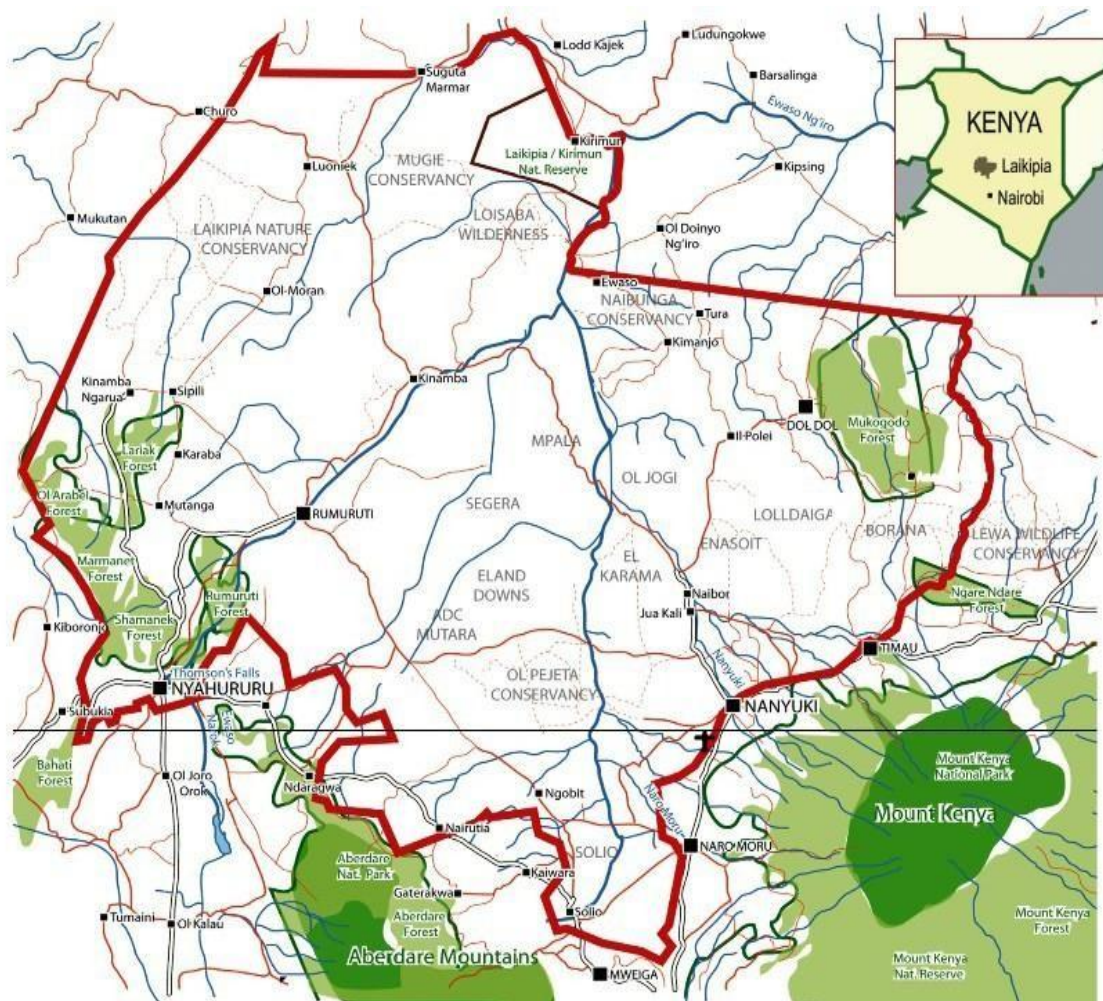
Source: Laikipia Wildlife Forum (2016).

APPENDIX E:

COMPENSATION CLAIM FORM A

(To be completed in Triplicate)

THE REPUBLIC OF KENYA

THE WILDLIFE CONSERVATION AND MANAGEMENT ACT, 2013

Wildlife Conservation and Management (Compensation Scheme) Regulations, 2015

Regulation 22

COMPENSATION CLAIM FORM FOR PERSONS INJURED/ DEATH CAUSED BY WILDLIFE

STATION＿＿＿＿＿＿＿＿＿COUNTY＿＿＿＿＿＿＿＿.NO＿＿＿＿＿＿＿＿＿

PART I- CLAIMANT DETAILS OF DEATH

NAME OF DECEASED＿＿＿＿＿＿＿＿＿＿＿＿＿＿ID NUMBER＿＿＿＿＿＿

ADDRESS＿＿＿＿＿＿＿＿＿＿＿＿POSTAL CODE＿＿＿＿＿＿＿＿＿

TEL. NUMBER＿＿＿＿＿＿＿＿＿＿SEX: Male Female AGE＿＿＿＿＿＿＿

NEXT OF KIN＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

ID NUMBER＿＿＿＿＿＿＿ (Attach copy of Identity Card)

ADDRESS＿＿＿＿＿＿＿＿＿＿＿＿POSTAL CODE＿＿＿＿＿＿＿＿＿

TEL. NUMBER＿＿＿＿＿＿＿＿EMAIL＿＿＿＿＿＿＿＿＿＿＿＿

RELATIONSHIP TO DECEASED＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

(First)＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

(Surname)＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

(Middle)＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

SIGNATURE＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

PART II- INJURY

NAME OF INJURED: ＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

ID NUMBER＿＿＿＿＿＿＿＿＿＿＿＿＿ (Attach copy of Identity Card)

ADDRESS＿＿＿＿＿＿＿＿＿＿＿＿POSTAL CODE＿＿＿＿＿＿＿＿＿

EMAIL ADDRESS (optional)＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

TELEPHONE NO.＿＿＿＿＿＿＿＿＿＿SEX: Male Female AGE＿＿＿＿＿＿

NEXT OF KIN＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

ID NUMBER＿＿＿＿＿＿＿＿＿＿＿＿＿ (Attach copy of Identity Card)

TELEPHONE NO＿＿＿＿＿＿＿＿＿RELATIONSHIP TO INJURED＿＿＿＿＿

SIGNATURE＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

153

PART III-PLACE OF RESIDENCE

ADDRESS_____POST CODE_____

ASSISSTANT CHIEF_____

LOCATION_____

CHIEF_____

DIVISION_____

PART IV-OCCUPATION

EMPLOYERS NAME_____

IF SELF EMPLOYED, NATURE OF BUSINESS_____

(Surname) _____

(Middle) _____

(First) _____

SALARY/WAGE/INCOME PER YEAR_____

PART V-PARTICULARS OF DEATH/INJURY

PLACE OF DEATH/ INJURY_____

DATE_____TIME _____

CIRCUMSTANCES OF DEATH/INJURY

_____

ANIMAL RESPONSIBLE FOR DEATH/ PERMANENT

INJURY_____

FOR OFFICIAL USE- ASSESSMENT

(a) POLICE STATION/POST_____

COMMENT FROM O.C.S/O.C.P.D

_____

NAME_____

DESIGNATION_____

SIGNATURE_____DATE_____

(b) MEDICAL OFFICER OF HEALTH

COMMENT FROM OFFICER OF HEALTH (STATE DEGREE OF INJURY)

_____

(Location)(GPS Coordinates)

_____

NAME _____

DESIGNATION _____

SIGNATURE _____ DATE _____

(c) COMMENT BY KWS WARDEN

_____

NAME _____

DESIGNATION _____

SIGNATURE _____ DATE _____

FOR OFFICIAL USE ONLY- WILDLIFE CONSERVATION AND COMPENSATION

COMMITTEE

APPROVED FOR COMPENSATION

_____

DEFERED/ REJECTED

Reasons:

_____

CHAIRMAN _____

SECRETARY _____

FOR OFFICIAL USE- KENYA WILDLIFE SERVICE

REMARKS BY DIRETOR GENERAL, KENYA WILDLIFE SERVICE

SIGNATURE _____ DATE _____

REMARKS BY CABINET SECRETARY

SIGNATURE _____ DATE _____

APPENDIX F

COMPENSATION CLAIM FORM B

(To be completed in Triplicate)

THE REPUBLIC OF KENYA

THE WILDLIFE CONSERVATION AND MANAGEMENT ACT, 2013

Wildlife Conservation and Management (Compensation Scheme) Regulations, 2015

Regulation 14(2)

COMPENSATION CLAIM FORM

CROPS, LIVESTOCK AND PROPERTY DAMAGED BY WILDLIFE

STATION_____ COUNTY_____ S. NO_____

PART 1 CLAIMANT DETAILS

NAME OF THE AFFECTED_____

ID/NO_____ (Attach copy of Identity Card)

ADDRESS_____POSTAL CODE_____

TEL NO._____ SEX Male Female AGE_____ NEXT OF KIN_____

ID NO_____ (Attach copy of Identity Card)

ADDRESS_____POSTAL CODE_____ TEL NO._____

(Last) _____

(First) _____

(Middle) _____

PART 2- CROP DESTRUCTION

CROP NAME_____

ANIMAL RESPONSIBLE_____

APPROXIMATE SIZE DESTROYED_____

STAGE OF GROWTH_____

ESTIMATED VALUE_____

MEASURES INPLACE TO PROTECT CROPS AGAINST DESTRUCTION BY

WILDLIFE

I._____

II._____

III._____

IV._____

PART III-LIVESTOCK PREDATION

LIVESTOCK TYPE_____

ANIMAL RESPONSIBLE_____

NO. OF LIVESTOCK AFFECTED_____

NO. DEAD_____ NO. INJURED_____

APPROXIMATE AGE AND SEX_____

ESTIMATED VALUE_____

MEASURES INPLACE TO PROTECT CROPS AGAINST DESTRUCTION BY

WILDLIFE

I._____

II._____

III._____

IV._____

PART IV-PROPERTY DESTRUCTION

DESCRIPTION OF PROPERTY DESROYED_____

ANIMAL RESPONSIBLE_____

ESTMATED VALUE_____

MEASURES IN PLACE TO PROTECT PROPERTY AGAINST DESTRUCTION BY

WILDLIFE

I._____

II._____

III._____

IV._____

PART VI- PARTICULARS OF INCIDENCE

PLACE OF INCIDENT_____ _____

DATE /TIME _____

CIRCUMSTANCES OF INCIDENT

ASSISTANT CHIEF: _____

LOCATION: _____

(GPS Coordinates)

(Location) _____

CHIEF: _____

DIVISION: _____

FOR OFFICIAL USE

(a) POLICE STATION/POST _____

COMMENT FROM O.C.S/O.C.P.D:

_____

NAME _____

DESIGNATION_____

SIGNATURE _____DATE _____

(b) OFFICER OF AGRICULTURE/LIVESTOCK/LANDS/VALUER

COMMENT FROM OFFICER_____

NAME_____

DESIGNATION_____

SIGNATURE_____DATE _____

(c) COMMENTS BY KWS WARDEN

_____

NAME_____

DESIGNATION_____

SIGNATURE_____DATE _____

FOR OFFICIAL USE- COUNTY WILDLIFE CONSERVATION AND

COMPENSATION COMMITTEE

APPROVED FOR

COMPENSATION_____

DEFERED/ REJECTED_____

Reasons_____

CHAIRMAN_____

SECRETARY_____

FOR OFFICIAL USE- KENYA WILDLIFE SERVICE

REMARKS BY DIRECTOR GENERAL KENYA WILDLIFE SERVICE

_____

SIGNATURE_____DATE

_____

REMARKS BY CABINET SECRETARY

_____

SIGNATURE_____DATE

_____

APPENDIX G:

GEOGRAPHICAL LOCATION OF LAIKIPIA COUNTY IN KENYA
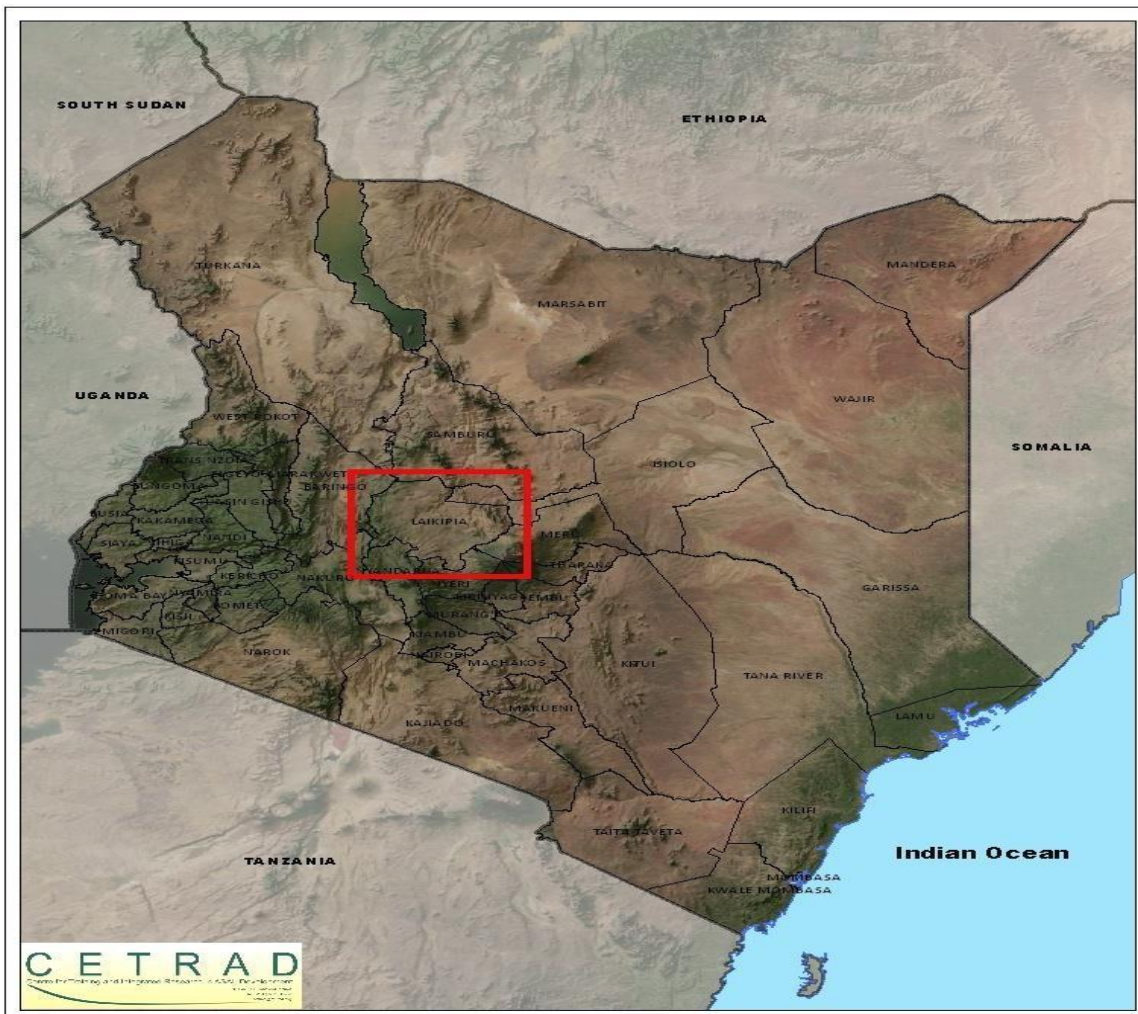
Source: GoK (2013)

APPENDIX H

LIVELIHOOD ZONES IN LAIKIPIA COUNTY
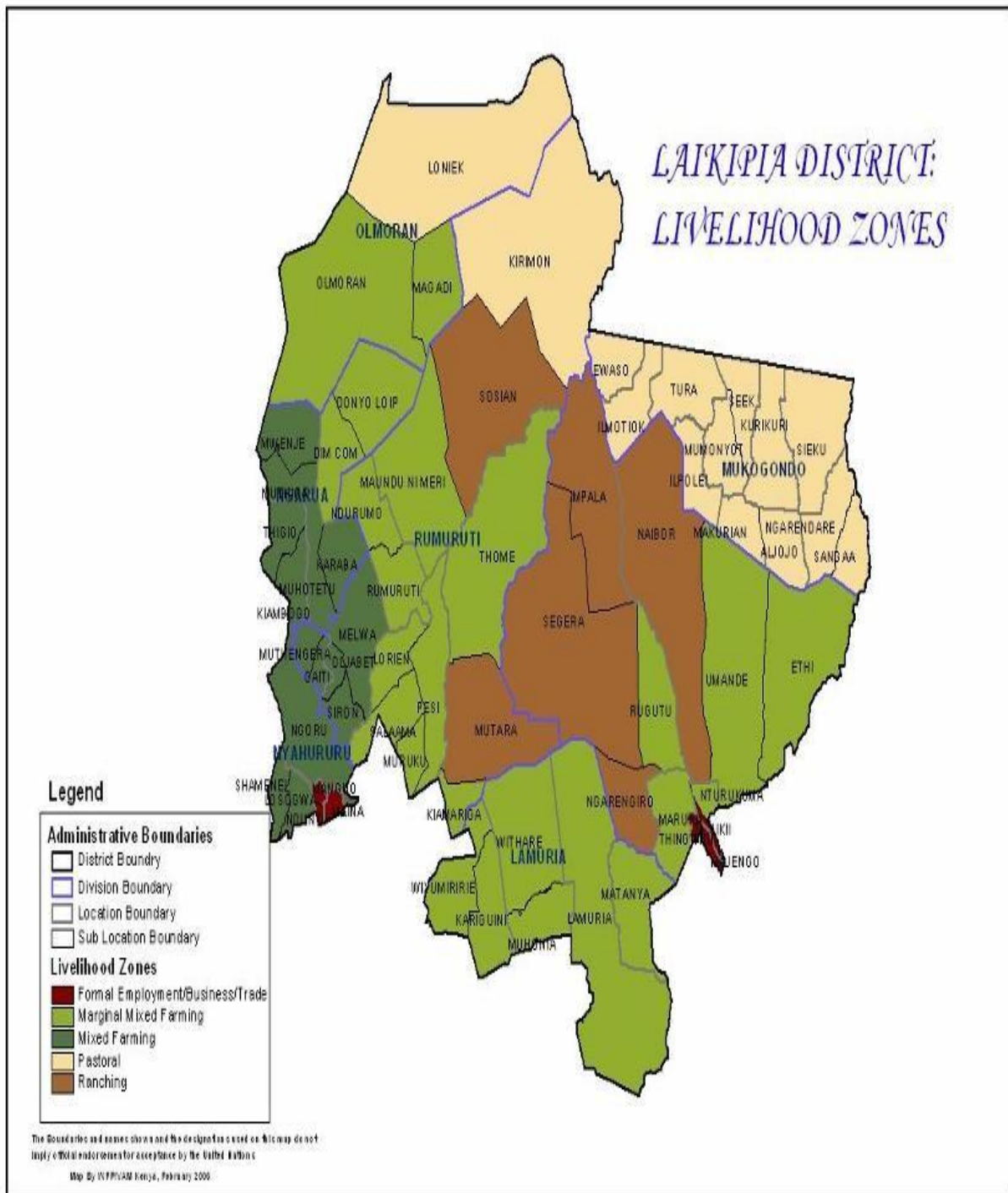
Source: Ministry of Land, Physical Planning Department (2006).

APPENDIX I:

RESEARCH AUTHORISATION

Ronald Orare Nyamwamu
Egerton University
P.O. Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on *"Effectiveness of agricultural extension wildlife mitigation strategies on human wildlife conflict among smallholder agropastoralists in Laikipia County,"* I am pleased to inform you that you have been authorized to undertake research in **Laikipia County** for the period ending **19th July, 2017.**

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

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

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Laikipia County.

The County Director of Education
Laikipia County.
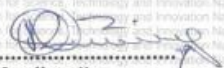
APPENDIX J:
RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. RONALD ORARE NYAMWAMU
of EGERTON UNIVERSITY, 170-40202
Keroka,has been permitted to conduct
research in *Laikipia   County*

on the topic: *EFFECTIVENESS OF*
AGRICULTURAL EXTENSION WILDLIFE
MITIGATION STRATEGIES ON
HUMANWILDLIFE CONFLICT AMONG
SMALLHOLDER AGROPASTORALISTS IN
LAIKIPIA COUNTY

for the period ending:
19th July,2017
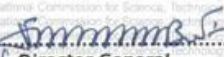
Permit No : NACOSTI/P/16/44307/11928
Date Of Issue : 20th July,2016
Fee Recieved :ksh 1000

....
Applicant's
Signature

....
Director General
National Commission for Science,
Technology & Innovation

APPENDIX K:

SAMPLE SIZE DETERMINATION

Sample Size for ±5% and ±10% precision levels (e) whose confidence level is 95% and P=0.5		
Size of population	Sample size (n) for precision (e) of ±5%	Sample size (n) for precision (e) of ±10%
100	81	51
125	96	56
150	110	61
200	134	67
250	154	72
300	172	76
350	187	78
400	201	81
450	212	82
500	222	83
600	240	86
700	255	88
800	267	89
900	277	90
1,000	286	91
2,000	333	95
3,000	353	97
4,000	364	98
5,000	370	98
7,000	378	99
9,000	383	99
10,000	385	99
15,000	390	99
20,000	392	100
25,000	394	100
50,000	397	100
100,000	398	100
>100,000	400	100

(Source: Glenn (1992). University of Florida. Retrieved from http://edis.ifas.ufl.edu/pd006 on 9th March 2016)