ANALYSIS OF ADOPTION OF MODERN AGRICULTURAL TECHNOLOGIES BY WOMEN IN LUANDA AND EMUHAYA SUB- COUNTIES, VIHIGA COUNTY, KENYA

BY

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DECLARATION

This Thesis is my original work and has not been presented for a degree in any other University.

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This work is dedicated to my late father Charles Lusigi and mother Rabecca Iminza.

ABSTRACT

The agrarian revolution of the 18th century witnessed the advent of modern agricultural technologies (MATs) such as use of fertilizers increased agricultural yields. Many women are engaged in agricultural activities. However Sub-Saharan Africa lags behind other regions in adoption of MATs yet women play a leading role in provision of labour like weeding. In Kenya, the effect of MATs such as concentrate feeds is yet to be felt among the women farmers. This lowered agricultural production threatening lives of millions of people who depend on agriculture. In Emuhaya and Luanda Sub-Counties an average yield of 4 bags of maize was realized compared to its potential of 15 bags per acre. This study analyses adoption of MATs by women in Luanda and Emuhaya sub-counties. The specific objectives were to: establish the MATs adopted by women in crop farming and animal husbandry, establish the relationship between education and adoption of MATs in crop farming and animal husbandry and to examine the benefits of adopted MATs by women in crop farming and animal husbandry. A cross-sectional survey was applied and a sample size of 384 women was drawn from a population of 61,640 using the (Fisher et al., 1983) formula. Stratified random sampling was used to select women practicing crop farming and animal husbandry proportionately. A questionnaire was used to collect information from women. An interview schedule was used to gather information from assistant chiefs and extension officers. Discussion guides were used to collect information from focus group discussions. A camera was used to take slides of MATs in use. Secondary data was acquired from journals, agricultural reports and statistical abstracts. Data analysis was done using frequencies, percentages, spearman correlation, cross tabulations and chi square tests. The results were presented using tables, bar graphs, pie charts and plates. The study established that 98.4% of the women had adopted various MATs in both crop farming and animal husbandry. Spearman's correlation results show a significant weak negative correlation between education and MATs like certified seeds and zero grazing respectively (r=-.221,p=.000),(r=-.213, p=.016). Important benefits in adoption were food security and high production. Chi square results show there was a relationship between some benefits of adoption and MATs such as fertilizer and improving soil fertility (p=.000) while improved grasses and high production (p=.001). Plates revealed that intercropping and zero grazing were common MATs adopted. The findings will help strengthen programmes that empower women with skills, information and resources to enhance uptake of MATs.

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LIST OF ABBREVIATIONS AND ACRONYMS

AASR	:	Africa Agriculture Status Report
AGRA	:	Alliance for Green Revolution in Africa
ASALs	:	Arid and Semi-Arid Lands
ASK	:	Agricultural Society of Kenya
CIMMYT	:	International Maize and Wheat Improvement Centre
FAO	:	Food and Agriculture Organization
FFS	:	Farmer Field School
FYM	:	Farm Yard Manure
GDP	:	Gross Domestic Product
GOK	:	Government of Kenya
HYVs	:	High Yielding Varieties
ICTs	:	Information and Communication Technologies
ILRI	:	International Livestock Research Institute
IFAD	:	International Fund for Agriculture Development
IFPRI	:	International Food Policy Research Institute
KALRO	:	Kenya Agricultural and Livestock Research Organisation
MATs	:	Modern Agricultural Technologies
MV'S	:	Modern Varieties
NALEP	:	National Agriculture and Livestock Extension Programme
NEPAD	:	New Partnership for Africa's Development
OAF	:	One Acre Fund
PRB	:	Population Reference Bureau
PSA	:	Population Situation Analysis
SDG	:	Sustainable Development Goal
SSA	:	Sub-Saharan Africa
USAID	:	United States Agency for International Development
WB	:	World Bank
WFP	:	World Food Programme

DEFINITION OF TERMS

Adoption: Acquisition and use of new methods of farming and other agricultural activities by farmers to increase production

Animal Husbandry: Farming of animals to produce foods such as meat, eggs, milk and other products like wool and hides.

Crop Farming: Cultivation of crops for food or other commercial uses.

Education: Formal schooling, training and awareness

Modern Agricultural Technologies: Farm inputs that have been developed scientifically for use by farmers so that they can cause change (increase in yields) at farm level. For example inorganic fertilisers, organic fertiliser that is home made, certified seeds thus the high yielding varieties (HYVs), tissue culture bananas, pesticides and herbicides, concentrates for animals, and improved grasses for animals. Modern Agricultural Technologies are also referred to as improved methods of farming, new technologies in agriculture, innovations and new methods of farming.

Technology: The application of scientific knowledge, skills and processes that facilitate human activities to meet a certain end.

Traditional Methods of Farming: It is the utilization of resources at hand like natural fertility of soils, rainfall and natural grass for grazing to produce what nature offers.

Women: Females aged 15 years and above.

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CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Adoption of Modern Agricultural Technologies (MATs) has driven food production to higher levels. This has been important in meeting the needs of ever increasing population in the world which is expected to reach 9 billion by 2050 (Population Reference Bureau (PRB), 2013). Consequently, technologies that enhance productivity in agriculture like inorganic fertilizers and improved seeds have been pursued as the most viable alternatives towards increasing agricultural productivity (Ogada, 2013). For example, the Green Revolution dramatically boosted yields of cereals through application of fertilizers and improved seeds that transformed agriculture in Europe and South East Asia (Muzari *et al*., 2012 and Ogada *et al*., 2014). Women make more direct and critical contributions to agriculture through labour provision. They constitute about 44 % of the global labour force in agriculture (FAO, 1994), 20% in Latin America to almost 50% in the Southern and Eastern Asia sub regions (World Bank, 2012) and 65% labour force in SSA (FAO, 2010). In Kenya, women provide 75% of labour in small scale agriculture (GOK, 2010). However, food shortages are still prevalent in many regions of the world where women play a key role in food production (Parvan, 2011).

In Africa, food production has been falling over the years or remained stagnant (Muzari *et al*., 2012 and Munyua, 2008). It has about 200 million of the world's hungry people (Millennium Development Goals (MDGs) Technical support Centre, 2004). Sub-Saharan Africa (SSA) has largely tried to keep up with the growing population's demand for more food by significantly expanding the area under production. However, adoption of new technologies in agriculture in Sub-Saharan Africa lags behind that of Asia and Latin America despite the fact that substantial public resources have been devoted to the development and provision of modern crop varieties (World Development Report, 2008). Adoption of MATs provides some assurance that the necessary growth in food production can be achieved. Much more still needs to be done to assure success of adoption of MATs in SSA.

MATs rely on the most innovative science. They involve application of mechanical, chemical and biological inputs such as tractors, fertilizers, agro-chemicals, livestock breeds, and highly yielding varieties, storage and processing facilities (Bhati, 2014). The United Nation Food and Agriculture Organization (FAO) consider continued application of modern technology as a means to growth in food production (Motes, 2010). This is in line with the Sustainable

Development Report (SDG) 2 to end hunger, achieve food security and improved nutrition to promote sustainable agriculture (http://www.un.org/sustainable). Agriculture remains important for the economies of most developing countries for food security, poverty alleviation and sustainable development (Ogada, 2013). It provides livelihood for 80% to 90% of the population in many countries (Action Aid, 2011). In Kenya, agriculture forms the backbone of the economy (Government of Kenya (GoK), 2012c). It contributes 26% of the gross domestic product (GDP) directly and another 25% indirectly (Republic of Kenya, 2010). The sector also accounts for 65% of the total exports and 18% of formal employment in the country, and 70% of informal employment in rural areas (Republic of Kenya, 2010). However adoption of improved farm technologies such as fertilizer, hybrid seed and concentrate feeds remained relatively low among farmers (Republic of Kenya, 2007). Besides, the impact of MATs such as fertilizer, hybrid seeds and concentrate feeds in Africa and Kenya is yet to be felt among the women farmers in spite the fact that they have been generated through research (Odini, 2014).

The situation is the same in Emuhaya and Luanda Sub-counties where low adoption of MATs contributed to a decline in food production (Republic of Kenya, 2008 and Mutoko *et al.*, 2014). The average production of maize was 4 bags per acre compared to its potential of 15 bags per acre (Republic of Kenya, 2013). Emuhaya and Luanda Sub-Counties are perpetually food deficit (GOK, 2004). The poverty incidence (per capita daily income of less than a dollar) is estimated at 65% of the population (KNBS, 2010). Food insecurity is rampant and almost all food stuffs are imported (Republic of Kenya, 2013). Hence Emuhaya and Luanda sub-counties are a perfect example of why the Kenyan government will not achieve the Big Four Agenda especially the pillar for food security (https://www.nation.co.ke**)**. Interventions are therefore needed to help restore agricultural production for food security. The Emuhaya Strategic Development Plan for 2008-2018, (2009) identified low adoption of MATs as a cause for low agricultural productivity. Recognizing and supporting women in adoption of MATs will guarantee successful implementation of the strategic plan.

FAO estimates that at least 80% of rural smallholder farmers worldwide are women. They contribute to food production and to enhanced food security. Munyua (2008) asserts that significant amount of Africa's economic activity rests in the hands of women. According to Guyer (1991); Kasante *et al*. (2001) and Quisumbing and McClafferty (2006), women provide the bulk labour for weeding, harvesting, transporting and processing while men

perform intensive tasks like clearing and ploughing. Besides, they have technical knowledge on seed selection practices, pest and weed control measures, harvesting and food preservation technologies, local biodiversity and sometimes use their home gardens to experiment with gathered species and tree products (Rathberger, 2011 and Njiro, 2003). This implies that huge potential exists among them to increase productivity through adoption of MATs. Hence problems of agricultural production can be tackled if questions on food security are considered from the perspective of women.

Though women represent a large and significant group of farmers, so far they have been relatively neglected in attempts to raise farmer productivity through technology development. Several studies on adoption of MATs tend to focus on the activities of the household heads who are male farmers and women who are household heads without paying attention to the majority farm women in the male headed households (Salasya *et al.* 1996; Chirwa, 2005; Nanyeena *et al.,* 2013 and Ogada *et al.* 2014). Besides, a comparison of demographic characteristics such as age, marital status, education level, and land holdings overlooks the circumstances of women farmers since they experience differently the economic, social, cultural, political and geographical environments around them (Njiro, 2003). Different experiences impact differently on their respective capacities and priorities in relation to the use of MATs. These studies have significant implications for Emuhaya and Luanda sub-counties although they do not emphasize the role played by these women in determining the effective adoption and utilization of MATs and its implications for increased food production. For adoption of MATs to be truly effective, it is essential that an evaluation of how programmes to support farmers consider the tastes and decisions of women farmers since they play an active role in crop farming and animal husbandry.

Women's active and continuous interaction with the environment as food producers has equipped them with complex traditional knowledge about the genetic resources of plants and livestock (Action Aid, 2011). This can form a basis for introduction of MATs to women. The government of Kenya with the support of development partners introduced efficiency and productivity enhancing programmes and projects at household levels like National Agriculture and Livestock Extension Programmes (NALEP). Improved technologies such as storage facilities, improved technologies for soil and water conservation, improved storage facilities, labour-saving and improved seeds have also been developed and disseminated, particularly by the Kenya Agricultural Research and Livestock Organization (KALRO)

(Ogada, 2013). However, concerns regarding their expertise and knowledge systems they are in charge have never been recognized and included in policy making and implementation (Njiro, 2003 and Oniang'o, 2005). Studies by Wangui (2003) and Odini (2014) found that women were involved in farming activities like seed selection, planting, weeding, threshing, keeping of livestock and milking. Nevertheless, these studies did not document the MATs applied in performance of these activities. Besides, adoption behaviour patterns of women within mixed farming systems in which they operate has not been addressed. Mujivane (1999) and Ouma (2012) only focused either on technologies adopted in crop and animal husbandry without considering both simultaneously. This disregards the reality that crop farming and livestock production have interconnected roles to play in agricultural development that ensures sustenance in mixed farming systems where women play a central role in decision making on implementation of MATs. Lack of sufficient information on MATs that are important to women farmers in Emuhaya and Luanda sub-counties may hinder implementers from providing ideas on appropriate technologies and policy changes that may make services more available for women. This study examined MATs adopted by women in crop farming and animal husbandry.

Education is perceived to influence adoption of MATs. According to Waller *et al.* (1998) education creates a favourable mental attitude for the acceptance of new practices especially information intensive and management intensive practices. Economists have hypothesized and also found that farmer education increases the probability of adopting MATs (Nelson and Phelps, 1966). Studies such as (Chirwa, 2005; Rehaman *et al*., 2012; Arege *et al*., 2007 and Saito *et al*., 1994) established that adoption of new technologies in agriculture was positively related to education level of a farmer. However, rural women in Africa and Kenya in particular suffer from the highest illiteracy rates and are the most visible face of poverty (Muia and Otiende, 2000). In Kenya, besides the progress made in attainment of universal primary education, access to secondary and higher levels of education remains below expectation (Government of Kenya, 2013). Women in Emuhaya and Luanda sub-counties are not different given that 20% of the female population did not go beyond primary education while a majority 62.6% had attained primary education level (Government of Kenya, 2010). Therefore the choices made by women in adoption of MATs are important since they reflect their knowledge levels acquired through education. Understanding their education levels will help interpret and understand adoption needs of women.

Adoption of MATs is seen as the most viable alternative towards increasing productivity. However, adoption among women is low because they fear risks that come with them (Croson and Gneezy, 2009). They may therefore apply technologies that may not guarantee some profit since they want to avoid as much risk as possible, (Ellis, 1998). Hence their choice for adoption will be based on the perceived benefits of the MATs such as increase in yield, increased income and improved food security (Nsabimana and Masabo, 2005). Nonetheless, studies such as (Bala *et al*., 2006; Nyerere, 2012 and Ani *et al*., 2004) did not look at benefits of MATs adopted by women. This makes it difficult to understand their capabilities and constraints in adoption of MATs. For a successful transfer of MATs, it is essential to comprehend their benefits. This study attempts to draw attention to women's role in adoption of MATs in agriculture and to understand their capabilities and constraints so that policies and programmes can be better designed to assist them.

1.2 Statement of the Problem

Adoption of MATs is important in enhancing agricultural productivity. Women are the majority key players in provision of labour in SSA and Kenya (FAO, 1994; FAO, 2010and GOK, 1994). However, adoption of MATs is low in Kenya (Republic of Kenya, 2008 and Mutoko *et al*, 2014). Moreover the impact of MATs is yet to be felt among women farmers in spite the fact that they have been generated through research (Odini, 2014). The situation is the same in Emuhaya and Luanda sub-counties where low adoption of MATs contributed to a decline in food production (Republic of Kenya, 2008 and Mutoko *et al*, 2014) despite the continued efforts by the government and research institutions such as KALRO to generate and disseminate productivity enhancing technologies through the media and government extension services to highlight on their availability and benefits in crop farming and animal husbandry (Ouma, 2012). This lowered agricultural productivity and pose a threat to food security considering the fact that maize production was at 4 bags compared to its potential of 15 bags per ha (Republic of Kenya, 2013). Emuhaya and Luanda Sub -Counties are perpetually food deficit (GOK, 2004). Food insecurity is rampant and almost all food stuffs are imported (Republic of Kenya, 2013). Hence Emuhaya and Luanda sub-counties are a perfect example of why the Kenyan government will not achieve the Big Four Agenda especially the pillar for food security (https://www.nation.co.ke). Application of MATs will therefore help increase production to meet their food demands and earn income to alleviate poverty.

This will succeed if women are actively involved since they make decisions in adoption and devote more time and labour in agricultural activities (Saito et al, 1999). They have detailed, complex knowledge of the growing practises in agriculture of which they are in charge (Oniang,o, 2005). It is therefore important to know MATs adopted such as fertilisers and veterinary services adopted in both crop farming and animal husbandry so as to help comprehend the crop and livestock activities which integrate more intensively to strike a balance and ensure sustainability. Wangui (2003) and Odini (2014) highlight the activities carried out by women but did not document MATs adopted. Further more studies have only looked at adoption of MATs in crop farming and animal husbandry separately, for example, (Chirwa *et al*., 2013 and Mujivane, 1999). This study looks at MATs adopted in crop farming and animal husbandry.

Adoptions of MATs rely on education which enhances ability to derive, decode and evaluate useful information for agricultural production, (Ani, 1998). The complex nature of MATs like maintenance of a green house and an incubator require raised skills acquired through education to equip them with information necessary to apply these technologies. Low adoption of these MATs imply that adoption needs of women in Emuhaya and Luanda sub-counties have not been met by the existing levels of education which have not been integrated well with the existing adoption programmes to address issues of low adoption. In Emuhaya and Luanda sub-counties, progress has been made in attainment of universal primary education, however, access to secondary and tertiary education remains below expectation, (GoK, 2013). Educational attainment at all levels has an effect on farming patterns. Farming remains the primary livelihood for most rural households and much of the performance in the agricultural sector is attributed to women who the majority are small scale farmers. Its success therefore revolves around investigating the different educational levels thus primary, secondary and tertiary and how they shape adoption levels. This study therefore investigates the effect of women's education on adoption of MATs.

Adoption of MATs has made differences in the farming activities of subsistence farmers as most of these technologies have provided job opportunities, increased standards of living, reduce labour and a source of income (Oladele *et al*., 2008). Understanding the benefits of new technologies in agriculture is important because most adopters will pick on a technology for the reason that they have seen it or understand that it will be of benefit (Rogers, 2003). However, Studies like Bala *et al*. (2006) and Nyerere (2012) did not investigate the benefits of MATs adopted by women. Understanding benefits of adoption like increased production,

source of income and improved standards of living will help comprehend the trends in adoption. This will shed light about constraints of adoption and therefore come up with ways of ensuring that MATs are adopted appropriately. This study looks at the benefits of MATs. For this reason this study investigated the education levels of women, their level of participation in adoption of MATs in crop farming and animal husbandry and the benefits of MATs among women in Emuhaya and Luanda sub counties.

1.3 Objectives:

The general objective of the study is to examine adoption of modern agricultural technologies by women in Emuhaya and Luanda Sub counties. The specific objectives are:

1. To establish the modern agricultural technologies adopted by women in crop farming and animal husbandry in Emuhaya and Luanda sub-counties.

2. To establish the relationship between education and adoption of modern agricultural technologies in crop farming and animal husbandry among women in Emuhaya and Luanda sub-counties.

3. To examine the benefits of adopted modern agricultural technologies in crop farming and animal husbandry by women in Emuhaya and Luanda sub-counties.

1.4 Research Questions

1. What are the modern agricultural technologies adopted by women in crop farming and animal husbandry in Emuhaya and Luanda sub-counties?

2. What is the effect of education on adoption of modern agricultural technologies by women in crop farming and animal husbandry in Emuhaya and Luanda Sub-counties?

3. Do the benefits of modern agricultural technologies influence adoption in crop farming and animal husbandry in Emuhaya and Luanda sub-counties?

1.5 Justification of the Study

Adoption of MATs is important in enhancing agricultural productivity. Women are the majority key players in provision of labour in SSA and Kenya (FAO, 1994 and 2010, GOK, 1994). However, their level of adoption and productivity is low in Kenya, Emuhaya and Luanda sub-counties (Republic of Kenya, 2008 and Mutoko *et al.*, 2014) despite the continued efforts by the government and research institutions like KALRO to generate and disseminate agricultural technologies that address their availability and benefits. Adoption of

MATs in crop farming and animal husbandry is mainly enhanced by education. This means the adoption needs of women in Emuhaya and Luanda sub-counties have not been integrated well with the existing adoption programmes to address issues of low adoption. This lowered agricultural productivity and pose a threat to food security considering the fact that maize production was at 4 bags compared to its potential of 15 bags per ha (Republic of Kenya, 2013). This study looks at the adoption behaviour of women in Emuhaya and Luanda sub-counties with a view of understanding what shapes their decisions to adopt MATs.

Findings of this study will contribute to the existing data on MATs adopted by women in crop and animal husbandry, adoption levels and their benefits. This information can be used by designers and implementers to develop appropriate MATs and formulate programmes that will increase women's exposure to MATs and empower them to adopt MATs effectively.

1.6 Scope and Limitations of the Study

This study was limited to Emuhaya and Luanda Sub-counties in Vihiga County. The target population was 384 women from the age of 15 years and above involved in crop farming and animal husbandry. Key informants were 4 agricultural extension officers and 8 local administration officers. Focus group discussions were also conducted. Some respondents solicited for favours before they could give any information, however the researcher managed to convince them to willingly give in information.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter will review the following topics: Women in agriculture, Modern agricultural technologies in crop farming, Modern agricultural technologies in animal husbandry, Constraints in adoption, Effect of education on adoption of modern agricultural technologies, Benefits of modern agricultural technologies and the conceptual frame work.

2.2 Women and Adoption of Modern Agricultural Technologies in Agriculture

Women play a key role in agricultural productivity. They perform distinct roles within the production and marketing of agricultural products from men. Within Sub-Saharan Africa (SSA) and Asian farming systems, men often perform more physically intensive tasks of clearing and ploughing and women are often responsible for planting, weeding, harvesting, and postharvest processing (Guyer, 1991; Kasante *et al*., 2001; Quisumbing and Mc Clafferty, 2006). Nonetheless, women's labour is increasingly becoming significant in agricultural production. They constitute 44% labour force globally (FAO, 1994). According to (FAO, 2010), women in SSA provide 65% of labour for food production and their proportion increases more than any part of the world because of the exit of male farmers due to urban migration, armed conflict HIV and AIDS and other intervening factors (FAO, 2010). As a result, many countries in SSA have seen an increasing trend in female headed households. Women thus became fully responsible for farm production and management.

In Central America, nearly 20 per cent of rural households are headed by women (Yudelman, 1994), while in Bangladesh, over a 20-year period, the proportion rose from 5-7 per cent to 16 per cent. By the mid 1980s, women in SSA headed an average of 31 percent of rural households, (FAO, 1998). In Kenya about 86% farmers are women, 44% of whom work in their own right (*de jure*) and 42% of whom represent their husbands in their absence (*de facto*) Saito et al. (1994). Hence a relatively large proportion of women than men are engaged on a more regular basis than men in most phases of production cycle for food, crops and livestock.

Nevertheless, the patriarchal nature of the society denies many women full control of productive resources despite male absence in their lives. The ownership of resources such as land, and purchase and utilization of oxen ploughs depend on inter and intra household

dynamics, where the presence of a male relative play a dominant role in decision making processes (Njiro, 2003). These cultural constraints prevent women from fully utilizing and making decisions about available resources. Moreover, women represent a large and significant group of farmers who so far, have been relatively neglected in attempts to raise farmer productivity. Saito and Weidemann (1990) reported on a village livestock project in Burkina Faso that failed because information and resources on small animals were directed at men, even though women were primarily responsible for small livestock production. In a Bolivian livestock and wool development project, even when project designers altered the situation to accommodate the realization that, traditionally, women and not men were responsible for llama and alpaca herding and shearing, project implementers failed to give women appropriate help, offering them instead training in what they considered were women's tasks - cooking, embroidery, knitting, crochet and artificial flower making (Mehra, 1994).

Several studies on adoption of MATs such as (Salasya *et al*., 1996; Chirwa, 2005; Ndiritu, 2011; Muzari *et al.* 2012; Nanyeena *et al*., 2013 and Ogada *et al*., 2014) focus on the activities of the typical male farmer and women under female headed households often identified as the household head. However, they pay no attention to the other household members including the contribution of the farm women under male headed households (Ragasa, 2012). These studies have significant implications for Emuhaya and Luanda sub-counties although they do not emphasize the role played by these women in determining the effective adoption and utilisation of MATs and its implications for increased food production. Besides, a comparison of demographic characteristics such as age, marital status, education level, and land holdings overlooks the circumstances of women farmers since they experience differently the economic, social, cultural, political and geographical environments around them, (Njiro, 2003). Different experiences impact differently on their respective capacities and priorities in relation to the use of MATs. This undermines the fact that women farmers are bearers of locally specific knowledge that can actively shape the policies that transform modern agriculture.

Researchers such as (Doss and Morris, 2001; Njiro, 2003; Quisumbing and Pandolfelli, 2009 and Peterman, Behrman and Quisumbing, 2010) urge that it is important to disaggregate the farming population for proper targeting of beneficiaries and end users. Morris and Evans (1999) recommended that research should give attention to certain agricultural groups such as farm workers, tenant farmers and women. This study looks at the role of women in adoption

of MATs. In view of their important role in agriculture, problems of agricultural production can be tackled if questions on food security are considered from the perspective of women. Research on women will help strengthen women's roles in agricultural tasks as they are a special link in the adoption of MATs and their assimilation into the overall culture of the communities they live in.

2.2.1 Modern Agricultural Technologies in Crop Farming

The last half century has witnessed rapid revolution in agricultural production particularly in the developed world. This allowed adoption of industrial scale farming techniques in agriculture which mainly concentrated on crop production (wheat, rice and later maize) (Hayami and Rottam, 1985). However, the Green Revolution that helped to boost yield of cereals and transformed agriculture in Europe and South East Asia has not been able to achieve the same results in Africa. This is a continent where food production in the majority of the countries in SSA has declined or remained stagnant (Muzari *et al*., 2012). The Africa Agriculture status Report (AASR) (2013) recommends that much more still needs to be done to assure success of the unique Green Revolution in SSA. SSA is now a net food importer (Mkandawire and Matlosa, 1993). Only around 50 percent of the maize area was under modern varieties (MVs) in developing countries whereas in developed countries MVs share was close to100%, (Kathage *et al*., 2013). Mean maize yields are 4 tonnes and 9 tonnes per hectare in developing and developed countries respectively (Shiferaw *et al.,* 2011), yet women contributed 60-80 percent of labour for food production, both for household consumption and for sale in SSA (FAO, 1994).

In Kenya, adoption of improved farm technologies such as fertilizer, hybrid seed and concentrate feeds remained relatively low among farmers (Republic of Kenya, 2007). Kenyan farmers used fertilizers at 35kg/ha far below the world average at 94kg/ha, (Republic of Kenya, 2012). According to AGRA (2010) report, 65% of farm households were estimated to have adopted improved maize varieties while for other food crops adoption of improved varieties was very low, ranging between 0-6%. In Emuhaya and Luanda sub-counties, low adoption of MATs is one of the contributing factors for the low agricultural productivity. According to (Republic of Kenya, 2008) the continuous tilling of the land without application of new agricultural practices in Emuhaya and Luanda sub-counties led to drastic decline in food production. For instance, the average maize production is 4 bags per acre compared to its potential of 15 bags per acre (Republic of Kenya, 2013). There is therefore need to invest

in MATs so as to transform agriculture which is important for food production. This is in line with the (Government of Kenya, 2002) which recommends the use of improved technology in faming activities to yield results in food production and food security.

The government of Kenya with the support of development partners introduced efficiency and productivity enhancing programmes and projects at household levels like National Agriculture and Livestock Extension Programmes (NALEP). Improved technologies like storage facilities, improved technologies for soil and water conservation, improved storage facilities, labour-saving and improved seeds have also been developed and disseminated, particularly by the Kenya Agricultural and Livestock Research Organization (KALRO). These efforts have had some remarkable achievements, especially in adoption and intensity of use of fertilizer and improved maize varieties (Ogada, 2013). MATs were also promoted through various methods like print media, radios, government extension services, farmer field schools (FFS), Agricultural Society of Kenya shows (ASK), information and communications technology (ICT) among others (Ouma, 2012). Thus sources of knowledge are many and this demands a wide range of skills required in enabling information transfer, sourcing and usage (FAO, 1993 and ZijP, 1994). Besides some achievements in adoption of fertilizer and improved maize varieties, adoption levels were still low and varying a cross regions (Ogada, 2013). Studies on adoption for example (Chirwa *et al.*, 2013; Ndiritu *et al.*, 2011; Koru and Stein, 2008) indicate that the use of agricultural inputs in crop production remains low among female farmers. Therefore it is important to understand the technical knowledge of women which is based on years of observation and experimentation to act as a starting point for the introduction of MATs.

The CIMMYT (1993) guide suggests that researchers should have a good idea of the crops, cropping systems, or farm operations that are important for women farmers. Women have detailed complex knowledge about the genetic resources of plants and livestock (seeds and breeds) and the growing systems of which they are in charge (Oniang'o, 2005 and Action Aid, 2011). Besides they have technical knowledge on seed selection practices, pest and weed control measures, harvesting and food preservation technologies, local biodiversity and sometimes use their home gardens to experiment with gathered species and tree products (Rathberger, 2011 and Njiro, 2003). However, in many communities, women are not considered "farmers" and therefore are sometimes not targeted in many agricultural and technology development and extension projects (World Bank, 2010). Many of these activities like weeding are not defined as "economically active employment" hence women farmers are

often forgotten in official agricultural statistics (CIMMYT, 1993). The exclusion of the knowledge systems of an important proportion of agricultural producers makes it difficult to understand and develop relevant technologies for women in the continent. This is compounded by the fact that (Wangui, 2003 and Odini, 2014) only highlighted farming activities carried out by women such as seed selection, planting, weeding, threshing, keeping of livestock and poultry and milking but did not document the MATs applied in performance of these activities. Hence, not much is known about agricultural technology development of women in Emuhaya and Luanda sub-counties. This study examined MATs adopted by women in crop farming.

2.2.2 Modern Agricultural Technologies in Animal Husbandry

Livestock production accounts for over 40 % of the world's Gross Domestic Product (GDP), (FAO, 2009) with values of 30% in developing countries (Parthasarathy *et al*., 2005). Intensification of the livestock sector in developed countries through application of external inputs such as more efficient feeding with grains and concentrates had led to high levels of livestock production (Descheemaeker *et al*., 2009). This is a sharp contrast to the low livestock productivity in SSA countries where fast growing commercial and intensive systems are developing near peri-urban centre's whereas at the same time small holders were still relying on traditional (semi) subsistence systems characterized by low productivity (Parthasarathy *et al*., 2005). Livestock contributes products such as milk, meat, eggs, hides and skins and manure for home consumption and surplus products are marketed earning farmers income and therefore contributing to household food security (Emongor *et al*., 2000). Besides, it acts as a store of wealth, collateral for credit and is an essential safety asset in times of crisis (Ndandula, 2011). Hence adopting MATs in animal husbandry will increase food production and alleviate poverty.

In Kenya livestock contributes over 12% to GDP and is dominated by small producers (FAO and AGAL, 2005). Livestock production is a prominent economic activity among pastoralists where it employs about 80% of the population (Republic of Kenya, 2012). They keep cattle in mixed herds and are concentrated in the arid and semi arid lands (ASALs). There is total dependence on livestock (cattle, sheep, goats and camels) by the pastoral households. Despite the good potential, these areas have less access to education facilities, (FAO and AGAL, 2005). Hence strengthening and expanding institutions of formal leaning in ASALs will help impart better modern practices into the pastoral systems to increase production. Small scale

dairy farming activity is mostly found in the central and rift valley provinces and coastal low lands with a higher concentration of small holder dairy farms in peri-urban areas. There are also limited number of large scale dairy farms owned both by private farms and public institutions, (FAO and AGAL, 2005).

In the mixed crop–livestock production systems in the high and medium potential areas of Kenya, livestock provide manure used to improve soil fertility resulting in better crop yield. Traction power from cattle is useful in land preparation, weeding and transportation (Emongor *et al*., 2000). This implies that crop farming and animal husbandry have interconnected roles to play in the development of agriculture. Crop-livestock interactions increase productivity and the income of farmers, and improve system resilience and environmental sustainability (Devendra and Thomas, 2002 and Parthasarathy Rao *et al*., 2005). Considering the relationship that exists between crop farming and animal husbandry some scholars for example (Mujivane, 1999; Nell and Schwalbach, 2002; Chirwa, 2005 and Nanyeena *et al.*, 2013) have either focused on crop farming and animal husbandry separately without considering both simultaneously. With increasing population density and land scarcity, crop and livestock activities tend to integrate more intensively (Steinfeld *et al*., 2006a). Therefore crop farming and animal husbandry should not be viewed as separate and inevitable competitive enterprises. This will add insights into the adoption behaviour of women as primary actors and decision-makers on input use, labour allocation, timing of operations and product marketing within the complex nature of the mixed farming systems. This study compared the levels of adoption of several MATs adopted by women in crop and animal farming in Emuhaya and Luanda sub-counties.

In Emuhaya and Luanda sub counties, most people keep indigenous zebu cattle while a few farmers practice dairy farming (Republic of Kenya, 2009). The National Census of 2009 indicates that only 9,521 commercial chickens were kept in the district. In Maghalaya India, it was established that 61% of pigs, 95% of cattle and 87% of poultry breeds kept by women were native. Besides, they practiced traditional methods of feeding. 2% of the women adopted modern housing and only 2.3% adopted recorded keeping (Mishra *et al*., 2010). This is an indication that the level of exposure and understanding of modern practises was relatively low. This contrasts with findings by Muiivane (1999) in Vihiga District who established that most women (71%) had experience in cattle management and the majority (99%) had established animal fodder and manually harvested fodder, and owned one or more dairy grade cows.

Intense efforts of many development programmes have targeted women small holder farmers with an aim of improving household food security and empowering them. Various Non Governmental Organisations (NGOs) such as the Heifer project, Africa 2000 Network and Farming System Kenya Limited have offered advice on technical matters like organising field days and assisting in providing heifers to women farmers to foster zero grazing development in the study area (Mujivane, 1999). NALEP integrates training in primary production, marketing and other activities like upgrading cattle herds, supporting women groups, fodder production, milk marketing, monitoring and evaluation (Welingo, 2009). Despite these efforts, there has been little success due to cultural and familial beliefs and practises that influence the decision making environments. According to (FAO, 2009) men are responsible for keeping and marketing large animals, such as cattle, horses and camels, while women tend to control smaller animals, such as goats, sheep, pigs and poultry.

2.2.3 Constraints to Adoption of Modern Agricultural Technologies

Despite their dominance in agriculture, women continue to adopt HYVs and management systems at low rates (Doss *et al.,* 2001). Women farmers operate under greater constrains than men. They have less access to information, technology, land, inputs and credit yet they have primary responsibility for the home and child care (Mujivane, 1999). Access to land is a basic requirement for farming. However, women are disadvantaged in both statutory and customary land tenure systems in Africa (Peterman *et al.,* 2010). Empirical evidence indicates that women are five times less likely than men to own land (Bill and Melinda Gates Foundation, 2012). When they own land, it tends to be smaller, of poor quality and typically with less secure tenure (FAO, WFP, and IFAD, 2012). In Kenya women account for 5% of registered land holders nationally and in Ghana mean value of men land holdings is three times that of women land holdings (Mead and Liedholm, 1998). In Luanda Division, Nyerere (2012) found that women are culturally discriminated against on land ownership, access, acquisition and inheritance. Technology can only be applied on available land. It therefore follows that those who don’t have access to land will not adopt technology relevant to its exploitation.

On the other hand, access to credit and inputs becomes difficult since formal financial institutions demand collateral to act as security usually in form of land, house or title to some immovable assets (Lubwama, 1999). Besides the transaction costs involved in obtaining credit transportation costs, paperwork, time spent waiting may be higher for women than for men owing to higher opportunity costs from forgone activities (Oniang’o, 2005). Failure to

access soft loan and credit for agricultural activities and inputs has a severe bearing on technology adoption. Extension services remain the key source of information on new technologies when deciding on whether or not to adopt an innovation. Its provision can lead to significant yield increases yet women do not get appropriate share of agricultural extension services such as seeds, fertilizer and credit delivered through the agricultural extension system (Oniang'o, 2005). However many women do not make use of extension services and agricultural technologies due to limited education, lack of control over land, and in some communities, cultural factors that limit women from using some technologies like sitting on tractors (Mehra, 1995). In most African countries, there is the widely recognized difficulty of male extension agents having any type of contact with individual female small holders due to entrenched norms and cultural difficulties in engaging face to face communication (Swanson and Rajalahti, 2010). Evidence from a number of Sub-Saharan countries suggests that male farmers have greater contact extension services than female farmers. In Ghana (Peterman *et al*., 2011) reported that 2% of female heads of households and female spouses in male headed households had contact with extension agents whereas nearly 12% of men did. In Kenya, contact with extension agents contributed significantly and positively to output on male managed plots but not necessarily female managed plots (Saito *et al.,* 1994). Hence women are unable to obtain useful and reliable information about MATs.

Most women lack resources such as information and knowledge to assist them to increase productivity in farming. Mchombu (2006) observed that that the biggest weakness of the agricultural sector in Africa is poor transfer of information. Access to information will help women to know about improved technologies and enhance the adoption of new innovations. However, Sudath (2008) noted that agricultural innovation diffusion is largely affected by information available on the innovation. Barriers of information may be alleviated by employing tools to provide an information bridge between agricultural experts and farmers. For example timely, accurate, and access to information through the media and ICT access to communication can be a potential avenue for improving yield among the women farmers. Nevertheless, their low level of education does not provide them with skills to access information. Although new ICTs have emerged, rural women need to know the services they can provide, where they can be found, and how they work in farming practices. According to Odini (2014) the ICTs available do not address the needs of the rural poor and are scarce at the case study to satisfy women's information needs.

2.3 Education and Adoption of Modern Agricultural Technologies

A new agricultural technology may reflect desirable traits but changes in the production process involved in the adoption of the technology may bring risk due to imperfect information and the possibility of committing errors. Either, women do not understand them, lack exposure and access through acquisition of resources to establish them. Whatson (1965) said that the fundamental problem of agricultural growth is of education. Hence the complexity of these technologies can only be solved through education which enhances ability to derive, decode and evaluate useful information for agricultural production (Ani, 1998).

The human capital theory stresses the significance of education and training as the key to participation in the global economy. Human capital analysis assumes that schooling raises earnings and productivity mainly by providing knowledge, skills and a way of analyzing problems (Becker, 1964). Thus a more productive and profitable agricultural sector is fundamental to cutting hunger, reducing poverty, generating economic growth and promoting sustainable use of natural resources. A World Bank perspective study on Africa states categorically that "raising educational levels enhances agricultural productivity" (1989:64).

A number of studies show that improvements in agriculture are strongly linked to education and that literate farmers are more likely to adopt modern agricultural practices. Moock (1976) established that the effect of schooling on farm output was greater for women than for men because men with more schooling tend to seek off-farm employment and are more likely to be successful in finding and keeping the job compared to the women. Paul and Saadullah (1991) in Bangladesh that technology adoption were faster among highly educated women in the rural village. This clarifies the significance of increasing the level of education for the women in developing countries to certain the SDG goals. Quisumbing (1993) found that a 10% increase in the number of women completing primary school led to a 65% increase in early adoption of new technology and a 14% increase in late adoption. This underscores the importance of formal education in adoption of MATs by women.

However, other studies produced mixed results. Raufu and Adetunji (2012) established that female education at all levels has no significant impact on land management practices in South Western Nigeria. A study by Mujivane (1999) in Vihiga district found that women's formal education had little impact on dairy grade cattle ownership. Informal learning takes place through informal interaction between women. This is likely to change the trend that the

more educated are capable of adopting a technology and vice versa. The illiterates, school drop outs and basic school leavers learn from educated people in the society to effect change in their lives. Weir and Knight (2000) found out that those without schooling may eventually copy the educated. The evidence presented show that educated farmers could be early innovators providing an example that may be copied by less educated.

Great strides have been made in the education of women. Women in Latin America have considerably advanced in education though in Southern Asia and SSA they are yet to make such strides (FAO, 2011). In SSA, survey shows that in most households, females have lower education levels than men and the situation persists in rural areas where educational attainment is lower despite high private rate of returns to women's schooling (FAO, 2010). In Kenya, besides progress made in the attainment of universal primary education, access to secondary and tertiary education remains below expectation among women (Government of Kenya, 2013). Likewise in Emuhaya and Luanda sub-counties, 14.1% did not attain formal education, 62.6% attained primary education while 17.4% comprise women who attained post primary education (Government of Kenya, 2010).

Low levels of education among women also means that few young women have the qualifications to enter agricultural colleges or research institutions, and this is reflected in the underrepresentation of women among researchers, teachers, trainers and extension staff of most countries (Mehra, 1991). This situation persists to date, despite a number of initiatives to increase women's representation (Ragasa, 2012). According to (Beintema and Di Marcantonio, 2009), only one in four agricultural researchers in SSA is female, or one in three in Latin America. There is, therefore, a very small pool of women agriculturalists to draw upon, and this can be a significant shortcoming in countries where, because of social and cultural factors, female staff is needed to reach and influence women farmers (Mehra, 1995). Thus it is necessary to investigate the different educational levels and how they shape adoption levels.

The Winrock International Report on Assessment of Animal Agriculture in SSA (1992) point out that primary and secondary education does not provide farmers with knowledge and skills relevant to agriculture. Odini (2014) also notes that agriculture as a subject is not taken seriously in primary and secondary schools. Either, the agricultural core curriculum is poorly designed and most students do not have access to learning aids that can enable them learn about new agricultural technologies. As for the middle-level training, the Winrock report

notes that it does not prepare graduates for the changing roles in agriculture while the university-level education in animal science and veterinary medicine is not well focused on contemporary needs of animal agricultural development. So quality improvement in quality output at all levels of education thus primary, secondary and tertiary are important in agricultural development and will assume greater importance as intensification precedes and agriculture grows in sophistication.

Conversely, a study by (Malenya *et al*., 2003) has sought to establish education as a necessary condition to finding remunerative nonfarm employment that generates regular cash income necessary to undertake farm investments. They argue that in high density areas where land is quite small emanating from subdivision, intensification may not offer a modest foundation for secure livelihoods. Hence attaining an above average education leads to the ability to find formal wage or salaried nonfarm employment which in turn leads to on-farm investment in agricultural intensification such as dairy cattle and tea bushes, upgraded housing, and increased use of mineral fertilizers and organic soil inputs such as manure and improved nitrogen-fixing fallows. Those who are poor in land, education, and capital face great difficulty overcoming entry barriers as they cannot self finance through such means as salaried nonfarm employment and cannot put their agricultural land and labour resources to their full productive use, thereby trapping them in poverty. Thus educational attainment and resulting incomes have an effect on farming patterns as well.

Farming remains the primary livelihood for most rural households and much of the performance in agricultural sector is attributable for small holder farms (Ogada, 2013). Its success therefore revolves around making formal education more broadly accessible and on stimulating increased school completion at all levels. Implementers of MATs can therefore integrate the existing education levels among women with the adoption programmes to address issues of low adoption in Emuhaya and Luanda Sub-Counties. However, while it is highly acknowledged that education impact on technology adoption, the level and extent to which it influences adoption of MATs by women has not been defined in Emuhaya and Luanda sub-counties. This study focuses on the gap by examining the effects of education levels on adoption of MATs.

2.4 Benefits of Adoption of Modern Agricultural Technologies

MATs enhance agricultural productivity and as a result incomes are increased. However the choice of technologies will depend on whether they are profitable or not. Suri (2011)

analyzed data on hybrid maize adoption in Kenya and found a large proportion of non adoption can be explained by low returns. This is in line with (Kathage *et al*., 2012) who concluded that non adoption of technologies is not always a sign of constrains but may also indicate low benefits. Besley and Case (1993), found that probability of adopting an agricultural technology increases as farmers realize the profitability of the new technology. It is therefore important to understand the conditions under which the improved technologies are profitable to women. Rathberger (2011) suggests that technologies must be introduced with a good understanding of local economic conditions and cultural practices. Therefore women will not adopt technologies that work against their immediate interests. However, a growing body of empirical evidence in developed countries has found that women were more likely to choose activities with lower expected returns and with lower risks (Fletschner *et al*., 2010). According to (Croson and Gneezy, 2009) women were risk averse. As a result they practice a lot of caution in their decision making and this restricts the applicability of profit maximization. This means they encounter several constraints which prevent them from adopting MATs that can benefit them. Researchers in Zimbabwe found that households with female labour constraints were less likely to adopt improved fallow technologies and in Kenya they were less likely to adopt expensive technologies like inorganic fertilizers.

A study by (Oladele *et al*., 2008) in Nigeria using the Pearson Product Moment Correlation, established a significant relationship between perceived benefits and adoption. This suggests that adoption of MATs depends on the benefits realised from them. In Rwanda a study by (Nsabimana and Masabo, 2005) found that 72% of the adopters had been sensitized on the advantages of the technologies while 89% of the non-adopters had not been sensitized. Furthermore most farmers (98%) were informed of the benefits of the technologies and specifically listed increase in yield, increased income and improved food security as the benefits. In Kenya a study by (Salasya *et al*., 1996) in Busia district found that farmers preferred local varieties of sorghum to improved varieties because they had more advantages such as early maturity, high yielding and good taste. Hence women farmer's knowledge about new technologies must also include information about returns from adoption including profitability and risk.

Invention of agricultural technologies has been the basis for agricultural development. Adoption of agricultural technologies has made differences in the farming activities of subsistence farmers as most of these technologies have provided job opportunities, increased

standard of living, reduce labour, provide income and have controlled a lot of diseases infestation both in crops and animals (Oladele *et al*., 2008). Awais and Khan (2014) urges that adoption of new agricultural technologies of HYVs seeds, chemical fertilisers, agro chemicals and methods of cultivation can improve the production of and productivity of agriculture sector leading to improvements in the economic conditions of the population. Adoption has also been associated with higher earnings and lower poverty rates (Oladele, 2008). According to (Kasirye, 2008) improved agriculture lower food prices. Affordability of food stuffs translates to enhanced household income for women farmers. Nevertheless, some of these technological packages had negative effect. In Tanzania, the project to modernize the traditional semi nomadic production of Maasai pastoralists did not display improvement in the rotational grazing over the existing practice under the bimodal rainfall regime (Morris, 1991). This can explain why technologies are adopted or not. If an agricultural technology has no benefit it will not be accepted and if accepted it will be discontinued. Hence introduction of modern technologies need to go hand in hand with information on consequences of these technologies.

Nonetheless, data on benefits of modern agricultural technologies adopted by women is limited. A study by (Ndiritu *et al*., 2011 and Chirwa *et al.*, 2013) established that female controlled plots and households show low application of fertilizers which implies low adoption levels. However, these studies never investigated whether this trend was as a result of low benefits. Likewise Mutoko *et al.* (2014) in their study in Emuhaya district within Western Highlands in Kenya, noted that farmers received less returns, made limited use of inputs and more of them focused on off farm activities. However they did not investigate whether low adoption was as a result of low benefits from the technologies. Nyerere (2012) in a study in Luanda division, found that most women did not adopt soil conservation practices like digging terraces, manuring, planting cover crops, crop rotation among others but never associated this trend to the fact that they may not have been informed about benefits of these activities. Other studies such as (Bala *et al.*, 2006 and Ouma, 2012) also did not look at the benefits of adoption. Adoption is done with an aim of changing production in agriculture. Hence it cannot be delinked from the perceived benefits of adoption which forms the basis of choices made by women to adopt agricultural technologies.

2.5 Theoretical Framework

The theoretical framework of the study was based on the Diffusion of Innovation theory by (Rogers, 2003). This theory describes how new ideas and technologies spread in different

cultures. Rogers defines an innovation as an idea, practise or object perceived as new by an individual. While diffusion is defined as the process by which an innovation is communicated through certain channels over time among the members of a social system. Rogers explains how an idea perceived to be new undergoes a decision making process before finally being adopted. He looks at the 4 elements of diffusion; innovation, communication channels, time and social system. Several studies such as (Ouma, 2012 and Ndandula, 2011), have used this theory to explain various processes associated with adoption of new practises among members of a social group.

This study on Luanda and Emuhaya sub-counties analyses adoption of MATs, perceived as innovations, processes that support adoption of these innovations and the resulting change thus the consequences. Rogers (2003) theory of Diffusion of Innovation was therefore found to be relevant to explain adoption of MATs by women in Luanda and Emuhaya Sub-Counties.

An innovation introduced to potential adopters does not always get adopted immediately even if it has proven advantages. This is because of the decision making process which involves seeking for information about the innovation because they face yield uncertainties and varying risk preferences. Women will source for information from a pool of alternatives at their disposal. This could be through the mass media sources like radio, television or newspapers which contain valuable information about the innovation. Other avenues include organised events by the government or non-governmental organisations (NGOs) for example KALRO, NALEP, NAAIAP, (Ogada, 2013) to display and provide information about innovations through events like field days, demonstrations, workshops and agricultural shows are very important.

However communication about an innovation may not be effective if the change agent for example an extension officer is more technically competent than the women. According to Mehra (1995), many women do not make use of extension services and agricultural technologies due to limited education. This may complicate understanding of an innovation and consequently discourage adoption. Human communication will have a greater effect in terms of knowledge gain, attitude formation and change if the parties involved are alike in personal and social characteristics. In this case women will interact with their peers whom they share the same language of communication, beliefs, same education and social status.

They exchange meaningful ideas about MATs and therefore acquire knowledge and skills to adopt innovations.

This leads them to another level where they seek to evaluate the MATs so as to reduce uncertainty. This is determined by characteristics of innovations as described by (Rogers, 2003). An adopter will look at the advantages of an innovation and its compatibility. When an innovation is seen to be of benefit, it will be adopted earlier. Also when a technology meets the standards and is well understood by women in the social setting, it will be adopted. However, a technology that is difficult to understand will be avoided. Adopters also try experimenting innovations on a small scale to see if it works for them. According to (Rathberger, 2011 and Njiro, 2003) women sometimes use their home gardens to experiment with gathered species and tree products. The results obtained from the trials will therefore determine the rate of adoption. When they see the results of an innovation the more likely are they to adopt but when the results are not seen, it can be abandoned. This is a process that takes time.

Rogers (2003) has emphasized the role of the social system in diffusion of innovations. The social system constitutes a boundary within which an innovation diffuses. Therefore a structure of a social system can facilitate or impede the diffusion of innovations in the system. Some norms in the society can discourage adoption of MATs by women, for example lack of control over land, and in some communities, cultural factors that limit women from using some technologies like sitting on tractor, (Mehra, 1995). Moreover, in most African countries, there is the widely recognized difficulty of male extension agents having any type of contact with individual female small holders due to entrenched norms and cultural difficulties in engaging face to face communication, (Swanson and Rajalahti, 2010). Therefore when a system is oriented towards change women will adopt MATs and realise the benefits. If the norms are opposed to change, then adoption may not take off as expected.

2.6 Conceptual Framework

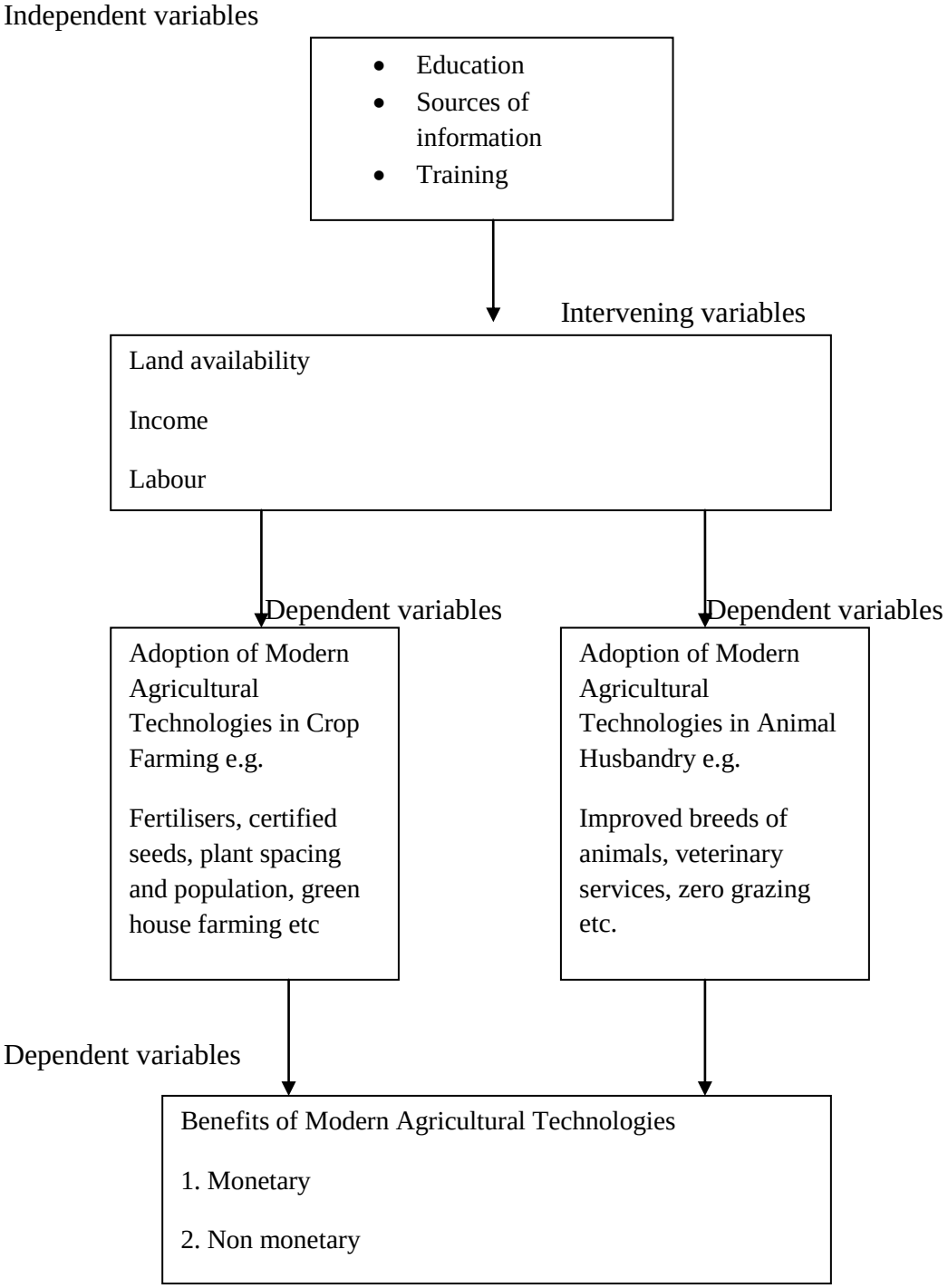

Fig. 2.1: Adoption of Modern Agricultural Technologies by Women

Source: Researcher 2015

The framework demonstrates adoption of modern agricultural technologies in crop farming and animal husbandry. The type of technology to be adopted depends on the education level of the woman, training and level of awareness. An educated female farmer may be able to

take up most of the technology because she can easily assimilate and idealize new knowledge that is useful for agricultural production. However women can be different in many ways. Some may have acquired education at lower levels and others at higher levels. Others have not acquired formal education but have acquired literacy skills to enable them to read and write. For this kind of farmer, extension services remain key source of information on new technologies and the training they receive can be essential in helping them realize the importance of these technologies in improving standards of living. This knowledge guides them on deciding whether or not to adopt an innovation. Hence women will adopt MATs depending on the perceived benefits. If a technology takes too much time for the benefits to be seen, women farmers may avoid it. This is because the decisions they make regarding the adoption, partial adoption or non-adoption of dairy technologies will have an effect their livelihoods. Valuable outcomes include income, employment generation and improved standards of living. These benefits will influence farmers to enhance their productivity. When a technology does not yield to their expectations they will abandon it.

Women will adopt MATs based on what assets they have. Access to land makes it easier for them to fully participate in adoption of MATs. Women who have access to land could take up technology and adjust them to their circumstances and maximize benefits derived from them. In circumstances where they are generally limited to user rights to land, they will not be able adopt new technologies in agriculture appropriate to its utilization.

This framework helps to analyze the processes farmers go through in making their decisions on what technologies to take up based on their characteristics and circumstances and considering constrains they face as smallholder farmers.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter will focus on research area and study population, research design, sampling strategy, data collection methods, data analysis and results presentation, reliability and validity and ethical considerations.

3.2 Study Area: Emuhaya and Luanda Sub- Counties

Emuhaya and Luanda sub- counties are woof the four sub-counties in Vihiga County. The other two are Hamisi and Sabatia. They are situated on longitude 34º35' E and latitude 0º 4' N. They cover a total area of 173.2 sq km and are divided into four divisions. Luanda and Ekwanda found in Luanda sub-county while and Elukongo and Esiembero are found in Emuhaya sub-county. This area has 16 administrative locations and 54 sub-locations. Luanda sub-county is divided into 5wards while Emuhaya sub-county is divided into 3 wards. The main market town is Luanda, located on Kisumu-Busia highway about 3km from Maseno (Republic of Kenya, 2009).

3.2.1 Topography

Its altitude ranges between1350m and 1500m above sea level. The Bunyore hills which rise above the general level are the source of the only main river Nasibi which runs westwards to join Etsaaba that empties its water into River Yala. The Jordan which has its source in Maragoli and Nandi Hills bisects Emuhaya from East to West. The soils are drystric acrisols, deep well drained slightly acidic to alkaline (Republic of Kenya, 2008).

3.2.2 Climate

Emuhaya and Luanda sub-Counties receive reliable rainfall that ranges from 1500mm to 2000mm and is bimodal in distribution. The peaks are gradually reached between April and June for the long rains and September, October November for short rains, (Republic of Kenya, 2008). The month of December January and February are generally characterized by low rainfall (Republic of Kenya 2008). The temperature varies between 14º and 32º degrees (Republic of Kenya, 2008). The figure 3.1 below shows the map of Emuhaya and Luanda sub- counties;

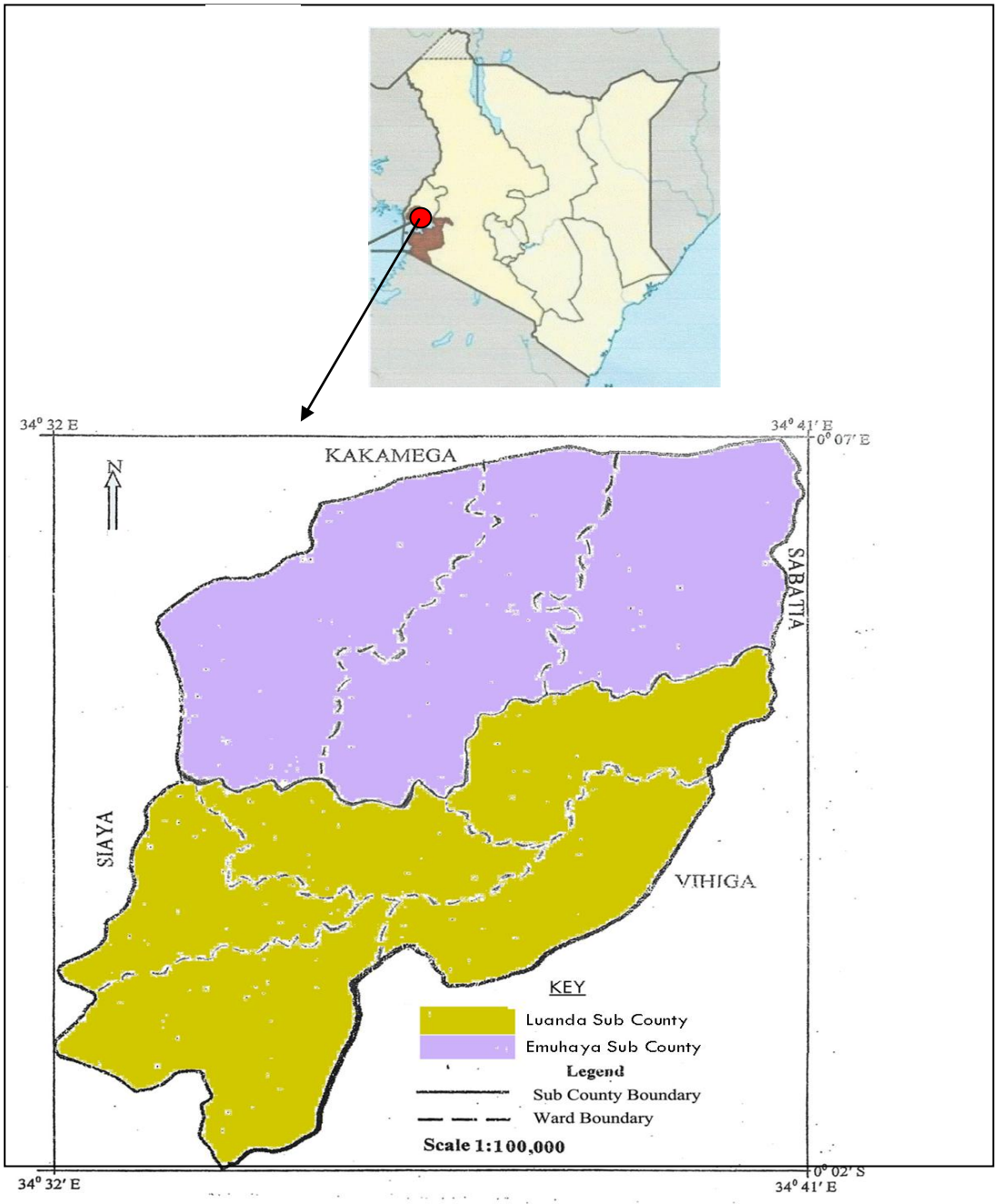

Figure 3.1: A Modified Map of Emuhaya and Luanda Sub Counties

SOURCE: The District Statistics Office

3.2.3 Population

According to the 2009 census, Emuhaya and Luanda Sub-Counties have a population of 185,069 (Kenya National Population Census (KNPC), (2009). Based on the area of 173.2 sq. kms, Emuhaya and Luanda Sub-Counties have an average population density of 1,067 persons per sq.km and the population growth is 3 percent per annum. The sub-counties have a total number of 43,030 households. The majority of the people are 'Abanyole' a sub-tribe of the larger Luhyia community (Republic of Kenya, 2009). About 57.6% of the population live in absolute poverty line which is set at Kshs 2,648 and Kshs1,238 per month for urban and rural areas respectively (GOK, 2004). The table 3.1 below shows the population profile of Emuhaya and Luanda sub-counties;

Table 3.1: Population Profile of Emuhaya and Luanda Sub-Counties.

Sub-County	Area Sq.Kms	Population-Males	Population-Females	Total	Density
Luanda	98.6	56,965	65,252	**122,217**	1,240
Emuhaya	74.6	42,077	49,458	**91,535**	1,227
TOTAL	**173.2**	**99,042**	**114,710**	**213,752**	**1,234**

(Source: The Kenya Population and Housing Census, 2009)

3.2.4 Human Activities

The "Abanyole" are peasant farmers and 90% of them depend on agriculture for their livelihood. Emuhaya and Luanda sub-counties have 164 sq. km arable land. The average farm size is about 0.5 hectares which is basically used for subsistence farming with a high bias in maize farming. The main food crops grown are maize, beans, bananas, and to a lesser extent sweet potatoes, cassava, sorghum, millet, groundnuts, soya beans, local vegetables and tea. Most households own local zebu cattle (average 1-2 per household) and a few households keep grade cattle. A few farmers practice fish farming, bee keeping and commercial poultry keeping. Other human activities include small scale trading activities, brick making, pot making, sand and stone harvesting for commercial purposes (Republic of Kenya, 2009).

3.2.5 Education

Emuhaya and Luanda sub counties have 93 primary schools and 34 public schools 185 early childhood development centres and 35 adult classes. There are a few tertiary colleges including youth polytechnics. There is one campus of Masinde Muliro University at Ebunangwe. Literacy rates are at 89.5% for men and 79.4% for women (Republic of Kenya,

2008). The table 3.2 below shows the distribution of population by sex and education level in Emuhaya and Luanda sub- counties.

Table 3.2: The Distribution of Population Aged 3 Years and above by Sex and Highest Level of Education Reached.

	Never Attended school	**Pre-Primary**	**Primary**	**Secondary**	**Tertiary**	**University**	**Youth polytechnics**	**Total**
Total	**21,606**	**10,851**	**104,076**	**25,267**	**3,301**	**1,142**	**612**	**166,855**
Male	9,061	5,553	48,416	12,005	1,715	767	386	77,903
Female	12,545	5,298	55,660	13,262	1,586	375	226	88,952
	(14.1%)	**(5.9%)**	**(62.6%)**	**(14.9%)**	**(1.8%)**	**(0.4%)**	**(0.3%)**	**(100%)**

(Source: The Kenya Population and Housing Census, 2010)

3.3 Research Design

A cross-sectional survey was used to carry out the study. Creswell (2005) defines surveys as procedures in quantitative research in which investigators administer a survey to a sample or the entire population of people in order to describe the attitudes, opinions, behaviours or the characteristics of the population. Surveys are concerned with conditions or relationship that exist, opinions that are held, processes that are going on, effects that are evident or trends that are developing. Data is collected through questionnaires or interviews to describe trends about responses to questions and to interpret the meaning of the data by relating results of the statistical test back to past research studies (Creswell, 2005). The purpose of this research was to record, describe, analyze and interpret the effect of women's educational levels on adoption of MATs.

3.4 Study Population and Sampling

Emuhaya and Luanda sub-counties are divided into 4 Divisions namely; Luanda, Ekwanda, Elukhongo and Esiembero. Each Division has 4 Locations and a total number of 54 Sub locations in the whole District. The target population was women aged 15 and above because they play a significant role in socio economic development. The statistics drawn from the projection sat the Sub-Counties statistics office (2008) indicate that the population of women from the age of 15 years and above is 61,420. The adequate sample size was obtained using

the (Fisher *et al.*, 1983), formula in which a study of a population which is greater than 10,000, the formula n= $z^2 \frac{pq}{d^2}$ is applied as follows:

n-Sample size,

z- Deviation at a confidence level

p-Proportion of study having traits required

q- 1-p

d- Level of statistical significance.

Therefore the sample size n= $\frac{(1.96)^2 \times (0.5) \times (1-0.5)}{0.05}$ =384.

The study employed stratified random sampling to sample women in the crop farming and animal husbandry. This was done proportionately in regard to their representation in the population as follows;

The sample size of the population is 384 and the unit of analysis was a woman. The population was divided into crop farming and animal husbandry female farmers with $\frac{1}{3}$ of the population chosen for animal husbandry and $\frac{2}{3}$ for crop farming. The result was N = $\frac{1}{3}$x384=128 (representing animal husbandry) and N=$\frac{2}{3}$x384=256(representing crop farming). This total led to 384 as the sample population. The other categories of samples were purposefully sampled. This includes 4 extension officers, 8 sub chiefs and focus groups.

The sampling unit was a location and the study population was stratified into 16 locations of Emuhaya and Luanda sub-counties.

3.5 Data Collection Methods.

The study employed primary and secondary sources of data.

3.5.1 Primary Data

The study used a questionnaire, interview schedules, discussion guide and a digital camera to collect data from the field.

3.5.1.1 The Questionnaire

A questionnaire was used to obtain important information about the MATs adopted by women and benefits of adoption of MATs. The questions used were of different forms as follows;

1. They were open ended in nature. The respondents answered some questions in their own words.
2. They were unstructured in nature. The respondents selected one or more options from pre- determined set of responses.
3. Simple dichotomy; the respondents answered closed ended questions with only 2 responses.
4. Multiple choice questions. The respondents were required to answer close ended questions with more than 2 responses.

The above questions were administered to provide a list of all possible alternatives from which the women selected the answers that best described their situation and also give them complete freedom of response. The questionnaire was divided into four parts; Part A dealt with socio economic and demographic information like; age, marital status, education level head of household, farm size and land ownership. Part B dealt with information on MATs adopted by women, sources of information and training. Part C entailed information on rates of adoption of MATs in crop farming and animal husbandry like use of certified seeds and adoption of exotic breeds of cattle while Part D dealt with information on benefits of MATs, constrains of adoption and suggestions for improvement of adoption.

3.5.1.2 Interview

The researcher used one on one interview schedules to obtain information from key informants who included 4 agricultural extension officers and 8 assistant chiefs serving in the district. Agricultural extension officers were brought on board to help understand the real agricultural environment in which women operate. Information on the structures that support women farmers in adoption of MATs and emerging challenges facing adoption helped the study to strengthen its findings and conclusion with information that was not attained through the questionnaire. The 8 sub-chiefs were targeted so to gain insight into the activities carried out by women at the grass root level. Assistant chiefs play an important role in linking the government and non-governmental institutions with the women farmers to implement the best practises that can bring change in production. This was done through probing questions on MATs adopted by women in crop farming and animal husbandry, sources of information, training, challenges of adoption and suggestions on how to improve adoption and the role of government in promoting adoption of MATs in agriculture.

3.5.1.3 Focus Group Discussions

Focus group discussions (FDGs) were undertaken with women to give opinion on adoption of MATs, the benefits of MATs to women, challenges of adoption and suggestions for improvement. Discussion guides were used to obtain extra information that could not come out using the questionnaires. The researchers purposely picked the 4 groups each comprising of 6-8 members while paying attention to homogeneity in relation to attributes like education, a common sub cultural language, social status and beliefs and farm practices. The discussion guides contained information regarding MATs adopted in crop farming and animal husbandry, sources of information, training, their importance to women farmers, challenges of adoption and suggestions for improvement. The researcher facilitated each FDG session while the enumerator recorded the outcome of the deliberations.

3.5.1.4 Photography

Adigital camera was used to take slides of various scenes such as MATs employed in crop farming and animal husbandry in Emuhaya and Luanda Sub-Counties. Slides complemented other methods of collecting data like questionnaires and interviews. They helped understand the real world experience in which women farmers use and access MATs in agriculture.

3.5.2 Secondary Data

This included other relevant literature sourced from text books, paper presentations, statistical abstracts, the government and districts agricultural reports, district development plans, news papers and journals from the internet. Secondary data provided important information on history and trends in adoption which helped shape the background information and literature review. Journals and paper presentations enriched the literature review with research findings from different authors which helped in comparisons with the study result. Agricultural reports from the district and government, statistical abstracts assisted this study with information on solid figures needed to put forward proof and arguments on population trends, production and other statistical information. This was used to strengthen evidence of discussions advanced in the study. Newspapers brought in ideas on the trends and emerging issues in the area of specialisation.

3.6 Data Analysis

The quantitative data was used to analyze frequency counts and percentages to establish MATs adopted by women. The number of occurrences of the MATs adopted was recorded and converted to percentages to establish the rates of adoption of various MATs adopted by

women in agriculture. This gave a picture of the different types of MATs adopted by women. Spearman's rho was used to establish the relationship between education levels and adoption of various MATs in crop farming and animal husbandry. Chi square tests were carried out to establish the relationship between adoption of MATs and benefits of MATs. The independent variable was education, sources of information and training. The dependent variables were MATs in crop farming and animal husbandry and benefits of MATs. Data was presented in form of graphs, tables and pie-charts. This gave a compressed picture of the data used to explain underlying relationships, to allow generalization and to enable prediction about use and access to MATs among women.

3.7 Reliability and Validity of the Research Instruments

3.7.1 Validity of Research Instruments

The researcher conducted a pilot study on a population similar to target population in one location. The respondents targeted were not part of the sampled population. This enabled the researcher to capture important comments and suggestions from the respondents which enabled the researcher to improve efficiency of the instruments, adjust some approaches and strategies to maximize the response rate as well as review some research questions. Content validity was also established by presenting the instrument to the experts who were my supervisors. After consultation, some questions (items) in the instruments which were irrelevant to the research questions had to be discarded and others revised.

3.7.2 Reliability of Research Instruments

The reliability of the instrument was tested using the split half method. The items were split into halves (odd and even). The odd and even items were then administered separately and scored accordingly. The scores of the two tests were then computed using PPMC. To estimate the correlation of the two halves, Spearman-Brown coefficient was used. The results are presented in table 3.3 below;

Table 3.3: Split –half Technique: Reliability Analysis

Cronbach's Alpha	Part 1	Value	1.000
		N of Items	1[a]
	Part 2	Value	1.000
		N of Items	1[b]
	Total N of Items		2
Correlation Between Forms			.653
Spearman-Brown Coefficient	Equal Length		.790
	Unequal Length		.790
Guttman Split-Half Coefficient			.776

a. The items are: EVEN

b. The items are: ODD

The table 3.4 above shows that the questionnaire for the women yielded an alpha reliability of 0.790, which is approximately 0.8 when rounded off. Mugenda and Mugenda (1999) have fixed 0.8 or higher as evidence for reliability. This means that the responses given to the items of the questionnaire by the respondents were both consistent and well understood.

3.8 Research Ethics

The researcher observed ethical issues as far as data collection was concerned. Permission was obtained from the university. Other relevant permissions were obtained from the local administration and the Sub-county agricultural Officer. The researcher also sought the consent of women respondents and household heads. The respondents were informed about the procedures of the study which they were to participate. They were also informed about the expected duration of participation, purpose of the research and the benefits of the study to the community. The respondents were assured of privacy and confidentiality for any information collected from them. Numbers were used for identification to maintain anonymity of the respondents. Other researcher’s work was acknowledged through relevant citations.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1Introduction

This chapter presents findings on Analysis of Adoption of Modern Agricultural Technologies (MATs) by Women in Emuhaya and Luanda sub-counties, Vihiga County. The study findings represented in this chapter includes socio-economic and demographic characteristics, MATs adopted by women in crop production and animal husbandry, adoption levels and the benefits.

4.2 Socio-economic and Demographic Information of the Women

The socio economic and demographic information examined in this study were age, education level, marital status, household composition, source of livelihood, involvement in decision making, size of the farm and ownership of land. This is displayed in the table 4.1 below;

Table 4.1: Demographic Representation of the Socio- economic Characteristics of Women

Socio demographic Characteristics of the Women (n=384)	Frequency (f)	Percentage (%)
Age (years)		
60 & above	90	23.4
45-59	133	34.6
30-44	129	33.6
15-29	32	8.3
Education (levels)		
Primary	199	51.8
Secondary	110	28.6
Tertiary	53	13.8
Others (maddrassa, adult education)	22	5.7
Marital status		
Single	22	5.7
Married	267	69.5
Divorced	4	1.0
Widowed	91	23.7
Decision making		
Yes	271	70.6
No	113	29.4
Source of livelihood		
Crop farming	273	71.1
Livestock farming	49	12.8
Off farm casual employment	54	14.1
Off farm permanent employment	5	1.3
Others (like petty trade, pottery etc)	3	0.8
Land size (ha)		
Less than 1	265	69
1-2	81	21.1
2-3	25	6.5
3 & above	13	3.4
Land tenure		
Privately owned	383	99.7
Leased	1	0.3

4.2.1Age and Educational Level

The study established that 34.6% of the women were between 45-59 years of age followed by 33.6% between 30-44 years, third 23.4% of age bracket 60 years and above, while 8.3% were between 15-29 years. This implies that majority of the women were adults who were in the economically active age group. Across tabulation between age and educational level presented in the table 4.2 below show that majority of the women who attained primary education belong to the age bracket 45-59, followed by 30-44 years. They are closely followed by their counterparts in the same age brackets with secondary level of education.

Their technology adoption behaviour is therefore important to agricultural productivity because they possess skills that will help comprehend MATs (Akudugu *et al.*, 2012). They are expected to be flexible in the decisions to adopt new initiatives and innovations. The youthfulness of the age group 30-44 means that they are likely to be open to changes and education more quickly than the women in the age bracket 60 years and above who are likely to be conservative and hence may not adopt new ideas and technologies faster for fear of risks and other expected events (Nsabimana and Masabo, 2005). The small numbers in the age group15- 29 years may imply that most of them have moved away in search of education and employment.

Table: 4.2: Age and Educational Level

		Educational level				
		Primary	**Secondary**	**Tertiary**	**Other**	**Total**
Age						
	60 & above	57	7	13	13	90
	45-59	69	50	8	6	133
	30-44	59	40	27	3	129
	15-29	14	13	5	0	32
Total		**199**	**110**	**53**	**22**	**384**

4.2.2 Marital Status and Decision Making

According to the marital status 69.5% were married, 23.7% widowed, 5.7% single and 1.0% was divorced. Adoption of MATs by women is largely affected by their marital status. Married women are expected to pick up most MATs because of easy access to resources. This is because men control productive resources such as land, labour and capital which are critical for the adoption of new technologies (Akudugu *et al*., 2012). However decisions made at this level on adoption of MATs can also shape the way women respond to adoption.

Results from a cross tabulation of marital status and decision making in table 4.3 below indicate that majority of the married women are involved in making decisions on adoption of MATs. This is important in adoption because they play a dominant role in implementation of Mats. However, it is interesting to find that widowed women have very little say in adoption of MATs when at the same time are considered to be heads of their households. It seems they have very minimal control on ownership and utilisation of resources at household level. According to (Njiro, 2003), the presence of a male relative plays a dominant role in decision making processes. Hence adoption of MATs by the widowed and divorced women may is low and slow because of minimal participation in decision making regarding MATs that meet their needs.

Table: 4.3: Marital Status and Participation in Decision Making

		Participation in decision making		
		YES	**NO**	**Total**
Marital status	Single	18	4	22
	Married	251	16	267
	Divorced	1	3	4
	Widowed	1	90	91
Total		**271**	**113**	**384**

4.2.3 Decision Making

Results show that 70.6% of the women were involved in making decisions on adoption of innovations while 29.4% were not. This means that collective views, concerns and opinions on adoption of MATs involved women (Akudugu *et al*., 2012). This is important in adoption of new technologies. A small number of women are not decision makers in adoption of MATs, meaning they could not make independent decisions in adoption of MATs. This result is different from (Paul and Saadulah, 1991) who established that 49% of the decisions concerned with homestead cultivation such as vegetables and other plant species were done by women while 56% of the decisions were done by men. This shows that participation of women in making decisions on adoption MATs can be more if levels of illiteracy are reduced.

4.2.4 Educational Level and Source of Livelihood

The majority, 51.8% had acquired at least primary education, 28.6% secondary education and 13.8% tertiary education, while a few 5.7% had not acquired formal education. Women with primary level of education are an important group in adoption. They possess literacy and numeracy skills that are important in interpretation of MATs. Quisumbing (1993) found that an increase in the number of women completing primary school led to an increase in early adoption of new technology. They can therefore play the role of early adopters who can be imitated by the other women (Rogers, 2003). A few women attained secondary level of education and their role in adoption of MATs is important because education will make them receptive to adoption. However a few of these women together with those who possess higher levels of education would seek off farm employment. A cross tabulation done on education and household source of livelihood in table 4.4 below show that few women with higher education seek off farm permanent employment. They can significantly impact on adoption of MATs because income earned will enable them to invest in acquisition of farm inputs (Malenya *et al*., 2003). They are therefore capable of adopting better management practices.

Table 4.4: Educational Level and Household Source of Livelihood

	Household source of livelihood					
	Food crop farming	**Livestock farming**	**Off-farm casual employment**	**Off-farm permanent employment**	**Other (specify)**	**Total**
Education						
Primary	152	25	20	0	2	199
Secondary	69	19	21	1	0	110
Tertiary	32	5	12	4	0	53
Other	20	0	1	0	1	22
Total	273	49	54	5	3	384

4.2.5 Main Source of Livelihood and Land Size

Most women 71.1% depend on food crop farming as the main source of livelihood, 14.1% on off farm casual employment, 12.8% on livestock farming and a few; 1.3% and 0.8% depends on off farm permanent employment and other sources like petty trade respectively. This implies that most women depend on crop production as a major source of livelihood. However, farming in Emuhaya and Luanda Sub-counties is done on small pieces of land, an average farm size of 0.5 ha (Republic of Kenya, 2009). This means that women will strive to adopt relevant MATs in crop farming to improve production and for fear of losing their livelihood strategy. This confirms findings by (Salasya, 2005) that maize and bean production as the most important activity in this area of study. A few women depend on livestock farming as a major source of livelihood. This implies that many of them are not directly in charge of livestock as this may be the domain of men in most households. According to (FAO, 2009) men are responsible for keeping and marketing large animals, such as cattle, horses and camels, while women tend to control smaller animals, such as goats, sheep, pigs and poultry. Women involved in off farm casual employment do so to complement food crop production and this act as a strategy to secure their families. Few women depend on off farm permanent employment and could be contributing to adoption of MATs by facilitating acquisition of farm inputs and labour (Malenya *et al.*, 2003). This result differs with (Ouma, 2012) in Lambwe Valley who established that 100% of the women farmers depend on crop farming. This means that livestock farming encounters difficulties that threaten the survival of livestock.

Cross tabulation results between source of livelihood and land size in table 4.5 below indicate that majority of women who depend on crop production as a source of livelihood do it on land less than 1 ha. Therefore their choice of MATs to be adopted is important. A majority of the women who seek off farm employment belong to the category of land size less than1 ha. They do this as a way of seeking alternative means of survival. Large land sizes also seem not to be utilised maximally for crop and animal farming. Much of it may have been reverted for other uses like cash crop farming, which is minimal in the area of study (Republic of Kenya, 2009).

Table 4.5: Household Source of Livelihood and Size of Farm Land

		Household Source of Livelihood					
		Food crop farming	**Livestock farming**	**Off farm casual employment**	**Off farm permanent employment**	**Other (specify)**	**Total**
size of farm land	Less than 1ha	176	38	47	2	2	265
	1-2ha	64	8	7	2	0	81
	2-3ha	21	3	0	0	1	25
	3 & above ha	12	0	0	1	0	13
Total		273	49	54	5	3	384

4.2.6 Land Sizes

Results show that 69% of the women had land size less than 1ha followed by 21.1% who had land size between1-2ha. A few women 6.5% and 3.4% occupied land size between 2-3ha and more than 3ha respectively. This implies that most women operate on small sizes of land which is linked to the continuous cultivation of crops because of increasing land fragmentation (Republic of Kenya, 2009). This limits the ability of the women to effectively manage the land in terms of adoption of innovations like mechanised farming which are economical when applied on large expanses of land so as to meet the demand for food production (Eze *et al.*, 2011).

4.2.7 Land Tenure System

This study found that 99.7% of the lands used by women were privately owned and only 0.3% is leased. This means that most women used land that was privately owned. Security of tenure empowers them to adopt MATs with ease associated with greater land improvements.

This confirms with (Ogada *et al*., 2014), who reported that application of fertilizer and improved maize varieties were highest on farms with title deeds than their counterparts with insecure land tenure. According to (AASR, 2013) lack of secure tenure affects long-term investment and thereby productivity and sustainability.

4.3 Adoption of Modern Agricultural Technologies in Crop Farming and Animal Husbandry.

4.3.1 Awareness of MATs among Women

All the respondents 100% were aware of MATs at least a modern agricultural method of farming which were recommended for farm practice. This means that all respondents know about MATs indicating that they are available and being implemented. Channels of information like workshops, training programmes, extension officers and interactions with neighbours may have played a role in creating awareness about MATs. According to (Doss *et al*., 2003*)* exposure of farmers is important for adoption as it increases awareness and knowledge of farmers. This is most likely to increase chances of adopting MATs by women in Emuhaya and Luanda sub-counties. This result is different from (Kamal and Idrees, 2015) in Pakistan who established that 62.5% respondents were unaware about MATs. This may have been as a result of lack of exposure resulting from socioeconomic factors such as education, high poverty levels and cultural beliefs. However, awareness of technology may not always guarantee adoption.

4.3.2 Adoption of Modern Agricultural Technologies

This study established that in total 98.4% women had adopted modern techniques in crop and animal husbandry while 1.6% had not. All the women in crop farming (66.6%) had adopted MATs while in animal husbandry, 31.8% adopted MATs while a small percentage of women 4.6% had not adopted MATs as shown in the table 4.6below;

Table 4.6: Adoption of Modern Agricultural Technologies

Adoption	**Frequency/ percentage**	**Adoption**	**Frequency/ percentage**	**TOTAL**	
Crop farming	f (%)	**Animal husbandry**	f (%)	**(f)**	**(%)**
YES	256 (66.6)	**YES**	122 (31.8)	**376**	**98.4**
NO	_	**NO**	6 (4.6)	**6**	**1.6**
TOTAL	256 (66.6)	**TOTAL**	128 (36.4)	**384**	**100.0**

The results show that all the women practicing crop farming adopted MATs. Either a majority of women in animal husbandry had adopted MATs. This implies that MATs were within their reach and also they managed to acquire them. This also shows the positive impact of sensitization programmes. Information obtained from focus group discussions (FGD) and sub chiefs show that women gained knowledge and exposed to MATs through Non Governmental Organisations (NGOs) like One Acre Fund (OAF), Kima International and the occasional government extension programmes. This result differs from (Nsabimana and Masabo, 2005), who found that 73% of the farmers interviewed had not adopted MATs in crop farming besides sensitization and exposure to technology through visits to demonstrations mounted by the Institut des Sciences Agronomiques du Rwanda (ISAR). There must have been other underlying issues that hindered adoption.

4.3.3 Modern Agricultural Technologies Adopted in Crop Farming

The results show that 98.8% respondents practiced intercropping, 94.9% used fertilizer, 68.8% used certified seeds, 40.2% practiced plant spacing and population, and 25.4% applied other agro-chemicals like herbicides and pesticides. Furthermore, 5.1% practiced agro forestry, 2% irrigation, 1.2% tissue culture bananas and 0.4% for mechanized farming and green house farming respectively. Also, 22% of the women adopted other technologies like crop rotation, push and pull, Integrated Soil Fertility Management (ISFM), horticulture and soil liming. This is displayed in table 4.7 below;

Table 4.7: Modern Agricultural Technologies Adopted in Crop Farming.

NO.	List of technologies in crop farming	Adopted f(%)	Not adopted f (%)
1	Intercropping	253 (98.8)	3 (1.2)
2	Fertilizer	243 (94.9)	13 (5.1)
3	Certified seeds	176 (68.8)	80 (31.3)
4	Plant spacing	103 (40.2)	153 (59.8)
5	Other agrochemicals (pesticides & herbicides)	65 (25.4)	191 (77.6)
6	Agro forestry	13 (5.1)	243 (94.9)
7	Irrigation	5 (2)	251 (98)
8	Tissue culture bananas	3 (1.2)	253 (98.8)
9	Mechanized farming	1 (0.4)	255 (99.6)
10	Green house	1 (0.4)	255 (99.6)
11	Others(crop rotation, push and pull, horticulture, soil liming and ISFM)	58 (22.7)	198 (77.3)

(Multiple responses)

Majority of the women practiced intercropping. Intercropping a variety of crops like maize, beans, cassava and bananas on the same farm indicates that there is crop diversification. This could be a risk minimization strategy due to population pressure which continues to diminish holdings due to land fragmentation (Jayne and Muyanga, 2012). This result is higher than (Oladele *et al*., 2008) who established that cereal legume intercropping adoption rate was 88.3%. However their study focused only on cereal legume intercropping while this study considered other types of crops intercropped like tubers, fibres and fodder trees besides cereal legume intercropping. The plate 4.1below illustrates intercropping;

Plate 4.1: Intercropped maize and beans (Ebusiratsi Sub Location)

Intercropping is the most common practice in the area. Maize and beans are the most common crops grown in this area. The beans benefit the cereals since they fix nitrogen in the soil which helps improve soil fertility to benefit the cereals. This also plays as a survival strategy to ensure that a family has enough food throughout the year.

Fertilizer had been adopted highly at 94.8%because of the urge to boost production. Fertilizer for planting is readily available in different packages of 50kg, 25kg, 10kg, and even less amounts sold in agro-vet outlets, shops and open air markets. Hence any amount of fertilizer can be acquired by women depending on their need and ability to afford. Besides, subsidized fertilizer is usually provided by the County and National governments. Either, the OAF organization provides farmers with farm inputs such as certified seeds and fertilizer for planting on credit. However, those who have scarce financial resources resort to using farm yard manure (FYM) which is the cheaper option to supplement the chemical fertilizer. Nevertheless, establishment of FYM requires raw materials like animal and plant wastes. For homesteads where there is no livestock, it is not easy to establish manure hence the only alternative would be to purchase FYM. Hence women who are constrained financially will not use fertilizer. This study result differs from (Bala *et al*., 2006) who found that adoption rate for fertilizer meant for cereals for the beneficiary group was 45.33% and 12% for non beneficiary group. It is possible that low levels of understanding prevailed among the non beneficiary group besides the existence of extension services in the area of study. Follow up activities were limited for the beneficiary group and this affected adoption. The plate 4.2 below show FYM;

Plate 4.2: Farm Yard Manure (Ebwiranyi Sub Location)

This plate displays a compost heap made of remains of animal feed heaped together with animal dung. The manure decomposes slowly until the next planting season when it will be ready for use. This farmer does not use chemicals to speed up decomposition. It is held in place by the banana stems which also decompose with time.

A majority of the women adopted certified seeds for planting. Certified seeds for maize like the katumani brands, 614 and 505 varieties were planted by women. Such seeds were found in farm input outlets available and others were acquired from the OAF organization on credit. However, because of scarce resources to obtain certified seeds, some women use uncertified seeds. This is in agreement with (Ojiem *et al*., 1996) who noted that given the rapidly increasing prices of hybrid seed and fertilizer, farmers seem to be justified in selecting their own local seed for production under low input conditions. This result differs from (Ani *et al.*, 2004) who found that only 22% of the rural women farmers in southern Ebonyi state had adopted improved seeds yet 84% of them were aware of them. These farmers did not value the importance of improved seeds, the local variety met their perceived grain quality or other needs better than other modern varieties available at any price (Hess, 1996).

This study also found that 40.6% applied agronomic practices like proper plant spacing. This means plant spacing and population was not systematic as designed and this did not translate into improved crop productivity. This study established that there was a low turnout of women in training on plant spacing and population. Therefore women farmers are inadequately equipped with information regarding better ways of planting considering correct plant spacing and population. The extension services needed to fill this gap were either not adequate or completely lacking as established by this study. Hence a majority of the women did not implement most production technologies effectively. A study by Bala *et al*., (2005) established that plant spacing adoption rate was 20% among the beneficiary group and 4% among the non beneficiary group. This is evidence of low levels of knowledge and awareness among women.

Use of other agro chemicals like pesticides and herbicides is also minimal at 25.4%. Some of these technologies require resources and knowledge to interpret the procedures of use and precautions to be taken applied them. Those without sufficient resources and knowledge on use applied traditional methods of plant protection like sprinkling ash on the affected crops. Moreover because of the small land sizes, weeding was done by hand and this justifies the minimal use of herbicides. This is in agreement with (BisandaandMwangi,1996), who noted that herbicides require skills and involve risks which peasant farmers cannot afford and that most farmers in SSA use hand hoes for hand weeding and a small minority used herbicides. This result of this study is slightly higher than (Ani *et al*., 2004) in southern Nigeria who established that adoption rate was at 23%. This may have been caused by lack of adequate funds to facilitate acquisition and low awareness on the use of plant protection measures and

weed control. The rate of adoption of irrigation, tissue culture bananas, green house farming and agro forestry was low. Low adoption of irrigation means that they rely on rainfall for farming yet Emuhaya and Luanda sub counties are well endowed with permanent rivers which make irrigation viable (Republic of Kenya, 2009). The tissue culture banana stems were not available when needed for planting. FGDs revealed that acquisition of inputs required to support is not easy. Plate 4.3 below shows tissue culture bananas;

Plate 4.3: Tissue culture bananas (Itumbu Sub Location)

These are genetically modified bananas which require good management practises to give a higher yield.

Green house farming which is acknowledge and capital intensive technology was not popular. The financial implication and demand for proper information led to low adoption. Farm mechanization was minimal implying that the small sized farms were not viable for mechanization. The average farm size in Emuhaya and Luanda sub counties is 0.5ha (Republic of Kenya, 2009). Eze *et al*. (2011) attributed this trend to a combination of insufficient land, capital and land fragmentation. This result is lower than (Ani *et al*., 2004) who established that 1.6% respondents adopted mechanization. High costs of operation hindered mechanization hence cheaper option of using simple tools like oxen and hoes to prepare their farms was preferred. Agro forestry is not widely practiced by women yet it is less demanding on labour and capital. They may be constrained by inadequate farming space, inadequate seedlings and insufficient knowledge on integrating it within their farming systems. This result is different from (Mujivane, 1999) who established that 40% of the women in dairy farming adopted agro forestry. They received training and support from NGOs through women groups.

The other technologies which include soil liming, ISFM, horticulture and push and pull have not been significantly adopted. Lack of proper sensitization and adequate funds to facilitate acquisition of resources slowed down implementation of these technologies.

To understand adoption levels of MATs adopted by women in crop farming, a summary of a combination of technologies adopted was prepared. This was adopted from Ogada (2013) who considered joint adoption of improved maize varieties, planting fertilizer and top dressing fertilizer as a complete package in adoption. Other combinations were classified as partial adoption and included planting fertilizer with certified seed, planting fertilizer with top dressing fertilizer, planting fertilizer only, certified seed only and top dressing fertilizer only. In this study, a joint adoption of the three MATs thus fertilisers, certified seeds and plant spacing was regarded as a complete package. These technologies were selected because they recorded high adoption rates. Those who adopted all the three technologies would be referred to as full adopters while those who adopted less than three technologies found in this category or any other MAT that does not fall within the complete package would be referred to as partial adopters.

The results show that 36.7% of the women were full adopters who applied fertilizers, used certified seeds and observed plant spacing. The partial adopters include 28.4% of the women who applied fertilisers and certified seeds while 23.4 used fertilizer only. Also 3.9% adopted fertilizers and plant spacing while 1.2% used certified seeds and plant spacing. The other partial adopters, 5.9% adopted other MATs like agro forestry, green house farming mechanised farming, agro chemicals etc. See table 4.8 below;

Table 4.8: Adoption Levels of MATs Adopted by Women in Crop Farming

NO.	Technology	Frequency	Percentage
1	Fertiliser	60	23.4
2	Fertiliser and certified seeds	74	28.9
3	Fertiliser, certified seeds and plant spacing	94	36.7
4	Fertiliser and plant spacing	10	3.9
5	Certified seeds and plant spacing	3	1.2
6	Other MATs (Agro chemicals, Agro forestry, irrigation, green house, mechanised farming, etc)	15	5.9
	Total	256	100

This result reveals that the majority of the women were full adopters. They are likely to get high yields compared to the other partial adopters. Full adoption promised high yields,

(Ogada, 2013). This also means that the full adopters can be able to access and afford resources required for implementation. Partial adopters of fertiliser and certified seeds value the inputs but ignore the best practices of planting such as proper plant spacing. What matters to this group was acquisition of the inputs for use. The best practises are probably taken for granted. This may also have been brought about as a result of lack of sufficient information to help interpret proper implementation of MATs. The category of partial adopters who adopted fertiliser only prefers to use local seed varieties. They may have lacked resources to acquire certified seeds. Also the local seed varieties seem to fulfil their perceived grain quality (Hess, 1999). This also applies to the category of women who used fertilizer and observed plant spacing. They are keen on the use of fertilizer so as to improve on the soils nutrients for better yields. The Emuhaya strategic Report (2009) indicate that continuous tilling of the land has led to soil exhaustion and decline in land productivity. The other partial adopters like women who planted certified seeds and observed plant spacing may have experienced resource constraints and hence not able to source for fertilizer for planting.

4.3.4 Modern Agricultural Technologies Adopted in Animal Husbandry

This study established that a majority 90.6% adopted veterinary technologies like; spraying, de worming, vaccination, antibiotics and multivitamins. Also, 88.3% fed their livestock on improved grasses, 79.7% practiced zero grazing, 65.6% adopted supplementary feeds. Others, 56.3% kept improved breeds, 38.3% practiced artificial insemination, 21.7% adopted proper housing unit, 2.3% deep litter system in chicken and 7.8% adopted other technologies like calf feeding and clean milk production. The results are displayed in the table 4. 9 below;

Table 4.9: Modern Agricultural Technologies Adopted in Animal Husbandry.

No.	Technologies in animal husbandry	Adopted f (%)	Not adopted f (%)
1	Veterinary technologies, (vaccination, spraying, de-worming, antibiotics, multivitamins)	116 (90.6)	12 (9.4)
2	Improved grasses	113 (88.3)	15 (11.7)
3	Zero grazing	102 (79.68)	26 (20.4)
4	Supplementary feeds	84 (65.6)	44 (34.4)
5	Improved breeds	72 (56.3)	56 (43.7)
6	Artificial Insemination (AI)	49 (38.3)	79 (61.7)
7	Proper housing unit	27(21.1)	101 (78.9)
8	Deep litter system	3 (2.3)	125 (97.7)
9	Others(clean milk production)	10 (7.8)	118 (92.2)

(Multiple response)

High adoption of veterinary technologies like animal spraying, de-worming, vaccines, and administration of antibiotics, multivitamins and treatment of diseases implies that women highly valued them as an efficient preventive and therapeutic program against external and internal parasites. Besides, the government occasionally carried out vigorous vaccination programme to prevent highly infectious diseases like foot and mouth (FMD), contagious bovine pleuropnemounia (CBPP). However, according to (Mulemba, 2009) this was only for diseases of national economic importance. This result differs from (Nell and Schwalbach, 2002) whose study on sheep and goat farmers found that full adopters of external parasites, internal parasites, and antibiotics were 67%, 12%, and 16%. None of these farmers adopted vaccination. This means that farmers were keen on external parasite control. However low turnout in internal parasite control, antibiotics and vaccines implies that farmers in South Africa preferred to treat diseases rather than prevent them.

Improved grasses like napier, desmodium, calindria and luciana were highly adopted since they constitute the main feed of the animals. This implies that they are mixed farmers who grow fodder crops alongside other food crops. Among these grasses napier grass is more popular as established by this study. Women prefer it because it is easy to manage and available. According to Kariuki and Waithaka, (1992) a cow could feeding on napier alone could produce up to 7 litres of milk per day. Bala *et al.* (2005) found that 58% of the

beneficiary group and 52% of the non-beneficiary group had adopted improved grasses. The extension support rendered to these groups was not sustained up to the end. The plate4.4 below displays napier grass;

Plate 4.4: Napier grass (Ebuhando Sub Location)

Napier was the most common fodder crop grown by the women.

Zero grazing system was also popular among women. This innovation is manageable on small farms. The animal movement is restricted and are fed in stalls. This result is different from (Mujivane, 1999) who established that 98% of the women in the area of study had adopted zero grazing system. They got support from NGOs operating in the region through women groups. This confirms with (Mutoko *et al*., 2014 and Republic of Kenya, 2008) that there is an increasing number of cross breed and dairy cattle under zero grazing to cope with diminishing pastures.

Women had adopted improved breeds of livestock because of their high value. Projects such as Livestock Development and Heifer International operating in the area of study aided acquisition of exotic breeds of cattle for dairy farming through established women groups (Welingo, 2009). The high demand of milk provides ready market for this product. This result differs from (Njiro, 2003) in Machakos district who established that 82.9% of the women respondents kept indigenous breeds. Machakos is more arid and the hot climate enables various disease vectors such as tsetse fly and ticks to thrive besides causing cattle feed and occasional water shortages which complicate adoption of improved breeds by the women (Emongor *et al*., 2000). Thus their preference for indigenous breeds is because they are hardy for they can transverse the neighbouring arid and semi-arid regions (ASAL) in search of pastures.

The plate 4.5 below show an improved breed of cattle housed in a zero grazing unit.

Plate 4.5: An exotic breed (Friesian) (Ebubayi Sub Location)

The plate 4.5above shows a friesian cow which is kept under the zero grazing system. The cow is housed in a modern housing unit. It is feeding on Napier grass which is a common fodder for cattle.

Low adoption of AI signifies poor accessibility or availability of the innovation. This could be due to time and resource constraints of the individual woman farmer in that the use of AI can be much more labour intensive than using a bull to breed cows (Howley, 2012). Bala *et al*. (2006) found that 90% of the beneficiary group and 60% of the non beneficiary group adopted AI. Regular contact with extension services and support received enabled these women to gain is easy access and afford AI services.

Deep litter system in poultry farming has been adopted by very few women implying that this technology is not affordable by many due to financial constrains. Plate 4.6 below shows poultry farming;

Plate 4.6: Poultry farming (Exotic breeds) (Esirulo Sub Location)

The management of such a unit of exotic breeds requires a proper housing structure, formulated commercial feeds and a frequent vaccination and treatment programme..

A summary of adoption levels of MATs adopted in animal husbandry was prepared based on the first five MATs that were highly adopted. These were; veterinary technologies, improved grasses, zero grazing, supplementary feeds and fodder preparation and improved breeds. This study adopted (Nell and Schwalbach, 2002) in considering the veterinary technologies adopted by farmers. They defined a full adopter as a farmer using the specific medication technology at the commended level, partial adopter as a farmer using less than the recommended level of the specific medication technology and a non-adopter as a farmer not using the specific medication technology.

In this study, women who had adopted all the 5 technologies would be termed as full adopters while the ones that had adopted less than the mentioned five would be termed partial adopters. Those who did not adopt any MATs in animal husbandry would be referred to as non-adopters.

The results indicate that 36.7% were full adopters. The partial adopters consist of various categories which recorded 27.3%, 21.1%, 6.3% and 3.9%. Non adopters' consist 4.7%. See table 4.10 below;

Table 4.10: Adoption Levels of MATs Adopted by Women in Animal Husbandry

Technology	Frequency	Percentage
1. Veterinary technologies and improved grasses	8	6.3
2. Veterinary technologies, improved grasses and zero grazing	27	21.1
3. veterinary technologies, improved grasses and supplementary feeds	5	3.9
4. Veterinary technologies, improved grasses, zero grazing, supplementary feeds and improved breeds	47	36.7
5. Other MATs (AI, modern housing unit, deep litter, clean milk production)	35	27.3
6.Not adopted	6	4.7
Total	**128**	**100**

The results show that full adopters were many in this category. They adopted a full package of veterinary technologies, improved grasses, zero grazing, supplementary feeds and fodder preparation and improved grasses. They had acquired quality breeds were trying to implement best practises for better yields. The partial adopters who only picked a few technologies may have experienced resource constraints that barred them from adopting a full package. However, the full adopters together with many partial adopters value veterinary technologies and improved grasses. Their priority is to ensure that their livestock are treated and prevented from diseases (Nell and schwalbach, 2002). The common improved grasses thus napier is valued as the main feed of cattle. Napier grass is easily available and manageable. The non adopters may have encountered serious constraints that bar them from adopting MATs in animal husbandry.

4.3.5 Period of Adoption

The results indicate that the majority 47.1% women had practiced modern methods between 5-10 years, 32% who had practiced MATs for less than 5 years and 20.8% above 10 years. This is shown in the table 4.13 below;

Table 4.11: Period of Adoption

Period of adoption (years)	Frequency	Percentage
Less than 5 years	117	30.6
5-10 years	181	47.1
10 and above	80	20.8
Not adopted	6	1.6
TOTAL	**384**	**100.0**

This result displays a trend in line with the theory of *Diffusion of Innovation* by (Rogers, 2003). Majority of the women have adopted MATs for the period less than 6years. They lag behind the other women in adoption of MATs. Rogers (2003), categorises them as laggards. Their traditional orientation slows their pace of adoption. They fear risks and so must always be certain that the new idea will work with the resources they have at their disposal. For those whose period of adoption of MATs is between 6-10 years (Rogers, 2003) categorises them as early adopters. These are potential adopters who looked to innovators for advice and information about the innovation. The knowledge gained is also passed over to the late

adopters who depend on them for evaluation of the MATs. Bandiera and Rasul (2002) looked at social networks and technology adoption in Northern Mozambique and found that the probability of adoption is higher amongst farmers who reported discussing agriculture with others. A few women had applied modern technologies for 10 years and above. These are the pace setters of adoption in their communities. According to Rogers (2003) they play a very important role in diffusion process. These are innovators who launch a new idea in the social setting by importing the technology from outside of the system boundaries. They have probably dealt with the high degree of uncertainty about an innovation at the time that they adopted it. They have gathered enough experience through observation and experimentation in modern farming and hence use MATs and integrate them in their farming enterprises. According to (Ani *et al*., 2004) farming experience of farmers to a large extent affects their managerial know how and decision making. However there is the other group of women who have not adopted MATs at all. They seem to be focused on traditional methods of farming either because of the low status in the society, financially low, oldest among the adopters and in contact with only a few members in the social setting (Rogers, 2003).

The chi –square tests carried out to test the relationship between period of adoption and main sources of information shown in table 4.14 below:

Table: 4.12: The Relationship between Period of Adoption and Main Sources of Information

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	30.051[a]	10	.001
Likelihood Ratio	28.949	10	.001
Linear-by-Linear Association	5.341	1	.021
N of Valid Cases	384		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.04

The *p* value is .001 implying that the relationship between sources of information and period of adoption is significant. Sources of information played a role in informing women on the MATs for adoption. According to (Odini, 2014) today there is a wide range of information sources on new innovative farming. Women could be using some them. Hence the time taken

in acquiring and implementing an innovation was important in gathering useful information about MATs. The table 4.15 below;

Table 4.13: The Relationship between Education and Period of Adoption

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.728[a]	2	.094
Likelihood Ratio	4.771	2	.092
Linear-by-Linear Association	.408	1	.523
N of Valid Cases	384		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 33.96.

The results indicate that the *p* value is .094 which is above the significant level 0.05.This means that educational level of women does not play a significant role in interpreting information and shaping decisions to adopt MATs. Instead the other factors like their social status, beliefs and opinion leadership played a major role in controlling their decisions to adopt MATs (Rogers, 2003).

4.3.6 Main Sources of Information on MATs

This study established that the main source of information for 33.9% of the women was from fellow farmers, 23.2% from agricultural field days, 12.5% from extension officers and 12.5% from other sources like NGOs. A few women 7.6% acquired information from printed materials, 6.8% from radio and 3.6% from television. This is displayed in the figure 4.1 below;

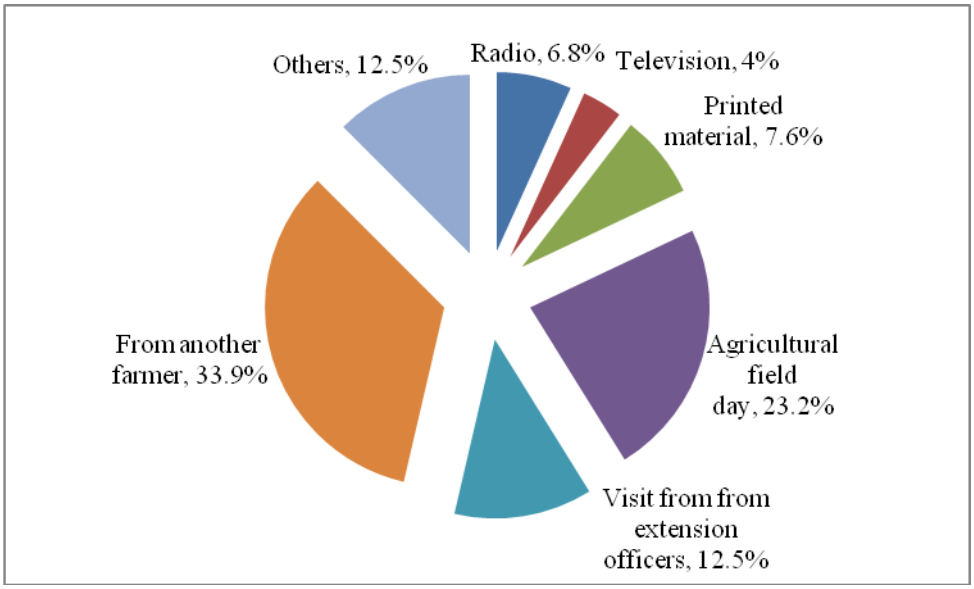

Fig.4.1: Main Source of Information on Modern Agricultural Technologies

This implies that a relatively large proportion of women learned from one another to effect change in production. This means that that there is a high possibility of innovation adoption and diffusion among women farmers (Rogers, 2003). This was necessitated by frequent interaction among women through their social networks and passed on information on MATs from one another. This result differs from (Okunlola *et al.*, 2011) in Nigeria who established that the majority respondents 42% of his study acquired information from fellow farmers. Women who had not acquired skills through education adopted innovations by imitating the early adopters. However, according to (Kathage *et al.*, 2013*)* farmer-to-farmer transfer of information is less straight forward, and being aware of a technology alone may not suffice for successful adoption. Hence a technical expert advice is needed to pass across accurate information about MATs.

Agricultural field days exposed a few women to MATs. The demonstrations carried out made it easier for them to implement the technologies on their farms. Farmers do better in what they see and practice than what they hear only. Low turnout of women for agricultural field days means that they were not informed about the events or are unable to attend because of time and distance, (Lubwama, 1999).

Extension services were not very frequent yet many women were involved in adoption of MATs. Non significance of extension information may be attributed to the poor frequency visits and this may not have a positive and significant effect on agricultural production. In most African countries there is a widely recognised difficulty of male extension agents

having any type of contact with individual female small holders due to entrenched norms and cultural difficulties in engaging face to face communication (Swanson and Rajarahti, 2010). This study finding differs with (Fadiji and Atala, 2009) in Nigeria who established that 43.2% of the respondents had extension visits seasonally. This implies there was improved interaction between extension officers and the farmers. Therefore constrains that exist in delivery of extension services need to be addressed. Information gathered from extension officers indicates that there exist less manpower and this hinders service delivery. Also the approach adopted by extension personnel to only visit farmers on request may only benefit a few women farmers.

Radio and television (TV) were not very important sources of information to women farmers. Thus information on MATs aired through radio and TV does not reach many women. It seems many of them lack the time and zeal to acquire information about MATs on radio and TV because of the numerous responsibilities to carry out at home. This is in agreement with (Lubwama, 1999) that programmes on appropriate technologies normally aired through mass media (radio, newspaper, television) do not often reach women since such programmes are aired at times when women are very busy. This result differs from (Fadiji and Atala, 2009) who found that the majority respondents 92.8% had access to radio. This implies that radio was valued as the main source of communication to farmers.

Few women had access to printed material like newspapers, pamphlets and books. This means the reading culture among women is poor. Besides there are few information centres in the county implying the information infrastructure is poor. According to Odini (2014), the Vihiga County Information and Documentation Centre (DIDC), which should play, an important role in collection and storage of information is not well stocked and is rarely open. Besides, printed material may only be applicable to women with substantial levels of education for them to be interpreted well.

Further analysis shows that farmer to farmer source of information was prominent among women in crop farming while agricultural field days were important in animal husbandry as follows in table 4.16 below:

Table: 4.14: A Comparison between Main Sources of Information in Crop Farming and Animal Husbandry

NO.	Source of Information	Crop Farming Frequency/Percentage	Animal Husbandry Frequency/Percentage
1	Radio	15 (5.9)	11(8.6)
2	Television	11 (4.3)	3 (2.3)
3	Printed material	21 (8.2)	8 (6.3)
4	Agricultural field day	39 (8.2)	51 (39.8)
5	Visit from extension	27 (10.5)	20 (12.5)
6	From another farmer	106 (41.4)	24 (18.8)
7	Others (NGOs etc.)	37 (14.5)	11 (8.6)
	Total	256 (100)	127 (100)

Farmer to farmer is the most popular means through which women gain knowledge about MATs in crop farming. This illustrates that there is difficulty in accessing information through the other sources of information. It seems their information seeking habits were influenced by the activity and problem at hand, that is, if for example women wanted to know how to apply pesticides they went looking for information from whomever they thought had the right information. Results from a study carried out by (Odini, 2014) show that 62% of the women acquired information by asking people and friends, 58% by listening and talking and 53% through discussing with those people who have the information. Farmer to farmer mode of obtaining information about MATs reaches many women, however it may not be very effective in terms of quality information if most of the discussions are not done with the technical experts. Hence it may not be reliable and women may find it difficult to stick on to the right agricultural practices which could enable them to be food secure. According to (Kathage *et al.*, 2013*)* farmer-to-farmer transfer of information is less accurate. Therefore the low percentages of women who access information through extension services show that the service providers could be facing difficulties in providing their role.

Agricultural field day is the most important media through which information on MATs reach women. Field days give women an opportunity to meet with the experts and practicing farmers who enlighten them on modern techniques in farming However, again the role of the extension services meant to provide expert services is less felt. There is minimal contact

between women and extension services. There is need to unlock the barriers that exist between extension services and women farmers.

4.3.7 Training on MATs in Crop Farming and Animal Husbandry

Results indicate that 72.1% of the respondents had undergone training while 27.9% had not had any training. This implies that majority of the women had acquired skills and information about MATs through training. This process exposed them to various technologies in agriculture. Information gathered from scheduled interviews by sub chiefs and focus group discussions show that facilitators of the training include the ministry of agriculture, the Anglican Church of Kenya, NGOs like One Acre Fund and Kima Integrated Community. Training and exposure to successful stories of agricultural technologies can help to break the long time culture and traditional phenomenon (Oladele *et al*., 2008). Even for those with low levels of education, training imparted them with knowledge which enabled them to understand about innovations. Some may have missed the training because of poor channels of communication. Either, the training centres' were far and those who were willing to participate in such programmes were constrained financially (Lubwama, 1999).

4.3.7.1Type of Training Attended in Crop Farming

Results indicate that 27.7% of the women had trained on fertilizer use and preparation of FYM, 27.7 % on seed selection, plant spacing and population, 14.8% on pesticide preparation, disease and weed control, 7.8% on intercropping, and 4.7% on crop rotation. The other areas trained included 3.5% on banana planting and spacing, 1.2% on green house farming and horticulture, 0.8% on agro forestry and tree nursery management. 27.3% of the women trained in harvesting and storage, ISFM, soil sampling and liming, climate change and land preparation. This is displayed in the figure 4.2 below;

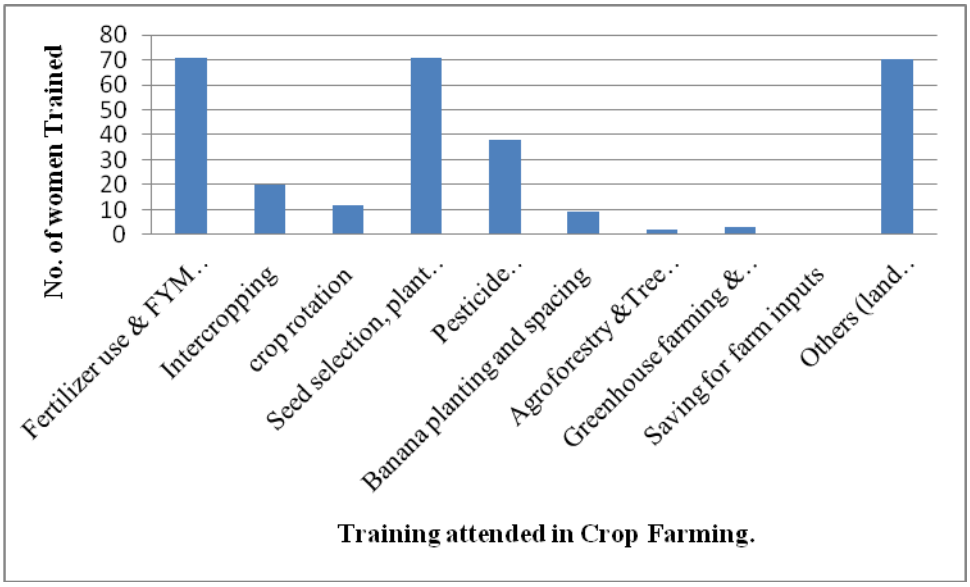

Fig.4.2: Type of training in crop Farming

It is evident that many women had been exposed to various technologies through training. However there was a low turnout of women training in various MATs in crop farming. It was noted that 22.7% and 7.8% of women trained on fertilizer use and preparation and intercropping. Besides the low turnout, there was high adoption of fertilizer and intercropping as reported by this study. This means that the few women train on various MATs become an important link in the diffusion process (Rogers, 2003). They pass on new ideas to their peers when they interact. Bandiera and Rasul, (2006) looked at social networks and technology adoption in Northern Mozambique and found that the probability of adoption is higher amongst farmers who reported discussing agriculture with others.

Low turnout in seed selection, planting and spacing is worrying because some other MATs like certified seeds and fertiliser depend on them for proper implementation. This could affect crop production. Tree nursery management, horticulture, green house farming, soil sampling and disease control recorded few women who turned out for the training. This is reflected in the low adoption of these technologies as reported in this study.

A summary of comparisons of adoption rates of various technologies adopted in crop farming against the areas that they were trained in reveal that few women participated in the training. However many women adopted relevant MATs in the areas that they were trained. See table 4.17 below;

Table 4.15: A Comparison of Adoption of MATs in Crop Farming and Areas trained

NO.	Technology/Adoption level (f)	Relevant area of training/ (f)
1.	Fertilisers (243)	Fertiliser use & FYM preparation (67)
2.	Intercropping (253)	Intercropping (18)
3.	Certified seeds (176)	Plant spacing & seed selection (69)
4.	Plants spacing & population (103)	Plant spacing & seed selection (69)
5.	Agro chemicals (65)	Pesticides preparation & weed control (43)
6.	Agro forestry (13)	Agro forestry (10)
7.	Other (Soil conservation, crop rotation, horticulture) (58)	Soil conservation (82)

High adoption rates were noted in fertilisers, intercropping, certified seeds, plant spacing and population, agro chemicals and agro forestry. However, low attendance rates were noted in terms of training. It is clear that training sessions are not attractive to many women. These are issues that need to be addressed. The various training programmes whether short-duration and long-duration needs to be organised within the community. To make them more attractive, the women should be provided a daily allowance along with inputs; seeds, agricultural implements, fertilizers, pesticides, seed bin, animal feed, etc. as incentive to attend the training programmes (Bala *et al*., 2006).It will be important to establish the nature of this training, time of training, education levels of participants, and levels of awareness so as to gain deeper understanding of this trend.

4.3.7.2 Type of Training Attended in Animal Husbandry

In animal husbandry, results collected indicate that most women53.1% had been trained on veterinary technologies, 35.9% on animal feeding pasture management and silage preparation, 18% on establishment of a housing unit, 12.5% on record keeping and 7.8% on cross breeding and AI. The other areas trained include 4.7% preparation of farm yard manure, 1.6% poultry keeping, 1.6% bee keeping, 0.8% dairy farming, and 0.8 % agribusiness in agriculture as shown in the figure 4.3 below;

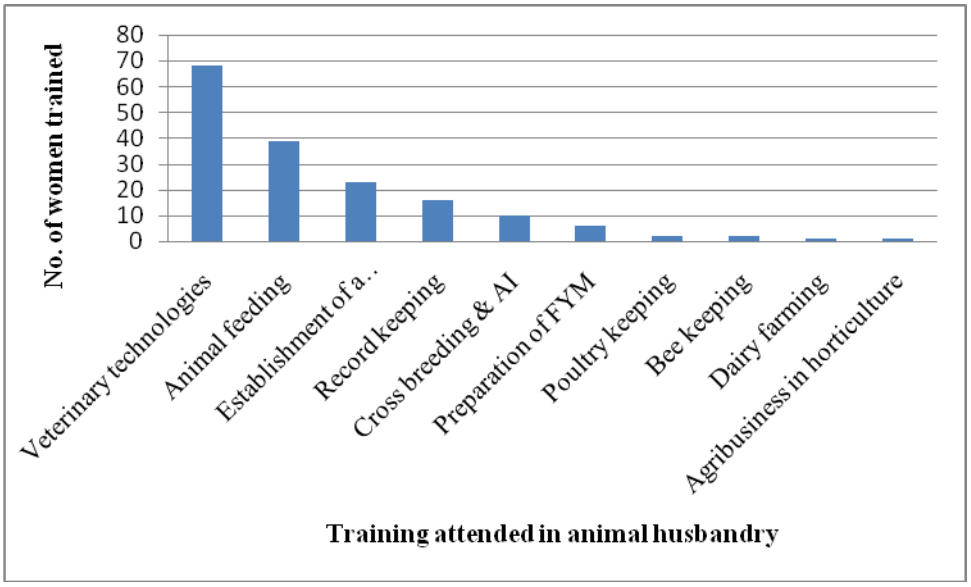

Fig. 4.3: Type of Training in Animal Husbandry

The trends displayed in training of women in animal husbandry show that many women trained in veterinary technologies. This promoted adoption of innovations in veterinary technologies as established in this study. Low turnout of women who trained in poultry keeping could have been the cause for low adoption of innovations applied in poultry keeping. Noted also was low turnout in agribusiness. Women often found it difficult to attend meetings and courses away from home because of heavy domestic responsibilities(Lubwama, 1999).Very few women had trained in dairy farming yet technologies that accompany dairy farming like spraying, vaccines, improved grasses, zero grazing and supplementary feeding were highly adopted. This is because of diffusion of new ideas among women in the areas trained. This was made possible through the social networks in the communities they live (Rogers, 2003).

A summary of comparisons of adoption rates of various technologies adopted in animal husbandry against the areas that they were trained in reveal that few women participated in the training. However many women adopted relevant MATs in the areas that they were trained. See table 4.18 below;

Table.4.16: Comparison of Adoption of MATs in Animal Husbandry and Areas Trained

	Technology adopted (f)	Relevant area trained (f)
1	Veterinary (116)	Veterinary (68)
2	Improved grass (113)	Dairy farming (68)
3	Zero grazing (102)	Dairy farming (68)
4	Supplementary feeds(84)	Silage preparation (14)
6	Artificial insemination (49)	AI & cross breeding (10)
7	Proper housing unit (7)	Housing unit (23)
8	Deep litter (3)	Poultry keeping (2)

This could imply that women preferred to attend training in some areas because of the need at hand. There are some MATs which may not be complicated in adoption. In such circumstances, they assume that they understand them and therefore may not find it necessary to attend such training. Many women who adopted veterinary technologies, improved grasses, zero grazing, supplementary feeds and fodder and deep litter did not take part in training. There is need to focus on training to establish why training is not popular among women. The availability of livestock training increases the level of dairy technology adoption through creating awareness on the advantages of the technology and then improving the farm management skill (Dehinenet et al., 2014). The training offered on establishment of a housing unit had more participants but only a few participated in adoption. This could mean that they face constraints such as capital to invest in construction of a housing unit.

4.4 Relationship between Education and Adoption of MATs

Spearman correlation was carried out to determine the relationship between women's education levels and adoption of MATs in crop farming and animal husbandry.

4.4.1 Education and MATs in Crop Farming

Results revealed that certified seeds had a weak negative spearman correlation (-.221**) significant at 0.01. Other technologies like agro forestry, tissue culture bananas, mechanised farming and green house farming had a very weak positive relationship with education of r= .038,r= .009, r= .048 and r= .048. Intercropping, fertilisers, plant spacing and population, agrochemicals, irrigation and others (crop rotation, push and pull, horticulture and Integrated Soil Fertility Management (ISFM) had a very weak negative correlation of r= -.009, r= -.030, r= -.013, r =-.033, r =-.067 r= -.086.This is shown in table 4.11 below;

Table 4.17: Relationship between Education and MATs in Crop Farming

Variables	*R*	*p*	Remarks
Intercropping	-.009	.892	Not significant
Fertilizers	-.030	.629	Not significant
Certified seeds	-.221**	.000	Significant
Plant spacing & Population	-.013	.838	Not significant
Agrochemicals (Pesticides /herbicides)	-.033	.598	Not significant
Agro forestry	.038	.548	Not significant
Irrigation	-.067	.286	Not significant
Tissue culture bananas	.009	.892	Not significant
Mechanized farming	.048	.443	Not significant
Greenhouse farming	.048	.443	Not significant
Others (Crop rotation, push & pull, horticulture & ISFM)	-.086	.168	Not significant

** P<0.01=significant, p>0.01=not significant

The results show that education is statistically significant to adoption of certified seeds. The negative coefficient indicates that women with higher education levels are unlikely to adopt certified seeds. Uncertified seeds are preferred for the short seasons because of the erratic rains experienced towards the end of the year. The weak correlation implies that certified seeds are readily available and women with less education levels have been exposed to certified seeds through various linkage systems like training and intervention of NGOs like One Acre Fund (OAF). Similar results were obtained by (Ani *et al*., 2004). Using the correlation coefficient *r*, he found that education was significant in adoption of improved seeds, fertilisers, mechanised farm operations, insecticides and herbicides. Hence the more educated farmers were able to adopt more agricultural technologies. This was also consistent with (Akudugu, et al., 2012) who established that the maximum level of education within the farm household was found to have a positive relationship with the probability of adoption and significant at 1 percent level.

The weak positive correlation between education and agro forestry, tissue culture bananas, mechanised farming and green house farming means that women with higher education levels

are likely to accept MATs but at minimal levels. The small land sizes of average 0.25 ha, may not be viable for mechanised farming. Agro forestry may therefore not be preferred because food crops are given priority. Women encounter constrains related to high costs, land for farming and labour. Green house farming and tissue culture bananas are capital intensive and high managerial skills are also required for implementation. Therefore women who have not had training will not adopt such MATs. This conforms to (Quisumbing, 1994) who has documented women's lesser access to critical resources (land, cash and labour), which often undermine their ability to mobilize labour. Agro forestry is a low managerial technology that may not need higher education to be interpreted.

Alternatively, negative weak correlations were recorded between education and intercropping, fertilisers, agrochemicals, plant spacing and population, irrigation; and other technologies (crop rotation, ISFM, horticulture and push and pull). Most of these technologies like intercropping, plant spacing and population do not require high skills in management hence may not require high levels of education for interpretation. These practises had been in use for a long time and therefore the experience gained enabled them to accumulate sufficient knowledge about these modern practises even without substantial education. Kathage *et al*. (2013) noted that education was found to have no impact on adoption of HYV technology because farmers had gained experience over time. Besides, fertilisers are affordable and are found in different quantities of 1kg, 5kg and more hence can be accessed easily. Their acquisition though not easy because of the financial implications is majorly influenced by other players like the One Acre Fund (OAF) and input subsidies from the county government. Hence it is possible that women with different levels of education can have access to depending on the different quantities required.

Agro chemicals are not popular probably because most of the farm work like weeding which is done manually is cheaper than the chemicals. Besides, they require high costs for acquisition. This also applies to other farm practises like crop rotation, horticulture, soil liming and ISFM. Besides ISFM is labour intensive. This result is different from (Ani *et al*., 2004) who established that women farmer's education was significant in adoption of fertiliser, certified seeds, mechanised farming, insecticides and herbicides.

4.4.2 Education and MATs in Animal Husbandry

In animal husbandry, Spearman correlation results show that education had a weak negative correlation of -.213*, -212* and a positive weak correlation of .181* withzero grazing,

improved breedsand clean milk production & calf rearing, significant at 0.05 level. The other MATs veterinary technologies, improved grasses and supplementary feeds and fodder preparation had a very weak negative correlation of r= -.141, r= - .081 and r= -.170. AI, proper housing unit and deep litter system had a positive correlation of r= .009, r=.062 and r= .082. This is shown in table 4.12 below;

Table 4.18: Relationship between Education and MATs in Animal Husbandry

Variables	***R***	***P***	**Remarks**
Veterinary technologies;	-.141	.114	Not significant
Improved grasses	-.081	.366	Not significant
Zero grazing	-.213*	.016	Significant
Supplementary feeds	-.170	.055	Not significant
Improved breeds	-.212*	.016	Significant
Artificial Insemination (AI)	.009	.917	Not significant
Proper housing unit	.062	.486	Not significant
Deep litter system in poultry	.082	.358	Not significant
Clean milk production & calf rearing	.181*	.041	Significant

*P<0.05=significant, p>0.05=not significant

Education had a significant relationship with zero grazing, improved breeds, and clean milk production and calf rearing at the level of 0.05. The weak negative correlation of -213* and -.212* between education, zero grazing and improved breeds imply that women are inclined to the cultural setting in which indigenous breeds of cattle are kept. The negative correlation implies that improved breeds are avoided because of risks involved. Mujivane (1999) established that education was not significant in adoption of zero grazing by women in Vihiga district. He queried the role of the other house hold members in adoption of technologies at a house hold level. The weak correlation between education, clean milk production and calf rearing implies that the standards required for clean milk production have a financial implication.

The weak negative correlation between education and other technologies like veterinary technologies, improved grasses, zero grazing, supplementary feeds and improved breeds implies that women keep indigenous breeds because they are less demanding in terms of

costs required for management. Education was not significant in adoption of deep litter system, housing and AI. The positive correlation implies that education is complimentary in providing useful information in understanding MATs for adoption. The weak correlation implies that women keep indigenous breeds which are less demanding in maintenance costs and also are preferred in the market for consumption compared to the exotic breeds.

4.5 The Rate of Adoption in Crop Farming

4.5.1 Crop Farming

4.5.1.1: Type of Seeds Planted

This study established that 68.8% of the women use certified seeds, 27.3% use uncertified seeds while 3.9% use both certified and uncertified seeds. This is shown in the figure 4.4 below;

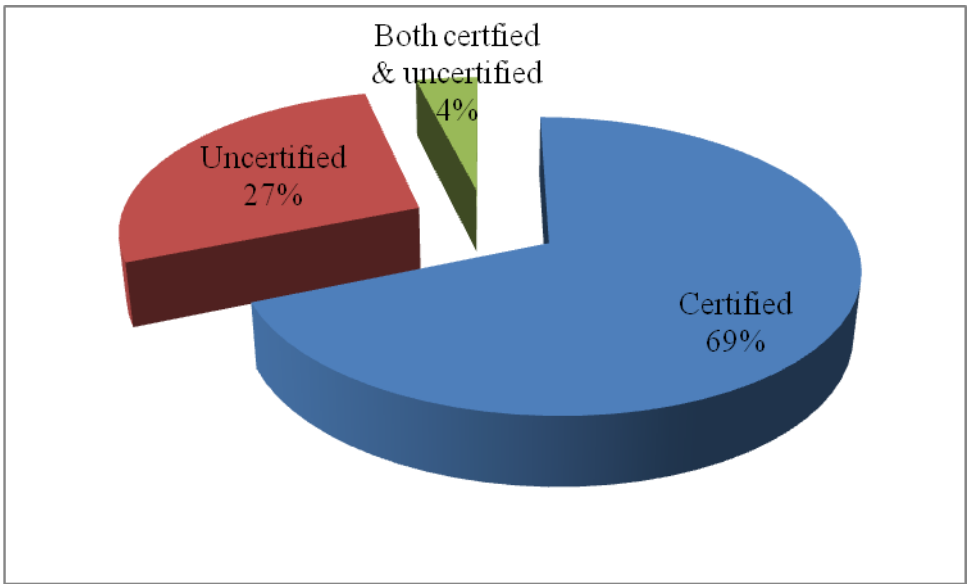

Fig. 4.4: Type of seeds planted

Many women preferred improved seeds to recycled seeds since they produce high yield. The few women who used recycled seeds find them resilient hence they met their perceived grain quality or other needs without requiring use of scarce cash resources to acquire the modern varieties available at any price (Hess, 1996). This result differs with (Mutoko, 2014) in Emuhaya who found that less than 30% of planted seeds were certified seeds. The widespread campaigns on availability and use of certified seeds by organizations in the area of study like the OAF have made it easier again to acquire certified seeds. They have made it easier for women to access the inputs on credit.

4.5.1.2: Type of Fertilizer Used

The data collected show that 56.2% of the respondents used chemical fertilizer38.6% used manure while 5% did not use any fertilizer. This is shown in the figure 4.5 below;

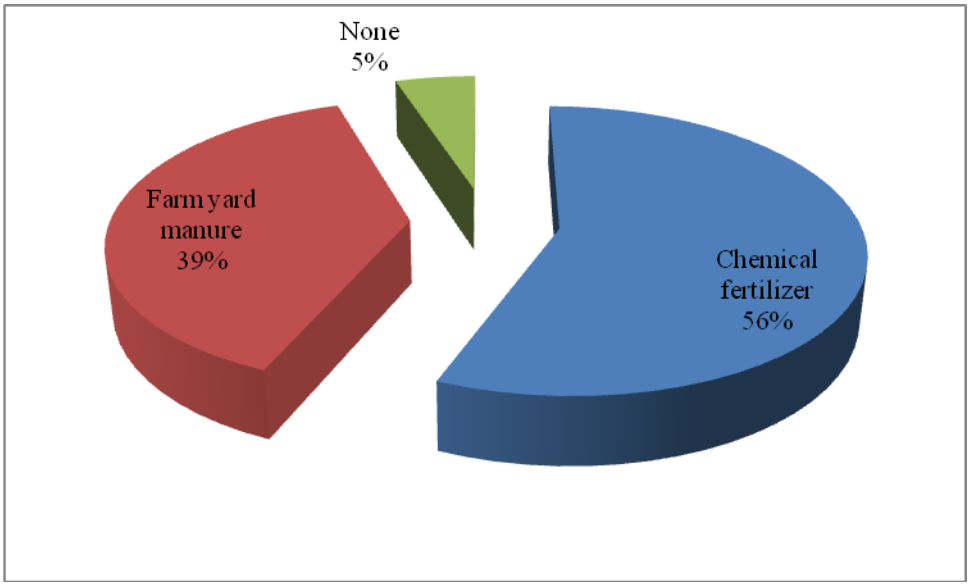

Figure4.5: Type of Fertilizer Used.

The results indicate that more women use fertiliser to enhance production. According to (Oluoch-Kosura, 1999) fertiliser is considered as a major agricultural output in Kenya. Chemical fertiliser is largely consumed compared to manure. A study done by (Mutoko, 2014) in this area of study revealed that chemical fertilizer was in use although the average consumption per household had declined to 30% while manure application had increased during the same period. Women who use manure may have found it useful and economically within their reach. Few women did not use any fertilizer at all. Other farmers do not adopt fertilizer use because they lack awareness of improved practices and also believe that their farms are still fertile (Nguluu et al., 1996).

4.5.1.3 Reasons for Use of Chemical Fertilizer

The results show that 41% used chemical fertilizer because it increased production, 16.4% boosted growth 7% was available, and 3.5% required less labour. A few respondents 5% used chemical fertilizer because it took less time to prepare, 5% said it was subsidized by the government and 5% strengthened crops. This is displayed in the figure 4.6 below;

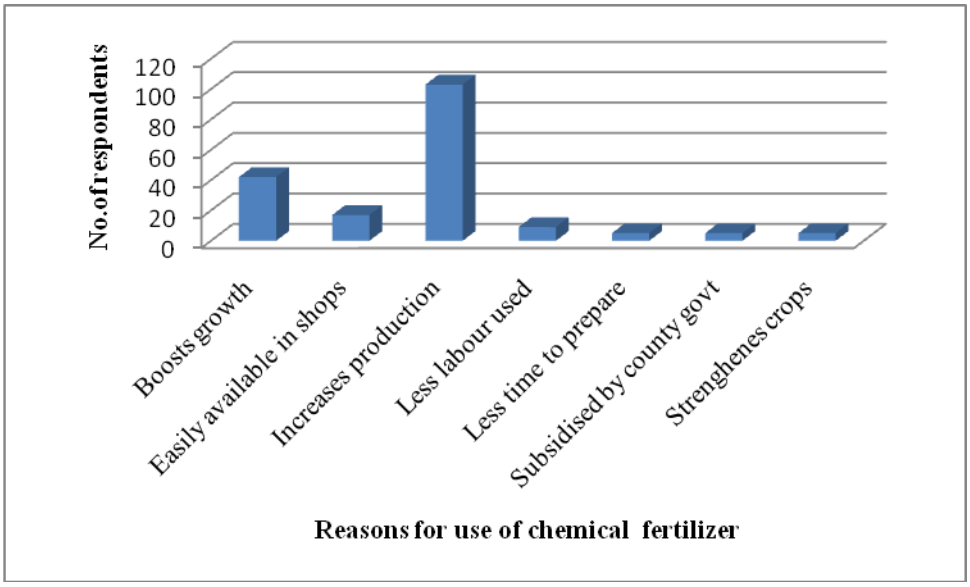

Figure 4.6: Reasons for Use of Chemical fertilizer

The above results show that many users for chemical fertilizers for planting were motivated by the fact that it enhanced yields. Chemical fertilizers used for top dressing like urea were preferred because they strengthened and boosted growth of plants. Less time and labour required for its preparation influenced its use. The government program of distributing fertilizer to poor farmers and also selling it to farmers at subsidized prices did not meet the needs of many women fully. This is because the quantity of fertilizer given was small and this did not fulfil their demand for fertilizer. Besides, many of them could not afford to purchase enough fertilizer even at subsidized prices. Therefore adoption rates of fertilizer are still low. Several studies such as (Chirwa *et al.*, 2013 and Ndiritu *et al.*, 2011) indicate that the use of agricultural inputs in crop production remains low among female farmers. This implies that they used less amounts of fertilizer than required and this affected production. Mutoko *et al.* (2014) observed that use of fertilisers had declined in this area of study.

4.5.1.4 Reasons for Use of Farm Yard Manure

Result for reasons given for the use of farm yard manure show that 27.7% used it because it was cheap, 13.3% said it was readily available, 11.3% boosted production 6.6% retained soil fertility, and 1.2% eradicated striga weed. A small number of respondents; 0.8% used manure for it improved soil texture, 0.8% reduced soil acidity, 0.8% felt that it cut down on use of chemical fertilizer while 0.8% said it boosted growth. This is shown in figure 4.7 below;

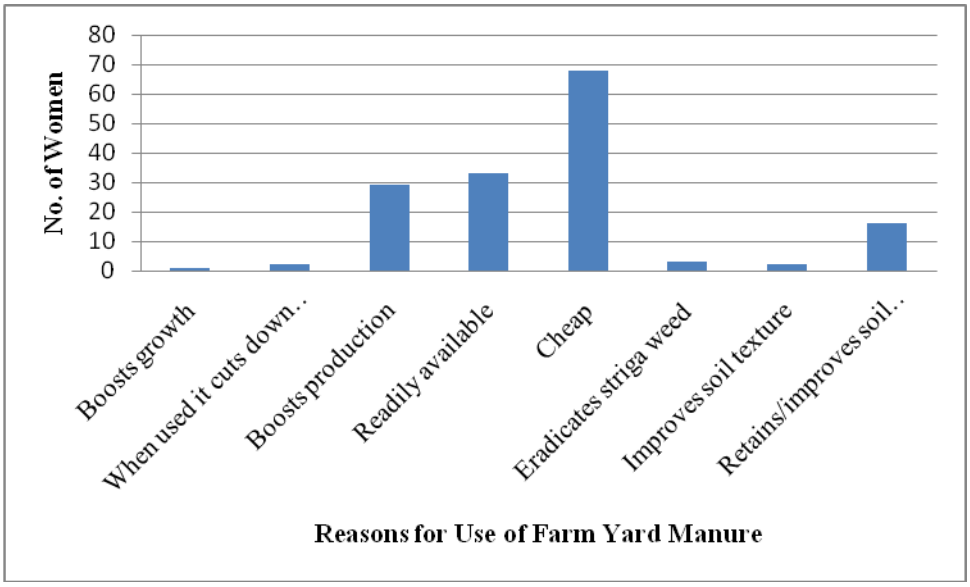

Figure 4.7: Reasons for Use of Farm Yard Manure

FYM is valued by women because it was cheap. This implies that the FYM users were constrained by financial resources hence went for it because it was the cheaper option. It was also preferred because of its availability. It was acquired from their farms or within the neighbourhood. Nonetheless, this requires labour services to extract the manure and transport it to the farm. A few women used FYM because it boosted yields and maintained soil fertility. However not many women used manure as a way of controlling striga weed which was a menace on many farms. Striga infestation is a more important factor that reduces yields of crops that receive nutrient inputs (Tittonel *et al*., 2008) Hence information regarding control of striga weed is scanty. Information gathered from FDGs revealed that women had not gained enough knowledge on how to control striga weeds. Manure was also used to cut down on the use of chemical fertilizers. This means that quantities of chemical fertilizer acquired are never enough to impact change in productivity. Therefore manure was used to compliment chemical fertiliser as a strategy to maximize the scarce resources available for use. According to (Malenya and Barret 2007), statistics indicate complementarities between manure and chemical fertilizer inputs.

4.5.1.5 Adoption of Agro Chemicals

This study found that 25.4% of the women used the other agrochemicals while 74.6% did not use them. This implies that only a few women used the other agro chemicals. This implies that a majority do not give priority to measures of controlling pests and diseases because of meagre resources, A few women who use them are informed about their existence and use.

Bisanda and Mwangi (1996) noted that herbicides require skills and involve risks which peasant farmers cannot afford.

4.5.1.6 Type of Agro Chemicals Used

This study established that out of the women who use agro chemicals 55.3% used insecticides, 50.8% used storage grain chemicals, 36.9% used herbicides, 4.6.% apply catalyst for the decomposition of FYM. The remaining1.5% and 1.5% adopted fungicides and lime for reducing soil acidity respectively. See the table 4.19 below;

Table 4.19: Agro Chemicals Used

NO.	Agro chemicals	Adopted: f(%)	Not adopted: f (%)
1	Insecticides	36 (55.3)	29 (44.7)
2	Storage of grain chemicals	33 (50.8)	32(49.2)
3	Herbicides	24 (36.9)	41(63.1)
4	Catalyst for decomposition of FYM	3 (4.6)	62(95.4)
5	Fungicides	1 (1.5)	64(98.5)
6	Lime to reduce soil acidity	1 (1.5)	64(98.5)

(Multiple responses)

Most women used more than one agrochemical especially insecticides and storage of grain chemicals and herbicides. The most commonly used agro chemical was insecticides followed by grain preservatives to control insect infestation on plants and harvested grains. This result is lower than (Ani *et al*. 2004) in Nigeria who found that 23%, 23.5% and 1.2% had adopted insecticides, herbicides and storage chemical respectively even after the rural women tried out the technologies and tested the outcome before adoption. There could be other serious issues underlying the use of these technologies like attitude and acquisition of resources that had not been addressed. The low turnout in adoption of catalysts for decomposition, fungicides and lime means they lack expert advice on application of the chemicals.

4.5.1.7 Source of Funds for Labour and Acquisition of Farm Inputs.

The study established that 33.2% of the women acquired their funding from their husbands, 27% from the income they earned, 21.8% from their children engaged in off farm employment and 18% from other sources like relatives and NGOs like OAF. See the table 4.20 below;

Table 4.20: Source of Funding for Women Farmers in Crop Farming.

NO.	Source of funding (n=256)	Frequency	Percentage
1	Husband	85	33.2
2	Woman	69	27
3	Children	56	21.8
4	Others like assistance from relatives & NGOs	46	18
	TOTAL	**256**	**100.0**

The above results imply that women get most support from their spouses in acquisition of inputs to implement MATs in crop farming. Men control most of the resources at the household level and hence are well placed to secure resources for adoption (Akudugu *et al*., 2012). However, women especially those who are household heads operate under great constrains because they have inadequate resources to implement MATs, (Oniang'o, 2005). Nevertheless, this study has established that a relatively high number of women also take direct responsibility in purchasing farm inputs from the income earned. Children engaged in employment also contribute towards acquisition of inputs on the farm. This means the children who are engaged in nonfarm employment that generates regular income facilitate adoption of MATs. This trend can also be explained by the role of formal education responsible for finding remunerative nonfarm employment. According to (Marenya *et al*., 2003) education serves to facilitate reinvestment in agricultural intensification to raise productivity. Other sources like relatives provide resources to facilitate adoption. NGOs like OAF provide seeds and fertilizers on credit. This gives them an opportunity to implement MATs.

4.5.2 Animal Husbandry

4.5.2.1 Adoption of Improved Livestock Breeds

This study established that most women 56.3% kept improved breeds while 43.7% did not. This implies that there is a changing trend from the traditional livestock breeds to better breeds for improved production. FGD revealed that some women acquired improved breeds through women groups. Mutoko *et al.* (2014) observed that there is an increasing number of cross breeds and graded dairy cattle under zero grazing. A relatively large number of women

do not keep improved breeds because of the high cost expenses involved in the management of the animals.

4.5.2.2Type of Improved Livestock Breeds Kept

The results show that 55.6% of the women who adopted improved breeds kept pure exotic breeds, followed by 34.7% who keep cross breeds while 9.7% keep both exotic and cross breeds. This is displayed in the table 4. 21 below;

Table 4.21: Type of Improved Livestock Breeds Kept

No.	Improved breeds kept (n=72)	Frequency	Percentage
1	Pure exotic breeds	40	55.6
2	Cross breeds	25	37.4
3	Both pure and cross breeds	7	9.7
	TOTAL	**72**	**100.0**

Many women had adopted pure exotic breeds to enhance production. Cross breeding of the local breeds with exotic breeds perceived to bear better genetic traits was also on the rise in Emuhaya and Luanda Sub-counties (Emuhaya Strategic Development plan, 2008-2018, 2008).

4.4.2.3 Dominant Improved Livestock Breeds Kept

Results show that 77.8% keep cattle, 45.8% chicken, 34.7% goats, 2.8% rabbits, 1.4% sheep and 1.4% keep pigs. This is shown in the table 4.22 below;

Table 4.22: Dominant Improved Livestock Breeds Kept

NO.	Breeds kept (n=72)	Frequency	Percentage
1	Cattle	56	77.8
2	Chicken	33	45.8
3	Goats	25	34.7
4	Rabbits	2	2.8
5	Sheep	1	1.4
6	Pigs	1	1.4

(Multiple responses)

Majority of the women kept cattle. A lot of value is attached to cattle than other livestock like goats, chicken, pigs and rabbits. Cattle are valued for their relatively high production of milk and also as a source of prestige (Ndandula, 2011). A few women had ventured into goat and chicken farming. Also pig, sheep and rabbit rearing is not popular among women. Probably they cannot make independent decisions on keeping of these animals. According to Njiro (2003) the presence of a male relative play a dominant role in decision making processes at a household level.

4.5.2.4 Management of Livestock

This study established that livestock is managed by 54.1% of the women, 27.8% husband, 12.5% hired labour and 5.6% by others like children and relatives. See table 4.23 below;

Table 4.23: Management of Livestock

	Management of livestock (n=72)	Frequency	Percentage
1	Woman	39	54.1
2	Husband	20	27.8
3	Hired labour	9	12.5
4	Others like children & relatives	4	5.6
	TOTAL	**72**	**100.0**

The results show that majority women were managers of their livestock while only a few men who are household heads were managers. This means that most women were in charge of livestock while their spouses were away (*de facto* managers) (Saito *et al*., 1994). Doss (2001) observes that in most parts in Africa, many men have claim over women's labour but women do not have similar claim over men's labour. However, women may not necessarily be the ones providing resources to manage livestock and even getting in contact with extension services. Hired labour was minimal and this could be attributed to inadequate funds. Other players like children and relatives were also involved but to a minimal extent. Most homesteads also rely on children to provide labour in management of livestock. Ndandula (2011), notes that children are also involved in routine activities such as herding, while activities to do with milking and feeding are left to the older household members.

4.5.2.5 Main Improved Chicken Breeds Kept

Results indicate that among the women who keep improved chicken, 42.4 % kept layers, 27.3% cockerels, 15.2% broilers and 9.1% ken bro. This is indicated in the table 4.24 below;

Table 4.24: The Main Improved Chicken Breeds Kept

	Chicken breeds (n=33)	Frequency	Percentage
1	Layers	14	42.4
2	Broilers	9	27.3
3	Ken bro	7	15.2
4	Improved local chicken breeds	3	9.1
	TOTAL	**33**	**100.0**

The results imply that most women preferred keeping layers. The demand for eggs was high and this provided income to the women. Low adoption of broilers, ken bro and improved local breeds means that women lacked sufficient resources for management of poultry. Nanyeena (2013) established that lack of inputs, skills for mixing chicken ratios, poor housing conditions and low market price were constrains encountered by farmers.

4.5.2.6 Dairy Farming

The results indicate that 85.9% practice dairy farming while 14.1% do not carry out dairy farming. Many women had ventured into dairy farming because it is an important source of income to many households. Milk obtained carters for the family needs as well as a source of income. However women involved in dairy farming act as managers on behalf of men who do not stay on their farms. An earlier result of this study shows that only a few women attended a training course in dairy farming yet many are involved in dairy farming. This could mean that men get access to extension information and then initiate the women in dairy farming. A study by (Mullins, 1992) confirmed that in a large percentage of male-contact farms, women were *de facto* managers although they were not primary contacts for extension agents. A few women did not take up dairy farming as it involves adoption of other management practices like veterinary technologies and acquisition of supplementary feeds which call for financial resources.

4.5.2.7 Type of Grazing System

The results show that 92.7% of the women who practice dairy farming have adopted zero grazing. The remaining 7.2% practice other grazing systems like open, controlled grazing and tethering as indicated in table 4.25 below;

Table 4.25: Type of Grazing System

NO.	System of grazing (n=110)	Frequency	Percentage
1	Zero grazing	102	92.7
2	Others (open, tethering & controlled grazing)	8	7.2
	Total	**110**	**100.0**

Zero grazing system is the most popular system of grazing among women who keep improved breeds. The grazing grounds have reduced and the high competition for the scarce resource made it difficult for open grazing (Emuhaya Strategic Development Report, 2008-2018, (2009). Jayne and Muyanga (2012) observed that zero grazing is more commonly practiced in high density areas producing higher levels of animal income per land unit because of reducing farm sizes. Besides, zero grazing is preferred because of better health and management and availability of more manure for fodders and crops reducing the use of expensive compound fertilisers (Oluoch–Kosura, 1999).

4.5.2.8 Breeding System Adopted by Women

It was established that 38.3% of the women use AI, 39.1% use bulls, 7.8% use bucks, 0.8% use bucks an bulls while 10.2% did not breed. This is shown in figure 4.8 below;

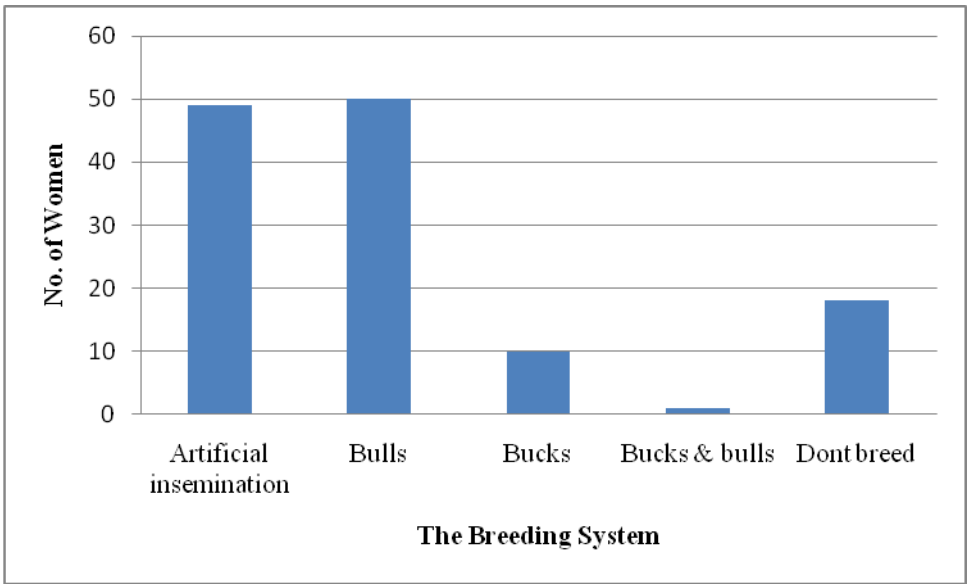

Figure 4.8: The breeding system adopted in animal husbandry

The results show that a relatively large proportion of women preferred using bulls followed by AI. Few women who keep improved goats preferred using bucks. Only one woman uses bucks and bulls to breed meaning she keeps both improved cattle and goats.

4.5.2.9 Reasons for Use of Artificial Insemination, Bulls and Bucks

Results show that among the women who breed using AI, 30.5% prefer it because it is easy to select improved breeds, 14.8% consider it effective while 11.7% indicated that it is disease free. For those who breed using bulls, 28.1% find it cheap, 16.4% believe it is easily accessible and 2.3% think that a veterinary officer is not available when these services are sought. 9.1 % and 9.1% of the women prefer bucks because they are cheap and readily available respectively. The results are shown in the table 4.26 below;

Table 4.26: Reasons for Use of Artificial Insemination, Bulls and Bucks

	Breeding system	Frequency (f)	Percentage (%)
	Artificial insemination		
1	Easy to select improved breed	39	30.5
2	Effective	19	14.8
3.	Disease free	15	11.7
	Bulls		
1	Cheap	36	28.1
2	Easy access	21	16.4
3	Veterinary officer not available	3	2.3
	Bucks		
1	Cheap	10	9.1
2	Available	10	9.1

(multiple response)

Most women who adopted AI preferred using it because they could easily select improved breeds of their choice from a wide range of breeds offered. AI is also perceived as an effective way of breeding since chances of a cow to conceive are high. AI is also considered to be a safe way of breeding since it cuts down on disease infections. Oluoch–Kosura (1999) looks at AI as a technology that enables farmers to achieve between 0.75% and 1% genetic potential improvement in their herd's milk production annually. Use of bulls (natural mating) can only achieve much less and if not well executed can most likely lead to retrogression.

Most women breed using bulls because it is cheap. This is because AI services are more expensive than the services offered by bulls. Bulls are also readily available therefore women did not strain to acquire the service. This is different from the AI service which was not easily viable at the user (dairy farmer) and service provider levels. Veterinary officers are not always available when the AI services are sought. The time taken to reach cows that are reported to be on heat would be much longer, with a good number of such cows being inseminated well past the optimum periods. Besides the logistics involved in distance, transport and time are not effective because of the ineffective choice of model of delivery of the AI service Oluoch-Kosura (1999). Bucks are preferred for breeding by women because the services are cheap. Besides they are readily available when needed. This means that AI services for goats are equally expensive and scarce.

4.5.2.10 Pastures Grown for Livestock

The results show that 83.6% grew Napier grass, 29.7% desmodium, 17.2% calindria, 10.9% mullato grass, 6.3% luciana, 4.7% maize stoves, and 7.8% grew other pastures like hay, legumes, mulberry, boma Rhodes, sesbania, tithonia and potato vines. This is displayed in figure 4.9 below;

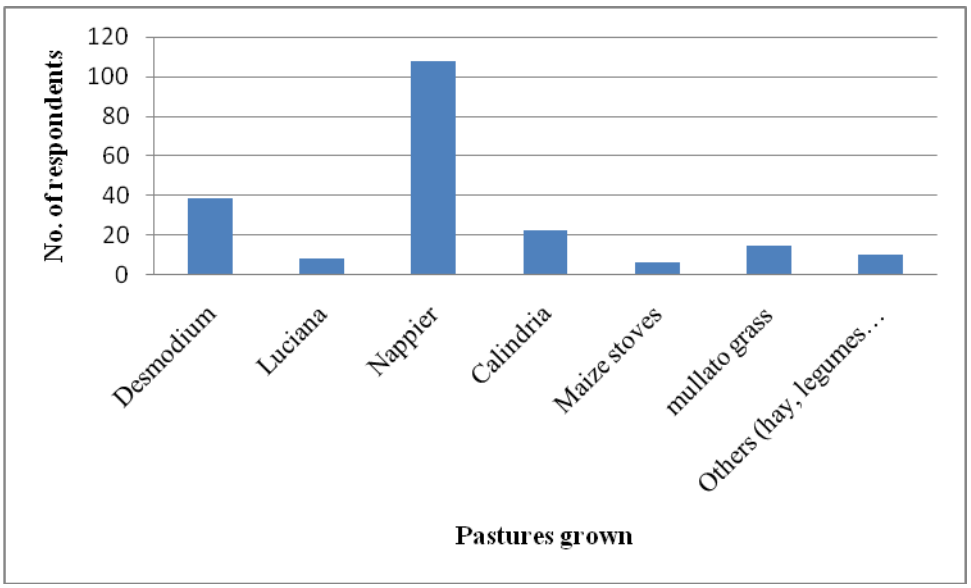

Fig. 4.9: Pastures grown

These results imply that Napier grass was the main feed under zero grazing system. It was easily available and manageable. This confirms (Kariuki and Waithaka, 1992), who established that it was deemed as the most popular fodder crop since under normal rainfall

conditions it was ready for harvest 4 weeks after cutting and on it alone, a cow could produce up to 7 litres of milk per day.

Desmodium, calindria and mullato grass were used by a few women. Less reliance on fodder trees is interesting because these fodder trees do not require much labour for maintenance as they are mostly intercropped by other food crops. It seems this fodder does not adequately meet their animals feed requirement. Besides, there was little information on their benefits. Other farm by-products which were in season like maize stoves and potato vines were also used as fodder. This happens in mixed crop- livestock systems especially with resource poor small holders. The maize and potatoes served as dual purpose crops which were common as the grain was used for human consumption and the residues for livestock feed (Lenne' *et al*., 2003) while the potato tubers were used for human consumption and vines were used for livestock fed.

4. 6 Benefits of Adoption of Modern Agricultural Technologies to Women

4.6.1 Improvement in Crop Farming and Animal Husbandry

The results show that 70.7% of the women who practiced crop farming recorded improvement while 29.3% had not seen improvement. Also the results show that 83% of the women who practiced animal husbandry registered improvement while 11.7% had not. This is shown in the table 4.27 below;

Table 4.27: Improvement in Production in Crop Farming and Animal Husbandry after Adoption of Modern Agricultural Technologies

Improvement in crop farming	**Frequency**	**Percentage**
Yes	181	70.7
No	75	29.3
Total	**256**	**100.0**
Improvement in animal husbandry	**Frequency**	**Percent**
Yes	107	83.6
No	15	11.7
Not adopted MATs in animal husbandry	6	4.6
Total	**128**	**100.0**

The above results imply that a majority of women who adopted MATs in crop farming and animal husbandry recorded high yields. High adoption of different production technologies as established in this study adopted in crop farming like fertilizer use and improved seed varieties may have contributed to improved yields in crop farming. Likewise, adoption of better management practices in animal husbandry like veterinary technologies and improved grasses led to desired results. According to (Oladele *et al*., 2008) the adoption of agricultural technology has made much difference in the farming activities of subsistence farmers. However, some of these technical packages have negative effects or unintended consequences. A few women had not registered improvement in both animal husbandry and crop farming. There was likelihood that the women farmers had not utilized the MATs properly like observing agronomic practices in crop farming like timely planting, plant spacing and population and application of proper amount of fertilizer. Owino (2010) in his study on fertiliser noted that the yields vary with different improved varieties, fertilizer types and intensity, and with management practices. Inadequate animal feeds and poor management practises in animal husbandry coupled with uncertainties led to low yields. This is in agreement with Salasya *et al*.(1998) whose report from KALRO indicates that viable technologies that had been developed were currently not being applied by the farmers and had led to as low as 6% of what is potentially viable. This resulted in continuous declining trend in production.

4.6.2 Sustenance of Production in Crop Farming

Results show that out of the women who had realised increase in production after adoption of MATs in crop production, 59.6% of them sustained production while 40.3% had not. Many women sustained production in crop farming because they continually observed better practises in farming. Moreover they have learnt to counter risks basing on the experience they have gained in implementation of MATs. According to (Rogers, 2003) they have probably reinvented the MATs to suit their needs. A fairly large number of women failed to sustain production. This could be as a result of inconsistence in proper application of MATs. Also their inability to counter constraints experienced during adoption probably hindered continuous sustained production. According to (Ogada, 2013) adoption is necessary but not sufficient to enhance yields. What is important is the efficiency with which these technologies are applied in the farmers' fields.

4.6.3 Sustenance of Production in Animal Husbandry

4.6.3.1 Sustenance in Milk Production

According to the results, 56.4% of the women who practice dairy farming sustained milk production while 43.6% did not. This means that a majority of the women are managing dairy farming. However a fairly large number of women farmers were unable to keep milk production high because of challenges that have not been overcome in dairy farming.

4.6.3.2 Milk Production in Litres per Cow per Day.

The results revealed that 15.5% of the women practicing animal husbandry yielded less than 4 litres, 30% between 5-9 litres, 39% between 10-15 litres and 15.5% yielded 15 litres and above. This is displayed in figure 4.10 below;

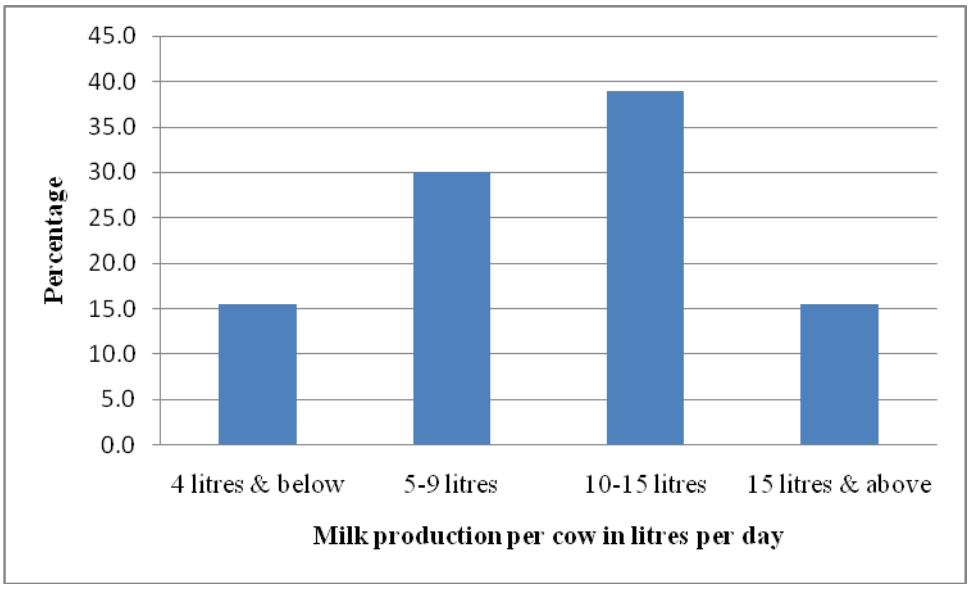

Fig 4.10: Milk production per cow in litres per day

This result implies that a relatively large proportion of the women yielded 10-15 litres of milk per day per cow. This is a fairly impressive performance indicating that there is evidence of some meaningful best practices taking place in dairy farming. These women may have acquired skills to boost production. According to (Dehinen et *et al*., 2014) the availability of livestock training also increases the level of dairy technology adoption through creating awareness on the advantages of the technology and then improving the farm management skill. The few women who net 4 litres and below per day per cow encounter constrains associated with inadequate resources and knowledge on dairy farming as an earlier result show that only a small number of farmers had been trained on dairy farming. Muzari *et al*.

(2012) stated that the major option for increased adoption of technology is to overcome the capital constraint through increased credit provision.

4.6.3.3 Sustenance in Chicken Production

The results show that 78.8% of the women who keep poultry upheld production while 21.2% did not. A majority of the women practising chicken farming had sustained production meaning they embraced MATs in animal husbandry. This presents the study area as one that has high potential in chicken farming. A few women who were unable to sustain production encountered challenges in production.

4.6.3.4 Meat and Egg Production in Chicken Farming

Results show that of the women who sustained production in chicken farming, 53.8% sustained meat production in chicken farming while 46.1% sustained egg production as shown in the table 4.28 below;

Table 4.28: Meat and Egg Production in Chicken Farming

Sustained production (n=26)	Frequency	Percentage
Meat	14	53.8
Egg	12	46.1
Total	**26**	**100.0**

This implies that management of chicken for meat has been easier than management of layers. Lack of inputs and skills for mixing chicken ratios, poor housing conditions and low market price are constraints in chicken farming (Nanyeena, 2013).

4.6.4 Benefits of Adoption of Modern Agricultural Technologies in Crop Farming and Animal Husbandry

4.6.4.1 Perceived Benefits of Modern Agricultural Technologies in Crop Farming

Benefits of MATs were ranked as follows; 72.6% ranked food security as the most important benefit. This was followed by 66.7% for high production followed by 57.4% for improved soil fertility. The other mentioned benefits of MATs in crop farming were improved standards of living, source of income and eliminates diseases. The results are displayed in the table 4.29 below;

Table 4.29: Benefits of Modern Agricultural Technologies in Crop Farming

NO.	Benefits	Frequency	Percentage
1	Food security	186	72.6
2	High production	171	66.7
3	Improve soil fertility	147	57.4
4	Improved standards of living	101	39.4
5	Source of income	97	37.8
6	Eliminates diseases	35	14.1

It is evident that the most important outcome of adoption of MATs is food security. Women who practiced subsistence farming employed technologies which met food needs for their families. MATs adopted also increased production. Most of the technologies adopted like use of fertilizer and improved seeds had boosted productivity. This also helped improve living standards since their nutritional needs were met. This confirms with (Oladele *et al*., 2008) that the adoption of agricultural technologies have provided job opportunities to some people in the social system, increase the standard of living, reduce labour, provide income and have control a lot of diseases infestation in both crops and animal.

4.6.4.2 Perceived Benefits of Adoption of Modern Agricultural Technologies in Animal Husbandry

The majority (57.3%) identified high production as the main benefit. This was followed by food security (52.5%) and source of income third at 43.5%. Other mentioned benefits include; improve living standards, creation of job opportunities, and elimination of diseases. The results are presented in the table 4.30 below;

Table 4.30: Benefits of Modern Agricultural Technologies in animal husbandry

NO.	Benefits	Frequency	Percentage
1	High production	70	57.4
2	Food security	64	52.5
3	Source of income	53	43.4
4	Improve living standards	46	37.7
5	Create job opportunities	44	36
6	Eliminate diseases	36	29.5

This implies that women who are engaged in animal husbandry highly regarded increased production as an advantage of adopting MATs. This could be as a result of adoption of technologies in feeding, breeding and animal health which increased milk, meat and egg production. A part from providing sufficient safe and nutritious food to meet their dietary needs, the income obtained from selling the farm products is used to buy food needed by the family. This also improves standards of living of many families and ultimately lowers the price of food staples as the producers of the food are also the consumers. According to (Marenya and Barret, 2006) when farmers adopt techniques the resulting improvements in productivity affects household welfare such as improved incomes, ability to educate children and invest in livestock assets. Mujivane (1999) established that benefits of zero grazing as obtaining a calf, milk production, employment, manure, credit and group membership.

An analysis of the benefits of MATs in crop farming and animal husbandry reveals that the benefits are varied. They can be categorised as those with monetary gains and those ones without monetary gains in table 4.31 and 4.32 as follows:

Table 4.31: Summary of Benefits in Crop Production

Monetary	Non monetary
1.Source of income	1. Food security (production oriented)
	2. High production (production oriented)
	3. Improves soil fertility (production oriented)
	4. Improves standards of living (prestigious/lifestyle)
	5.Eliminates diseases (production oriented)

Table: 4.32: Summary of Benefits in Animal Husbandry

Monetary	Non monetary
1.Source of income	1. High production (production oriented)
	2. Food security (production oriented)
	3. Improve living standards (prestigious/lifestyle)
	4. Create job opportunities (work oriented)
	5. Eliminate diseases (production oriented)

The table 4.31 and 4.32 above show that women adopt MATs majorly because they increase production of yields. They are mainly driven by consumption (Ogada, 2013). However, some of their produce also reaches the market. The income gained is used to carter for the other household needs. MATs act as a source of employment. This is done through hiring of labour services which are paid for.

Chi square tests were done to establish the relationship between benefits of MATs adopted in crop farming and animal husbandry. The MATs that recorded high adoption rates in crop farming thus intercropping, fertilizers and certified seeds were considered. In animal husbandry, veterinary technologies, improved grasses, zero grazing; supplementary feeds and improved breeds were considered because they recorded high adoption rates. The results obtained are displayed in the tables 4.33, 4.34, 4.35, 4.36, 4.37 and 4.38below;

In crop farming results obtained for the Chi square tests between food security and intercropping, fertilizers and certified seeds are p= .079, p= .633 and p=.558 respectively. See table 4.33 below;

Table 4.33: Relationship between Food Security and MATs in Crop Farming (Intercropping, Fertilizers and Certified Seeds)

NO.	Modern Agricultural Technologies	*P* value	Remarks
1	Intercropping	.079	Not significant
2	Fertilizers	.633	Not significant
3	Certified Seeds	.558	Not significant

The results show that food security does not influence adoption of some MATs in crop farming. This could be as a result of low returns from crop farming. According to (Republic of Kenya, 2013) production in crop farming is low as the average production of maize was 4 bags per acre compared to its potential of 15 bags per acre. A majority of the women farm on land less than 1 ha which is linked to the continuous cultivation of crops because of increasing land fragmentation (Republic of Kenya, 2009). This therefore means they do not solely depend on crop farming to meet their food requirements. Mutoko *et al*. (2014) noted that the majority of the households in Emuhaya and Luanda sub Counties prioritized allocation of resources to activities that improve their returns mainly from off-farm engagements because of the low returns from farming as compared to other economic activities.

Results for the chi square tests between high production and intercropping, fertilizers and certified seeds are p= .000, p= .063 and p=.291 respectively. See table 4.34 below;

Table 4.34: Relationship between High Production and MATs in Crop Farming (Intercropping, Fertilizers and Certified Seeds)

NO.	Modern Agricultural Technologies	*P* value	Remarks
1	Intercropping	.000	Significant
2	Fertilizers	.082	Not significant
3	Certified seeds	.291	Not significant

The significant relationship between intercropping and high production implies that women have embraced it as a strategy to reduce risks especially in this system where population pressure continues to diminish holdings (Jayne and Muyanga, 2012). A study carried out by (Oladele *et al*., 2008) established that the adoption of cereal/legume intercropping had the highest percentage (88.3%), which may be as a result of wide range of usage of this agricultural technology among farmers as it reduced the risk of incurring losses on the farm. The major food crops grown in Emuhaya and Luanda Sub counties include maize, beans, bananas, potatoes and sorghum (Mutoko *et al*., 2014). The insignificant relationship between fertilizers, certified seeds and high production imply that these inputs are not efficiently used. According to (Mutoko *et al*., 2014) land related investments exemplified in use of improved seeds, chemical fertilizers and conservation structures were unexpectedly low on farms. Lack of adequate funds prevents women from acquiring the required amounts of fertilizers and

certified seeds. Under such circumstances uncertified seeds are seeds are used This is in agreement with (Ojiem *et al*., 1996) who noted that given the rapidly increasing prices of hybrid seed and fertilizer, farmers seem to be justified in selecting their own local seed for production under low input conditions.

Chi square tests between improving soil fertility and intercropping, fertilizers and certified seeds show *p*= .001, *p*= .000 and *p*=.008 respectively. See table 4.35 below;

Table 4.35: Relationship between Improving Soil Fertility and MATs in Crop Farming (Intercropping, Fertilizers and Certified Seeds)

NO.	Modern Agricultural Technologies	*P* value	Remarks
1	Intercropping	.001	Significant
2	Fertilizers	.000	Significant
3	Certified seeds	.008	Significant

The significant relationship between improving soil fertility and all the MATs (intercropping, fertilizers and certified seeds) imply that women adopt these technologies to improve soil fertility. Soil exhaustion and decline in land productivity is rampant in Emuhaya and Luanda sub counties because of continuous tilling of the land (The Emuhaya strategic Report, 2009). Therefore women have opted to adopt MATs that enrich soils to boost production. This could also mean that some level of efficiency was observed in adoption of these MATs. Oladele *et al*. (2008) found that in cereal/legume intercropping technology, improving the soil nutrients is the prominent benefit (70%) since soil nutrient is of major importance to crop production. Besides, fertilizer application (68.3%) recorded among the farmers increases growth rate and farm produce rapidly. The peculiar significant relationship between certified seeds and improving soil fertility could be due to the fact that this technology is mostly adopted together with fertilizer as a package. Looking at the adoption levels, this study established that a majority of the women adopted certified seeds alongside fertilizers.

In animal husbandry, the chi square tests between high Production and veterinary technologies, improved grasses, zero grazing, supplementary feeds and improved breeds show *p*= .559, *p*= .001, *p*= .464, *p*= .003 and *p*=.387 respectively. See table 4.36 below;

Table 4.36: Relationship between High Production and MATs in Animal Husbandry (Veterinary Technologies, Improved Grasses, Zero Grazing, Supplementary Feeds and Improved Breeds)

NO.	Modern Agricultural Technologies	*P* value	Remarks
1	Veterinary technologies	.559	Not significant
2	Improved grasses	.001	Significant
3	Zero grazing	.464	Not significant
4	Supplementary feeds	.003	Significant
5	Improved breeds	.387	Not significant

High production is significant in adoption of improved grasses and supplementary feeds. Napier grass is part of the main feed under the zero grazing system. This is because it matures fast under normal rainfall conditions and increases milk production (Kariuki and Waithaka, 1992). Besides it is easily available and manageable. The other fodder used as feeds like other farm by-products which were in season like maize stoves and potato vines were also used to supplement the use of napier. Other supplementary feeds such as commercial feeds acquired from agro dealers are also used to boost milk, meat and egg production. However the insignificant relationship between high production and MATs like veterinary technologies, zero grazing and improved breeds indicate that women concentrate on prevention of disease measures for fear of incurring expenses in treatment or loss of livestock. Besides, zero grazing has been adopted because land for grazing has become scarce. According to the (Emuhaya Strategic Development Report, 2008-2018, (2009) grazing grounds have reduced and the high competition for the scarce resource made it difficult for open grazing. Adoption of improved breeds is on course as noted by Mutoko *et al*., (2014). However, the high costs involved in management of improved breeds could be the reason why women may not be realising the benefits.

Results for the chi square tests between food security and veterinary technologies, improved grasses, zero grazing, Supplementary feeds and Improved breeds p= .417, p= .015 and p=.432, p= .916, p= .072 respectively. See table 4.37 below;

Table 4.37: Relationship between Food Security and MATs in Animal Husbandry (Veterinary Technologies, Improved Grasses, Zero Grazing, Supplementary Feeds and Improved Breeds)

NO.	Modern Agricultural Technologies	*P* value	Remarks
1	Veterinary technologies	.417	Not significant
2	Improved grasses	.015	Significant
3	Zero grazing	.432	Not significant
4	Supplementary feeds	.916	Not significant
5	Improved breeds	.072	Not significant

The result shows that there is an association between food security and improved grasses. This means that adoption of grasses like napier impacts on farm production. Napier is the most common fodder that is grown on farms. It is easy to manage and is relied upon by women to feed livestock .This is because it increases milk production at farm level (Kariuki and Waithaka, 1992). Apart from providing dietary needs to the family, milk sold earns women a source of income which can be converted to meeting other needs for the family. Other MATs are not related to food security because of the constraints related to management.

Chi square tests between source of income and veterinary technologies, improved grasses, zero grazing, supplementary feeds and improved breeds show p= .826, p= .316, p= .080, p= .233 and p= .950 respectively. See table 4.38 below;

Table 4.38: Relationship between Source of income and MATs in Animal Husbandry (Veterinary Technologies, Improved Grasses, Zero Grazing, Supplementary Feeds and Improved Breeds)

NO.	Modern Agricultural Technologies	*P* value	Remarks
1	Veterinary technologies	.826	Not significant
2	Improved grasses	.316	Not significant
3	Zero grazing	.080	Not significant
4	Supplementary feeds	.233	Not significant
5	Improved breeds	.950	Not significant

The results show that the MATs adopted are not associated with source of income. This could imply that management of these practises may not be efficient. Women may not be having enough resources in acquisition and management of these technologies and hence production seems to be low. Therefore women may be resorting to other activities to generate income. Mutoko *et al*. (2014) observed that significant changes took place in the Emuhaya farming system whereby off-farm income was getting more important over time.

4.6.5 Challenges of Adoption in Crop Farming and Animal Husbandry

4.6.5.1Challenges of Adoption in Crop Farming

Challenges were established as follows; 80.5% cited lack of adequate funds, 36.7% inadequate land, 36.3% climate changes, 16.4% expensive labour and 8.9% pests and diseases. Other challenges 9.7% included poor seed quality, inadequate extension, time consuming, negative attitude and striga weed. This is shown in figure 4.11 below;

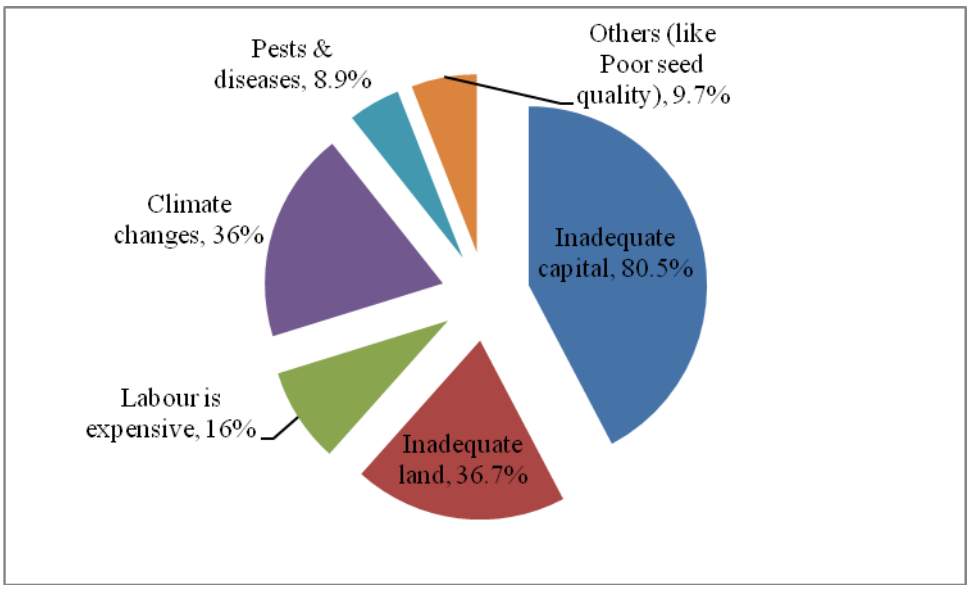

Fig 4.11: Challenges of adoption of modern agricultural technologies in crop farming

From the above results it can be deduced that inadequate funds was a major constraint in adoption MATs. Most of these inputs like fertilizers and improved seeds were considered expensive. The subsidies imposed on them by the county and national Governments have not significantly imparted on the acquisition of farm inputs. Moreover are not receptive to inputs offered on credit by NGOs like OAF because of the high interest rates. This confirms (Lubwama, 1999) that even when there is accessibility, the interest rates are too high for farmers to afford.

Land was another major constraint in adoption of technologies in agriculture. Women under study had a prime responsibility for food production but were limited by smaller sizes of land. This confirms (Nyerere, 2012) study in Luanda division that women are culturally discriminated against on land ownership, access, acquisition and inheritance. Farming practices like cropping required substantial sizes of land for effectiveness. The current ownership system that promoted land fragmentation reduced available land for effective adoption (Emuhaya strategic Development Report, 2008-2018, 2009). Besides sometimes women may not make independent choices on how to utilise land because men control most resources in the homesteads (Akudugu *et al*., 2012)

Changes in the climate have disrupted planting patterns. Occasional droughts and prolonged rainfall affects crop production. Munyua (2008) acknowledges that farmers and in particular women are vulnerable to drought, floods and environmental degradation. They therefore need support and their needs addressed like starting initiatives in irrigation for horticulture so as to cope up with the changing climate. Labour was available but access to it was restricted by affordability (Quisumbing and Pandolfeli, 2009). Sometimes children belonging to the homestead are used to provide labour (Ndandula, 2011). MATs in farming like farm mechanization require capital. Since women farmers were resource constrained they were not able to hire labour.

The other challenges equally affect production. Poor quality seeds that find their way in the market bring losses to women who spent their limited resources to acquire them. Besides inadequate extension services constrains acquisition of the relevant information that promotes technology adoption. An interview with extension officers revealed that there is shortage of staff and enough resources to effectively deliver appropriate information to women. This confirms (Doss *et al*., 2003) that remote areas and poor rural women tend to be underserved and this limits their uptake of technological innovations.

4.6.5.2 Challenges of Adoption in Animal Husbandry

Challenges in adoption of modern methods in animal husbandry were established as follows; the majority 71.1% lacked enough capital, 35.2% lacked adequate land, 32% cited diseases, 16.4% labour was expensive and 14.1% drought. Others 11.7% include theft, inadequate extension services, lacked market for produce and negative attitude. This is displayed in figure 4.12 below;

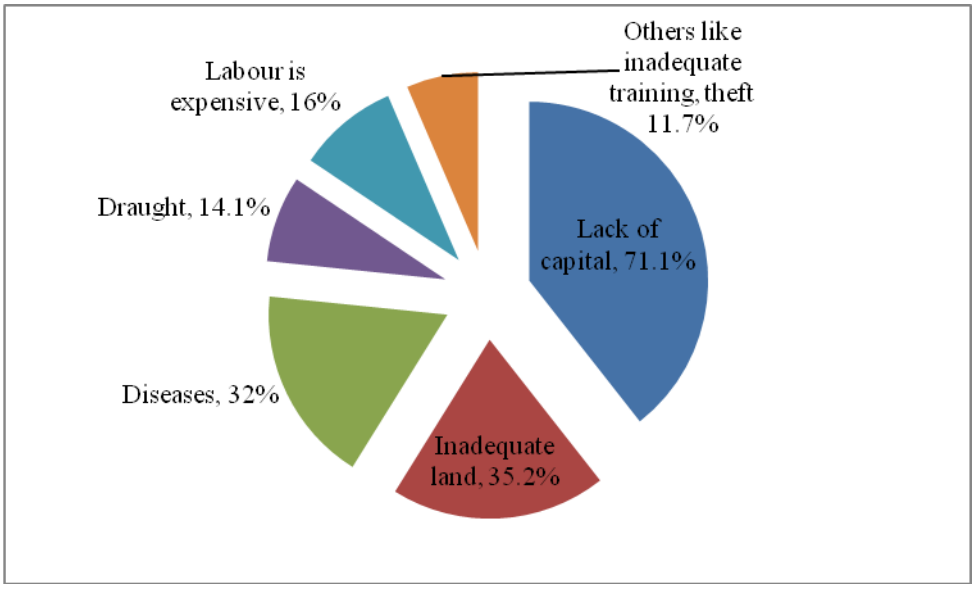

Fig. 4.12: Challenges of adoption of agricultural technologies in animal husbandry

Capital is a major constrain in adoption of MATs in animal husbandry. Management of livestock requires capital to purchase feeds, carter for veterinary services and proper housing. Most women cannot carry out all these services effectively because of inadequate funds.

Land size is generally small in the study area. Most farms cannot support dairy farming effectively because of inadequate space for growing fodder and food crops. The little land space limits chances of intensifying farming. According to (Republic of Kenya, 2009) the average agricultural farm size is about 0.5 hectares which is too small for substantial farming to be done. Where the livestock herd is bigger, land degradation takes a tall on the farm.

Diseases and pests discourage adoption especially if the livestock succumbs to diseases. This put the women farmers' at a disadvantage because most of them rely on them as a source of income. Waithaka and Kariuki (1992) diseases such as mastitis and foot rot can arise with poor management and low hygiene. Other uncertainties brought about by climate changes like drought also constrain adoption. Drought cause shortages in animal feeds and this affects production of milk. This is because irrigation technologies have not been developed fully as reported by this study. Their economies become vulnerable to major climatic changes like drought which destroy many of the assets that have been created. Studies done by (Hassan, *et al.*, 1998; Salasya *et al.*, 1998 and Kimenye, 1997) report that favourable climatic environment affect adoption. Labour services are also expensive and this puts a burden on the women. In most circumstances children are relied upon to provide labour like grazing of animals. Ndandula (2011) notes that children are also involved in routine activities such as

herding, while activities to do with milking and feeding are left to the older household members as these are important when it comes to milk production and quality.

Other challenges include inadequate extension services which deny women an opportunity to get updates on modern practises in animal husbandry. In Emuhaya and Luanda sub-counties women have less access to extension services. Doss et al., (2013) finds that remote areas and poor rural women tend to be underserved and this limits their uptake of technological innovations. Even for those who have, access, quality and service and appropriateness are often cited as issues (Ragasa, 2012). Theft of livestock also discourages livestock keeping. The Emuhaya strategic plan of 2008- 2018 (2009), outlines theft as one of the causes of decline in livestock keeping in the area.

4.6.6 Suggestions for Improvements in Agricultural Production

4.6.6.1Crop Production

The study sought to find out alternative ways through which crop production can be sustained. The results show that majority respondents 43.8% would prefer to get inputs, 37.5% needed training and 14.5% cited need for credit facilities while the remaining 4.3% called for other measures like acquisition of more land space as shown in table 4.39 below;

Table 4.39: Alternatives for Improvement in Crop Farming

No.	Alternatives to sustaining crop farming	Frequencies	Percentages
1	Credit	37	14.5
2	Training	96	37.5
3	Subsidy on inputs	112	43.8
4	Others(like market and demonstrations)	11	4.3
	Total	**256**	**100.0**

The majority suggested that prices of inputs in crop farming like chemical fertilizers supplements to be subsidized. This means women encountered cash constraints in acquisition of inputs. African women smallholders have relatively less access to input technologies, including improved seeds and fertilizers. Investing in women farmers increases overall crop production (Africa Agriculture Status Report, 2013). Training was recommended by women as a way of equipping them with skills to manage adoption of MATs. Good and timely information on new technologies and techniques is essential for farmers when deciding

whether or not to adopt an innovation (Africa Agriculture Status Report, 2013). Credit facilities were required to enable women to access and acquire MATs with ease. Access to financial services remains a key impediment for women entrepreneurs. Female small-scale farmers do not have the financial capacity to increase their market access, increase production.

Women also suggested that they needed market to sell their products. But this potential will only be actualized if rural women have better and fairer access to markets to sell their products (Africa Agriculture Status Report, 2013).

Also establishment of demonstration farms would help them get a better experience of how to implement MATs.

4.6.6.2 Animal Husbandry

In animal husbandry, 62.5% felt that they needed training, 29.9% needed credit facilities, 10.2% proposed subsidy on inputs, 4.7% needed market for their produce and 3.9% suggested an exchange programme as indicated in table 4.40 below;

Table 4.40 Suggestions for Improvement in Animal Husbandry

	Suggestions for improvement in animal husbandry	Frequencies	Percentages
1	Training	81	63.3
2	Sourcing for credit	30	21.9
3	Market expansion	6	4.7
4	Subsidize price of feeds and vaccines	13	10.9
5	Exchange programme	5	3.9

(Multiple response)

A majority of the livestock farmers recommended training. Women farmers are rarely reached by extension services and included in on-farm research programmes. Women's crops and livestock activities, especially crop processing and storage have received relatively little attention in agricultural research and technological development programmes (FAO, 2010). Credit facilities were needed to help women to help strengthen projects that had been established. Many studies have shown that improving women's direct access to financial resources leads to higher investments in human capital (FAO, 2010). Women also desired to have market that would absorb their products. They also advocated for exchange

programmes. Experiences gained from different environments and shared ideas between different groups could help them understand better ways of implementing MATs.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

This study established that all women in the study area were aware of some MATs in crop and animal husbandry. A majority of the women had adopted a variety of MATs at varying degrees. The most popularly adopted technologies in crop farming include intercropping, fertilizers and certified seeds. Other technologies like mechanized farming, irrigation and agro forestry, green house farming, and tissue culture bananas had been adopted at low rates. A majority of the women were partial adopters in crop farming. In animal husbandry, most women had adopted improved grasses, zero grazing and veterinary technologies. Others like deep litter system, improved chicken breeds, clean milk production and calf feeding had been adopted at low rates. A majority of the women in animal husbandry were partial adopters while a small number of women were non adopters.

Education was found to be significant in adoption of MATs such as certified seeds in crop farming. However it was not significant in adoption of other technologies such as intercropping, fertilizers, plant spacing, green house farming, mechanized farming, agro forestry and irrigation. In animal husbandry education was found to be significant in adoption of zero grazing, improved breeds and clean milk production. Education was also found to have minimal influence on adoption of the other MATs such as veterinary technologies, improved grasses, supplementary feeds, artificial insemination, housing unit and deep litter system. The most popular source of information in crop farming was farmer to farmer while in animal husbandry was agricultural field days. The other sources of information such as extension services and mass media were not popular crop farming and animal husbandry. There was a low turnout of women in various training sessions organised in animal husbandry and crop farming.

This study found that most women recorded improvement in agriculture after adoption of MATs in farming. However, only a few women practicing crop farming managed to sustain production as opposed to the majority in animal husbandry who sustained production of milk and chicken products. The most important benefits of adoption were high production, food security and improved living standards. The other benefits identified were source of income, improved soil fertility, raised standards of living, provision of job opportunities and

eliminates diseases. A summary of benefits of MATs show that most benefits are production oriented. Chi square tests show the presence and lack of a relationship between some benefits and MATs adopted. For example in crop farming, an association was noted between intercropping and high production (p= .000), while there was no relationship between fertilizer and food security (p= .633). In animal husbandry an association was noted between improved grasses and high production (p= .001), while improved breeds were not related to high production (p= .387).

5.2Conclusions

High adoption rates of some MATs in crop and animal husbandry imply that they are easily accessible and affordable. This has been made possible by role played by the private organisations like the One Acre Fund and subsidies from both the national and county governments. Other MATs require low managerial skills hence they are easy to interpret. Low adoption rates of some MATs imply that there is scarcity in acquisition of resources they are required to adopt them. This includes land, capital and skills to handle the MATs. Full adopters of some MATs in crop farming and animal husbandry have considerable amount of resources and therefore display some level of efficiency in adoption of MATs. The high number of partial adopters and a section of non adopters in animal husbandry can be explained by lack of sufficient resources, correct information and training useful in acquisition and use of MATs.

Education is important in interpretation and adoption of some MATs. Some MATs are knowledge intensive MATs and require high skills in adoption. For the women who have not acquired formal education sources of information such as extension services and training come in to complement formal education. However the minimal contact between extension services and women farmers show that women are not well updated on MATs that could be important for adoption. The low attendance of training sessions point to difficulties experienced accessing information about training.

Most benefits cited are production oriented implying adoption of MATs is done with a view to increase food production and meet their consumption needs. The association noted between some MATs and benefits of adoption in crop farming and animal husbandry show that resources for use are available. Either, some level of efficiency has been applied in adoption of these MATs. However lack of relationship between benefits such as food security

and adoption implies that adoption of MATs is also dictated by the prevailing socio economic conditions.

5.3 Recommendations

Concerted efforts should be put in place to empower women with resources to acquire MATs suitable to their needs. Therefore the National and County governments should work towards increasing the subsidies on the farming inputs so as to make farming affordable. The private institutions such as the non governmental institutions that run socio economic programmes should be properly linked to women farmers in order to address their adoption needs and aspirations.

Enhance women's understanding of usage modern agricultural technologies by empowering them with appropriate information. Extension services are important in meeting this goal because they come in to complement the low levels of education. However, extension services should be intensified by the county government so as to reach the women. Farmer to farmer as a source of information is important but has to be enriched. The small social units such as women groups should be used as learning groups that are attached to agricultural extension experts. This may enhance their understanding of MATs and acquisition of managerial skills in handling MATs. More weight to be given to training sessions so as to attract more participants. Timing of the sessions and where they are held should be made in such a way that women find it easier to attend. However, for effective learning, other complimentary channels for imparting information and skills like hands-on training, demonstration plots and creation of farmers groups are needed to enhance effective learning.

Introduction of MATs should go hand in hand with information on the consequences of these MATs. There is need to establish appropriate technologies suitable for the women so as to guarantee proper implementation and realise the short and long term benefits of these innovations.

5.4 Suggestions for Further Studies.

1. A study on the role of channels of information in adoption of modern agricultural technologies by women.

2. A study on how the other household member's education levels impact on adoption of modern agricultural technologies by women

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APPENDICES

APPENDIX 1: QUESTIONNAIRE FOR WOMEN RESPONDENTS

This questionnaire is intended to collect suitable information on the study entitled 'THE EFFECT OF WOMEN'S EDUCATIONAL LEVEL ON ADOPTION OF MODERN AGRICULTURAL TECHNOLOGIES IN AGRICULTURE IN LUANDA AND EMUHAYA SUB COUNTIES, VIHIGA COUNTY.'

Kindly respond to the questionnaire by filling in the blank spaces or ticking in **(√)** the preferred answer where there is a provision for choices.

All the information will be treated with the confidentiality it deserves.

Respondent …….. Date …….

PART A

SOCIAL DEMOGRAPHIC CHARACTERISTICS OF THE STUDY POPULATION

1. Age ……
2. Marital status

   1. Single ☐ 2. Married ☐ 3. Divorced ☐ 4. Widowed ☐
3. Educational level

   1. Primary ☐ 2. Secondary ☐ 3.Tertiary ☐ 4. Other (specify) .....
4. What is your households' main source of livelihood?

   1. Food crop farming ☐ 2. Livestock farming ☐
   3. Off farm casual employment ☐ 4. Off farm permanent employment ☐
   5. Other (specify) ……..
5. Do you participate in making decisions on adoption modern agricultural technologies?

   1. YES ☐ 2. NO ☐
6. What is the size of your farm land? (Acres)……..
7. Is the land

   1. Privately owned ☐ 2. Communally owned ☐ 3. Leased ☐ 4.Other (specify)……..

PART B

MODERN AGRICULTURAL TECHNOLOGIES ADOPTED BY WOMEN

8. Do you know about any modern agricultural technology?

   1. YES ☐ 2. NO ☐

9. If YES in 8 above, which was your main source of information about modern agricultural technologies?

   1. Radio ☐ 4. Attending an agricultural field day ☐
   2. Television ☐ 5.Visit from extension officers ☐
   3. Printed material ☐ 6.From another farmer ☐
   7. Other (specify)……

10. Have you adopted any modern agricultural technology?

    1. YES ☐ 2. NO ☐

11. If YES in 10 above, what modern agricultural technologies have you adopted in crop farming?

    ……
    ……
    ……
    ……
    ……

12. Which modern technologies have you adopted in animal husbandry?

    ……
    ……
    ……
    ……

13. For how long have you adopted modern agricultural technologies?

    1. 1-5 years ☐ 2. 5-10 years ☐ 3.10 and above ☐

14. Have you ever been trained on how to apply modern agricultural technologies?

    1. YES ☐ 2. NO ☐

15. If YES in 14 above, which type of agricultural training did you attend?

    ……
    ……

B. ADOPTION RATES OF MODERN AGRICULTURAL TECHNOLOGIES IN CROP PRODUCTION AND ANIMAL HUSBANDRY

(a). Crop production

16. Which type of seeds do you plant?

    1. Certified seeds ☐ 2. Uncertified seeds ☐

    3. Both certified & uncertified ☐

17. Which main type of fertilizer did you apply during planting and top dressing?

    1. Chemical fertilizer ☐ 2. Farm yard manure ☐ 3. None ☐

18. What is the reason for your choice in 17 above?

    ……

    ……

    ……

19. Do you use other agrochemical on your farm?

    1. YES ☐ 2. NO ☐

20. Name any other agro-chemicals used in order of importance.

    1. …….. 2. …….

    3. …….. 3. ……..

21. Where do you get the funds to provide for labour and buy inputs for farming?

    1. Husband ☐ 2. Children in formal or non formal employment ☐

    3.Woman ☐ 4. Others ……

b). Animal husbandry

22. Do you keep improved livestock?

    1. YES ☐ 2. NO ☐

23. If answer is YES in 23 above, which improved breeds of livestock do you keep?

    1. Exotic breeds ☐ 2. Cross breeds ☐ 3. Both exotic & cross breeds ☐

24. Indicate the dominant livestock kept

    1. …….. 4. ……..

    2. …….. 5. ……..

    3. …….. 6. ……..

25. Who manages the livestock kept?

26. 1. Husband ☐ 2. Woman ☐ 3. Hired labour ☐ 4. Others……...

27. Which main type of chicken breeds do you keep?

    1. Layers ☐ 2. Broilers ☐ 3. Ken bro ☐

    4. Improved local chicken breeds ☐

28. Do you practice dairy farming?

1. YES ☐ 2. NO ☐

29. If YES in 29 above, which system of grazing do you apply?

1. Zero grazing ☐ 2. Open grazing ☐ 3. Tethering ☐

4. Others (specify) ……..

30. What system of breeding have you adopted?

1. Artificial Insemination ☐ 2. Bulls ☐ 3. Bucks ☐

4. Others (specify) …….

31. Give reasons for your answer in 31 above,

……

……

……

32. What pastures do you grow for your dairy cows?

……

……

……

……

PART D

THE BENEFITS OF MODERN AGRICULTURAL TECHNOLOGIES

(a). Crop farming

33. Has there been improvement in yields in crop farming after adoption of modern agricultural technologies?

    1. YES ☐ 2. NO ☐

34. If YES in 34 above, have you managed to keep production high?

    1. YES ☐ 2. NO ☐

    …….....

    .....

    .....

35. How have you benefited from modern agricultural technologies applied in crop farming? Below are listed some benefits of modern agricultural technologies in crop farming. How important are they to you? (circle the number)

NO.	Benefits	Not important	Less important	Important	Most important
1	Food security	1	2	3	4
2	High production	1	2	3	4
3	Improve soil fertility	1	2	3	4
4	Improved standards of living	1	2	3	4
5	Source of income	1	2	3	4
6	Eliminates diseases	1	2	3	4

36. What challenges have you encountered in the process of adoption of modern agricultural technologies in crop farming?

    ……

    ……

    ……

37. Indicate by choosing ONE alternative that can help you sustain production

    1. Credit ☐ 3. Inputs ☐

    2. Training ☐ 4. Other (specify) ……

(b). Animal husbandry

38. Has production in output improved in animal husbandry after adoption of modern agricultural technologies?

    1. YES ☐ 2. NO ☐

39. What is the total milk yield on average per cow per day after adoption of modern agricultural technologies (Litres) ……

40. Have you sustained milk production?

    1. YES ☐ 2. NO ☐

41. Have you kept chicken production high?

    1. YES ☐ 2. NO ☐

42. How have you benefited from modern agricultural technologies applied in animal husbandry? Below are listed some benefits of modern agricultural technologies in animal husbandry. How important are they to you? (circle the number)

NO.	**Benefits**	**Not important**	**Less important**	**Important**	**Most important**
1	High production	1	2	3	4
2	Food security	1	2	3	4
3	Improved standards of living	1	2	3	4
4	Create job opportunities	1	2	3	4
5	Source of income	1	2	3	4
6	Eliminate diseases	1	2	3	4

43. What challenges have you encountered in the process of adopting modern agricultural technologies in animal husbandry?

    ……

    ……

    ……

44. Suggest ways of improving production in animal husbandry

    ……

    ……

    ……

THANK YOU

APPENDIX 2: INTERVIEW SHEDULE FOR AGRICULTURAL EXTENSION OFFICERS

The interview schedule is prepared for the purpose of collecting relevant information for an academic proposal entitled; THE EFFECT OF WOMEN'S EDUCATIONAL LEVEL ON ADOPTION OF MODERN AGRICULTURAL TECHNOLOGIES IN EMUHAYA AND LUANDA SUB- COUNTIES, VIHIGA COUNTY. Please provide the appropriate answers for the questions. Information given will be treated as confidential and for research purposes only.

NAME:_____CONTACT: _____

1. How long have you worked as an extension officer in this district? …….
2. Do women farmers understand modern agricultural technologies?

   1. YES ☐ 2. NO ☐
3. Have women adopted modern agricultural technologies in crop farming and animal husbandry?

   1. YES ☐ 2. NO ☐
4. How can you rate adoption of modern agricultural technologies by women?

   1. Very poor ☐ 2. Poor ☐ 3.Average ☐ 4. Good ☐
   5. Very good ☐
5. Which modern technologies have women adopted in crop farming and animal husbandry?

   ……
   ……
   ……
6. What factors do you think have contributed to knowledge uptake of modern technologies in agriculture?

   ……
   ……
   ……
7. Do you normally disseminate information and knowledge to women concerning modern agricultural technologies?

   1. YES ☐ 2. NO ☐
8. Which type of information and knowledge have you disseminated to women about modern agricultural technologies?

……

……

……

9. Which channels do you use to disseminate information and knowledge to women in Emuhaya and Luanda sub counties?

……

……

……

10. Do you think this has equipped women with knowledge and skills about modern agricultural technologies?

1. YES ☐ 2. NO ☐

11. What challenges do you encounter in delivery of services to women farmers?

……

……

……

12. Is there any partnership between government and the community members with other NGO'S and donors promoting adoption of modern agricultural technologies?

1. YES ☐ 2. NO ☐

13. If YES, how has this partnership assisted women to adopt modern agricultural technologies?

……

……

……

……

14. How do women benefit from modern agricultural technologies in agriculture?

……

……

……

……

15. What challenges do women encounter in adoption of modern agricultural technologies?

……

……

……

16. What opportunities do women farmers have to enhance modern agricultural technologies?

    ……
    ……
    ……
    ……

17. What do you suggest can be done to make women adopt modern technologies in agriculture in the district?

    ……
    ……
    ……
    ……..

18. Which plans have the government put in place towards prioritizing active adoption of modern agricultural technologies among women in Luanda and Emuhaya sub counties.

    ……
    ……
    ……
    ……
    ……
    …….

THANK YOU

APPENDIX 3

INTERVIEW SCHEDULE FOR ASSISTANT CHIEFS

The interview schedule is prepared for the purpose of collecting relevant information for an academic proposal entitled, THE EFFECT OF WOMEN'S EDUCATIONAL LEVEL ON ADOPTION OF MODERN AGRICULTURAL TECHNOLOGIES IN LUANDA AND EMUHAYA SUB COUNTIES, VIHIGA COUNTY. Please provide the appropriate answers for the questions. Information given will be treated as confidential and for research purposes only.

NAME:_____CONTACT:_____

SUB-LOCATION_____

1. Do women participate in adoption of modern agricultural technologies?

   1. YES ☐ 2. NO ☐

2. Which modern agricultural technologies have women adopted in crop farming and animal husbandry?

   ……

   ……

   ……

   ……

3. How would you rate participation of women in adoption of modern technologies in agriculture?

   1. Very poor ☐ 2. Poor ☐ 3.Average ☐ 4. Good ☐

   5. Very good ☐

4. Do the women get trained on how to apply modern agricultural technologies?

   1. YES ☐ 2. NO ☐

5. If YES, who trains them?

   ……

   ……

6. Which type of training have they received?

   ……

   ……

   How have they benefited from the training?

   ……

   ……

7. Do you think modern practices in agriculture benefit women?

   1. YES ☐ 2. NO ☐

8. If answer in 4 above is YES, explain how?

   ……

   ……

   ……

9. What challenges do women encounter in adopting modern agricultural technologies?

   ……

   ……

   ……

   ……

10. What can be done to promote participation of women in modern agricultural technologies in agriculture?

    ……

    ……

    ……

11. What role does the government play in promoting adoption of modern agricultural methods by women?

    ……

    ……

    ……

THANK YOU

APPENDIX 4

DISCUSSION GUIDE FOR FOCUS GROUPS

The discussion guide is prepared for the purpose of collecting relevant information for an academic proposal entitled, THE EFFECT OF WOMEN'S EDUCATIONAL LEVEL ON ADOPTION OF MODERN AGRICULTURAL TECHNOLOGIES IN LUANDA AND EMUHAYA SUB COUNTIES, VIHIGA COUNTY. Please provide the appropriate answers for the questions. Information given will be treated as confidential and for research purposes only.

NAME OF GROUP: _____ CONTACT: _____

SUB-LOCATION: _____

1. Do you know what modern agricultural technologies are?

   1. YES ☐ 2. NO ☐

2. If YES, have you adopted modern agricultural technologies in crop farming and animal husbandry?

   1. YES ☐ 2. NO ☐

3. If YES in 2 above, name the technologies adopted in;

   (i). Crop farming

   ……

   ……

(ii). Animal husbandry

   …….....

   .....

4. How long have you adopted modern agricultural technologies in agriculture?

   ……

5. How much land have you put under;

   1. Crop farming? …… (Acres)

   2. Animal husbandry? …… (Acres)

6. Have you been trained on modern agricultural technologies in agriculture?

   1. YES ☐ 2. NO ☐

7. If YES, by who?

……

…….....

8. Indicate the type of training you received in modern agricultural technologies?

……

……

9. Which technologies did you adopt before and after training?

……

……

10. Are there some modern technologies that you would prefer to employ but you are unable to do so?

1. YES ☐ 2. NO ☐

11. If YES, which technologies are these?

……

…….

12. What prevents you from adopting them?

……

……

13. In what ways does the adoption of modern agricultural technologies benefit women?

……

……

14. What challenges do you encounter in adoption of modern agricultural technologies?

……

……

15. What do you suggest can be done to women farmers to adopt modern agricultural technologies?

……

……

16. In what ways can modern agricultural technologies be enhanced in the district?

……

……

THANK YOU

APPENDIX 5

APPROVAL LETTER

MASENO UNIVERSITY

SCHOOL OF GRADUATE STUDIES

Office of the Dean

Our Ref: MA/NS/00111/013

Private Bag, MASENO, KENYA
Tel:(057)351 22/351008/351011
FAX: 254-057-351153/351221
Email: sgs@maseno.ac.ke

Date: 01st February, 2016

TO WHOM IT MAY CONCERN

RE: PROPOSAL APPROVAL FOR MOUREEN ADAMBA LUSIGI—MA/NS/00111/2013

The above named is registered in the Master of Arts in Geography Programme of the School of Environment & Earth Sciences, Maseno University. This is to confirm that her research proposal titled "Effect of Women's Educational Level on Adoption of Modern Agricultural Technologies in Emuhaya District, Vihiga County" has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

MASENO UNIVERSITY
DIRECTOR
02 FEB 2016
SCHOOL OF GRADUATE STUDIES

Prof. P.O.Owuor
DEAN, SCHOOL OF GRADUATE STUDIES

APPENDIX 6

APPROVAL FOR DATA COLLECTION

VIHIGA COUNTY GOVERNMENT

DEPARTMENT OF AGRICULTURE, LIVESTOCK, FISHERIES AND COOPERATIVES

SUB COUNTY AGRICULTURE OFFICE,
EMUHAYA SUB COUNTY

P.O.BOX 36-50307

LUANDA
Email-scaoemuhaya@gmail.com

10TH, FEBRUARY, 2016

REF: DoALFC/SCAO/EMU/ADM 1/VOL1/26

TO WHOM IT MAY CONCERN

RE: RESEARCH PROPOSAL DATA COLLECTION BY MOUREEN ADAMBA LUSIGI ID CARD NO. 11849751

The above named is a Masters of Arts in Geography student at Maseno University, Student Registration Number MA/NS/00111/2013. Her research proposal titled "Effect of Women's Educational Level on Adoption of Modern Agricultural Technologies in Emuhaya District, Vihiga County" has been approved by the University.

She will therefore be conducting the data collection exercise for a period of three months, beginning February-May 2016 in Emuhaya and Luanda Constituencies (Larger Emuhaya District).

The purpose of this letter is therefore to kindly request you to provide her and her team of enumerators with any necessary assistance she may need in the course of this study exercise.

DISTRICT AGRICULTURAL OFFICER P.O. BOX 74 EMUHAYA EMUHAYA DISTRICT

Daniel B.O.Ragudwa

For: Sub County Agricultural Officer

EMUHAYA SUB COUNTY

SUB COUNTY AGRICULTURAL OFFICER LUANDA SUB COUNTY DATE 10/2/2016 SIGN

Jane A. Otieno

Sub County Agricultural Officer

LUANDA SUB COUNTY