CONTRIBUTION OF ECOSYSTEM SERVICES TO LIVELIHOODS IN KIBWEZI SUB-COUNTY, MAKUENI COUNTY, KENYA

BY

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DECLARATION

Declaration by student

I, the undersigned, hereby declare that this thesis is my original work and that it has never been presented for the award of any degree in this University or elsewhere.

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ABSTRACT

Worldwide people depend on ecosystem services for their survival but the nature of that dependence is hardly ever fully understood. While many researches describe links between ecosystem services and dimensions of poverty, few provide sufficient context to enable a thorough understanding of the contribution of ecosystem services to livelihoods. A considerable dearth of knowledge remains in understanding the links between ecosystem services and how human wellbeing can be improved through the utilization of ecosystem services. Kenya ranks highly as one of the countries rich in biodiversity but continues to face the challenge of poverty with people depending on these services remaining poor. Despite the presence of variant ecosystems in Kibwezi Sub-County, 50.5% of the population live below the poverty line. There is a general expectation that ecosystem services should benefit human wellbeing and help secure livelihoods especially the rural poor. Therefore, the purpose of this study was to examine the contribution of ecosystem services to livelihoods in Kibwezi Sub-County, Makueni County. The objectives of this study were to: determine the contribution of higher plant species richness to the communities' livelihoods; determine the influence of water availability on food crop and livestock production and establish the effect of socio-cultural ecosystem services on communities' livelihoods in Kibwezi Sub-County. A cross-sectional descriptive research design was used. Households were covered as sampling units from a total population of 248,704 persons. A minimum sample size of 384 household heads were interviewed. Purposive sampling was used to get key informants. Primary data were collected through questionnaires, key informant interviews, Focus Group Discussions, field observation and photography. Secondary data were obtained from published and unpublished reports. Pearson product moment correlation was used to establish relationship between higher plant species richness and number of livelihoods supported. Least squares regression analysis was used to predict the relationship between rainfall, amount of water used during irrigation and food crop yields. Qualitative data was analysed by creating patterns and themes, then evaluating the usefulness of information in answering the research questions. The study revealed that Kibwezi Sub-County is endowed with 60 higher plant species with a significant strong correlation: between higher plant species richness and the area dominated by the plant species (r=0.721, p<.05), and the number of livelihoods supported by the plant species (r=0.896, p<0.5). About 67.2% of the variation in total rainfed crop yields was explained by total monthly rainfall amounts for short rains (r^2= 0.672, p< .01), while 51.9% of variation in total irrigated crop yields was explained by total amount of water used for irrigation (r^2=0.519, p<.01). The Chi-Square test results (Asymp. Sig.) of 0.011 showed that socio-cultural ecosystem services and livelihoods were related. The study concluded that in Kibwezi Sub-County, higher plant species influence livelihoods with only few people utilizing them, water availability influence food crop and livestock production while few people are aware that socio-cultural ecosystem services influence livelihoods like tour guiding, handcraft selling and cultural troupe performance. The study recommends sufficient utilization of higher plant species to support more livelihoods, tree planting, regeneration and agroforestry to increase the number of higher plant species, intensive water harvesting and awareness creation on the value of socio-cultural ecosystem services to the livelihoods of local communities in Kibwezi Sub-County.

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LIST OF ABBREVIATIONS AND ACRONYMNS

ASARECA -Association for Strengthening Agricultural Research in Eastern and Central Africa

ASAL - Arid and Semi-Arid lands

CBS -Central Business Statistics

FAO -Food and Agriculture Organization

GDP -Gross Domestic Product

GoK - Government of Kenya

IFAD -International Fund for Agricultural Development

IUCN -International Conservation of Nature

KALRO - Kenya Agricultural Livestock and Research Organization

KESCDP -Kibwezi East Sub-County Development Plan

KEFRI - Kenya Forest Research Institute

KII -Key Informants

KWS -Kenya Wildlife Service

MDDP - Makueni District Development Plan

MDG -Millennium Development Goals

NGO - Non- Governmental Organization

NP -National Park

NWFP - Non- Wood Forest Product

TEEB - The Economics of Ecosystems and Biodiversity

UN - United Nations

UNDP -United Nations Development Programme

UNEP -United Nations Environment Programme

USA - United States of America

WRI -World Resources Institute

WORKING DEFINITION OF TERMS

Ecosystem – Refers to any geographic area with plants, animals and microorganisms interacting with nonliving components as a system.

Ecosystem Services- Are the benefits people get from the ecosystems. They include provisioning, regulating and cultural services that directly affect people and supporting services needed to maintain the other services.

Higher Plant Species – Are those land plants with phloem and xylem for conducting water and minerals throughout the plant to evolve to a larger size and they include trees and shrubs

Livelihoods- Are the means by which people make a living. For this study, livelihood means monetary and non-monetary (consumptive) benefits derived from socio economic activities which communities engage in for example, like charcoal burning, crop production, livestock keeping, bee keeping and handcraft selling among others.

Home gardens -Refers to an area of land individually owned, surrounding family home which combines physical, social and economic functions for monetary and non-monetary benefits.

Provisioning ecosystem services- Are the goods or products obtained from the ecosystems such as food, fresh water, timber, fuel, medicines, ornamental resources, fibre and genetic resources.

Regulating ecosystem services- Are the benefits obtained from an ecosystem's control of natural processes.

Species richness- The number of different species of plants represented in a given region.

Socio-cultural ecosystem services- Are the non- material benefits from the ecosystems for example ecotourism, spiritual, recreational and educational services.

Sustainable use –Refers to the use of components of biological diversity in a way that does not lead to the long-term decline thereby maintaining potential to meet the needs of present and for the generations.

Wetlands –Refers to areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The concept of ecosystem services emerged in the 1970s as 'environmental services' (Costanza et al. 1997) and was re-named 'ecosystem services' in the mid-1980s (Daily 1997), and really gained momentum from 1997 onwards. Ecosystem services are the benefits people obtain from the relationship between biotic and abiotic components of the environment. TEEB (2008) and MEA (2005) describe the services as conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life by directly or indirectly supporting humans' survival and quality of life. De Groot, Rudolf, Matthew, Wilson and Boumans (2002) group these services into Provisioning services such as food, genetic resources, wood, fiber and medicines; Regulating services such as water regulation; socio-cultural services like recreational, spiritual, religious and tourism benefits, and supporting services needed to maintain the other services such as soil formation and nutrient cycling.

Global policy interest in ecosystem services has increased in the past two decades with various studies being undertaken, because of the significance of ecosystems in providing services to rural people in developing countries (Salzman, Thompson & Daily, 2001; Michaelidou, Decker & Lassoie, 2002; Deutsch, Folke & Skanberg, 2003). For instance, Deutsch et al. (2003) focused on the dependence of human well-being on ecosystem services at the global level and the decreasing capacity of ecosystems to continue producing those services. Michaelidou et al. (2002) studied the relationship between community well-being and ecosystem viability at a regional scale, noting that they are both interconnected and interdependent. Further, a study by Petheram, Campbell, Marunda, Tiveau and Shackleton (2006) noted that in developing countries, the

majority of populations depend on traditional energy sources like firewood and charcoal, subsistence farming and products harvested from the surrounding ecosystems. These studies concentrated on the importance of ecosystem services in providing services to rural people at global, regional, developing countries and the decreasing capacity of these ecosystems in providing these services. A better understanding of the contribution of ecosystem services to the communities' livelihoods was particularly needed at a local scale.

The well-being of every human population in the world is fundamentally and directly dependent on ecosystem services and humans derive vast and uncounted benefits from the functioning of ecosystems (MEA, 2003). United Nations (2006) noted that the Millenium Development Goals (MDGs) aim to achieve a significant improvement in the lives of at least 100 million slum dwellers by 2020. However, the proportion of people whose income is less than a dollar a day is yet to be achieved hence the people have to depend on ecosystem services for their well-being. Studies by UNDP, UNEP, World Bank and WRI (2000) noted that about 75% of the world's populations rely on traditional medicine for primary health care and 42% of the world's 25 top-selling drugs in 1997 were derived from natural sources. Thus, Local people often rely on products, services, or land from nearby ecosystems to meet their needs and their use constitutes one demand on biological resources of these areas (European Communities, 2008; Salafsky & Wollenberg, 2000). These researches generally conclude that people depend on ecosystems services; for example, provisioning services like food and medicine. The same ecosystems also provide higher plant species as provisioning services capable of providing variety of products which could be utilized by the communities through various livelihoods to improve their well being. Therefore, there was need to clearly establish whether higher plant species in these

ecosystems provided variety of products influencing the livelihoods of the people to improve their well being.

A study by Egoh, et al. (2012) established that in Africa, 80% of the people depend on ecosystem services for the provisioning of wood for cooking, poles for fencing, water for drinking and other products for sale. This finding compares well with findings by WRI et al. (2007) and CBD, (2002) that ecosystem in Africa have rich biological diversity which Africans rely for survival. The studies further focused on ecological and social impact of extraction of natural resources, human activities, serious threats faced by these ecosystems and their decreasing capacity to offer these ecosystem services. World Bank, (2003) noted that the dependence of people on ecosystems services in Africa is more apparent in rural communities whose lives are directly affected by the availability of resources such as food, medicinal plants and firewood. These studies (WRI et al., 2005; Egoh et al., 2012; CBD, 2002 and; World Bank, 2003) concur that rural communities in Africa directly depend on ecosystems for survival and specifically, the provisioning services. The studies also focused on the rich biological resources found in Africa which people rely on for their survival concluding that extraction of these resources leaves the ecosystems under threat. The biological resources also include forests, which are catchment areas of many permanent rivers, and streams from which water from these sources could be used through irrigation to support livelihoods like food crop production and livestock keeping hence improving the wellbeing of the people. Thus, there was need for the current study to examine water regulation as an ecosystem services and find out how water available from these ecosystems influence food crop and livestock production as livelihoods for the people accessing these ecosystems.

Jones and Murphree (2004) noted that in the humid and forested areas in the West and Central parts of Africa, food, tourism raw materials and agriculture are important ecosystem services. A study by Chaposa (2002) concluded that in dry Miombo woodland in Eastern Tanzania, 50% of rural household income was derived from the sale of forest products such as fuel wood, honey, charcoal, and wild fruits. This study has similar findings noted by Mwakatobe and Mlingwa (2005) in Malawi that an estimate of US $ 1.7 million was obtained each year from the sale of honey and bee wax, employing 2 million rural people. These findings reveal that ecosystems in Africa like rain forests support food crop production through agriculture, sale of honey and wild fruits, tourism and provides employment to rural people through which income is obtained to acquire family basic needs for survival. These ecosystems are also capable of providing other services like socio-cultural ecosystem services, for example, ecotourism, recreation and educational services that are capable of supporting livelihoods of the local people. This leads to the need for further clarification on other socio-cultural ecosystem services accessed from ecosystems and clearly establish the effect these socio-cultural ecosystem services on communities' livelihoods.

In East Africa, more than seven in ten poor people live in rural regions, with most engaged in ecosystem dependent activities, such as fishing, hunting, artisan mining, logging, livestock rearing, collecting fuel wood, herbs, or other ecosystem products (IFAD, 2001 & WRI et al, 2005). From the above studies, it is evident that ecosystems can support various activities. However, it is not exhaustively clear whether these activities are depended on higher plant species which are genetic resources under provisioning ecosystem services. A study by Monela, Chamshama, Mwaipopo and Gamassa (2005) noted that ecosystem services may be sold, used

directly or used in customary ritual performances. Studies by RoK, (2006) and CBS, (2005) concur that ecosystem services play a significant role in Kenya's economy, and human well-being since 80% of Kenyans people rely on them for survival. Similar findings were noted by Mati, Simon, Hussein, Patrick and Felix (2008) that the Mara-Serengeti ecosystem, which is a world famous wildlife sanctuary, supports a thriving tourism industry not only due to its annual wildebeest migration, but also the sale of traditional artifacts by the local nomadic pastoralists. These studies concur that ecosystems in East Africa provide products which are sold for income and these ecosystems support various activities like handcraft selling from which income is obtained. From the researches, it is not clearly evident whether activities like food crop farming and livestock keeping which depend on water as a product from ecosystems through water regulation are also supported by these ecosystems. Therefore, there was need for further investigation on the influence of water availability on foodcrop and livestock production as livelihoods by the people accessing these ecosystems.

Ecosystem in Kenya supports abundant and varied wildlife, for example, 6506 higher plants, 359 mammals, 344 birds, 261 reptiles, 63 amphibians and 314 fish species (WRI, 2003). From this list of higher plant species, it is not clearly documented whether these higher plant species support livelihoods of the Kenyan people. According to FAO (2002), Kenya's forests have several wood and non-wood forest products that contribute to the economy and livelihoods of the country and its people. Forest products include timber, wood fuel and charcoal, fodder plants, medicinal plants, and other non-wood forests products such as tannins, essential oils and bee wax (FAO, 2002). A report by GoK (2001) contradicts this information that an estimated 12.6 million people in Kenya live below the poverty line and yet this big number should be relying on

the several ecosystems in Kenya for various livelihoods to improve their well being. Silvestri, Zaibet, Said and Kifugo (2013) carried out a study on mapping and valuing ecosystem services especially those that will be lost if a particular part of the landscape is modified in Ewaso Ng'iro basin, Kenya. The study concluded that the basin is a wetland surrounded by communities who obtain variety of products for sale and that anthropogenic activities are a threat to the ecosystem. There was need also to investigate on if water available from this ecosystem supported livelihoods like food crop and livestock production. In addition, the basin hosts variety of genetic resources that could also influence the livelihoods of the communities in the region and therefore, the need to examine influence of higher plant species richness on the livelihoods of the communities living near the basin.

A study by Mati et al.(2008), on the impacts of land-use/cover changes on the hydrology of the Mara Basin shows that, the basin supports the economic livelihoods of pastoral people, farmers, fishers, some hunter-gatherers and other people relying directly or indirectly on tourism. Timilsina (2007) concluded that protected areas through ecosystem services play a critical role in sustaining natural resources and livelihoods of local people. Studies by Georgiadis, Ihwagi, Olwero and Romanach (2007), and; Ojwang' and Wargute (2009) in the Ewaso Ng'iro basin ecosystem concluded that the basin is home to diversity of species with more than twenty species of indigenous large mammals. Kiteme and Thenya, (2011) noted that Ewaso Ng'iro basin has several riverine permanent wetlands with a total area over 50 Ha. These studies (Georgiadis et al., 2007; Ojwang' & Wargute, 2009 and; Kiteme & Thenya, 2011) acknowledged that the basin ecosystem is a home to diversity of species which could be of use to the local communities. However, in depth investigation on the variety of genetic resources like higher plant species in Ewaso Ng'iro ecosystem, could have provided clear link between higher plant species and

communities livelihoods, and lead to conclusion whether or not, higher plant species influence livelihoods. In addition, wetland ecosystems regulate water and are potential areas for livelihoods like food crop and livestock production and yet, much was not revealed on whether there was any significant relationship between water availability on food crop and livestock production as livelihoods done by the communities. The fact that these ecosystems could provide socio-cultural ecosystem services influencing the livelihoods of the communities further motivated this study.

Makueni County is one of the poor counties in the Lower Eastern region of Kenya with a poverty level of 73 % and has the highest number of poor individuals (631,865 persons) as compared to other counties, for example, Kitui County with poverty level of 62.5% with 518,951 poor individuals, Machakos County with poverty level of 57% with 617,423 poor individuals, Taita Taveta County with poverty level of 54.8% with 168,240 poor individuals and Garissa county with poverty level of 54.5% with 217,305 poor individuals (Republic of Kenya Economic Survey, 2012). Despite the high poverty levels, the county is endowed with many untapped resources that have the potential of changing the fortunes of the inhabitants (Makueni District Vision and Strategy, 2015) improving their wellbeing. Makueni county has a total of 5 gazetted forests and 4 un-gazetted forest areas covering 25 km^2 and 5 km^2 respectively with variety of animal and plant species in these ecosystems (Makueni District Vision and Strategy 2005-2015).

These biological resources which provide ecosystem services like higher plant species found in these forests, water regulation as an ecosystem service and non-material benefits from these ecosystems can be accessed by the residents to improve their well being. Mbuvi and Boon (2009) carried out a study on the livelihood potential of forest products, focusing on non-wood forest products in Mbooni Division of the former Makueni District. The study concluded that

forests in Mbooni Division provided various products to the riparian communities. The study focused on non-wood forest products with unclear information on whether the woody forest products which are higher plant species also provided products to the communities. Therefore, there was need to carry out a similar study and specifically focus on the influence of higher plant species on communities' livelihoods. Consequently, these ecosystems provide non-material benefits known as socio-cultural ecosystem services and there was need to establish whether or not these services influenced communities' livelihoods.

Adhikari's (2011) study focused on poverty reduction through the promotion of alternative livelihoods in rural dry lands while minimizing pressure from land-based activities in Makueni County. Nyariki and Ngugi (2002) concluded that arid and semi arid lands ecosystems support variety of livelihood activities like apiculture, poultry keeping, timber production, woodcarving and brick making, among others. It is not well established in this study whether these livelihoods are supported by higher plant species which are genetic resources from ecosystems providing various products from which communities derive the livelihoods. The same semi arid ecosystems could provide regulating ecosystem services leading to provision of water used by the people for survival. Therefore, information on the influence of water availability on food crop and livestock production in arid and semi arid ecosystems was needed hence, the need for the current study.

Kibwezi Sub-County in Makueni County hosts Tsavo West National Park and Chyullu hills game Reserve (RoK, 2009). Though Tsavo is a key tourist attraction, there was need to establish whether this protected ecosystem provided socio-cultural ecosystem services, which could influence the livelihoods in Kibwezi Sub-county. Forest ecosystems provide species diversity which provides products to the riparian communities (Karanja, Kalege & Moi, 2002). Kibwezi forest is rich in variety of species which can satisfy the social objective particularly provision of

livelihood benefits to the users (Mbonde & Luke, 2012). Experts say a county whose main features include hills and protected areas has no excuse crying over poverty (Daily Nation 5 th July, 2013). The study by Karanja, Kalege and Moi acknowledge the fact that forest ecosystems provide provisioning ecosystem services like plant species which provide products to the riparian communities. It is not clearly revealed whether these species are higher plant species and further, the link between higher plant species and livelihoods in Kibwezi sub-county still remained unknown.

Kibwezi Forest is a source of rivers, springs and streams, which provide water, which is an essential determinant for some livelihoods. This water could be accessed through irrigation to support food crop and livestock keeping, improving the well being of the people. Therefore, there was need to investigate further on the influence of water availability food crop and livestock production as livelihoods in Kibwezi Sub-county. The fact that ecosystems provide the non material benefits also known as socio-cultural ecosystem services which could also influence the livelihoods of the communities in Kibwezi, further motivated this study. Therefore, despite the growing interest (MEA, 2005; WRI, 2005; TEEB, 2008 and; Michaelidou et al., 2002) in the concept of ecosystem services, there remained the above important knowledge gaps which called for further research regarding how ecosystems services contribute to community livelihoods in Kenya generally and in Makueni County in particular.

1.2 Statement of the Problem

In reality, ecosystem services underpin daily economic activities and the quality of life by providing goods and services which not only provide income, but also other benefits for human

welfare. Kibwezi Sub-County has a variety of ecosystems including un gazetted forests with a diversity of plant species, rivers, streams and springs. In addition, the Sub-County has protected areas such as the Chyullu hills game reserve and the Tsavo West National Park which are key tourist attractions capable of contributing to the livelihoods of the people. According to RoK (2009), the population in the Sub-County living below the poverty line is 34% and 67% of urban and rural population respectively yet the ecosystem services in the region such as higher plants species could be accessed by the residents through various livelihoods to improve their well-being. Thus, it is worth noting that there is insufficient knowledge on the influence of higher plant species richness on the livelihoods of the communities in the region.

Kibwezi forest ecosystem is a source of rivers, springs, and streams which provide water that serves as an essential determinant for some livelihoods. This water could be accessed by the residents to increase food crop and livestock production which could improve the wellbeing of the people. Therefore, there was need to examine the influence of water availability on food crop and livestock production in Kibwezi Sub-County. Further, ecosystems provide socio-cultural services to people for example, aesthetic, spiritual, educational, and recreational values of the landscape which could support various livelihoods improving the people well being. However, there was scarcity of detailed information on socio-cultural ecosystem services provided by ecosystems in Kibwezi Sub-County and how these services affected the livelihoods of the residents hence, the need for the current research. The purpose of this study was therefore to examine the contribution of ecosystem services to rural livelihoods in Kibwezi Sub-County of Makueni County, Kenya.

1.3. Objectives of the Study

The general objective of this study was to examine the contribution of ecosystem services to livelihoods of communities in Kibwezi Sub-County of Makueni County, Kenya

The specific objectives were:

1. To examine the influence of higher plant species richness on the communities' livelihoods in Kibwezi Sub-County.
2. To determine the influence of water availability on food crop and livestock production in Kibwezi Sub-County.
3. To establish the effect of socio-cultural ecosystem services on communities' livelihoods in Kibwezi Sub-County.

1.4 Research Questions

The research was guided by the following research questions;

1. What are the higher plant species found in Kibwezi Sub-County?
2. How does plant species richness influence the livelihoods of the communities in the Sub-County?
3. What are the sources of water in Kibwezi Sub-County?
4. How does water availability influence food crop production in Kibwezi Sub-County?
5. How does water availability influence livestock production in Kibwezi Sub-County?
6. What are the socio-cultural ecosystem services provided by ecosystems in Kibwezi Sub-county?
7. How do socio-cultural ecosystem services influence communities' livelihoods?

1.5 Justification of the study

This study aimed at gaining indepth understanding of the contribution of ecosystem services to rural livelihoods. In reality ecosystem services underpin our quality of life as well as our social cohesion (MEA, 2003) but still the link between ecosystem services and livelihoods is not clearly understood. A critical missing link for some ecosystem services is the scant knowledge on their contribution to rural livelihoods in semi arid areas. To make the dependence of human wellbeing on ecosystem services more clear, there was need for more studies to be undertaken not only including the direct benefits but take into account all the indirect benefits (socio-cultural services) derived from ecosystem services. Specifically, there was need to generate knowledge on the influence of higher plant species richness on communities' livelihoods, to examine the influence of water availability on food crop and livestock production as livelihood activities and examine the effect of socio-cultural ecosystem services on communities' livelihoods especially from ecosystems in rural areas. It should be realized that many people may be benefiting from ecosystem services without realizing it and thus fail to appreciate their importance. Therefore, a clear understanding of these links can provide information that can lead to the reform of institutions and better decisions that ultimately improve the state of ecosystems and the services they provide to the society hence, improving the well-being of the people. It is expected that, by providing information and creating awareness on the contribution of the various ecosystems in Kibwezi region to the livelihoods and the well-being of the local communities, the study would be beneficial to researchers, policy makers, the local administration and the society at large.

1.6 Scope and Limitations of the Study

This study was done in Makueni County because it is one of the poor counties in the Lower Eastern region of Kenya with a poverty level of 73 % and has the highest number of poor people

(631,865 persons) compared to other counties in Kenya (Government of Kenya Economic Survey, 2012) and yet, the county has resources including ecosystems providing goods and services which can be tapped to improve the well being of the people. The study was limited to Kibwezi Sub-County, focusing on examining the contribution of ecosystem services to livelihoods in the rural areas of Kibwezi Sub-County. The study was conducted in Kibwezi Sub County which is one of the five sub counties in Makueni County. Among the five counties, it is the largest with an approximate area of 3,985km^2 with majority (67%) of the population living below poverty line. The Sub-County is endowed with a variety of ecosystems evidenced by Kibwezi forest, Kiboko, Kibwezi, Thange and Mtito Andei rivers, Umma and Uzima springs and protected areas ecosystems which provides ecosystem services that are potential to supporting communities' livelihoods improving their well being.

Ecosystem services are grouped in to four categories, which include provisioning services such as genetic resources, regulating services such as water regulation, socio- cultural services such as recreational, inspirational and spiritual services and supporting services such as climate regulation, nutrient cycles and crop pollination. However, in this study, the researcher only focused on three categories namely; provisioning services which include genetic resources focusing on higher plant species richness, regulating services focusing on water regulation, and socio- cultural ecosystem services. Supporting ecosystem services such as nutrient cycles, soil formation and crop pollination were not included in the study. This is because supporting services are those that are necessary for the production of all other ecosystem services (MEA, 2005). They differ from provisioning, regulating, and cultural services in that their impacts on people are either indirect or occur over a very long time.

CHAPTER TWO

LITERATURE REVIEW

2.1 Influence of Higher Plant Species Richness on Livelihoods

In a fundamental sense, ecosystems are the planet's life-support systems for human species and all other forms of life for the provision of basic needs like food, water, clean air and shelter, with over half of the world's population relying on direct products of ecosystems (WHO, 2005). According to MEA (2003) millions of people around the world depend partly or fully on natural products collected from ecosystems for medicinal purposes. A study by Joshi (2009) concluded that forest ecosystems provide a great number of species of plants and animals and the enormous diversity of genes in these species satisfy social objectives particularly the provision of livelihood benefits to users. In their study on plant species richness and livelihoods, Persha, Harry, Ashwini, Arun, and Catherine (2009) concluded that forest ecosystems in South Asia provide firewood, fodder and timber for livelihood support for local populations. Another study by Pantaleo et al. (2011) established that ecosystems such as wetlands host a variety of plant species, which make appreciable contribution to rural livelihoods in terms of direct cash and contribution to food security.

Findings by Pantaleo et al. (2011), do not clearly indicate the variety of plant species being referred to, and the different types of plant uses from which the livelihoods can be clearly identified. Woodland ecosystems are also very useful in supporting livelihoods in terms of providing various products like wild fruits, firewood, timber, poles and other services to the surrounding communities as demonstrated by Giliba et al. (2011). However, from the study by Giliba et al. (2011) it is not clear whether these products are harvested specifically from higher

plant species which are provisioning ecosystem services. Further, these studies generally agree that ecosystems provide various products which support livelihoods but there is no clear link between the products and the livelihoods. These products are provisioning ecosystem services which could be obtained from different genetic resource for example, higher plant species and further support variety of livelihoods for the surrounding communities. Therefore, there was need to provide an indepth understanding on the influence of higher plant species no communities' livelihoods.

Biological diversity from various ecosystems offers numerous benefits to rural communities and the society at large, yet the roles of plant and animal diversity in contributing to sustainable livelihoods and poverty alleviation are widely debated (Brandon, 2000). A study by Munthali, (2007) observed that protected areas like forest ecosystems retain higher levels of biological resources than surrounding areas and contribute substantially and directly to rural livelihoods. In Central Africa, the use of wildlife from forests (bushmeat) accounts for up to 80% of protein intake in rural households (Nasi et al., 2008). According to UNEP (2008), forest and woodlands occupy about 22% of the land area in Africa and the region accounts for around 17% of the global forest cover with abundant plants and animals' species diversity. In their study on non forest products and livelihoods, BowenJones, Brown and Robinson (2003) observed that in the humid and forested areas found in the West and Central parts of the continent, local communities rely mostly on food and raw materials such as non-timber forest products coupled with agriculture. The study concluded that livelihoods are supported from a combination of these products as well as small to medium scale agriculture. These studies agree that ecosystems in Africa have biological resources that contribute to rural livelihoods and the studies majorly

focused on food and raw materials obtained from forest ecosystems. These biological resources also include higher plant species and could support variety of livelihoods improving the well being of the people. Thus, there was insufficient information on the influence of higher plant species richness on rural livelihoods hence the need for the current research.

Wild foods from various plant species are important locally in many developing countries, often bridging the hunger gap created by stresses such as droughts and civil unrest (Michaelidou et al, 2002). A study by Ham (2005) in South Africa observed that communities collectively harvest about 2000 tons of *S birrea*, and earn $180,000 annually, representing more than 10% of average household income in the communities. Phytotrade (2005) reported that a gross revenue of $629,500 was earned from wild fruit selling of natural tree products which included $44,120 for *Ximenia caffra*, $22,250 for *Adansonia digitata* (baobab) and $20,000 for *Kigelia* spp. These studies confirm that income is obtained from the sale of products from wild fruits. Given that these plant species grow in ecosystems, the species could also provide other products which could be sold for income and other uses supporting livelihoods. It may also be necessary to establish whether these higher plant species influenced livelihoods of the communities harvesting these products.

Other studies reported that natural resources are the basis of subsistence in many poor communities and that the livelihood in developing countries like herbal medicine and wild fruit selling, is directly dependent on ecosystems (Degroot et al., 2012; UNEP, 2011). In rural communities where employment opportunities are limited, many people collect natural resources for their own use or for sale to supplement household income (Yemiru, Roos, Campbell &

Bohlin, 2010). A study by Bennett, Peterson, Garry, Gordon and Line (2009) concluded that many elements of human well-being are directly dependent on the products of ecosystems with food, water and biomass energy being prime examples. These studies confirm that income is obtained from the sale of products from ecosystems. Higher plant species from these ecosystems could also provide variety of products which could support variety of livelihoods from which income could be obtained improving the lives of the people. Thus, there was insufficient information on the influence of higher plant species richness on livelihoods for the people relying on them.

In East Africa, a study by McClean et al. (2003), concluded that ecosystem services in Uganda showed that majority of papyrus harvesters in Lake Bunyonyi wetlands obtained income from the sale of papyrus or crafts made from papyrus. In Kenyan rural areas, Ngugui and Conant, (2008) agree that people continue to rely on harvesting wild species, green spices and flavourings to enhance local diets, and many tree fruits provide famine foods when crops or the economy fails. Mara Basin wetland ecosystem supports the economic livelihoods of pastoral people, farmers, fishers, some hunter-gatherers as demonstrated by Mati et al. (2008). A study by Mogaka (2002) concur that in Kenya, almost 3 million people live adjacent to forests and the majority of these depend on agriculture or agricultural-related activities as a livelihood. Generally, these studies (Ngugui & Conant, 2008; Mati et al., 2008 and; Mogaka, 2002) noted that ecosystems in Kenya support various livelihoods for different people living near the ecosystems for income generation. Among the services provided by Kenyan ecosystems are provisioning ecosystem services which include genetic resources like higher plants which can contribute to the wellbeing of the communities by supporting various livelihoods. Therefore,

there was need to provide sufficient information on higher plant species richness and how these species influence livelihoods.

2.2. Influence of Water Availability on Food Crop and Livestock Production

Many aspects of the world's hydrological (water) cycle are regulated by the natural functions of ecosystems and associated geophysical processes which lead to availability of fresh water, essential for growing food, drinking, personal hygiene, washing and cooking, among other uses (Nkem, Daniel, Maria, & Markku, 2007). According to World Bank (2004) ecosystem services are a daily lifeline for many of the 1.1 billion people living in severe poverty and over 1.6 billion people depend on these services for their livelihoods. A study by Nkem et al. (2007), noted that in developing countries, the production of food is one of the most basic of ecosystem services and takes place both in natural and agricultural ecosystems while Bennet et al. (2009), concluded that in Africa, income from small-scale agriculture practiced on ecosystems account for some two-thirds of the household incomes of poor families. Further, USAID (1998) concluded that 'micronutrients' come from a varied diet including fruits many of which are traditionally sourced from natural ecosystems. These studies agree that ecosystems support livelihoods specifically food crop production where various vegetables are grown for consumption. Water is a product provided by the ecosystems through water regulation as a provisioning ecosystem services and plays a key role in food crop and livestock production as livelihoods. Thus, there was need to provide adequate information on the influence of water availability on food crop and livestock production which are important community livelihoods.

According to Rainforest Conservation Fund (2015), the world's rainforest ecosystem services such as provision of rainfall, soil stability and a regulated climate are integral to the successful production of food in many parts of the world. As further noted by RCF (2015), some rainforest service's extend across vast geographical area as is evident in the Amazon forest that makes as much as 50% of its own rainfall through a combination of processes which support agriculture in the region. Loulia (2011) observed that the winds moving westwards from the Atlantic Ocean carry moisture to the region, which the plants then recycle through transpiration, releasing it in to the atmosphere through their leaves and forming the basis of precipitation that supports food crop production. When the moisture hits the high walls of Andes, the water is deflected to the South, providing important rainfall that supports agriculture in South central Brazil and Northern Argentina (Loulia, 2011; RCF, 2015). These studies concur that the Amazon forest like any other forest ecosystems makes rainfall through ecological processes and that this rainfall truly supports agriculture. There was need to clearly reveal whether the total amount of rainfall received had any influence on food crops yields and livestock keeping as livelihoods improving the wellbeing of the people in Brazil and Northern Argentina.

According to Loulia (2011), ecosystems like rainforests recycle huge quantities of water, feeding rivers, lakes and irrigation systems which enhance food crop production. Goodland and Pimental (2000) noted that animals in semi-arid areas are heavily dependent on water for feed production. The sale of livestock and livestock products like milk, blood and hides is a vital strategy to enhance income and cope with major or unexpected family expenses and production of all these vital goods and services depends on water (Reda, 2002; Peden, Freeman & Notenbaert, 2006).

Further, Peden et al. (2006), added that livestock keeping in Sub-Saharan Africa is the preferred means of wealth savings in semi arid areas and an opportunity to further increase household income. A study by Anderson, Bryceson and Campbell (2004) concluded that about 268 million people living in Africa's arid and semi-arid areas which comprise 43% of the continent's surface area, 75% are rural dwellers whose livelihoods exhibit a strong reliance of ecosystems services. CEPSA (2008) reported that the livelihoods of the vast majority of the 268 million people, who live in arid and semi-arid areas in Africa, depend on transforming multiple ecosystem services into economic and socio-cultural goods and services that support their livelihoods. Some of these transformations could include using water from these ecosystems to irrigate crop farms and thus, supporting food crop production as a livelihood. These studies (Peden et al., 2006; Anderson et al., 2004 &; CEPSA, 2008) concur that ecosystems in arid and semi arid areas provide services, which contribute to the livelihoods of the rural dwellers. Among the services provided by ecosystems are also regulation services, for example, water regulation through which water is available in ecosystems for various uses including food crop production through irrigation and livestock keeping. There was need to highlight on how water availability as an ecosystem service influence livelihoods of the rural dwellers specifically food crop production and livestock keeping.

According to Pantaleo et al. (2011), wetlands ecosystems in Tanzania provide wide ranges of economic benefits to the surrounding communities. For example, 95% of domestic, irrigation and industrial livestock water; 80% of traditional irrigation schemes, and 95% of rice and vegetation production depended on water from the wetland ecosystems. Nierenberg (2005) concluded that large numbers of poor farmers and herders in semi arid areas depend on livestock

for their livelihoods. A study by Rweyemamu (2009) reported that the wetlands of Bahi, Tanzania have enabled cultivation of paddy rice which contributed significantly to household food security generating 65% of the total household food crop production with the surplus being sold for income. Further, Silvetri et al. (2013), concluded that in areas with less rainfall, food crop production is possible around more permanent water sources through irrigation. Other studies have concluded that since water is essential for life, the ecosystems associated with rivers and wetlands acquire special significance in dry land areas, since they supply a range of services that are of value to people (Meyer, 2007; Turpie & van Zyl, 2002). These studies concur that water is the most important provisioning service that supports food production and is provided by rivers and some wetlands from these arid regions. However, there was need to carry out a correlation to establish if there was a significant relationship between water used during irrigation and the total amount of crop yields harvested by the local communities.

A study by Mogaka (2002) indicated that households in Kenya, living within a distance of 5 kilometres from forests depend directly on the forests for crop farming in different areas. Anne, Kipkemboi, Rahman and Gretchen (2013) carried out a study in Nyando river basin on hydrology, ecosystem functions and livelihood outcomes on Nyando papyrus wetlands concluding that the wetlands were used for agriculture, grazing and papyrus harvesting. In most of Kenya's arid and semi-arid areas, pastoral livelihood strategies dominate, involving moving livestock periodically to follow the seasonal supply of water and pasture majorly dependent on ecosystems (Nyariki & Ngugi, 2002). Agro-pastoralism (food crop production with livestock keeping) is a livelihood activity in areas where rainfed agriculture is possible around permanent water sources (Kidane, Dejene & Malo (2004). Further, Kidane et al. (2004), concluded that

these agricultural lands are typically dominated by a mix of food, livestock and high value vegetables which are often destined for export. Dry land ecosystems supply food from livestock and crops, water for domestic use and irrigation and all these livelihood activities are directly dependent on ecosystem services as demonstrated by Silvetri et al. (2013). Ecosystems like forests are sources of rainfall through the ecological processes forming catchment areas of rivers and streams which are the base livelihoods for example, food crop production and livestock keeping as noted by the above studies. Therefore, it necessary was to provide adequate information on water regulation specifically focusing the influence of water availability on food crop and livestock keeping as livelihoods.

In Makueni County during heavy rainfall seasons, while surface water provides the bulk of water related ecosystem goods and services, groundwater is widely used throughout the region for domestic water supply and livestock watering (RoK, 2009). Water is the most important regulating ecosystem service provided by different ecosystems such as forests and wetlands like rivers, streams and springs (Mbonde & Luke, 2012). In their study on the livelihood potential of non-wood forests products, Mbuvi and Boon (2009) concluded that forests in Mbooni division in Makueni County provided various products to the riparian communities. The rural poor depend more directly on the natural water sources for domestic water supply, other productive uses and water available therefore is of great importance for the well-being of poor communities as demonstrated by RoK (2009). These studies noted that ecosystem products like non-wood products provide income to the riparian communities. These ecosystems can provide other services like water regulation which leads to water availability supporting livelihoods, specifically food crop and livestock production. Therefore, there was need for the current study

to clearly highlight on the available water sources and further reveal whether the amount of water accessed could have any significant influence on food crop and livestock production as livelihoods affecting the wellbeing of the people in the study area. Therefore, despite the above relevant researches on ecosystem services, there were still gaps of knowledge on how water availability influences food crop and livestock production as livelihoods specifically in rural areas of Kibwezi Sub-County of Makueni County, Kenya.

2.3 Effect of Socio-cultural Ecosystems Services on Livelihoods

Worldwide, communities obtain many non-material benefits from ecosystems including sites and opportunities for tourism, recreation, aesthetic appreciation, inspiration and education (WHO, 2005). A study by World Bank (2000) in Madagascar concluded that 41 reserves covering approximately 1.5 million hectares provided ecotourism benefits which were significant and expected to increase overtime, providing greater returns to surrounding communities. McMichael et al. (2005), concluded that various traditional practices linked to ecosystem services, including seasonal cycles of thanks giving and celebration, play an important role in developing social capital and enhancing social well-being but are yet to be recognised by the riparian communities. Other aspects of human well-being, such as the ability to earn an income that permits access to the basic material for a good life, are also often directly or indirectly linked to ecosystem services as noted by Kikoti, (2009); MEA, (2003) and; Kamal and Britta, (2009). According to World Bank (2003), the income from nature-based tourism in South Africa is largely based on the spectacular biodiversity in Southern Africa. The above relevant studies agree that ecosystems provide socio-cultural services which through income generation enhance the human well-being.

However, it is worth noting that this income could be obtained through various livelihoods arising from these socio-cultural services yet this link was not clearly revealed by these studies. In addition, the study by the Word Bank (2003) majorly focused on income from tourism yet biodiversity attracts other services like recreation, spiritual and religious services which could also bring income and benefit the people depending on them. From these studies, it was not clearly highlighted whether ecotourism and any other socio-cultural ecosystem service supported any livelihoods of the people. Therefore, there was need to clearly reveal the relationship between socio-cultural ecosystem services livelihoods of the people accessing these services.

The varied ecosystems of Africa are not only habitat to diverse species, but also provide a number of services and goods for the local population and the economies of African countries (UNEP, 2008). Studies conducted in Africa conclude that Africa has diverse ecosystems like rainforests, wetlands and deserts savannahs which provide provisioning services like forest food and raw materials (McLean, 2005; UNEP, 2008; FAO, 2002; BowenJones et al., 2003). However, despite the diversity of ecosystems found across the African continent, Western (2003) noted that more than half of African communities live in rural areas relying on ecosystem services for their survival. For example, approximately 90% of Burundians, 88% of Ugandans and 84% of Ethiopians live in the countryside. This large rural population means that the majority of the people depend on various and varying ecosystem services directly or indirectly, for example, the socio-cultural ecosystem services which could support livelihoods.

These studies further concur that Africa is rich in varied ecosystems which provide services to the people. However, these studies (McLean, 2005; UNEP, 2008; FAO, 2002; BowenJones et al., 2003 and; Western, 2003) concentrated on provisioning ecosystem services like food and raw

materials acknowledging that ecosystems in Africa provide provisioning ecosystem services. It is worth noting that these ecosystems provide also the non-material benefits also known socio-cultural ecosystem services like ecotourism, spiritual, religious and recreation services like which could influence the livelihoods accessing these ecosystems. Therefore, there was need for confirmatory investigation on the effect of socio-cultural ecosystem services on communities' livelihoods.

Other researches on socio-cultural ecosystem services contend that ecotourism incorporates environmental, social, community and visitor benefits and has a prominent role as a local poverty reduction tool (Drumm & Moore, 2005; Baker, 2008; Moscardo, 2008). For instance, Baker (2008) attests that ecotourism, which denotes a small-scale sustainable form of tourism in which local control and benefits are of primary importance, should be encouraged to conserve resources and provide alternative sustainable livelihood strategy to reduce poverty in the communities. Moreover, Mann (2006) asserted that tourism, like any other industry, needs to be strategically and sustainably developed in order to unleash its potential positive impacts to the local people. Ecotourism has minimal negative impacts on the environment. In other words, ecotourism has demonstrated the economic value of natural areas for recreation and tourism itself, local economic development and socio cultural development (Drumm & Moore, 2005; Mitchell & Faal, 2008; Moscardo, 2008 and; Mad, Radam, & Shuib, 2009). According to Mad et al. (2009), and Mitchel and Faal (2008), a common ecotourism goal is the generation of economic benefits such as employment, revenue from the parks and profits for companies which contribute to the Gross National Domestic Product.

These studies (Drumm & Moore, 2005; Mitchell & Faal, 2008; Moscardo, 2008 and; Baker, 2008) only suggest that ecotourism can provide employment to the local communities leading to income generation. These ecosystems may also provide other socio-cultural ecosystem services that could have an effect on the communities livelihoods, hence current study delved on other socio-cultural ecosystem services and their effect on communities' livelihoods in Kibwezi Sub-county.

The diverse vegetation cover in East Africa results in different ecosystem services delivered in different parts of the continent which also affect the ecosystem services accessed by the locals (Rebelo, McCartney & Finlayson, 2010). According to UNEP (2012), key economic sectors are dependent on ecosystem services such as forests and forest related products. Mati et al. (2008), noted that the pastoralists in East Africa generate income by selling traditional artefacts. According to Thompson (2002), in some areas like Mara-Seregeti ecosystem, tourist-related services provide important additional income for local pastoralist communities. These studies (UNEP, 2012; Mati et al., 2008 and; Thompson, 2002) noted that ecosystems provide benefits to the local communities supporting livelihoods like handcraft selling which lead to income generation. However, there was need to reveal other socio-cultural ecosystem services which could be accessed from these ecosystems and further provide clear relationship between socio-cultural ecosystem services and livelihoods.

Other studies concluded that ecosystem services can be used in improving the human wellbeing and through the use of these ecosystem services, MDGs such as eradicating extreme poverty and hunger as well as improving human health, can be achieved in a developing country like

Tanzania (Sukhdev, 2008; Songorwa, 2007; European Communities, 2008). While other researchers such as Binns and Nel (2002); Chhabra, Healy, and Sills (2003) and; Gaylard, (2004) discuss the benefits of tourism in general, Barber, Dalziel, Derks and Kula (2006) noted that the benefits derived by informal traders from the sales of curios to tourists in many developing countries are insufficiently researched. Similarly, very little literature has revealed the contribution of this industry to people's livelihood. For this reason, there may have been an underestimation of the importance of the tourism informal handicraft sector in eradicating poverty and empowering the poor as asserted by Chhabra et al. (2003). This notion challenges many researchers who have shown these benefits at country level but failed to show specifically how these benefits influence people's livelihoods, particularly those engaged in the selling of handicraft products in rural areas. Anderson et al. (2004) therefore concluded that ecosystems and livelihoods studies should pay more attention to specific socio-cultural ecosystem services to provide more comprehensive and reflective insights on the significance of socio-cultural services provided by ecosystems. Further, Anderson et al. (2004) argued that without such critical information, the contribution of ecosystems services to the livelihoods of people will not be properly conceptualized and contextualized. Therefore, this study attempted to gain an in-depth understanding of the effect of socio-cultural ecosystem services on communities' livelihoods like handcraft selling so as to conclude logically at small scale level and avoid the fallacy of generalization.

Kenya's ecosystems provide human beings with recreational, exercise opportunities and, along with the biodiversity they contain, feed into many cultural, intellectual and spiritual traditions that contribute to human well-being (WRI, 2007). Further, WRI (2007) observed that cultural

and recreational activities in the variant ecosystems in Kenya are the source of economic revenue through tourism. Kenya savannahs are home to wildlife that boosts tourism, an industry that accounts for approximately 19% of Kenya's GDP (ASARECA, 2006). Kisangau and Herrmann (2007) carried out a study on the utilization and conservation of medicinal plants used for primary health care in Makueni County concluding that harvesting of medicinal plants for sale is a socio-cultural ecosystem service, which lead to household income. These studies agree that ecosystems provide socio-cultural ecosystem services like tourism and selling of herbal medicine. It's worthy to note that the same ecosystem could provide other socio-cultural services which could also generate income to the people practising them. In addition, the effect of these social cultural ecosystem services to the communities' livelihoods still remained unexplored. Therefore, despite the available literature review on the concept of ecosystem services, there still remained the above important knowledge gaps regarding how socio-cultural ecosystem services actually known or unknown contribute to the livelihoods of the communities depending on these services hence the need to carry out the current research in Kibwezi Sub-County of Makueni County, Kenya.

In summary, it is observable that previous studies have emphasized ecosystem services generally without any specific focus on the influence of higher plant species on people's livelihoods in many parts of the world including the semi arid areas of Kibwezi Sub-County. The studies also address forests and wetlands as potential areas for agriculture but specific focus on the influence of water availability on foodcrop and livestock production was not keenly highlighted. In addition, ecosystems provide socio-cultural services which could affect the livelihoods of the local communities and yet the above literature had hardly examined this. This study therefore,

aimed at examining the contribution of ecosystem services on rural livelihoods of the local residents in Kibwezi Sub-County of Makueni County, Kenya.

2.4 Theoretical Framework on Ecosystem Services and Livelihoods.

Over the past few decades, many attempts have been made to systematically link the functioning of ecosystems with human wellbeing (MEA, 2005). Central elements in this link are the physical and biological resources found on the earth and the ecosystem services that are provided by these ecosystems (MEA, 2005; Limburg, O'Neil, Constanza & Farber, 2002). The people's interaction with the environment and its effects on human welfare stretches back centuries as evident in writings in the Roman times on the increase in populations and decline in what is now called ecosystem services (Johnson, 2000). At the same time, the interdisciplinary field of ecology and economics developed the concept of natural capital which includes renewable resources and ecosystem services to demonstrate the significance of ecosystems in providing the biophysical foundation for societal development and human economies.

The theoretical framework for this study was based on Ecosystem services Framework. The ecosystem services framework approach is based on the recognition of the interconnectedness of ecological processes and socio-economic processes. It is an anthropocentric approach, based on the ways in which ecosystems contribute to human well-being. In particular, the framework brings the human dependency and uses into the picture. As such, it goes beyond the reflection in terms of services provided by ecosystems and benefiting humans. The ecosystem services framework includes frameworks such as the Millennium Ecosystem Assessment (MEA, 2005; MEA, 2003) and the UK National Ecosystem Assessment (Limburg et al., 2002) which generally focus on biotic resources, their direct use; either consumptive or non-consumptive use and

indirect uses by humans. MEA, (2005) is a framework which allows for the appraisal of both ecological and social conditions of ecosystems and provides a basis for accessing goods and services from ecosystems and sustainable use of ecosystem goods and services which improve the human well-being. Therefore, in this study, the researcher considered some goods and services like genetic resources specifically higher plant species richness, water availability as an ecosystem regulation service and socio-cultural ecosystem services as non-consumptive uses of ecosystems.

The specific focus was on understanding the contribution of these ecosystem services to livelihoods. This involved the study on how genetic resources specifically higher plant species richness influenced the livelihoods of the people of Kibwezi Sub-County in Makueni County. The study concluded that higher plant species supported livelihoods like livestock keeping, firewood selling, charcoal burning, handcraft selling, brick making, and wild fruit selling, among others, as explained in Chapter Four of this study. Water is also an ecosystem service which could influence communities livelihoods especially food crop and livestock production as revealed in Chapter Four of this study. Ecosystems provide socio-cultural services to the communities accessing them hence the current study aimed at evaluating the effects of socio-cultural ecosystem services on the rural communities' livelihoods.

It is worth noting that ecological economists have also called for a broader dialogue between economists and other social scientists to better understand the many contributions of nature to human well-being (MEA, 2003). Further, TEEB, (2008) noted that ecosystem services are often invisible to decision makers whose opinions have important impacts on the environment. Thus,

decision makers tend to ignore the impact of their decisions on the provision of ecosystem services. Unless this imbalance is fixed with proper incentives for their sustainable provision, global society is unlikely to see the type of fundamental change necessary to sustain environmental quality and human wellbeing (WRI, 2007). According to Maltby (2009), fundamental changes are needed in the way ecosystems and their services are viewed and used by the society. A major difficulty is that many ecosystems services are public goods and user levels are therefore difficult to regulate even when they are at or near the point of exhaustion (Maltby, 2009). Limburg et al. (2002), noted that although people benefit from ecosystem services, individuals or groups usually have insufficient incentives to maintain ecosystems for continued provisioning of services. In some cases, knowledge is lacking about the contribution of ecosystem services to human welfare.

2.5 Conceptual Framework

Ecosystem services underpin our well-being including the production of most of basic needs and so are of significant value (MEA, 2003). Human well-being is assumed to have multiple constituents including the basic material for good life and adequate livelihoods. This includes, having sufficient food stocks, security, shelter, clothing, health services, a healthy environment, and good social relations. Ecosystems host a variety of species which human beings can depend on for various livelihoods. Therefore, the conceptual framework represents a summary of dependent and independent variables used in this study. The independent variables for this study were; provisioning ecosystem services which included the higher plant species richness as genetic resources from ecosystems, regulating ecosystem services which focused on water regulation and socio-cultural ecosystem services which included ecotourism, recreational,

spiritual and educational services which could be accessed from ecosystems in Kibwezi. (see Figure 1. Pg.32). The dependent variables for the study were the livelihoods which could be supported by the three ecosystem services for example, crop farming, livestock keeping, handcraft selling, bee keeping home stay operators and tour guides, among others.

However, the availability of these ecosystem services are highly dependent on the functioning of the ecosystems which may be affected by other factors like changes in rainfall, runoff, and household characteristics which act as intervening variables which can also affect the distribution and range of ecosystems and species respectively. Changes in ecosystems will in turn affect the delivery of ecosystem services, thereby affecting human well-being and resilience. Nevertheless, the ecosystem services are the foundation of daily life and are available without people necessarily being conscious of how they influence their livelihoods. Therefore, the current study examined the contribution of ecosystem services to rural livelihoods hence providing reliable data to justify the dependence of humans on ecosystem services as seen in the conceptual framework below.

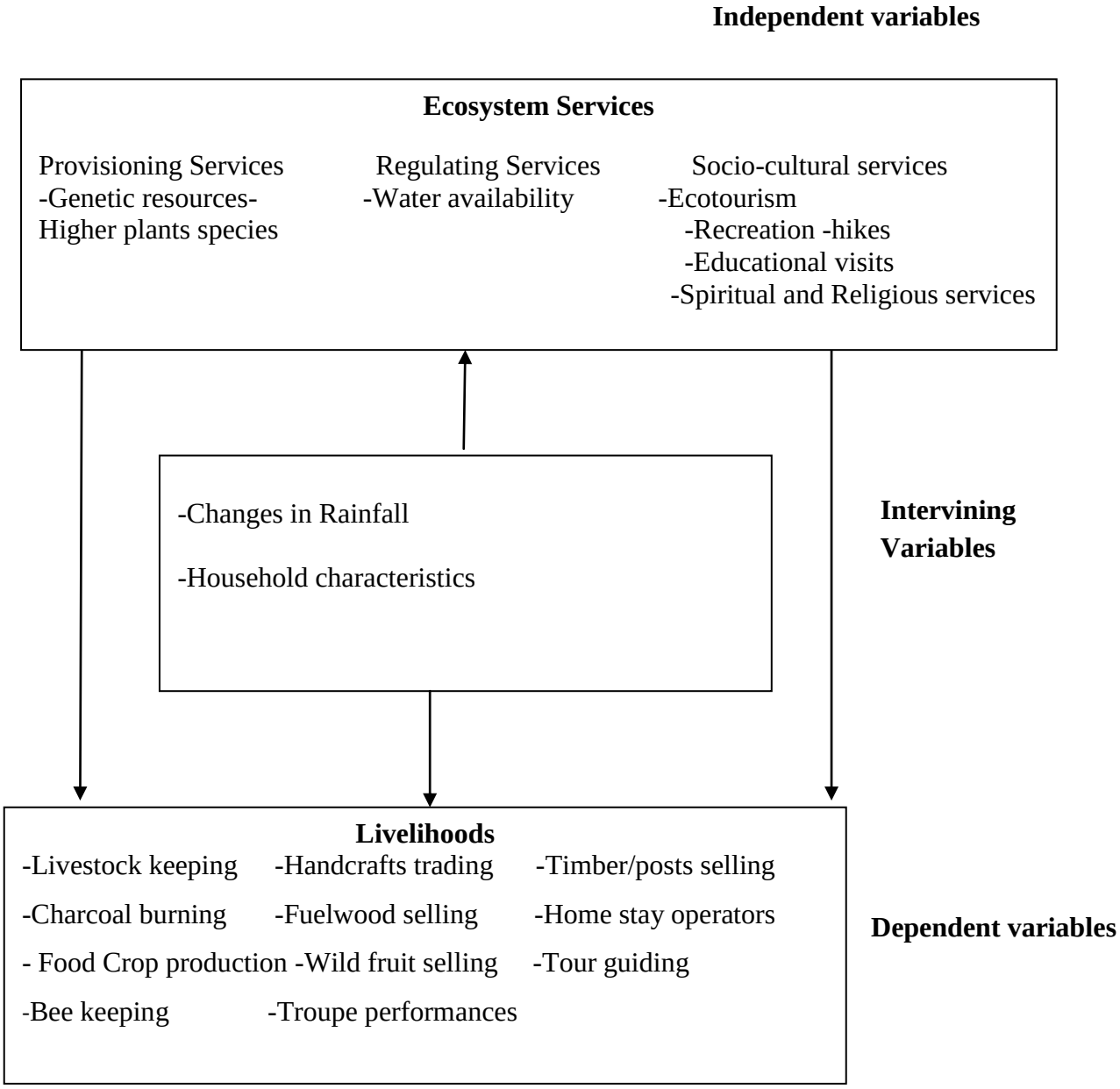


Figure 1: Conceptual Framework.

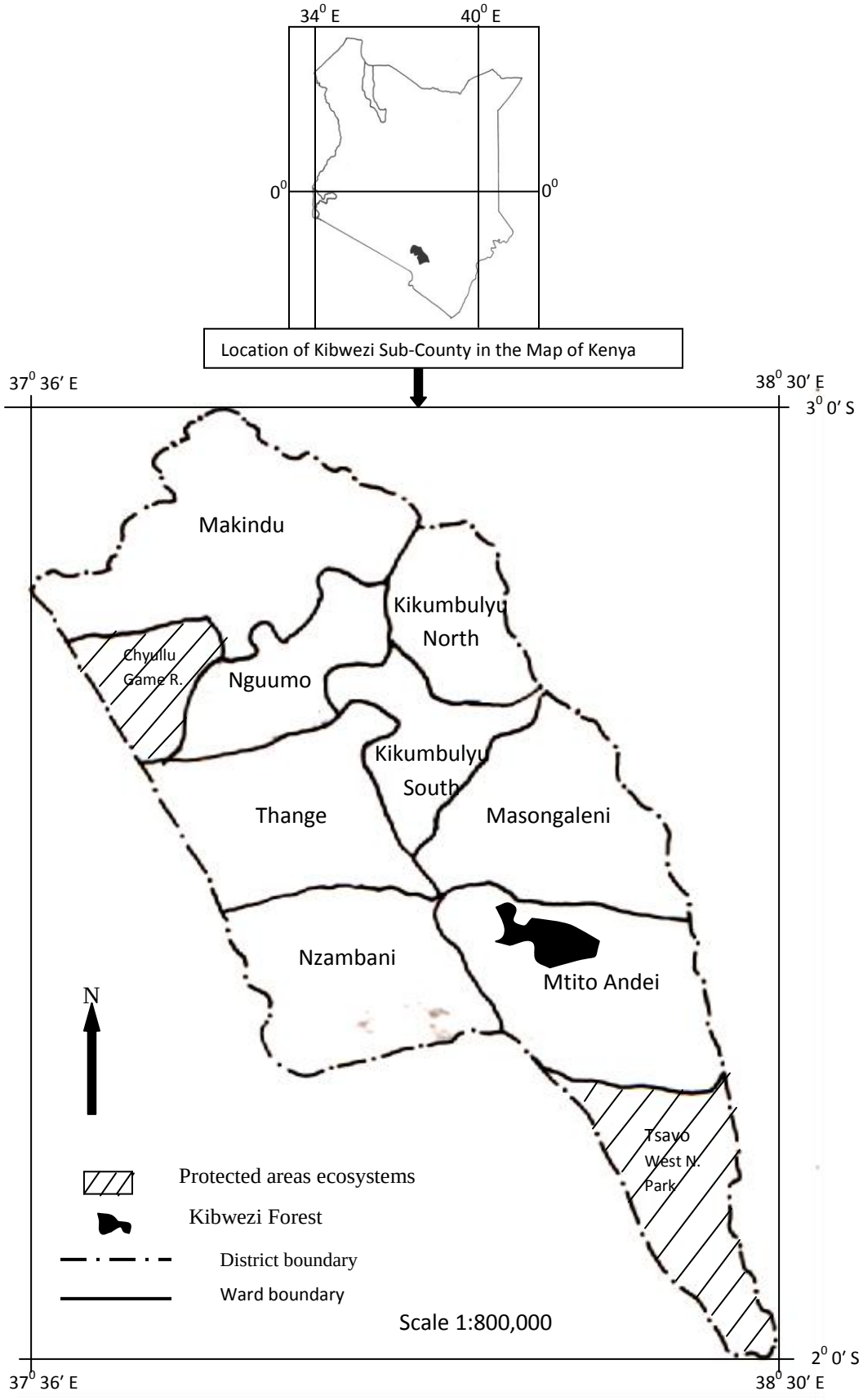
Source: Researcher, (2015)

CHAPTER THREE

METHODOLOGY

3.1 Location and Size

Kibwezi Sub-County is located in Eastern region of Kenya at 2°24'40" South of the equator and 37°57'54" East of the Prime Meridian (see Figure 2, Pg.34). It is one of the five Sub counties in Makueni County (RoK, 2009). It has eight wards namely; Masongaleni, Mtito Andei, Thange, Nzambani, Makindu, Nguumo, Kikumbulyu North and Kikumbulyu South. It has thirty nine Sub- locations (see Table 1, Pg. 39). Tsavo West National Park and Chyullu Game Reserve are also found in the district. The study location falls between 2^0 30' and 2^0 0' and longitudinally falls between 37^o 30' East and 38^o East. It has an area of 3,985km^2 (RoK, 2009).


34⁰ E
40⁰ E
0⁰
0⁰
Location of Kibwezi Sub-County in the Map of Kenya
37⁰ 36′ E
38⁰ 30′ E
3⁰ 0′ S
Makindu
Kikumbulyu North
Chyulu Game R.
Nguumo
Kikumbulyu South
Thange
Masongaleni
Nzambani
Mtito Andei
Tsavo West N. Park
N
Protected areas ecosystems
Kibwezi Forest
District boundary
Ward boundary
Scale 1:800,000
2⁰ 0′ S
37⁰ 36′ E
38⁰ 30′ E

3.1.1 Climate

Kibwezi Sub-County is characterized by extreme rainfall variability. The rainfall pattern is bi-modal with the long (unreliable) rains occurring from March to May and the more reliable short rains occurring from October to December. Rainfall ranges from 150mm to 650 mm per annum (RoK, 2009). From June to October is a long dry period while January to March is a short one. The temperature ranges are between 18°C- 24° C during the cold seasons and 24° C-33°C during the hot seasons. Wet seasons are interspersed with extremely dry seasons and variations in the onset of rainy seasons add to the difficulty of ensuring adequate food production (RoK, 2009). Rainfall in the area is becoming increasingly uneven and this affects subsistence production of food crops. This has resulted to alternative sources livelihoods, for example, charcoal burning handcraft selling, bee keeping, firewood selling and brick making, among others for income generation to ensure provision of basic needs for the families. The residents also rely on ecosystems like rivers and streams to carry out irrigation for food crop production.

3.1.2 Human Population

Kibwezi Sub-County has a population of 248,704 persons (RoK, 2009). The population density is 62.4 persons per km^2 (RoK, 2009). The total number of households is 41,451 with an average household size of 6 persons. The population living below the poverty line is 34% and 67% of urban and rural population respectively (RoK, 2009). It is somewhat cosmopolitan, having attracted migrants with people of different ethnic backgrounds living in Makindu, Kibwezi and Mtito Andei (RoK, 2009). Due to high population, high poverty levels and increase in household basic needs, the residents opt to engage in variety of livelihoods as means of survival and these livelihoods are all dependent on the ecosystems in Kibwezi Sub County.

3.1.3 Crop Production

Staple food crops produced include grain cereals such as maize, sorghum, millet and legumes such as pigeon peas, cow - peas, green grams and beans (RoK, 2009). Fruits are also produced such as Mangoes, watermelons, lentils, pawpaw and oranges (RoK, 2009). Grafted mangoes are vastly gaining momentum due to the high demand and favourable conditions. Horticulture is recent in the Sub-County dating as far back as the 1970's, when economic production systems of irrigated agriculture were introduced along the main rivers such as the Makindu, Kibwezi, Athi and Mtito Andei (RoK, 2009). Except for the Athi River, the rest of the rivers originate from permanent springs whose source of water is the Chyullu catchment with Chyullu Hills Game Reserve ecosystem, in the South-West of the Sub-county. The average farm size is 3.44 Ha for small- scale farmers and 30.4 Ha for large - scale farmers. Small farmers are more common (RoK, 2009). Crop production is mainly subsistence with small portion of farms allocated to horticulture and vegetables for commercial purposes (RoK, 2009). Ecosystems provide water regulation as an ecosystem service through which water is made available through rainfall and in rivers and streams for irrigation where the residents of Kibwezi are able to harvest variety of food crops for consumption and sale, improving their well being.

3.1.4 Livestock Production

Livestock keeping is a source of livelihood in the Sub-County. The main livestock reared include dairy cattle, beef cattle, sheep, poultry, goats and donkeys (RoK, 2009). The number of animals varies in each household and most of the animals kept are local breeds. The livestock is kept for products like meat, milk, eggs, hides and skin for both home consumption and local sales (RoK,

2009). The animals graze in the resident's farmlands and along the wetlands which are all ecosystems.

3.1.5 Other Livelihoods

Other livelihoods in the Sub-County include bee keeping, charcoal selling, wood carving, mat making, hunting and gathering, firewood selling, herbal extraction, aquaculture, and commercial businesses (RoK, 2009). Extraction and processing of natural resources (sand, papyrus, bricks, mats, pots) and small scale trading are also important livelihoods in the District. Other resources found in the Sub-County include forests, wildlife, and water (rivers) (RoK, 2009).

3.1.6 Ecosystems in Kibwezi Sub-County

The semi arid areas of Kibwezi Sub-County are endowed with a variety of ecosystems which include majorly Kibwezi Forest, rivers, streams, springs and large tracts of lands owned by the residents. Kibwezi Forest Reserve covers an area of 5849 hectares (Mbonde & Luke, 2012). The forest is home to varied plants and animal species with part of a network of protected areas including Tsavo Conservation area, and Chyullu Hills Game Reserve. Ecosystems support variety of plant species, which provide products that can be consumed or sold for income. These species are the genetic resources classified under provisioning ecosystem services. Among these species are higher plant species that can support variety of livelihoods improving the well being of the people.

Rivers in Kibwezi Sub-county include Kiboko, Kibwezi, Makindu, Mtito Andei, Thange, Muooni and Tsavo. Kibwezi River, a tributary of Athi River, is the main source of water in the Sub-County (RoK, 2009). From Umani Springs, it passes underground in the forest and re-surfaces in Kibwezi town. The Umani Springs are an increasingly important water source for the

human population in the surrounding areas as well as the wildlife, as it is one of the surface water in the dry seasons in this Sub-County. The much smaller Umani Springs that are at the origin of Kibwezi Forest are dependent on rainfall on the Northern part of Chyullu hills where forest cover is relatively intact and which was in corporated into the Chyullu Hills Game Reserve (RoK, 2009). All these water sources imply that the ecosystems in Kibwezi provide water regulation as an ecosystem service from which water is made available for various uses. Water is an essential determinant for some livelihoods for example, food crop and livestock keeping from which the residents of Kibwezi are able to grow variety of food crops and vegetables for consumption and local sales improving their well being.

3.1.7 Biodiversity in Kibwezi Sub-County

Ecosystems of Kibwezi Sub-County are highly diverse with a large number of "typical" coastal species having moved there along a larger river connecting to the coastal forest strip. The forests are home to Sykes and Vervet monkeys, birds include Black kite, Crowned crane, lovebirds, Sacred ibis, African Crowned eagle, Crowned Hornbill, African Hawk Eagle and large flocks of Crested Guinea fowls (Mbonde &Luke, 2012). These species are potentials for tourist attraction in the Sub County particularly to the locals through which income can be generated especially for those employed as tour guides. The Sub-County also shares a small part of the famous Tsavo National Park, which is considered to be home to some of the world's famous wildlife including the 'big five'- Maasai lion, black rhino, cape buffalo and the red elephant (RoK, 2009). This ecosystem is a tourist attraction centre for both locals and non-locals providing the non-material benefits known as socio-cultural ecosystem services. The wetlands attract a colourful variety of water birds and also large mammals, especially elephant and buffalo, of which a

substantial proportion are thought to be dry season migrants from the Chyullu Hills Game Reserve. Plant species include both exotic and indigenous species like *Acacia-Commiphora* woodland of varying density, *Euphorbia Spp., Commiphora Spp., Combretum Spp.* among others (Mbonde & Luke, 2012). These variant ecosystems with diversity of species are capable of providing non-material benefits to the residents of Kibwezi through provision of socio-cultural ecosystem services like ecotourism, recreational, inspirational and educational services which can influence the livelihoods of the people of Kibwezi, hence improving their well being.

3.2 Research Design

The study adopted a cross-sectional descriptive design because data was collected at once from the study area and described to depict the contribution of ecosystem services to secure livelihoods based on the respondents' perspectives. Descriptive research is a process of collecting data in order to answer questions concerning the current situation and involves a one-time interaction with groups of people (Mugenda & Mugenda, 2003). According to Achola and Bless (2006), descriptive research design is a survey design used to investigate, assess opinions and preferences in environmental issues and problems. This research design was considered the most appropriate method to measure attitudes, opinions and beliefs in a natural setting through use of questionnaires and interviews (Achola and Bless, 2006). It also enables a researcher to gather adequate data within the appropriate time and use it to describe nature of the existing conditions (Mugenda & Mugenda, 2003). Therefore, the researcher interacted with the participants through interviews to collect the necessary information on provisioning, regulating and socio-cultural ecosystem services provided by ecosystems in Kibwezi Sub-County and how these ecosystem services influenced the

livelihoods of the people. Households were the sampling units while the unit of analysis was the household heads.

3.3 Sampling Procedure and Sample Size

The study used cluster sampling and simple random sampling techniques to select respondents proportionally from the identified households based on the list of names from Ward Executive Officers. According to Achola and Bless (2006), cluster sampling technique helps in reducing travel costs and time and permits careful planning of the data collection process. Kibwezi Sub-County has a population of 248,704 persons (RoK, 2009). The sample size was guided by the formula: $n = \frac{Z^2 pq}{d^2}$ (Mugenda and Mugenda, 2003).

Where: n= the desired minimum sample size (when target population is more than 10,000)

Z= the standard normal deviate at the required confidence level (Marginal error); at 95%, z=1.96

p= the proportion in target population estimated to have the characteristics being measured

q= 1-P

d= Level of Significance

Therefore: at 0.05 Confidence level, Z =1.96, P= (50% =0.5) Hence; n = $\frac{(1.96)^2 \times (0.5 \times 0.5)}{(0.05)^2}$ = 384. Therefore a minimum sample size of the study was 384. This means that a total of 384 households were interviewed. The study targeted respondents who were household heads, that is both adult men and women in the study area. They provided important information on higher plant species, livelihoods supported by the plant species, influence of water availability on food

crop and livestock production and effect of social cultural ecosystem services on livelihoods of the residents of Kibwezi Sub-County.

To make the study representative, saturated sampling technique was used whereby a total of the eight wards making Kibwezi Sub-County were included in the study. The Wards were taken to be the sampling unit because the population was scattered within the Sub-County and some wetland ecosystems such as rivers, for example, Kiboko, Thange and Kibwezi River are shared by different wards. Each ward consisted of sub locations and had a specific boundary. Table 1 shows the Name of the Ward, Sub locations and total population in each ward.

Table 1: Name of Wards, Sub locations and total population in Kibwezi Sub-County

No.	Name of the Ward	Names of Sub Locations	Total Population
1.	Masongaleni	Masimbani, Ulilinzi, Kyanguli, Masongaleni, Mukaange	32,270
2.	Mtito Andei	Kiteng'ei, Kambu, Kathekani, Mtito Andei, Part of Tsavo West National Park	34,354
3.	Thange	Utithi, Mikuyuni, Thange, Part of Chyulu game reserve	31,654
4.	Nzambani	Mang'elete, Muthingiini, Part of Chyulu game reserve	33,442
5.	Makindu	Kai, Kiu, Manyatta, Kisingo, Kamboo, Kyale, Kaasuvi, Mulilii, Ngakaa, Mitendeu, Kalii	42,094
6.	Nguumo	Ndovoini, Syumile, Muuni, Kaunguni Part of Chyulu game reserve	28,208
7.	Kikumbulyu North	Kathyaka, Ngulu, Ndetani	20,314
8.	Kikumbulyu South	Mbui nzau, Kalungu, Ngandani, Kinyambu	26,368
Total	**8**	**39**	**248,704**

Source: Modified from RoK, 2009

Therefore, the study involved eight wards with thirty-nine sub locations giving a total population of 248,704 persons for Kibwezi Sub-County. The total number of households in the Sub-County was 41,451. Thus, in order to get the average number of individuals per household, the total number of population in the Sub-County was divided by total number of households giving a mean of 6 household members. To get the approximate number of households in a ward, the total population from each ward was divided by the mean of household members giving an approximate total number of households in each ward as summarised in Table 2.

Table 2: Sample size determination from each ward in Kibwezi Sub-County.

No.	Name of Ward	Total Population	Number of Households	Proportional Sample Size
1.	Masongaleni	32,270	$\frac{32,270}{6}$ =5,378	$\frac{5,378}{41,451}$ x 384 = 50
2.	Mtito Andei	34,354	$\frac{34,354}{6}$ =5,726	$\frac{5,726}{41,451}$ x 384 = 53
3.	Thange	31,654	$\frac{31,654}{6}$ =5,276	$\frac{5,276}{41,451}$ x 384 = 48
4.	Nzambani	33,442	$\frac{33,442}{6}$ =5,574	$\frac{5,574}{41,451}$ x 384 = 52
5.	Makindu	42,094	$\frac{42,094}{6}$ =7,016	$\frac{7,016}{41,451}$ x 384 = 64
6.	Nguumo	28,208	$\frac{28,208}{6}$ =4,701	$\frac{4,701}{41,451}$ x 384 = 44
7.	Kikumbulyu North	20,314	$\frac{20,314}{6}$ =3,386	$\frac{3,386}{41,451}$ x 384 = 32
8.	Kikumbulyu South	26,368	$\frac{26,368}{6}$ =4,394	$\frac{4,394}{41,451}$ x 384 = 41
Total	**8**	**248,704**	**41,451**	**384**

Source: Modified from RoK, 2009

To get a minimum sample size of 384 households, the total number of households from each ward was divided by the total households for the entire Sub-County and then multiplied by the total sample size as shown in Table 2 column 5. Systematic random sampling was used to get individual household heads from the proportional sample size for each ward. The list for all household heads names was obtained from the Ward Executive officers. To get the sampling interval, the total number of households in each ward was divided by its proportional sample size as asserted by Mugenda and Mugenda, (2003). For example, to get the sampling interval for Masongaleni ward, a total of 5,378 households was divided with a proportional sample size of 50 to get a sampling interval of 107. That is 5,378/50 = 107. The starting point was randomly determined from which every 107 household name in a list of 5,378 household names was included till a total of 50 household members was obtained. This rule was applied to all wards until a total of 384 household heads was obtained and were visited for questionnaire administration.

3.3.1 Purposive Sampling

Purposive sampling was used to select 13 key informants who included; two agricultural extension officers, four Kenya Wildlife Service officers from Tsavo West National Park and Chyullu Hills Game reserve, two officers from Kibwezi Forest department, one herbalist, one officer from water services in Kibwezi, one officer from Kenya Agricultural Livestock and Research Organization (KALRO), Director of civic education Kibwezi in District, and head of Kyai irrigation scheme. Mugenda and Mugenda (2003) asserted that purposive sampling technique helps the researcher to interview a group of people believed to be experts in their field. It allows a researcher to use cases that have the required information with respect to the objectives of the study. The agricultural officers provided information on the various crops

grown in the region; the KWS officers on the importance of the park and the reserve to the people; forest officers on the various activities carried out in the forest and types of higher plant species; the hydrologist on the sources and use of water; the director of civic education on the various livelihoods; and officers from KALRO and Kyai irrigation scheme on crops grown under irrigation and their uses.

3.4 Sources of Data

In this study, both primary and secondary data were collected.

3.4.1 Primary Sources

Primary data on higher plant species, uses of higher plant species, livelihoods supported by higher plants, food crop yields, types of livestock kept, livestock products and socio-cultural ecosystem services was collected from the field by surveying household heads and key informants. Key informant interviews were administered to elicit data which served to confirm some of the information collected from household interviews.

3.4.2 Secondary Sources

Relevant literature on ecosystem services and livelihoods was sought from both published and unpublished sources. These were obtained from relevant journal texts, websites, textbooks, magazines, newspapers, government reports (published and unpublished reports) assessed from libraries at Maseno University, Kibwezi Sub-County Agricultural Office, and Makindu weather meteorological station. Makindu weather meteorological station provided rainfall data for the whole of Kibwezi Sub-County for a period of 15 years (2000-2014). Kibwezi Sub-County agricultural office provided the annual crop yield data for a period of 3 years (2012, 2013, 2014).

These sources provided the requisite background information for the study. In addition, this data was useful in enhancing the data collected from the household heads.

3.5 Data Collection Methods

Questionnaires, Interviews, Focus Group Discussions, Observation and Photography were used to collect primary data on socio-demographic characteristics of the respondents, higher plant species, their uses, livelihoods supported by higher plant species, data on water sources, crop yields, types and number of livestock, livestock products and effect of socio-cultural ecosystem services on livelihoods in Kibwezi Sub-County.

3.5.1 Questionnaires

Structured questionnaires with both closed and open-ended questions were administered to 384 household heads who were adult males and females (See Appendix B). The respondents included craft persons, farmers, herbalists, and fuel wood harvesters. The data obtained was used to explain the influence of higher plant species richness on livelihoods in the region, influence of water availability on food crop yields and livestock production, and the effects of socio- cultural ecosystem services on livelihood in the District. Questionnaires were self administered by the researcher with the help of enumerators so as to give respondents clarification on questions that they could not properly understand. The use of questionnaires was advantageous because it was administered to respondents in their own private settings.

3.5.2 Key Informants Interview

Interviews were applied to 13 key informants who included; two agricultural extension officers, four Kenya Wildlife Service officers from Tsavo West National Park and Chyullu Hills Game Reserve, two officers from Kibwezi Forest department, one herbalist, one officer from Water

Services Board in Kibwezi, one officer from KALRO, director civic education Kibwezi Sub-County and head of Kyai irrigation scheme. They were interviewed owing to their experience in their various work stations which made them knowledgeable on plant species richness, water availability and use, socio-cultural ecosystem services and livelihoods of the people in the region.

3.5.3 Observation and Photography

Non-participant observation technique was employed to witness some of the ecosystem products such as food, fuel wood, water, and cultural practises. In addition, some of the community livelihoods in the study area for example crop farming, livestock keeping, and bee keeping were also observed (see Appendix E). Photographs were taken to enhance the quality of the study because they will represent the significant physical characteristics related to the study.

3.5.4 Focus Group Discussions (FGD)

A total of eight FGD's were conducted, one in each of the eight wards in the Sub-County to ensure total representation. Each group had ten participants comprising adult males and females, with a leader and a secretary. Each Ward representative provided list of the participants through purposive and snowball sampling techniques. Structured open-ended questions were used for discussion. Focus Group Discussions aimed at validating data on types of plant species, uses and livelihoods supported by these species, water availability and use on crop and livestock production, and information on the effect of socio-cultural practices on livelihoods. This helped in clarifying the information gathered through other research instruments such as any issues raised during the interview sessions. The technique also helped in the investigation of

phenomena that could not be obtained through direct observation such as individual opinions and attitudes. Comprehensive notes were taken during the discussions.

3.6 Plants Species' Identification

The respondents listed different types of higher species during the survey. The plants were listed in local names (*Kikamba*) while Maundu and Tengnas (2005), was used to identify the plants' scientific names. Information on other species of plants was obtained from the KEFRI centre. Species richness was obtained by simple counting of the total variety of species listed in the questionnaires by the respondents.

3.7 Data Analysis Procedure

Both qualitative and quantitative data analysis were used to get results for this study. The data was first edited and cleaned up by going through the questionnaires to identify errors, incompleteness, or gaps in the information obtained from the respondents. The raw data was coded and then entered into the computer ready for analysis. Qualitative data collected from open-ended questions, was analysed and organised according to the themes, sub-themes, categories and sub-categories that emerged. Notes from the field that comprised of direct observed variables and responses not captured by the questionnaires were grouped into themes and discussed. Observations from the field were also analysed aided by the digital photographs taken in the field. The relevant photographs taken from the field were uploaded to the computer, edited using Microsoft Office Picture Manager, and imported to Microsoft Office Word for presentation and discussion. Microsoft Excel Software (Office 2007) was used to get means and percentages for quantitative data. Correlation and regression analysis of related variables in objectives One and Two was run by use of the Statistical Package for Social Science (SPSS) version 17.

3.7.1 Plant Species Richness and Livelihoods.

Qualitative data on types of plant species, their uses, and the livelihoods supported by the plant species was analysed by organizing and systematically creating themes, categories and patterns. The qualitative data was re-evaluated to determine its adequacy, credibility, consistency and usefulness of the information in answering the research questions. Pearson product moment correlation coefficient (*r*) was used to establish the relationship between species richness, approximate area dominated by the plants and the livelihoods supported by the higher plant species. The significance level (α) was set at 0.05. The total number of plant species were coded on five point Likert scale as follows; **1**=0-11 plant species, **2**=12-23 plant species, **3**=24-35 plant species, **4**=36-47 plant species , **5**=48-59 plant species. This was then correlated with the area covered by plant species through data transformation on approximate areas covered by the species (Appendix E) in acreage by assigning codes 1-5 on plant species acreage as follows; **1**= below 0.25 acres, **2**=0.25- 0.50 acres, **3**= 0.6-1.0, **4**=1-2 and **5**=2-3 and above.

3.7.2 Influence of Water Availability on Food Crop Production and Livestock Production.

The components of verbal discussion captured from different respondents on water sources and use were edited and cleaned up, then organized and systematically analysed to create themes, sub-themes, categories, sub-categories and patterns. Least squares regression analysis was undertaken to establish the relationship between rainfall amounts, total amount of water used during irrigation and yields for both rainfed and irrigated crops. The significance level (α) was set at 0.05. Microsoft excel was used to get the means and percentages of the respondents owning livestock and products obtained from the livestock. All these data were processed using

Statistical Package for Social Science (SPSS version 17) and Microsoft Excel Software (Office 2007).

3.7.3 Influence of Socio-cultural Ecosystem Services on Livelihoods

The components of verbal discussions captured from the respondents on socio-cultural ecosystem service like ecotourism, religious and spiritual services, information on handcraft selling and how these services influenced the livelihoods was analysed qualitatively by editing, cleaning up, organising and creating the data into patterns and themes. Microsoft Excel Software (Office 2007) was used to get means and percentages for quantitative data on the number of respondents aware of socio-cultural ecosystem services, livelihoods supported by ecosystem and awareness of diversity of culture in the study area. Chi Square test was used to establish the relationship between socio-cultural ecosystem services and livelihoods. The set significance level was 0.05. The whole process ensured that the information was accurate and consistent in answering the respective research questions.

3.8 Results Presentation

The results on the contribution of ecosystem services on livelihoods were described and presented in form of discussions, tables, plates, graphs, and pie charts. Data on annual rainfall variability as well as water sources were presented by use of bar graphs. Scatter graphs were used to show the strength of association between rainfall and common rainfed crop yields (maize, cowpeas, green grams, sorghum, beans, millet, pigeon peas) and the amount of water used for irrigation and food crop yields for irrigated crops (Kales, Maize, Spinach, Orchards, baby corns, Asian vegetables and Fruits). Respondents' demographic data (frequency of responses and percentages), data on higher plant species and uses, types of livelihoods,

summarized rainfall data, annual rainfed crop yields, respondents average rainfed crop yields and irrigated crops and responses on social cultural services in Kibwezi Sub-County were presented by use of tables. Photographs (Plates 1-14) were used to show observational information on examples of higher plant species, types of livelihoods supported by higher plants species, rainfed and irrigated crops.

3.9 Validity and Reliability of the Instruments

The validity and reliability of the instruments used for data collection was tested as explained below.

3.9.1 Validity of the Instruments

According to Bridget and Lewin (2005), validity is the degree by which the sample of test items represents the content the test is designed to measure. In this study, face and content validity were considered. Face validity is a qualitative means of ascertaining whether a measure on the face of it appears to reflect the content of a concept (Bryman & Bell, 2003). Saunders, Lewis, & Thornhill (2007) indicated that content validity is a qualitative means of ensuring that data collected using a particular instrument represents a specific domain or content of a particular concept as intended. Further, validity refers to making common sense, being persuasive and seeming right to the reader and the results having the appearance of truth or reality (Lacity & Jansen, 1994; Cronbach, 1971). Consequently, the determination of the face and content validity of the research instruments in this study guaranteed accuracy and connection among the questions asked and variables measured. Normally, face and content validity are ensured by obtaining subjective judgments by the experts in the concerned field who jugde the survey's

appearance, relevance and representativeness of its elements (Bryman & Bell, 2003; Sekaran, 2003; Mugenda & Mugenda, 2003). Therefore, the researcher sought the opinions of experts in the field of study from the School of Environment and Earth Sciences, Maseno University. They assessed the ease of use, clarity, readability and the concepts to be measured by the instrument in relation to the objectives of the study.

3.9.2 Reliability of the Instruments

Reliability refers to the consistency of measurement and is increased by including many similar items on a measure, by testing a diverse sample of individuals, using uniform testing procedures and so as to give internal consistency of the data collected (Mugenda and Mugenda, 2003). According to Ary, Jacobs, and Gall (1996), pre-testing is the best way to minimize ambiguity, enhance clarity and ascertains responses to the style and content of the questions. Reliability was ensured through conducting a pilot study. This was done by administering the instruments to a sample size of approximately 10% (38 respondents) of the total sample size of the targeted households as recommended by Wuensch (2012). The pilot study helped in refining the research instrument so that results obtained from the field would be a true representation of the situation on the ground. Split-Half technique of reliability testing was employed whereby the pilot questionnaires were divided into two equivalent halves and then a correlation coefficient for the two halves computed. A Pearson product moment correlation coefficient of 0.74 was obtained. According to Kiess and Bloomquist (2000) a minimum correlation coefficient of 0.65 is recommended which indicated that the instruments were reliable as the coefficient fell within the expected range. The household heads used for pre-testing were excluded from the final sample of the study.

3.10 Ethical Considerations

The researcher sought approval to conduct the research from the School of Graduate Studies Board as well as the Ethics Review Committee both of Maseno University. The researcher further sought approval from the local administration specifically by the Sub-County Commissioner of Kibwezi Sub-County to carry out the study. The study adhered to professional research ethics to avoid unnecessary misunderstandings, conflicts and ethical dilemmas. Participation in the study was voluntary and no sensitive information was collected. Informed consent was obtained from all participants (see Appendix A). The researcher made various efforts to protect all participants' views and make clear and fair agreements prior to their participation. To protect the data, the results obtained were stored in the computer with a password which was only accessed by the researcher so as to ensure the security and confidentiality of data obtained from the participants.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Demographic Characteristics of the Respondents.

The data collected mainly focused on gender, age, education, main occupation, period lived in the study area, and main sources of livelihoods. Literature has shown that household livelihood activities are influenced by both internal and external factors (Ellis, 2001; Morduch & Sicular, 2002; Ibekwe et al., 2010). Such factors include age, gender of household heads, years of education, and household size among others.

4.1.1 Gender

A total of 384 households were interviewed. Table 3 shows the gender distribution of respondents involved in the survey.

Table 3: Gender characteristics of the respondents

Gender	Frequency	Percentage (%)
Male	185	48.2
Female	199	51.8
Total	**384**	**100.0**

Source: Field Data, 2015

As depicted in Table 3, 48.2 % of the respondents were males while 51.8% were females. The higher percentage represented by females can be interpreted that women are involved in household activities like firewood collection, wild fruit selling, handcraft selling and crop cultivation. Asha (2009) conform to the findings of this study (Table 3) that women in Sub-Saharan African countries are known to be more involved in activities that aim at providing for the family than men with 93% being involved in arable and vegetable gardening. Cleaver (2005),

in his study on gender and livelihoods in Sub-Saharan Africa argues that women are more involved in household activities than men due to their ability and willingness to engage in various income generating activities, where a high proportion of cash income tends to be spent on family welfare. Other studies (Spring, 2000; Whitehead, 1994 and; Stone and Stone, 2000) concur that women are more concerned about the welfare of other household members than men, and therefore more likely to spend any increase in benefits on meeting household needs rather than personal needs and wants.

4.1.2 Age Distribution

This ranged from below 19 to above 60 years. The average age of the respondents was grouged at an interval of ten years as summarized in Table 4. Age was included because it is a determinant of people carrying out various livelihoods for survival in Kibwezi Sub-County.

Table 4: Age of respondents in Kibwezi Sub-County

Age –Groups (Years)	Frequency	Percentage (%)
less than 19 years	12	3.1
20-29 years	53	13.8
30-39 years	118	30.7
40-49 years	102	26.6
50-59 years	69	18.0
60 years and above	30	7.8
Total	**384**	**100.0**

Source: Field Data, 2015

As observed from Table 4 above, the age group 30-39 years has the highest frequency. Thus, it is the dominant age group among the sampled population. Age interval of 30 – 39 years and 40-49 years had the highest percentage of 30.7% and 26.6% respectively. From the results presented in Table 4, it is evident that most of the respondents' were in age range from 30 to 49.

This suggests that most of the respondents were of active ages and were engaged in various livelihood activities. A study by Paumgarten and Shackleton (2011) reported that mature respondents are more engaged in different socio-economic activities to ensure the families are fully provided with the basic needs. Ghosh, Goldar and Mitra (2010) and Ellis (2001) noted that at the age of 25 years, most people are married and are active in direct and indirect activities from the environment thus contributing to household security. Vera-sanso (2004) argued that younger people aged 20–24 have a lower reported workforce participation rate than those aged 25 and above and by 35 years, 90% of men are married and under pressure to generate income for their families by securing regular work.

4.1.3 Household Size

House hold size is an important determinant on ecosystem services and livelihoods since family needs are majorly derived from the environment and their use is determined by the household size. The mean household size of the study area was 6 members (RoK, 2009). The household summary is provided in Table 5.

Table 5: Household size of the respondents

House Hold Members	Frequency	Percentage (%)
1-4 members	145	37.8
5-9 members	207	53.9
10-14 members	22	5.7
15-19 members	10	2.6
Total	**384**	**100.0**

Source: Field Data, 2015

Findings in Table 5 depicts that the majority (53.9%) of the interviewed households had 5-9 members. This can be interpreted to imply that the larger the household size, the more the demand for various needs like food, water and shelter all of which are derived from the ecosystems. This could be owing to the fact that in large sized households, resources are spread thinly on maintaining a large number of people in terms of meeting their basic and other needs and the fact that increased household size is also synonymous with more dependants who do not contribute to household income. Thus, in order to augment income to meet the basic needs, households often engage in activities that rely on the ecosystem. This finding (Table 5) corroborates the findings of Mujwahuki (2013) that, in a rural setting, the mean of 6-7 individuals in a household is a big size and implies that the members will consume more basic needs like water and other resources obtained from the environment. Studies by Babatunde and Qaim (2009) and Ellis (2000) concluded that the larger the household size, the more the likelihood to participate in alternative livelihoods which are all dependent on the ecosystems. Further, Harjes (2007) reported that increase in household size increased the likelihood of adopting more livelihoods for survival.

4.1.4 Education of the Respondents.

Education level determines the accessibility and wise utilization of natural resources and their use (Ibekwe et al., 2012). Table 6 below shows the education level of the respondents interviewed.

Table 6: Education level of the respondents

Education Level	Frequency	Percentage (%)
Primary	139	36.2
Secondary level	151	39.3
Certificate /Diploma	82	21.4
Degree and above	12	3.1
Total	**384**	**100.0**

Source: Field Data, 2015

Findings from Table 6 revealed that 36.2 % of the respondents have attained primary education, 39.3% secondary education, 21.4 % certificate /diploma education and 3.1% had degree and above. This can be interpreted that in that area a big percentage of respondents have primary and secondary education. This implies that majority of the respondents are able to read and write and hence can understand information about ecosystem services. Education is perceived as a life-long process both in and out of school, to foster awareness and better understanding of environmental issues (RoK, 2003). In the study area, only 24.5 % have diploma and above. This result (Table 6) is supported by the findings of Norsida and Sadiya (2009) and Ibekwe et al. (2010), that individuals who have more years of schooling have a higher likelihood of participating in various activities from the environment for income generation. Sewnet, Ndemo, and Beyene (2015) noted that there is a significant association between education level of the household head and livelihood diversification in that more educated household heads are engaged in livelihood diversification strategies. This is because the educated households are capable of calculating the costs and benefits of income generating activities and hence, make informed decisions to engage in several activities.

Bounkoungu and Niamir, (2001) established that high levels of education enhance access to information relating to ecosystem services since people can read the information pertaining to these services from the media. Education in dry lands is the long-term driver of livelihood diversification as noted by Little, Aboud and Lenachuru (2009) while Nyariki, Wiggins, and Imungi, (2004) noted that both formal academic education and workplace skills provide knowledge and skills relevant to living and working in rural areas where a majority of the people rely on ecosystems for survival.

4.1.5 Main Occupation of the Respondents

Occupation is an activity that serves as ones regular source of livelihood. The study established that the respondents in Kibwezi Sub-County were involved in different occupations. The summary is presented in Table 7.

Table 7: Occupation of the respondents

Main Occupation	Frequency	Percentage (%)
Formal employment	83	21.6
Casual labour	43	11.2
Business	64	16.7
Farming	179	46.6
Others	15	3.9
Total	**384**	**100.0**

Source: Field Data, 2015

As depicted in Table 7, majority of the respondents (47.6%) were involved in farming, 21.6% in formal employment, 11.2% in casual labour, 16.7% in business, and 3.9% in other occupations like wild fruit selling. This implies that a greater percentage (78.4%) is self employed and relied

on the services provided by ecosystems in the study area to generate income. Due to inadequate formal employment opportunities, many people in rural areas have resolved to rely on ecosystems for their livelihoods (Michaelidou et al., 2002). Households in rural areas engage in livelihood activities such as trading, small scale business enterprises and processing of agricultural goods and arts and craft in order to supplement earnings from agriculture to cope with increasing vulnerability associated with agricultural production (Ekong, 2003; Matthews-Njoku and Adesope, 2007) as well as to enable them generate adequate and secure standard of living. Babatunde and Quaim (2009) noted that while farming remains the dominant occupation among rural households in semiarid areas of Nigeria, off farm occupation especially self-employed activities are the main sources of income for households. Further, Mujwahuki (2013) observed that farming is practiced by the majority of respondents in rural areas of Muleba Sub-County who practice small scale agriculture in ecosystems like wetlands and swamps to get their food.

4.1.6 Period of Time Lived by the Respondents in the Study Area.

The period of time the respondents lived in the study area was included because it was an evidence whether the information given by the respondents was truthful since, the more the time the respondents stay in the study area, the more reliable the information given. The findings are presented in Table 8.

Table 8: Period of time lived by the respondents in the study area

Period in Years	Frequency	Percentage (%)
1-5 years	3	0.9
5-10 years	26	6.7
More than 10 years	355	92.4
Total	**384**	**100.0**

Source: Field Data, 2015

The study revealed that 92.4% of the respondents have lived in the area for more than 10 years and 6.7% for 5-10 yrs (Table 8). Apparently, the information obtained from the respondents was consistent because when people live in a certain area for a long period of time, they get experience on the conditions of the environment and are able to provide relevant information to researchers on the various activities they do for a living (Omari, 2006). Babatunde and Qaim (2009) reported that living in an area for a long period of time makes one to interact with the environment, become aware of the available natural resources like plant species, wetlands, and apply their knowledge in accessing these resources as a means for their survival.

4.1.7 Approximate Farm Sizes owned by Respondents

The respondents were further asked to state the approximate size of their farms in hectares. Figure 3 shows a summary of the approximate farm sizes owned by the respondents in Kibwezi Sub-County.

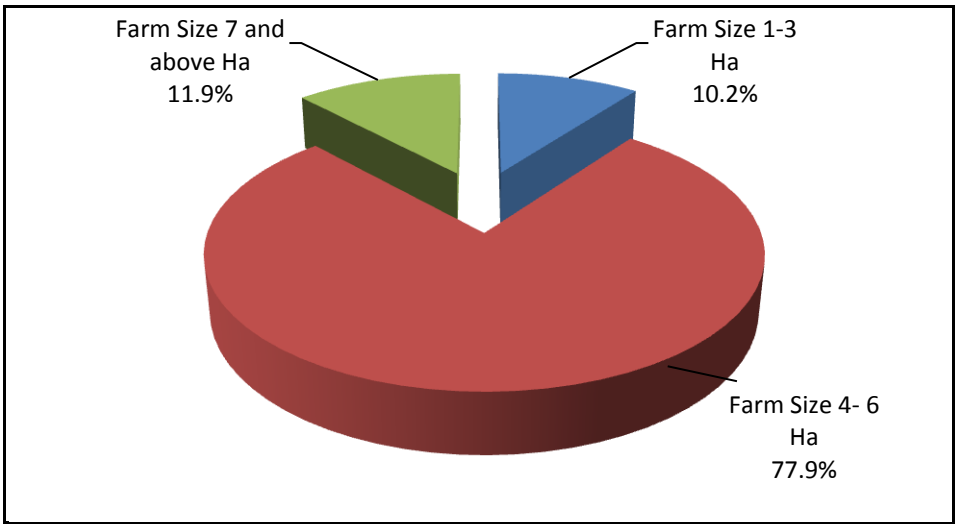


Figure 3. Approximate farm sizes owned by respondents in Kibwezi Sub-County.
Source: Field Data, 2015

Figure 3 shows that the majority of respondents (77.9%) owned farms of average sizes of 4 to 6 hectares, while 10.2% of the respondents owned farms of average sizes of 1 to 3 hectares. These results suggest that most respondents owned more than three hectares of farms capable of supporting more higher plant species which could in turn sustain a variety of livelihoods. RoK, (2009) confirms that the average farm size in Makueni County is 3.44 Ha for small-scale farmers and 30.4 Ha for large-scale farmers with the former being more common.

4.1.8 Main Sources of Livelihoods by the Respodents in the Study Area.

The study established that the respondents carry out various livelihood activities to generate income to sustain their lives. Table 9 provides the summary of main sources of livelihoods by the people of Kibwezi Sub-County.

Table 9: Main sources of livelihoods

Main source of livelihood	Frequency	Percentage (%)
Crop farming	171	44.5
Livestock keeping	84	21.8
Formal Employment	83	21.6
Handcraft selling	16	4.2
Charcoal burning	8	2.1
Brick making	9	2.3
Others (Business, tour guiding)	13	3.5
Total	**384**	**100.0**

Source; Field Data, 2015

Table 9 shows that the majority of the people (44.5%) are involved in farming, 21.8% in livestock keeping, 4.2% in handcraft selling; 2.1% in charcoal burning, 2.3% in brick making, 21.6% in formal employment, and 3.5% in other livelihoods. Other livelihoods include gathering wild fruits and selling timber. It is worth noting that the residents of Kibwezi Sub County were involved in more than one livelihood but for the purpose of this study, the researcher only concentrated on identifying the livelihood which could be the major source of income to the respondent hence the above results (Table 9). These results therefore mean that ecosystems support the majority (78.4%) of the livelihoods in the study area while formal employment accounts for 21.6%. This is because livelihoods like crop farming, livestock keeping, handcraft selling, charcoal burning and brick making all depended on ecosystem services. This can further be interpreted that the residents of Kibwezi Sub-County carry out various livelihoods to generate income to acquire basic needs. These findings (Table 9) conform to the assertion by Emerton (2005) that ecosystem services support 44% of livelihoods from which income is generated accounting for 46% of the total household economy.

In support, studies by Chaposa (2000) and Costanza et al. (1997), concluded that the livelihood needs of local people demand for ecosystem services and many if not all human activities in this the world depend on these services. Monela et al. (2005), reported that 36% of families in Shinyanga region in Tanzania use income from the sale of woodland products to pay for education costs. Mortimore et al. (2008), reported that dry land ecosystems support crop, livestock and other forms of livelihoods for vast numbers of people with other lesser known commodities which are not intensively produced, but they are harvested from the ecosystem and traded, thus contributing to the livelihoods of rural people.

4.1.9 Household Income

The households were requested to reveal their monthly income and their responses are summarized in Figure 4.

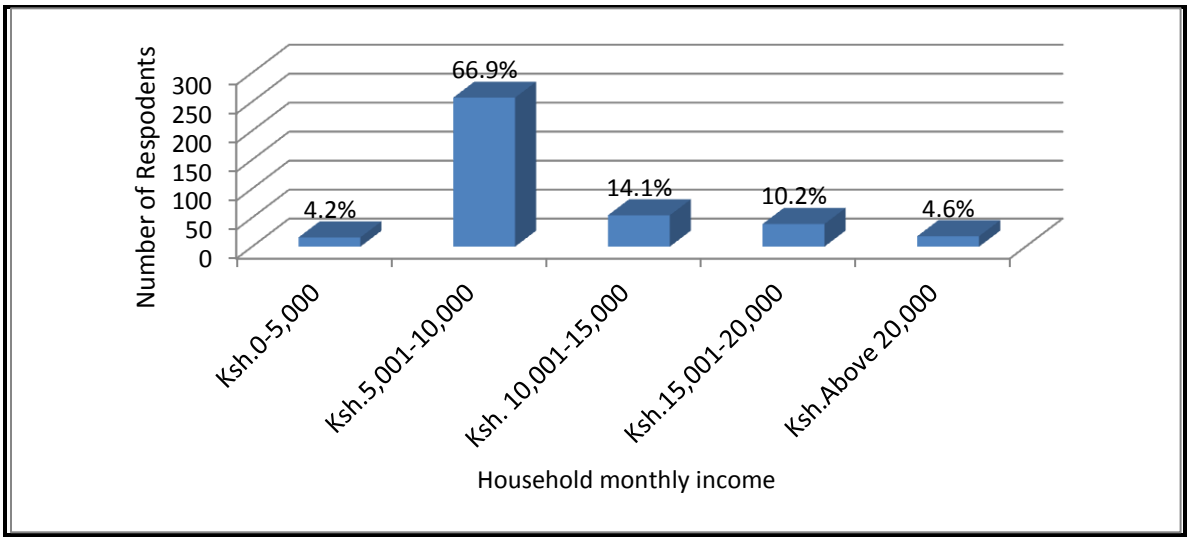


Figure 4; Monthly household income
Source: Field Data, 2015

Results in Figure 4 revealed that a majority (66.9%) of the households had a minimum monthly income within Kshs. 5, 000 -10,000. Only 4.6% had a monthly income of above Kshs.20, 000.

This was an indication that majority of the families are low-income earners since they fall in the income brackets of Kshs. 0-23,000 according to the new income classification by Treasury Department, Ministry of Finance, (2010). The highest number of respondents with income within the range of Ksh.5,000- Ksh.10, 000 can be attributed to the involvement of the respondents in various livelihoods (Table 9) aimed at raising cash to acquire family basic needs.

This can further be interpreted that ecosystems in Kibwezi Sub-County play a crucial role in people's livelihoods through the provision of household income. Therefore, the residents need to utilize the available ecosystem services to engage in more livelihoods so as to increase the levels of income. A study by Mutinda (2012), established that in semi arid areas of Yatta Sub-county, 50% of the population has an income levels of Ksh. 2000 per month while, the current study has established that 66.9% households has an income level of more than Ksh.5,000 per month. This could be attributed to the fact that the residents of Kibwezi have large tracts of lands (Fig.3 Pg.59), which they can rely on for various livelihoods as compared to the residents of Yatta who have an average land size of 2 acres (Mutinda, 2012) characterised by scanty vegetation which cannot support variety of livelihoods for income generation. The finding (Figure 4) are consistent with findings by Cavendish, (2000) who contends that income for the majority of rural dwellers is derived from natural resource-based activities like crop farming, livestock production, fuel wood sales and brick making among others. In support, Fisher (2004) also found out that income for the people in rural areas is realized from various livelihoods from the environment. Similarly, Kamanga et al. (2009), established that households in rural areas rely on income from resource collection activities which are all from the ecosystems.

4.2 Influence of Higher Plant Species Richness on Livelihoods of Communities in Kibwezi Sub-County

The findings of the first objective focused on identifying higher plant species richness found in Kibwezi Sub-County and how higher plant species richness contribute to various livelihoods like timber/post selling, herbal medicine selling, livestock keeping, handcraft selling, bee keeping, and charcoal burning among others.

4.2.1 Higher Plant Species and Their Uses in Kibwezi Sub-County

The study established that Kibwezi Sub-County is endowed with variety of higher plant species which support the livelihoods of the people. The results are summarised in Table 10.

Table 10: Higher plant species in Kibwezi Sub-County in local names and botanical names, households with higher plant species and their uses.

Local Name	Botanical Name (Maundu &Tengnas, 2005)	Number of households with the species (%)	Higher plant species and their uses	
			Consumptive	Non consumptive
Ikuu	*Commiphora africana*	224 (59.3)	Firewood, poles, fodder for livestock	Fencing
Itiithi	*Commiphora spp.*	130 (33.9)	Poles, firewood, fodder for livestock	fencing
Itula	*Commenila benghalensis*	219 (57.0)	Poles, firewood, fodder for goats and sheep	Fencing
Kiamba	*Adansonia digitata*	162 (42.2)	Fruits, medicine, reeds for basketry	Shade, marking rainy season
Kiembe	*Magnfera spp.*	218 (56.8)	Fruits, fodder, firewood, charcoal	Shade
Kikwasu	*Tamarindus indica*	58 (15.1)	Fruits, hanging bee hives	Shade
Kilawa/Mulawa	*Grewia bocolor*	300 (78.1)	Firewood, forage for bees, fodder, fruits	Shade
Kiluli	*Boscia angustifolia*	30 (7.8)	Forage for bees, fodder for livestock	Hanging bee hives
Kilului	*Balanites aegyptiaca*	176 (46.0)	Fruits, fodder for goats and sheep	Fencing

Local Name	Botanical Name (Maundu &Tengnas, 2005)	Number of households with the species (%)	Higher plant species and their uses	
			Consumptive	Non consumptive
Kiongoa	*Combretum paniculatum*	316 (82.3)	Fodder, timber, firewood, charcoal	Fencing
Kisambalau	*Syzygium cuminii*	64 (16.7)	Fruits, firewood,	Hanging bee hives
Kisaya	*Bechrmia discolor*	30 (7.8)	Fruits, firewood, forage for bees	Shade
Kithea	*Cordia sinensis*	64 (16.7)	Fruits, firewood	Shade
Kithiia/Muthiia	*Acacia mellifera*	342 (89.1)	Fencing, posts, fodder for goats and sheep	Forage for bees, fencing
Kitimu	*Citrus limon*	95 (24.7)	Fruits, medicine, firewood	Not identified
Kitootoo	*Pachystigma schumannianum*	89 (23.2)	Fruits, firewood, fodder for goats	Not identified
Kiusya	*Sterculia africana*	84(21.9)	fodder, reeds for basketry, charcoal	Hanging bee hives,
Kivau	*Dombeya kirkii*	32 (8.3)	Firewood, reeds for basketry and building	Shade
Kivavai	*Asimina triloba*	36(9.4)	Fruits, medicine	Not identified
Kyaa kyosi	*Combretum schumanii*	45(11.7)	Fodder, charcoal, firewood	Not identified
Kyooa	*Albizia anthelmintica*	108(28.2)	Firewood, fodder for goats and sheep	Not identified
Kyuasi	*Lannea schumanii*	113(29.5)	Posts, poles, firewood	Shade
Mbaiki/kikaiki	*Acacia thomasii*	98(25.5)	Fodder, firewood, burning charcoal	Preserving water shed
Mikuswi	*Acacia brevispica*	339(88.3)	Fodder for livestock	Forage for bees
Moringa	*Moringa oleifera*	101(26.3)	Medicine, Firewood, fodder	Shade
Muange	*Delonita elata*	165(43.0)	reeds for typing, firewood, leaves eaten by goats	Hanging bee hives,
Muangi/Baboo	*Delonix elata*	58 (15.1)	Making of tables and mats	Preserving watershed
Muatine/Kiatine	*Kigelia africana*	11 (2.86)	Making illicit brew, firewood,	Hanging bee hives
Mukame	*Neutonia hildbrandii*	141 (36.7)	Making bee hives, fodder for goats, timber for carvings	Hanging bee hives
Mukau	*Melia volkensii*	224 (58.3)	Firewood, Medicine, Timber, Fodder for livestock	Shade
Mukayau	*Salvadora persica*	275 (71.6)	Firewood, fodder for goats	Fencing

Local Name	Botanical Name (Maundu &Tengnas, 2005)	Number of households with the species (%)	Higher plant species and their uses	
			Consumptive	Non consumptive
Mukenea	*Xanthoxylum chalebem*	116 (31.3)	Medicine, charcoal, firewood	Not identified
Mukokola	*Combretum exalatum*	235 (62.2)	Firewood, fodder for livestock	Not identified
Mukunasi	*Phoenix sp.*	27 (7.0)	Firewood	Scenic beauty
Mukuyu	*Ficus sycomorus*	26 (07.8)	Fruits,	Hanging bee hives
Mulela	*Acacia xanthopholea*	89 (23.2)	Fodder for livestock, charcoal, firewood	Hanging bee hives, forage for bees
Mung'uthe	*Lonchocarpus eriocalyx*	76 (19.8)	Herbal, medicine, firewood	Fencing
Munina	*Acacia elator*	26 (07.8)	Charcoal, fodder for livestock, timber	Forage for bees
Munoa Mathoka	*Dicrostachys cinerea*	35(09.2)	Firewood, charcoal	Not identified
Musanduku	*Eucalyptus camaldulensis*	209(54.4)	Timber, firewood, posts	Wind break
Musemei	*Acacia nilotica*	97 (25.3)	Charcoal, firewood, fodder for goats	Forage for bees, fencing
Musukulu/Muchola	*Delonita spp.*	180 (46.9)	Firewood, charcoal	Fencing
Muswaki	*Salvadora persica*	15 (04.0)	Medicine	Not identified
Mutandi	*Ochna inermis*	57 (15.0)	Firewood	Not identified
Muthuingi	*Ormacarpus kirkii*	65 (17.9)	Firewood	Not identified
Mutungate	*Commiphora habessinica*	62 (16.1)	Medicine, firewood	Forage for bees
Mutungu/Kitungu	*Commiphora africana*	154 (41.1)	Charcoal, fodder for goats and sheep	Fencing
Muuku	*Terminalia brownii*	47 (12.8)	Medicine, firewood	Shade
Muvingo	*Dalbergia melanoxylon*	124 (32.3)	wood for carvings, Posts, charcoal	Shade
Muvuaia	*Steganotaenia spp.*	109 (19.4)	Medicine, firewood	Not identified
Muvuavoi	*Steganotaenia eraliacea*	15 (04.0)	Fodder for goats and sheep	Not identified
Mwaa	*Acacia tortillis*	337 (87.8)	Timber, Fuel, fodder for livestock, medicine	Forage for bees
Mwalandathe	*Cassia abbreviata*	165 (43.0)	Medicine, firewood	Shade
Mwalula	*Croton dichoca*	86 (22.7)	Firewood, charcoal, fodder for goats	Fencing, forage for bees
Mwaluvaini	*Azadirachta indica*	176 (46.0)	Medicine, firewood	Shade
Ndau	*Euphobia spp.*	367 (95.6)	Firewood, fencing poles, medicine	For fencing home compounds

Local Name	Botanical Name (Maundu &Tengnas, 2005)	Number of households with the species (%)	Higher plant species and their uses	
			Consumptive	Non consumptive
Pine	*Pinus patula*	125 (32.5)	Timber, posts, firewood	Wind break
Yiulu/Iulu	*Commiphora spp*	342 (89.0)	fodder for goats and sheep	Fencing
Yumbu	*Ficus spp.*	68 (18.4)	Firewood, fodder for goats	Not identified

Source: Field Data, 2015

The study established through household questionnaires and FGDs that the area is endowed with a variety of higher plant species as shown in Table 10. A total of 60 higher plant species of trees were identified. The plant species include both indigenous and exotic trees with few shrubs. Indigenous tree species include; Mwaa (*Acacia fortillis),* Itula (*Commiphora baluensis),* Mukayau (*Salvadora persica),* Ndau *(Euphobia spp.),*Yuilu *(Commiphora spp*.), Kithiia *(Acacia mellifera),* Mukame (*Neutonia hildbrandii),* Mikokola (*Combretum exalatum)* Ikuu (*Commiphora Africana)* and Kiembe *(Magnfera spp*.) among other species (Table 10). Exotic tree species include Musanduku (*Eucalyptus spp.),* Pine *(Pinus spp.)* and *Grevillea* species.

The dominant higher plant species identified from the study include Kithiia/Muthiia (*Acacia mellifera*) (89.1%), Mwaa (*Acacia Tortillis*) (87.8%), Ndau *(Euphobia spp.)* (95.6%), Yiulu (*Ficus spp.)* (89.0%), Mikuswi (*Acacia brevispica*) (88.3%), Mukokola (*Combretum exalatum)* (62.2%), Mukau (*Melia volkensii*) (58.3%), Itiithi (*Commiphora spp.) (*66.1%) Musanduku (*Eucalyptus camaldulensis*) (54.4%) and Itula *(Commelina benghalensis*) (57.0%). This implies that these dominant species provide more uses to the residents of Kibwezi since they exist in large numbers thereby capable of supporting variety of livelihoods. From the results (Table 10), it evident that higher plant species provide both consumptive and no-consumptive

uses with few species being identified for non-consumptive uses. The consumptive uses include, provision for firewood, charcoal, posts and timber for building and construction, wood for making handcrafts, herbal medicine, reeds for making baskets, fodder for cattle, goats, donkey and sheep and wild fruits for food and local sale.

The non- consumptive uses include fencing, hanging of bee hives, forage for bees, scenic beauty, shade and protection of watersheds. Examples of these higher plant species include; Muange (*Delonita elata*), Muatine (*Kigelia africana*), Mukuyu (*Ficus sycomorus*), Mulela (*Acacia xanthopholea*, Ndau (*Euphobia spp),* Mwalula *(Croton dichoca)* and Mwaluvaini (*Azadirachta indica)* among others (Table 10). These non-consumptive uses identified could be as a result of preferences in terms of tree sizes since the higher plant species used for hanging bee hives were observed to be huge in size capable of holding more than two bee hives. The study established that the respondents were not able to provide non-consumptive uses for all higher plant species identified in the region, for example, Yumbu (*Ficus spp*), Kitootoo *(Pachystigma schumannianum),* Kitimu (*Citrus limon),* Mukenea *(Xanthoxylum chalebem),* Munoa mathoka *(Dicrostachys cinerea)* and Mukokola *(Combretum exalatum)* among others (see Table 10). This could have been as a result of inadequate recognition and utilization of these higher plant species by the residents for their improved well-being. Other higher plant species for example, Musemei (*Acacia nilotica*), Mwaa (*Acacia tortillis*), Muvingo (*Dalbergia melanoxylon*), Mwaluvaini (*Azarditachta indica*) and Musukulu (*Delonita spp*.) as observed by Maundu and Tengnas (2005) are potential species for hanging two to three bee hives. These higher plant species could have been considered by the residents for Kibwezi Sub-County for hanging bee hives and hence, increasing the number of households carrying out bee keeping as a livelihood in the study area.

Despite the variations in use of higher plant species, the residents of Kibwezi rely on a total of 60 higher plant species which support variety of livelihoods.

A similar study to the current findings (Table 10) by Backeus, Pettersson, Stromquist & Ruffo, (2006) in semi arid areas of Ihombwa region in Tanzania enumerated 86 species of trees. Other studies by Luoga (2000) and Giliba et al. (2011), enumerated 79 and 110 species of trees in Kitulanghalo and Bereku forest reserves respectively. Kamal et al. (2009), recorded a total of 85 wild plant species in semi arid areas of Dhading District in Nepal out of which 61 species (72%) had multiple functions as food, medicine, or cultural and economic importance. Similar contributions from wild plants have been noted by Balla, Awasthi, Shrestha, Sherchan and Poudel (2002) in semi arid areas of Tanahun and Chitwan Districts of Nepal while Shrestha (2001) reported that 20-30% of the food requirements in rural communities of Nepal were met by wild plant species. Madzwamuse, Schuster, and Nherera, (2007) contend that although semi arid areas have fewer higher plant species than the tropics or semi-tropics, they are characterised by a high degree of endemism and contain plant resource products with high use to the local communities.

Cavendish (2000) posits that plant species contribute to rural livelihoods in a number of ways generally adding to a diversified livelihood portfolio. Further, these findings (Table 12) are consistent with the ecosystem services framework (MEA, 2003 & MEA, 2005) that maintains that ecosystems provide consumptive and non-consumptive goods which human beings depend on for various livelihoods. However, the above studies (Backaus et al., 2006; Luoga 2000; Giliba et al., 2011 and Kamal et al., 2009) only identified the number of plants species in the

studied ecosystems, providing their general uses. The current study has focused specifically on higher plant species and their specific uses concluding that, the semi arid regions of Kibwezi Sub-County are endowed with 60 species of higher plants which are useful to the local communities for provision of firewood, charcoal, timber, herbal medicine, hanging bee hives, forage for bees, fodder for livestock and wood for making handcrafts. Therefore, despite factors like climatic, edaphic variability and anthropogenic activities which are associated with the difference in species richness (Giliba et al., 2011), Kibwezi Sub-County has a variety of plant species which the local communities use to sustain their livelihoods.

4.2.2 Land Area (Acres) Occupied by Higher Plant Species

The study established that higher plant species dominate different areas of the households' lands in acres. The respondents were able to approximately state the acreage occupied by these plant species (see Appendix F). The study further established that an approximate acreage of 1-2 was dominated by 95% of the higher plant species with some species (16.6%) dominating large areas as represented by the highest number of the respondents, for example, Ndau (*Euphobia spp*.) (95.6%), Muthiia *(Acacia mellifera*) (89.1%), Ikuu (*Commiphora africana*) (59.3%), Kilawa (*Grewia bicolor*) (78.1%), Kiongoa (*Combretum paniculatum) (*82.3%), Mukayau (*Salvadora persica)* (71.6%), Mukokola (*Combretum exalatum*) (62.2%), and Yiulu (*Commiphora spp.)*(89.0)%. Few (46.6%) higher plant species covered approximate area of below 0.25 acres (see Appendix F). This can therefore be interpreted to mean that those respondents who had higher plant species dominating large areas derived more uses, hence implying that they were involved in more livelihoods. Through observation (Plate 5 b), some higher plant species were seen to dominate certain areas more than others. For example, Kiamba/Muamba (*Andasonia*

digitata) species were seen in great numbers in Kinyambu region where they were evenly distributed.

The dominant species observed at Kiboko sub location are Itula (*Commiphora baluensis)* which were highly concentrated along Mombasa- Nairobi highway. Mwaa *(Acacia spp.)* were more concentrated in Kathekani sub location in Mtito Andei location and sparsely distributed across Kibwezi Sub-County. A study by Niemeijer et al. (2005), concur that higher plant species are usually few in most rural areas mainly characterized by density of species tolerant to arid soil conditions and their composition support a variety of livelihoods of the local communities. Bene, Beall and Cote, (2000) as well as Mortimore et al. (2008), observed that arid and semi arid lands are characterized by sparsely populated hardy plant species of trees and shrubs that withstand the stress of arid zone environments and play a vital role in maintaining an ecological balance and improving the livelihoods of the people in the arid regions.

There was need to establish whether the area covered by the higher plant species influenced the number of higher plant species. A Pearson product moment correlation between higher plant species richness and the area in acreage dominated by the higher plant species was undertaken. The results are presented in Figure 5.

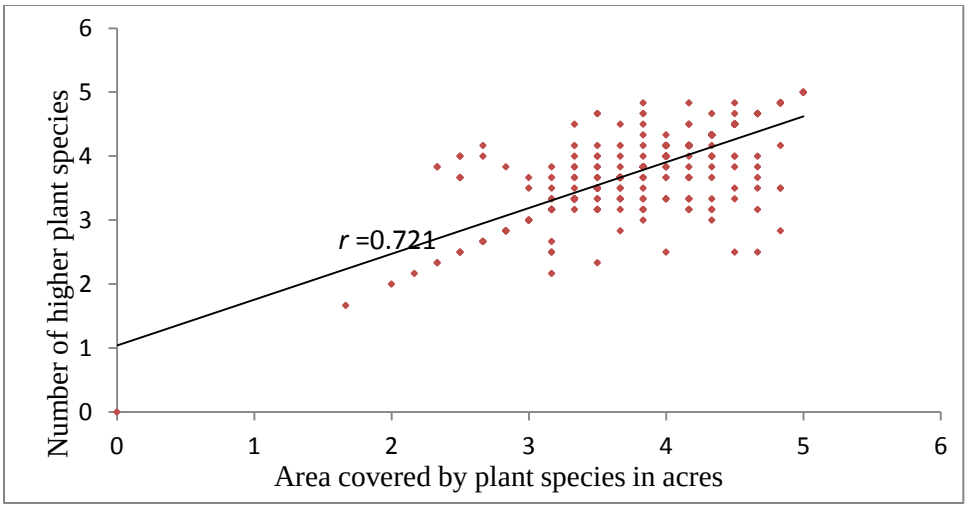


Figure 5: Correlation between the number of higher plant species and area covered by higher plant species.

From Figure 5, the correlation analysis yielded to $r = 0.721$. This showed that there was a strong positive correlation between the area covered by the higher plants species and the number of higher plant species richness, which was statistically significant 0.05. According to Hopkins (2002), a correlation of 0.7-0.8 is considered to be strong. Therefore, this implies that the area dominated by species influenced the species richness in that the larger the area dominated, the higher the plant species richness. This can be further interpreted that those households with higher plant species covering large acreages have more plant species, hence have higher chances of getting income through the various uses. Persha et al. (2009), established that tree species richness dominated human landscapes in India and supported livelihoods in the region. In their study on species richness and livelihoods, Giliba et al. (2011,) concluded that plant species richness provide products and services which support livelihoods to the surrounding communities. However, these studies (Persha et al., 2009; Giliba et al., 2011) generally highlighted plant species while the current study established further that the area covered by

plant species influences the number of higher plant species which in turn influence the livelihoods supported.

4.2.3 Influence of Higher Plant Species Richness on Livelihoods

The households were told to list the various activities contributing to their livelihoods supported by variety of plant species found in their lands. Evidence from questionnaires, FGDs and observations identified livelihoods supported by higher plant species as summarised in Table 11.

Table 11: Livelihood activities supported by higher plant species in Kibwezi Sub-County.

Livelihood activities	Frequency	Percentage (%)
Brick Making	22	5.7
Wild Fruit Selling	31	8.1
Livestock Keeping	85	22.1
Bee Keeping	39	10.2
Timber Selling	86	22.4
Planted Fruit Selling	26	6.8
Charcoal Burning	14	3.6
Firewood Selling	31	8.1
Herbal Medicine selling	14	3.6
Handcraft Selling	36	9.4
Total	**384**	**100**

Source: Field Data, 2015

Among the livelihood activities reported in Table 11, livestock keeping and timber/post selling are the major livelihoods accounting for 22.1% and 22.4% respectively while charcoal burning and firewood selling were the least, both accounting for 3.6% respectively. It was noted that the respondents were involved in more than one livelihood dependent on higher plant species but for the purpose of this study, the researcher only focused on a livelihood which could be majorly supported by the higher plant species, resulting to the list of livelihoods in Table 11. These

results imply that the residents of Kibwezi depend on a variety of higher plant species to carry out various activities which enable them to get income to cater for basic needs. However, these low percentages of respondents being involved in the livelihoods could mean that there is under utilization of the 60 varieties of higher plant species found in the region to support these livelihood activities.

In a study on the links between forest products, livelihoods and poverty alleviation in semi arid areas of South Africa, Shackleton, Campbell, Lotz-Sisitka, and Shackleton, C., (2008) established that ecosystems in arid and semi arid areas provide plant species which can supplement livelihoods through direct provisioning and trade of ecosystem products. From this study, plant species and livelihoods are linked although it is not clearly indicated on the percentage of the respondents involved in the livelihoods as established by the current study that about 22.1% confirmed that higher plant species supported livestock keeping. Ecosystem services framework (MEA, 2005) maintains that the wellbeing of communities in rural areas in African countries is critically dependent on ecosystems that sufficiently support their livelihoods and income. By contrast, the residents of Kibwezi Sub-County seem not to sufficiently rely on provisioning ecosystem services specifically higher plant species to engage in the livelihoods in higher numbers since from the findings (Table 11) only few people confirmed to be engaging in the identified livelihoods.

Ellis and Allison, (2004) concluded that dry lands ecosystems of Southern Africa have many species used by local people as part of their livelihoods. Other studies (Machakaire, 2001; Scoones et al., 1992 and; Warinwa, 2000) concluded that throughout the world, plant species provide green social security to hundreds of millions of people, are important for household food

security, health and income generation through various livelihoods. Therefore, these studies are in support that dryland ecosystems have plant species which support livelihood while, the current study has confirmed that ecosystems in Kibwezi Sub County support variety of higher plant species capable of supporting livelihood activities and there is need for the respondents to utilize them sufficiently so as to increase income and hence improve their well being.

Pearson product moment correlation between higher plant species richness and the types of livelihoods supported by the higher plant species was undertaken. The results are summarized in Table 12.

Table 12: Correlation between higher plant species and types of livelihood supported by higher plant species

		1	2	3	4	5	6	7	8	9	10	11
1	Higher plant species	1	.711**	.638**	.332**	.233**	.243**	.212**	.230**	.159**	.620**	.397**
2	Brick Making	.711**	1	.258**	.358**	.158**	.162**	.294**	.346**	.123*	.439**	.360**
3	Wild Fruit selling	.638**	.258**	1	.127*	0.065	.110*	.170**	.162**	0.009	.378**	.173**
4	Livestock Keeping	.332**	.358**	.127*	1	.325**	.281**	.232**	.287**	.262**	.300**	.396**
5	Bee Keeping	.233**	.158**	0.065	.325**	1	.224**	.200**	0.04	.142**	.220**	.212**
6	Herbal Medicine	.243**	.162**	.110*	.281**	.224**	1	0.053	0.03	.167**	.181**	.183**
7	Timber/post Selling	.212**	.294**	.170**	.232**	.200**	0.053	1	.317**	.219**	.167**	.287**
8	Planted Fruit Selling	.230**	.346**	.162**	.287**	0.04	0.03	.317**	1	.182**	0.083	.484**
9	Charcoal Burning	.159**	.123*	0.009	.262**	.142**	.167**	.219**	.182**	1	.111*	.667**
10	Handcraft Selling	.620**	.439**	.378**	.300**	.220**	.181**	.167**	0.083	.111*	1	.251**
11	Firewood Selling	.397**	.360**	.173**	.396**	.212**	.183**	.287**	.484**	.667**	.251**	1

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

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

The results in Table 12 indicate that there is a significant high positive correlation between higher plant species and brick making ($r=.711$, $p<.01$), Wild fruit selling ($r=.638$, $p<.01$) and handcraft selling ($r=.620$, $p<.01$) while there was a weak positive relationship between higher

plants species and livestock keeping (r=.332, p<.01), herbal medicine selling (r=.243, p<.01), timber selling (r=.212, p<.01), firewood selling (r=.397, p<.01) and charcoal burning(r=.159, p<.01). The weak relationships obtained in livestock keeping, charcoal burning, timber selling, can be explained that these livelihoods do not require to be supported by variety of higher plant species, but they can be sustained by an individual higher plant species provided that the species richness is high. Despite the variations in the levels of significance (Table 12) it can be deduced that relationship between the higher plant species in Kibwezi Sub-County and the livelihoods carried out by the residents. This therefore means that higher plant species influence livelihoods since the residents in Kibwezi are able to get income though engaging various livelihoods in the region.

Further, Pearson product moment correlation was done to establish the relationship between higher plant species and the number of livelihoods supported. The results are summarized in Figure 6.

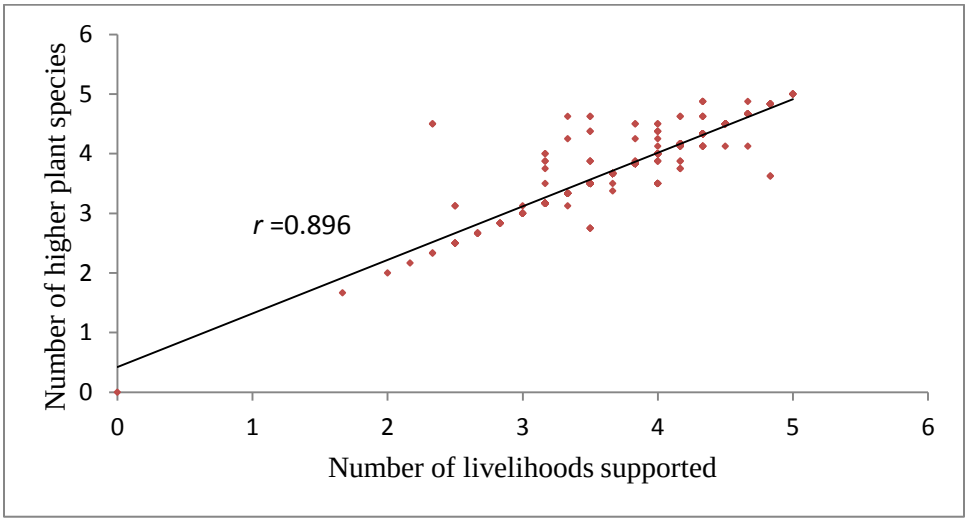


Figure 6: Correlation between number of higher plant species and number of livelihoods supported.

From Figure 6, the correlation analysis yielded to r = 0.896. This was a strong positive relationship and was statistically significant in that an increase in the number of higher plant species richness led to an increase in the number of livelihoods supported. Therefore, this can be interpreted to mean that higher plant species are strongly correlated to the number of livelihoods supported in that, the higher the number of higher plant species, the more the number of livelihoods supported. Thus, the diversity of ecosystems in Kibwezi Sub-County evidenced by large tracts of lands owned by the residents are endowed with large numbers of higher plants species which provide variety of uses capable of supporting high number of livelihoods from which the residents can obtain income to improve their well being.

A study by Nyariki and Ngugi, (2002) established that ecosystems in rural semi arid areas yield a wide variety of useful products such as timber, fuel wood, charcoal, wild fruits, gums, resins, honey, and traditional herbal medicines whereby the revenues collected from the sale of these products and services contribute significantly to livelihoods of the local people. The current study has established that higher plant species in Kibwezi Sub-County are strongly correlated with livelihoods derived from the various uses of these higher plants. These findings (Figure 6) compares well with findings by Persha et al. (2009), that tree species richness and livelihoods in India were positively and significantly correlated. A study by Nyariki and Ngugi (2002) established that rural dryland plant species in Kenya support variety of extractive livelihoods activities like timber production, charcoal making, apiculture, and brick making among others. In addition to providing food directly, Harris and Mohammed, (2003) reported that wild plants in rural India provide an opportunity for cash generation and many wild plant resources have significant economic value derived from their collection and sale. Despite the highlight on the importance of plant species and livelihoods supported by plant species in dryland ecosystems by

the above studies, the current study has clearly revealed on that there is a significant relationship between higher plant species and the number of livelihoods supported in Kibwezi Sub-County. The various livelihoods supported by higher plant species are subsequently discussed below.

Firewood Selling

The study revealed that 8.1% (Table 11) of the respondents confirmed that selling firewood in the study area is a livelihood. Further, correlation analysis yielded r=.397, p<.01 (Table 12) demonstrating a weak positive relationship which was significant. The low percentage (8.1%) engaged in selling firewood could mean that demand of firewood in the Sub-County is low since people can access firewood from their large tracts of lands and also in Kibwezi forest at a low fee. However, these results imply that higher plant species richness in the region influenced fire wood selling as a livelihood. The study (Table 10) established that firewood is collected from various plant species found in the region. Some of the species used for firewood include Muthulu *(Croton megalocarpus),* Mukame *(Hildebrandtii*), Ndau *(Eucalyptus grandis)* and Musanduku (*Eucalyptus camaldulensis*) among others. The Plate 1 displays firewood for sale obtained from various plants species in Kinyambu market in Kibwezi location.

Plate 1: Firewood for sale at Kinyambu market.
Source: Field Data, 2015

The study established that firewood is obtained from different higher plant species inhabiting the ecosystems in the region. Household interviews (8.1%) (Table 11) revealed that firewood in Kibwezi location is majorly collected from Kibwezi Forest for sale at nearby market centres of Kibwezi, Kinyambu, and Mbui Nzau. One female participant involved in firewood selling expressed the following:

> Only women with a monthly firewood license are allowed to get into the forest. Each pays Kshs. 100 per month and is supposed to carry one head load of dead fallen and dry trees from Mondays to Fridays for either consumption or local sale. One head load is sold at Kshs. 100. I collect a total of Kshs. 500 within 5 days and Kshs.2, 000 a month. I sell to those who operate hotel businesses in Kibwezi town and also to individual urban dwellers who cannot afford forms of fuel for example kerosene, electricity and gas. Some also sell firewood from their farms inform of an ox-cart which retails at Khs.300 or a bundle of 20 big pieces of wood costing Kshs. 100 per load. I use the cash to buy basic family needs like food, clothing, and medicine as well as paying school fees for my children (Female, 35 years old).

Therefore, this means that higher plant species in ecosystems in Kibwezi provide firewood from which those residents involved in the sale of firewood generate income to sustain their family needs. Previous studies by Wuver and Attuguayefio (2006), as well as Ghana and Korem (1985), established that firewood is the energy source of choice for the majority (81.7 %) of people in Africa because of its availability, relative cheapness, and ease of use. In a study on the contribution of the sale of firewood towards rural livelihoods in Swaziland, Manyatsi and Hlophe (2010) noted that the contribution of sale of firewood to the livelihood of the respondents was significant. The current study has established that higher plant species are significantly correlated with sale of firewood as a livelihood with higher plant species, for example, Muthulu *(Croton megalocarpus),* Mukame *(Hildebrandtii*), Ndau *(Eucalyptus grandis)* and Musanduku (*Eucalyptus camaldulensis*) supporting this livelihood. Amous (1997) reported that firewood is used predominantly at the household level and constitutes a sizable proportion of the energy consumed in many dryland countries. Babulo et al. (2008), noted that the sale of firewood has

become a thriving business as evident in the piles of firewood that can be frequently spotted displayed along highways in rural areas targeting the passing motorists.

Because of the high rate of unemployment, many people are engaging in the firewood selling as a source of income (Babulo et al., 2008). In Tanzania, firewood is an important source of cooking fuel in towns where they are bought from sellers while people in rural areas rely solely on firewood for cooking and other household tasks (Westman, 2000). Therefore this study concluded that selling firewood is a livelihood from which income is obtained to supplement basic needs for families in Kibwezi Sub-County.

Charcoal Burning

The study revealed that charcoal burning is a livelihood practised by the respondent in the study area (3.6%) (Table 11) and a correlation analysis yielded to $r = .159$, $p < .01$ (Table 12). This implies a weak positive relationship which was statistically significant. This weak relationship could have been due to the fact charcoal burning results to deforestation, destroys wildlife habitat and contributes to climate change (Ruddell et al., 2007) and this could have discouraged the residents from being involved in this livelihood. Nevertheless, the study (Table 10) revealed that charcoal is also a source of fuel obtained though burning various plant species found in the region. Respondents interviewed (3.6%) revealed that some species for example Mwaa *(acacia tortilis*), Mukame *(hildebrandtii*) Muuku (*terminalia brownii*) Mukenea (*Zanthoxylum chalybeum*) Munina (*Acacia elator*) and Mulela (*Acacia xanthopholea*) are well known to produce quality charcoal.

Plates 2 (a), (b) and (c) show charcoal burning activities at Masimbani sub location and packed charcoal for sale at Mbui Nzau market next to Makindu town along the Nairobi -Mombasa highway.

(a)

(b) (c)

Plate 2 (a), (b) and (c): Charcoal burning and charcoal for sale at Mbui Nzau market along the Nairobi-Mombasa highway.
Source: Field Data, 2015

Through household questionnaires (3.6%) (Table 11) and observation (Plate 2 a, b, c) the study established that charcoal burning is a source of livelihood for some residents in the region since firewood and charcoal constitute the dominant source of energy for most households. Charcoal is majorly sold along the Nairobi –Mombasa highway to the travellers with a sack being sold at Kshs. 600. An interview with a key informant revealed;

> Charcoal burning is a livelihood in this region since a sack is sold at Kshs. 600 and sometimes Kshs. 800 to the highway travellers. Infact, in a day, a charcoal seller can sell about 5 sacks

> realizing a minimum of Kshs. 3,000 and this is enough money in a local area like Kibwezi. The income raised is mainly used to meet the basic family needs like food, clothing, and school fees although some people also spend it on illicit brews. We have also put some mechanisms in place to ensure the environment of Kibwezi is not degraded. For example, we have the Kibwezi Charcoal Products Association, a self-help group from Mikuyuni sub-location in Kibwezi location that brings people together to benefit from charcoal production as they protect the environment. This association educates people on how to grow trees and produce charcoal within their homes. It controls charcoal burning and tree destruction in the existing natural forest. The group is legally established under the Forest Act on Charcoal Production Rules 2009 (A male forest officer in Kibwezi Town-April 2015).

This information confirmed that charcoal burning is a source of income in the region and mechanisms are put in place to ensure that the environment is not degraded especially through deforestation. In a study on charcoal production as a livelihood Benjamin et al. (2011), established that in Gushegu district of Ghana, charcoal selling is an important livelihood involving 70% mostly women. The current study has established that only 3.6 % of the respondents both male and female rely on higher plant species in Kibwezi Sub-County to produce and sell charcoal as a livelihood. This disparity in percentage could have been attributed to the differences in demand of charcoal as a source of energy which could have been higher in Gushegu district compared to Kibwezi Sub-County. A study by Niemeijer et al. (2006), reported that arid and semi arid ecosystems in Africa provide fuelwood for charcoal production as a livelihood for majority of the people living in these regions. Charcoal production in semi arid areas of Luangwa District, of Nzambia is a means of livelihood with 67% of the producers confirming they would starve if charcoal burning was banned (Anang, Akuriba & Adongo, 2011). Studies by Giliba et al. (2011) and Monela et al. (2007), reported that in semi arid areas of Tabora in Tanzania, charcoal production venture is on the rise because it is taken as a full time job to supplement household income.

Arku et al. (2008), contend that approximately 80% of households in low income neighborhoods of Accra use charcoal and/or wood as their primary source of energy. Wetsman (2000) concur that small-scale charcoal production is a significant source of income for many households in Tanzania with farmers constructing earth kilns by covering stacked wood with vegetation and then with soil, a technique commonly referred to as 'mudding'. These small kilns are wedge shaped and use about 5 to 6 cubic metres of wood from different plant species to produce about 12- 15 bags of charcoal. Mwakatobe, Lowassa and Keyyu (2005) contend that ecosystems in semi arid areas in Eastern Africa are relied on for charcoal production as the main source of household energy accounting for over 90% of energy consumption. However, despite the agreement by the above (Monela et.al., 2007; Arku et al., 2008; Mwakatobe et al., 2005) studies that ecosystems in semi arid areas support fuel wood as a livelihood, the current study has explicitly identified the higher plant species in Kibwezi Sub-County supporting charcoal production as a livelihood.

Livestock Keeping

Livestock keeping is a major source of livelihood for 22.1% (Table 11) of the respondents in the study area. In addition, there was a moderate positive relationship between livestock keeping and higher plant species in the region($r=.332$, $p<.01$) (Table 12). This low percentage (22.1%) could mean that majority of the residents owning livestock do not rely on higher plant species as main fodder for their livestock but could be grazing their livestock in grass dominated lands especially wetland ecosystems and their large tracts of lands which are dominated by thickets and bushes. The study established that indigenous species, including cattle, sheep, goats and donkeys are kept

by the households in the study area (Table 20). Plate 3 (a) and (b) show local indigenous breeds of cattle and goats in their shed.

(a) (b)

Plate 3 (a) and (b): Local indigenous breeds of cattle and goats in their sheds

Source: Field Data, 2015

Household questionnaires (22.1%) (Table 11) revealed that these animals feed on various trees and shrubs (Table 10). These include Mwaa (*Acacia spp.),* a tree which bears fruit eaten by sheep, cattle, goats, and donkeys; Mikuswi (*Acacia brevispica*), Mulului (*Balanites aegyptica*), shrubs which provide pods which are good fodder for goats and cattle while Mukayau *(Salvadora persica*) leaves and fruits which are important fodder for goats. Kiamba *(Adansonia digitata)* leaves are used as fodder for goats and cattle while and Muangi (*Delonix elata*) provides fodder for all livestock. These animals are grazed freely in the household lands from morning to evening when they return to their sheds. The animals kept provide products like meat, milk, hides, and skin which are sources of income to the livestock keepers (Table 24).

The findings (Table 12) agree with those by Niemeijir et al. (2005), that posit that the rural semi arid lands in China are home to 78 million cashmere goats and cattle which supply 65-75% of

products to the country providing 50% of household income. Further, Niemeijir et al. (2005), found that 50% of semi arid lands of Kenya are suitable for livestock keeping as a livelihood. The livestock sector employs about 50% of the labour force who get income to acquire family needs like food, clothing and shelter, and other social expenses like medical and educational costs (Niemeijir et al., 2005). FAO (2002) reported that in the semi arid region of Niger, on the border of the Sahara, the rangeland ecosystems support livestock production which contributes 46% of local household income. Kidane (2005) observed that major species browsed for forage in semi arid region of Ethiopia are *Acacia senegal (*Wild), *Acacia tortilis* (Forsk.), *Balanites aegyptiaca (*Hayne), *Bauhinia rufescens (*Delile), *Combretum aculeatum (*Lam) and *Colophospermum mopane (*Vent*).* Therefore, these studies concur that livestock keeping is a livelihoods in arid and semi arid areas proving employment and household income generation. The study has further revealed that variety of higher plant species in Kibwezi Sub-County support livestock keeping as a livelihood which help in meeting people's consumption requirements not only by directly providing them with food and transport but also generating income for the purchase of other consumptive goods and services.

Poles/ Timber Selling

The study established that 22.4 % of the respondents sell timber/ posts as a livelihood (Table 11) and that there was a weak relationship between this livelihood and the higher plant species richness in the region which yielded $r=.212$, $p<.01$ (Table 112). This implies that despite the weak correlation, the varieties of higher plant species in the study area provide wood for selling timber as a livelihood. The study established (Table 10) that some of the species used for timber include Muthiia (*Acacia mellifera*) and Mulului (*Balanites aegyptica)* which is known for being termite resistant. Household questionnaires (22.4%) revealed that Muvingo (*Dalbergia*

melanoxylon) is an excellent hard wood which produces very valuable timber for furniture. Muuku (*Terminalia brownie*) on the other hand, provides hard durable timber and poles for building houses and is resistant to termites. Selling of timber depends on the type of species and the size of the tree. A Key informant from KEFRI expressed the following:

> We are encouraging the residents of Kibwezi to embrace growing of trees in their farms and nearby river banks because products such as timber suffer little seasonal price fluctuations compared to food crops or livestock. Tree products such as poles and timber can be stored easily and hence offer less risks compared to perishables such as most agricultural products. It is not easy to convince the communities around here but those farmers who have responded to our advice are now making enough money (Female officer 33 years old, at KEFRI Kibwezi Town).

Therefore, it can be concluded that sale of timber/posts for income generation is a livelihood supported by higher plant species in Kibwezi Sub-County since few residents have embraced planting of higher plant species as evidenced by Plate 4 which shows a farm planted with a hard wood species of Mukau (*Melia volkensii*) for timber production.

Plate 4: Plant species of Mukau *(Melia Volkensii)* planted for timber production in Kibwezi Sub location
Source: Field Data, 2015

The study established that Mukau *(Melia Volkensii*)species grows naturally in several Districts such as Makueni, Taita, Taveta, Kitui, Mwingi, Mbeere, Tharaka and Mandera where it is known by different common names such as Mpenda Bure (Kiswahili), Kirumbutu (Taita), and

Mukau (Kamba, Mbeere, Tharaka). *Melia volkensii* is a high value timber tree whose timber compares favourably with camphor and Meru oak. The timber is close grained, termite resistant and mostly used for making high value furniture, window and door frames, rafters and poles. During a key informant interview, an officer from KEFRI reported that:

> The approximate gross income from 1 ha of *Melia volkensii* is 3million shillings. Although some farmers do not have title deeds to their lands, they have large tracts of land which can be used for establishment of Mukau woodlots since the population density in this region is still low. Further green grams, beans, and cowpeas are easily intercropped with Mukau trees to ensure food security. Some farmers in Kibwezi location have planted more than 25acres of this species (10 hectares) (Male KEFRI officer, 37 years, Kibwezi Town)

This report from the key informant confirmed that high income can be generated from the sale of higher plant species established as woodlots in the Sub-County improving the well being of the residents involved. Whereas Giliba et al (2011), established that higher species such as *Pterocarpus angolensis, Dalbergia melanoxylon, Pterocarpus rontundifolius,* and *Albizia verscolor* are used for timber production in Tanzania, the current study has established that *Acacia mellifera*, *Balanites aegyptica, Dalbergia melanoxylon, Terminalia brownie* and *Melia volkensii* are among higher plant species used for timber production in Kibwezi Sub-County . Mwaburi and Musyoki (2011) contend that people living in the drylands diversify in low risk high return economic activities like timber production by planting tree species adaptable to climatic conditions of the area. Ndengwa (2013) posits that some indigenous plant species in dry areas of Kenya are currently major sources of household income since the net value of investing in an acre of Mukau woodlot is approximately Ksh112,789 or US$ 1,327 with the internal rate of return of 42%. This is 1.6 to 4 times higher than the net present values of growing major crops every year which have the high probability of failure.

A study by Westman (2000), noted that even though house construction styles are slightly different in Bahati District of Tanzania and are changing in some areas of the country, the majority of rural people still relied on local forests for their house construction needs. As noted by Zenele (2012), timber farming contributes to income, employment, and business opportunities hence alleviating poverty among households. The growing of trees by small-scale timber growers is aimed at making a profit which forms a portion of the household's average total income as noted by Karumbidza (2005). Research in other countries has shown that tree farming proved to be the most profitable enterprise among households (Vermeulen, 2000). Therefore, the present study established that timber selling is an income generating activity for the people of Kibwezi Sub-County with the proceeds being used to cater for basic needs of families. The area is endowed with large tracts of land which, if utilized for the planting of appropriate tree species, could potentially support variety of livelihoods enhancing household income in addition to the protecting the environment.

Herbal Medicine Selling

The study established that the sale of herbal medicine was a livelihood for 3.6 % of the respondents in the study area (Table 11). This low percentage of respondents being involved in this livelihood could be attributed to the fact that only few people could be knowledgeable on how to mix the various parts of trees to make the herbs. However, the study established that different species of higher plants (Table 10) are used by the people of the region for medicinal purposes and as spices, which highlights the significance of higher plant species on the health of Kibwezi residents. The study established that various parts of indigenous higher plant species are used to cure various ailments as summarized by Table 13.

Table 13: Indigenous plants for herbal medicine in Kibwezi Sub-County

Local Name	Botanical Name (Maundu &Tengnas, 2005)	Part of tree used	Diseases treated and conditions improvement
Moringa	*Moringa oliefera*	Leaves in powder form. Leaves are sources of Vitamin A, B, and C	Diabetes, anaemia, sleep improvement, boosts energy
Mukalawa Mukenea Mutaa	*Grewia bicolour* *Zanthoxylum chalybeum* *Rubus spp*.	All the leaves are mixed together with water	Brucellosis
Mwala ndathe Mukayau Mukenea	*Cassia abbreviate* *Salvadora persica* *Zanthoxylum chalybeum*	Roots of Mukayau and Mwala ndathe dried and powdered mixed with dried leaves of Mukenea and	Anthritis (*Mutambuko)*
Kivu	*Grewia villosa*	Roots chewed	Asthma
Songe Mukenea Mutula	*Digera spp.* *Zanthoxylum chalybeum* *Carissa edulis*	All leaves are dried, mixed, grinded together	Kidneys infection
Mukenea	*Xanthoxylum chalebem*	Burning the stem to look like a charcoal and grinded to form a paste. Taken in porridge.	Ulcers (*Kitau kya nda)* Libido booster for men
Kivavai Muthulu Mwooa	*Asimina triloba* *Croton megalocarpus* *Albizia anthelmintica*	Leaves and Bark All grinded in to powder form	Amoeba
Mwooa	*Albizia anthelmintica*	Bark dried and powdered taken in warm water	Tape worms
Mwalovaini Mwela-ndathe Muthulu	*Azadirachta indica* *Cassia abbreviate* *Croton megalocarpus*	Leaves and the bark boiled with water and the mixture is taken	Malaria, backache
Muanzo	*Lonchocarpus spp.*	Roots are dried and grinded	Constipation for an infant
Muuku Mukenea	*Terminalia brownii* *Zanthoxylum chalybeum*	Barks are dried, grinded and taken with tea	Cleansing blood

Local Name	Botanical Name (Maundu &Tengnas, 2005)	Part of tree used	Diseases treated and conditions improvement
Muteta Kiunduwa	*Zanthoxylum chalybeum* *Cassia abbreviate*	Barks for all the three trees	Blood pressure
Itula Mukokola Kivu	*Commelina benghalensis* *Combretum exalatum* *Grewia villosa*	Stem, bark, roots All dried grinded and mixed together	Cervical cancer
Muvua iia Mutuva Mulawa	*Syzygium spp.* *Grewia tembensis* *Grewia bicolor*	Roots dried and powdered and mixed with water	Heart burn
Mwiyianzo	*Lonchocarpus spp.*	Roots dried, powdered and mixed with water Added in drinks	Typhoid
Museve	*Commiphora spp.*	Chewing leaves	Constipation Diarrhoea
Kilului	*Balanites aegyptiaca*	Bark and stem. Burned and grinded to form powder.	Dirty tongue
Muthulu	*Croton megalocarpus*	Leaves dried and powdered	Faster healing of a wound
Muthulu Munguuthe Muvingo	*Croton megalocarpus* *Lonchocarpus spp.* *Dalbergia melanoxylon*	Barks. All grinded and mixed with water	Tuberculosis
Muswaki	*Phoenix spp.*	Chewing the bark	Mouth cleaning and prevents tooth decay

Source: Personal Communication with Herbalist in Makindu Town, 2015

As depicted in Table 13, several plant species are sources of herbal medicine for the people in the study area. The various parts of the plants used are leaves, roots barks and seeds. Several parts of different plants are mixed together and water added. The mixture is taken or added in to liquids like porridge and tea. An interview with a herbalist revealed that all the herbs are prepared using small quantities of honey. This is meant to preserve them for a longer period of time. Herbalists are well known in their villages and those in need of their services often visit them in their homes. During an interview, one male herbalist reported:

> I receive people suffering from various ailments and most of them tell me that they have tried all hospitals around in vain. I mix different parts of trees which I obtain from my land or from other parts of the District. The cost of medicine ranges from Ksh.100 to Kshs.500 for simple ailments like constipation of infants, diarrhea, and wounds, paid once depending on the agreement with the patient. More than Kshs, 2000 is paid in installments for chronic ailments like diabetes, Arthritis, and Tuberculosis. Every day, my work is to prepare drugs since some are given in large quantities like 5 litres. In a week, I can raise Kshs.1000 to Kshs.3, 000 which I use to buy food, clothing, pay school fees and buying more herbal plant species from farms and forests within the District. (55 years old, Male herbalist at Kisingo Sub location)

Therefore, it is worth noting that several parts of higher plant species in Kibwezi Sub-County can be used for preparation of herbal medicine from which income can be generated from the sale of herbs. Whereas Shahidullah and Emdad (2010) established that 27% of interviewed respondents in arid areas of Natore District in Northwest Bagladesh revealed their livelihoods were completely dependent on herbal medicine selling, the current study established that only 3.6% respondents revealed that they depended on herbal medicine selling as a livelihood. This higher percentage in Natore District compared to Kibwezi Sub-County could have been as a result of awareness on how various parts of plant species can be mixed and the diseases they cure. A study in Mbooni forest of then Makueni District by Mbuvi and Boon (2009) reported that nearly all households in the area harvest plants for medicinal purposes from their grazing lands with small amounts harvested from farmlands. A study by Deccan, Development Society (2002), reported that wild plants in Medak District in India are used as food and folk medicines for common ailments such as headache, swellings, wounds, scabies, and digestion problems as noted by DDS, (2002). Further, Kalaba, Chirwa, Syampungani and Ajayi (2013) concur that dryland species, especially medicinal plants are becoming commercialized in this age of health consciousness to earn the traders a lot of income to support their families.

In Bangladesh, 90% of the medicinal plants are wild sourced and out of approximately 5,000 species of indigenous and naturalized plants growing in the country, more than 1000 contain medically useful chemical substances for herbal medicine selling as a rural livelihood security (SEDF & IC, 2003). However, these studies (Shahidullah & Emdad 2010; DDS, 2002; Kalaba et al., 2013 and; SEDF& IC, 2003) majorly focused on variety of medicinal plants harvested from ecosystems. A clear focus on the type of plants and specific parts of the plants used could have been provided by the above studies to create more in depth understanding on provisioning ecosystems services and herbal medicine selling as a livelihood. Therefore, the current study provided clear information on higher plant species from ecosystems and with various parts of higher plant species that support herbal medicine selling as a livelihood. The ecosystems in Kibwezi such as farm lands and grazing lands , have a variety of plant species which are useful in herbal medicine selling and well utilized can be sources if income improving the well being particularly the herbal medicine sellers

Wild Fruit Selling

Gathering of wild fruits for food and selling is a livelihood in the study area as confirmed by 8.1 % of the respondents (Table 11). Further, correlation analysis between higher plant species and wildfruit selling yielded to r=.638 (Table 12). This was a strong positive relationship with a set significance level of 0.01 for the analysis. This implies that the higher plant species influenced wild fruit selling as a livelihood in the study area. The current study (Table 10) revealed that wild fruits are gathered from various plant species. From Kiamba *(Adasonia digitata*), fruits locally known as Namba (Kikamba) and Mabuyu (Kiswahili) are obtained. From Mulului (*Balanites aegyptica*), fruits locally known as Ndului. From Kisaya (*Bechrmia discolour*), fruits known as

Nzaaya. From Kithea (*Cordia sinensis*), Nthea fruits are obtained. Kithumula (*Tamarindus indica*) provides Nthumula fruits while Kikwasu (*Tamarindus indica*) provides the Ngwasu fruits. Household questionnaires (8.1%) (Table 11) revealed that Kiamba (*Adansonia digitata*) is the most widespread of the *Adansonia* species in most parts of Kibwezi Sub-County and Makueni County at large. Plates 5 (a) display baobab fruits and (b) displays baobab tree *(Adasonia digitata)* species respectively.

(a) (b)

Plate 5 (a) and (b): Dry baobab fruits being sold at Mtito Andei market and a baobab *(Adasonia digitata*) species.
Source: Field Data, 2015

The baobab fruits have different morphological forms and their prices vary depending on the sizes. Through observation (Plate 5 a), *Andasonia digitata* species bears fruit that is 15 to 20 cm long. Different baobab shapes do not affect the quality of juice produced which is extracted from ripe baobab fruits which are diluted with water and sweetened with sugar. The KEFRI officer further reported:

> The Kiamba tree species is well know but under-estimated by the residents of the region and Eastern province generally yet the few who value it have benefited from the sale of its products

> especially the Namba fruits. This tree is well known but its value is under estimated. The species can live as long as 3,000 years. The leaves can be eaten as relish, while the fruit powder dissolved in milk or water and used as a drink. The powder is dissolved in porridge to make it taste sour while the seeds also produce edible oil. This tree can produce jam for sale to the locals and in large cities of Nairobi and Mombasa (Female, 33 KEFRI officer Kibwezi Town).

This is an evidence that higher plant species in the Sub-County provide variety of wild fruits which can be consumed or sold for income but majority (91.9%) of the residents do not sufficiently value these wild fruits as confirmed by the key informant, for example, *Andasonia digitata* species. This could be attributed to the fact that these higher plant species are evenly distributed in the region and residents could assume that the locals could be disinterested in buying the wild fruits and yet if displayed in the town centres along Nairobi-Mobasa highway could be bought by the travellers. The findings (Table 11) are comparable with those of Leakey, Tchoundjeu, Schreckenberg, Shackleton, S. and Shackleton, C., (2005) and Ruiz-Perez et al. (2004), that the harvesting of wild fruits from forests and semi domesticated trees growing on-farm and homesteads can substantially boost rural income and employment opportunities in semi arid regions of Africa. In Southern Africa, the sale of indigenous fruits contributes to household income, with women and children being the major beneficiaries (Ramadhani, 2002). In contrary, Akinnifesi et al. (2004), reported that in semi arid areas of Malawi, Mozambique and Zambia, 79% of rural households in relief food and indigenous wetland vegetables as a coping strategy during critical seasonal hunger period.

According to FAO (2003) diets in Kenya are supplemented with wild foods for example, edible seeds, nuts, fruits, vegetables and honey. For example, in Machakos District during the rainy season, wild leaves contribute 35% of human diet while in Northern semi-arid areas of Pokot region, people consume the leaves of *Balanites aegyptiaca* during periods of drought. A study

by FAO, (2003) reported that the Marula tree (*Sclerocarya birrea*) in the Miombo ecosystem of Southern Africa is the source of a popular product known as *Amarula cream* which is sold to 63 countries in the world. It is not clearly reported from the above studies if sale of wild fruits was a livelihoods by the people. There was also the need to provide a clear link between ecosystem services and livelihoods as revealed by the current study that, wild fruit selling is a livelihood influenced by provisioning ecosystem services from which variety of higher plant species provide fruits for sale where income is obtained to enhance the wellbeing.

Handcraft Selling

The study established that 9.4% (Table 11) of the respondents are involved in handcraft selling as a livelihood and there was a strong positive correlation between higher plant species and handcraft selling as a livelihood in Kibwezi Sub-County ($r=.620$, $p<.01$) (Table 12). This low percentage of respondents involved in handcraft selling could be attributed to the fact that some carving skills are needed to enable one carve curios out of raw plant species which only few people in the Sub-County could be experienced. Nevertheless, these results imply that handcraft selling as a livelihood is supported by the plant species in the region and more people need to be involved in this livelihood so as to increase income by carving more curios and selling them. Plate 6 displays various handcrafts for sale.

Plate 6: Carvings being displayed for sale at Mutito Adei town in Kibwezi location.
Source: Field Data, 2015

The interviewed respondents (9.4%) confirmed that they participated in the making of various carvings of wild animals, warriors, kitchen wares, stools, chairs, tables and several other items which are sold in the nearby market centres of Kinyambu, Mtito Andei, Makindu, Kiboko, Kibwezi and Voi. Through observation (Plate 6), it was established that most of these items are displayed near bus stages along the Nairobi -Mombasa highway hence targeting the travellers as potential customers. The materials used for carving are obtained from the households lands. During Focus Group Discussion session, participants revealed that craft making is an important livelihood with men being involved in the actual carving while the women engage in sales. A male discussant explained the following;

> We assign our women the work of selling carvings because our women are known to have sweet tongues of convincing the customers and they end up on selling several commodities at high prices. A customer can end up buying two or three handcrafts when he had planned to buy one. Us men we do not have bargaining powers and sometimes we give up easily when a customer insists he or she has this amount of money (Male, 29 years old in Kaasuvi village)

The suitable species include *Dalbergia melanoxylon* also referred to as African black wood locally called Muvingo, or black ebony. Trees for carvings are harvested when they are mature and according to one of the handcrafts respondent, certain species are designated for specific uses to prevent overexploitation. For example, *Mellia volkensii* is harvested for mortar while *Dolbergia melanxylon* for carving trophies. Other species include Mukame (*Newtonia hildebrandtii)* which provides red wood for carvings, while Muange, (*Delonita elata)* and Mukenea (*Zanthoxylum chalybeum)* are best for home furniture like table and chairs.

A previous study by Yilma and Kim (2003), concur that in Ethiopia some people from local communities make a living by collecting craft materials from wetlands or making carvings from trees in Western Highlands for sale to generate income for their families. Westman (2000) concur that trees are used to make a wide range of products that can broadly be classified as household utensils, tools, and equipment and that the highly preferred species for domestic uses in Tanzania include: *Rauvolfia caffra, Albizia harveyi, Teclea nobilis, Grewia bicolor*, and *Cordia sinensis.* Selling of handcrafts to tourists is increasingly becoming a source of employment as noted by Binns and Nel (2002), and the handcraft industry gives both women and other marginalized groups an opportunity to gain an income to sustain their lives (Peach, 2007). Gaylard (2004) reported that the handicraft industry is one of the potential sectors that can generate income with low barriers to entry for the marginalized population and thus empowers large number of women. Further, Richard (2002) noted that a majority of those involved in selling of curios are women since they are more concerned with feeding the family. Therefore, the current study has clearly identified and categorized the higher plant species used for various woodcarvings concluding that provisioning ecosystem services, for example, genetic

resources provide higher plant species which influence variety of livelihoods like handcraft selling leading to household income generation.

Bee keeping

Beekeeping is a livelihood practiced by some respondents (10.2%) in the study area (Table 11) with a weak positive relationship with higher plant species (r=.233.p<.01) (Table 12). This low percentage (10.2%) could mean that the residents of Kibwezi have limited themselves to the few known species commonly used for hanging bee hives instead of utilizing the variety of higher plant species to hang more bee hives leading to increase in the number of the people carrying out this livelihood hence, more income generation. Bee keeping is done in forests and bushes around the homes by those with necessary permit to practise it in Kibwezi Forest displayed in Plate 7.

Plate 7: Bee hives hung on a *Mukame* (*Neutonia hildbrandii*) species in Kathekani sub location
Source: Field Data, 2015

Through household interviews (10.2%), the study established that various plant species are used for making the beehives for example, Mukame *(Neutonia hildbrandii)* Muange *(Delonita elata)* and Mwala Ndathe (*Cassia abbreviata*) while the preferred species for hanging the beehives are Mwaa (*Acacia spp.),* Mukuyu (*Ficus spp.),* Kiusya *(Sterculia Africana),* and Kikwasu (*Tamarindus indica.* Through observation (Plate 7), the beehives are hunged on huge trees like

Mukame (*Neutonia hildbrandii)* and in areas were acacia trees are in high density. This is because species like *Acacia mellifera* provides nectar for bees and the common used hives are bark and log hives with the former being more dominant in Kibwezi Sub-County. The respondents (10.2%) involved in keeping bees expressed that bee keeping does not involve a lot of work since bees depend on flowering plants and water from the wetlands around. Bees collect gums and resins from plants, and move freely in the wild. Plate 8 (a) and (b) display honey packed in various bottles for sale.

(a) (b)

Plate 8 (a) and (b): Packed honey in bottles being displayed at Mtito Andei market for sale.
Source: Field Data, 2015

As depicted in Plate 8 (a) and (b), the harvested honey is packed in recycled bottles and displayed for sale especially to highway customers in towns and market centres along the Mombasa-Nairobi highway, for example, Mtito Andei, Kinyambu, Mbui Nzau, Voi and Makindu town. Bee keeping is mainly carried out as a source of food and income for the family. Further, honey is a traditional medicine or food in most societies and whether sold fresh at village level or in sophisticated packaging, it generates income for households. Interviews with a beekeeper revealed the following;

> One Kg of honey is sold at Kshs.500 (1000 mls), half Kg at Kshs.250 (500 mls) and a quarter Kg at Kshs.120 (250 mls). The price is not fixed and sometimes i can get a customer who is in a hurry and sell above the normal price. In a day, I can go home with a minimum of Kshs. of 2, 000. My third born is now in Form Four and I rely on this money to pay his school fees (Male, 48 years old, Mtito Andei Town)

This confirms that bee keeping is a livelihood from which honey harvested in Kibwezi Sub-County ecosystems is sold for income generation and generally this honey is liked for its good quality and organic nature i.e. lack of chemicals. A study by Kidane, Dejene and Malo (2010) observed that in Ethiopia, beekeeping was improving the livelihoods of rural people through increasing the income of smallholders in the drylands. Mwakatobe and Mlingwa, (2005) reported that in Malawi, bee keeping provided employment for about 2 million rural people. Further the study (Table 11) confirms the assertion by Lemessa (2007), that farmers in Somali Regional states in Filtu and Dollo Ado Districts admitted that beekeeping contributes about 4% to their livelihoods. Maydell (2001) observed that beehives in Sale region are made of hard durable species such as *Commiphora eminii, Rauvolfia caffra, Acacia albida,* and *Ocotea usambarensis* and *are* usually hung in trees that are easy to climb neither too large nor soft.

A study by Kidane et al. (2010), concluded that beekeeping is particularly important in areas where rain-fed agriculture is less favoured (e.g. drought prone areas) and it is an important means of survival in highly degraded areas where food crop production is limited. Despite the weak positive relationship, it can be deduced that higher plant species support bee keeping as a livelihood in the study area. Thus, beekeeping activity relies much on ecosystem services in the sense that the whole process cannot be achieved without having logs for making beehives serving as hanging sites, flowers, and bees which are all either products or services from the

ecosystem. Wild, cultivated areas and wastelands are all ecosystems which influence bee keeping as a livelihood.

Brick Making

Brick making is another livelihood practised the respondents in the study area (Table 11) with a strong positive correlation between higher plant species and brick making (r=.711, p<01) (Table 12). This implies that higher plant species significantly influence brick making as a livelihood. Though observation (Plate 9), the study revealed that brick making takes place near water points especially along the riverbanks. The process involves use of various parts of higher plant species such as tree leaves, and twigs, which are all obtained from the ecosystems. The sticky soil model is moulded using a rectangular wooden box joined by wooden scapers of different sizes prepared using wood from Mukame (*Neutonia hildbrandii*) or Mukau (*Melia volkensii*) and sometimes Itula (*Commiphora baluensis)* species. The moulded bricks are lefts to dry under the sun for 5-6 days while still covered with the vegetation. Finally a kiln is built which burns the bricks until they turn red in colour. The bricks are burned using maize husks and firewood. Plate 9 displays bricks ready for sale.

Plate 9: Ready made bricks along a stream in Kwa Kyai irrigation scheme in Kibwezi Sub- location
Source: Field Data, 2015

The study established that for the bricks to turn red in colour, which ensures durability, firewood is preferred which include indigenous species like Mukokola *(Combretum exalatum*), Itungu (*Lannea alata),* Mukalawa (*Grewia spp),* Mbaiki *(Acacia thomasii) and* Muthiia *(Acacia mellifera*) which are strong enough to burn for 5 days when not dry are preferred. All these plant species are cut from home gardens. Brick making is done for income generation. Each brick is sold at Kshs. 5 and one brick furnace produces around 20,000 bricks. Therefore a total of Kshs.100, 000 may be realised from one furnace by the end of the process. These bricks are sold to customers within the community and in towns for use in building permanent houses. The brick makers are encouraged to back fill the holes where they scoop soil by planting more trees so as to rehabilitate the environment. All the trees and braches used during the process are obtained from home gardens. Further, only mature trees should be used to burn bricks. Yilma and Kim (2003) concurs that wetland ecosystems are preferred areas for brick making for household income generation. Westman (2000) noted that tree species provided wood as the predominant source of energy for some small-scale processing enterprises such as brick making in Bahati District of Tanzania. This study therefore established that brick making is a livelihood which relies on various plant species in the study area from which income is raised for essential needs in the family.

4.4 Influence of Water Availability on Food and Livestock Production in Kibwezi Sub-County.

The study also aimed at establishing the influence of water availability on food crop and livestock production in Kibwezi Sub-County. The results of this objective are presented as below;

4.4.1 Main Sources of Water in Kibwezi Sub-County

The study established that there are various sources of water used for food crop production with the most accessed being rainfall, boreholes, streams, rivers, and springs. The results are summarized in Figure 7.

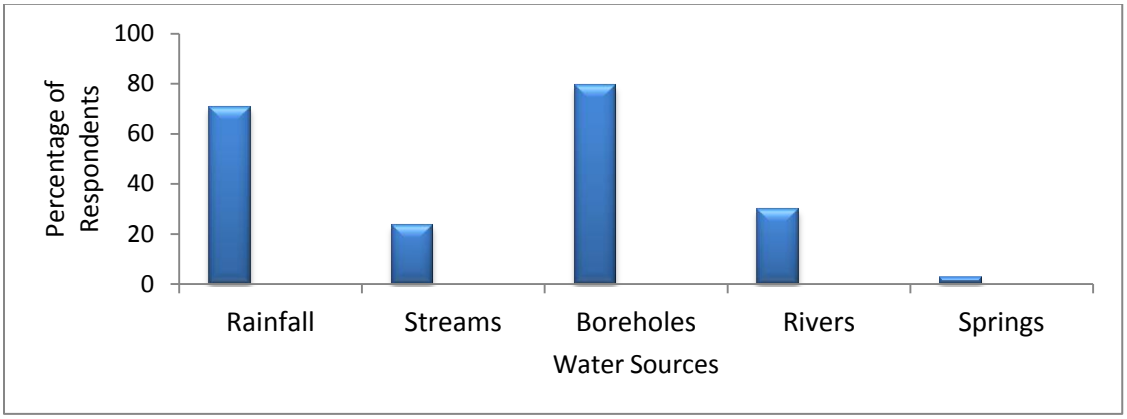


Figure 7. Sources of water in Kibwezi Sub-County
Source: Field Data, 2015

As depicted in Figure 5 above, a majority of the respondents (79.2%) use water from boreholes while 70.3% rely on rain water, 23.4% on streams, 29.7% on rivers, and 2.6% on springs. Some of the streams include; Kathekani, Makindu and Maangi Uvungu while rivers are Thange, Kiboko and Kibwezi. Springs in the study area are Umani, found in Kibwezi Forest, Kiboko springs, and Uzima springs in the Tsavo East National Park. Rainwater is harvested through collection from the house rooftops and stored in tanks for various purposes like cooking,

drinking kitchen gardening and watering animals. The respondents (70.3%) revealed that rainwater was mostly reliable during rain seasons and its quantity was affected by unpredicted rainfall fluctuations (see Appendix F). Despite the noted fluctuations, the rainwater received in the region is a product of ecological processes from the ecosystems. The results (70.3%) therefore reveal that water is obtained from different sources and this implies that ecosystems in the study area play a critical role in the provision of freshwater for human consumption and other purposes.

The findings (Figure 7) of this study concur with the study by Mujwahuki (2013) that in Muleba District of Tanzania, the residents obtain water from different sources, for example, rainwater, swamps, springs, boreholes and rivers. A study by Morton and Kerven, (2013) reported that large volume of water available to people living in drylands is found in perennial and seasonal rivers that originate at higher elevations. A study by Niemeijir (2006) established that water regulation as an ecosystem service in dryland ecosystems results to rainfall for primary production and domestic uses. Further, Hutchinson and Herrman, (2007) concluded that approaches to water accessibility in dryland areas range from development of groundwater resources through boreholes for domestic and productive uses. A study by Hesse, (2011) reported that dryland ecosystems are also among the world's most variable and unpredictable environments where rainfall is low and erratic and there is high inter-annual climate variability.

However, these studies (Niemeijir, 2006; Herrman, 2007 and; Hesse, 2011) did not specifically highlight that ecosystems play a significant role in contributing to the minimal rainfall available in these regions. Therefore, despite the rainfall variability in the study area, this study concludes that wetland ecosystems in the study area are key sources of water and the availability of rainfall

is, by large regulated and maintained by the ecosystem functioning and processes which support the livelihoods of the people in these areas.

Rainfall is bimodal meaning that the area receives two rainy seasons. March-May is the season for long rains while October - December is the season for short rains (RoK, 2009). According to RoK, (2009), annual rainfall in Kibwezi Sub-County is 500-600mm whereby each season receives about 250 mm and rains are not properly distributed for the crop cycle. It is erratic meaning that it can all come in one week or one month thus affecting food crop production. Figure 8 shows the rainfall distribution for the period of 15 years in Kibwezi Sub-County.

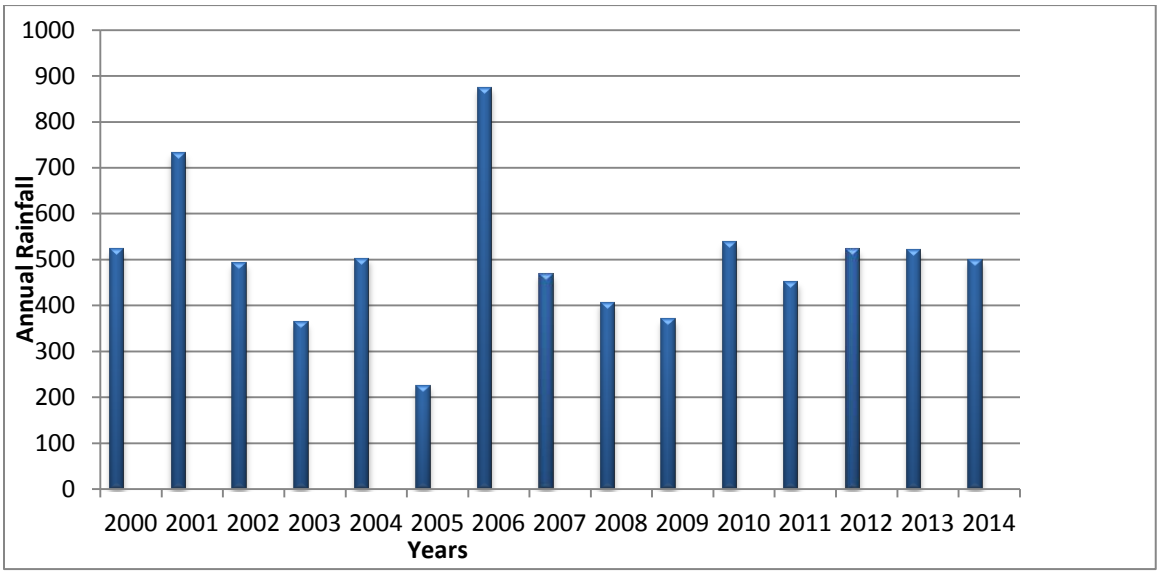


Figure 8: Rainfall variability in Kibwezi Sub-County

Source: Makindu weather Station, 2015

As depicted in Figure 8, rainfall is highly variable in Kibwezi in that it fluctuates every year. Some years received high rainfall for example, 2006, 2001, 2010 and 2012 which was 873 mm, 730 mm, 537 mm and 521 mm respectively. Years which received low rainfall were 2005, 2003 and 2009 which was 225 mm, 362 mm, and 368 mm respectively. This can be interpreted to

mean that during the heavy rains, the households harvested water and stored in tanks for future use. Therefore, rainfall supports food crop production which is a livelihood by the residents of Kibwezi Sub-County.

These results (Figure 8) conform to the findings by Morton and Kerven, (2013) that dry rural areas are characterised by scarce and unreliable rainfall, often concentrated during a relatively short rainy season sometimes bimodal in nature, and with substantial inter-annual variation and is also spatially highly variable, to the extent that a community in one location may receive abundant precipitation, while others adjacent remain dry. A study by Beaumont, (2001) established that in the African Sahel this rainfall may average 200 to 250mm, but in some years drop to less than 100mm, and in others rise to 400 mm. Further, Hesse (2011), reported that dryland ecosystems are also among the world's most variable and unpredictable environments where rainfall is low there is high inter-annual climate variability. However, Hesse's study did not specifically highlight that these ecosystems play a significant role in contributing to the rainfall available in the regions. Therefore, despite the rainfall variability in the study area, the current study concludes that ecosystems are sources of water, for example, rainfall which may not be enough to support crop farming as a livelihood and through availability of water in other sources, for example, boreholes, springs, and rivers, the residents can use this water to support crop farming through irrigation thereby generating income to improve their well being.

4.4.2 Distance Covered to Reach Water Sources

The study established that the distance covered by the households to the various water sources varied. This is summarized in Table 14.

Table 14: Distance covered by the respondents to reach various water sources.

	BELOW 1 KM		1-2 KM		2-3 KM		3-5 KM		TOTAL	
	F	%	F	%	F	%	F	%	F	%
Rain	0	0	0	0	0	0	0	0	0	0
Rivers	80	70.2	19	16.7	10	8.8	5	4.3	114	100
Stream	77	85.6	9	10.0	3	3.3	1	1.1	90	100
Borehole	205	67.4	67	22.1	28	9.2	4	1.3	304	100
Springs	7	70.0	2	20.0	1	10.	0	0.0	10	100

F= Frequency %= percentage
Source: Field Data, 2015

As depicted in Table 14, respondents who covered a distance of less than 1km to reach streams were 85.6% while 70% and 67.4% covered a distance less than a kilometre to reach rivers, springs and boreholes respectively. Only about 6.7% households walked a distance of 3-5 kilometres to reach the water sources. Thus, an average distance covered by households to reach the nearest water source is one kilometre. This implies that ecosystems such as wetlands and forest in the study area have enabled the accessibility of water which is an important service for enhancing the livelihoods such as food crop production which enhances income through marketed surplus.

MEA (2005) contends that ecological processes and functions in forests, wetlands, grasslands and other ecosystems regulate water availability at different points. Storage options along the continuum, from soil and groundwater to natural wetlands and dams, can make water more accessible in drylands at different spatial and temporal scales as asserted by CA, (2007). . Further, (MEA, 2005) concur that wetlands, in particular rivers are often regarded as functioning as natural sponges; they expand by absorbing excess water in time of heavy rain and contract as

they release water slowly throughout the dry season to maintain stream flow for accessibility by the surrounding communities.

4.4.3 Uses of Water

The households were interviewed on the uses of water obtained from the ecosystems in the study area. The various uses of water are shown in Table 15.

Table 15: Uses of water by the respondents

Water Uses	No. of Respondents	Percentage (%)
Cooking, human drinking, washing and watering animals	372	96.9
Cooking, Human drinking and washing	360	93.8
Kitchen gardening	245	63.8
Irrigation	294	76.6

Source, Field Data, 2015

From Table 15, it can be concluded that the main uses of water by the households include cooking, human drinking, washing, watering animals and kitchen gardening. This is because majority (96.9%) used water for cooking, human drinking, washing and watering while (93.8 %) used water for cooking, human drinking and washing with 63.8% for kitchen gardening and 76.6% for irrigation. This means that water in an important resource which greatly influences the daily activities of the households. This is because cooking plays a key role in human life, every day people have to cook their food so as to get energy and nourishment and be able to participate in various social and economic activities. Water for drinking is essential for the normal operation of the human body and is also important for the growth of the animals. Kitchen gardening and irrigation is equally important as it enhances vegetable and other food crops

availability in the households while access to drinking water, sanitation and hygiene (washing) is critical for the survival, development and the wellbeing of the people.

A study by Niemeijir et al. (2005), reported that water available in semi arid regions determines the allocation of rainfall for various uses like primary production, irrigation, livestock watering, and domestic uses while the current study has confirmed that water available in Kibwezi Sub County ecosystems is used majorly for cooking, human drinking, washing, watering animals and kitchen gardening. Falkenmark (2003) and Bennet et al. (2009), reported that physical processes like evaporation (creating clouds) and condensation (precipitation) enhance chemical interactions with soils influencing ground water recharge there by providing terrestrial and aquatic ecosystems with water for human use. Whereas this study established that about 63.8% of the household use water for kitchen gardening, Hesse (2011) established that in semi arid areas of Ethiopia, about 89% of households used. Further, Hutchinson and Herrman (2007), concluded that approaches to water accessibility in dryland areas range from the development of groundwater resources through boreholes for domestic and productive uses. However, these studies did not clearly indicate that the drylands ecosystems are the sources of underground water is accessed by the people of Kibwezi Sub-County for domestic purposes as well as irrigation. Therefore, water is one of the most vital natural resources provided by ecosystems of the world and its availability has always played an important part in determining not only where people can live, but also their quality of life.

4.4.4 Common Rain Fed Crops

The study established that the common types of rainfed crops grown include maize, cowpeas, pigeon peas, green grams, beans, sorghum and millet. The total crop yields harvested were recorded in terms of sacks each weighing 90 kilograms. The results are summarized in Table 16.

Table 16: Common rainfed food crops and approximate yields per range of acreages.

Common Rainfed Crops	Botanical Name (Maundu and Tengnas, 2005)	Yields in Sacks (1 sack=90 Kgs)					
		0-2 (1-2 acres)	3-4 (2-3 acres)	5-6 (3-4 acres)	7-8 (4-5 acres)	9 and above (above 5 acres)	Total Number of Respodents out of 384
		(F) (%)	(F) (%)	(F) (%)	(F) (%)	(F) (%)	(F) (%)
Maize	*Zea mays*	43 (11.5)	117 (31.2)	64 (17.0)	57 (15.2)	94 (25.1)	375 (97.6)
Cowpeas	*Vigna unguiculata*	85 (41.2)	43 (20.9)	39 (18.9)	23 (11.2)	16 (7.8)	206 (53.7)
Green Grams	*Vigna radiata*	79 (24.4)	83 (25.6)	32 (9.9)	31 (9.6)	99 (30.5)	324 (84.4)
Pigeon Peas	*Cajanas cajan*	82 (27.4)	78 (26.1)	40 (13.4)	47 (15.7)	52 (17.4)	299 (77.7)
Beans	*Phaseolus vulgaris*	78 (35.0)	63 (28.3)	42 (18.8)	25 (11.2)	15 (6.7)	223 (58.1)
Sorghum	*Sorghum bicolor*	221 (73.4)	41 (13.7)	12 (4.0)	17 (5.6)	10 (3.3)	301 (78.3)
Millet	*Eleucine coracana*	139 (54.7)	69 (27.2)	25 (9.8)	14 (5.5)	7 (2.8)	254 (66.1)

Key; F= frequency % = percentage of respondents
Source: Field Data, 2015

As depicted from Table 16, the study established that majority (97.6%) of the respondents grew maize with 31.2% harvesting more than 3-4 sacks, 53.7% grew cowpeas with 41.2% harvesting a maximum of 2 sacks, 84.4% grew green grams with 30.5 % harvesting more than 9 sacks, 77.7% grew pigeon peas with 27.4% harvesting a maximum of 2 sacks, 58.1% grew beans with 35% harvesting a maximum of 2 sacks, 78.3% grew sorghum with 73.2% harvesting maximum of sacks, while 66.1% grew millet with 54.7% harvesting a maximum of 2 sacks. The study also established that the respondents grew a combination of these crops for example, maize, cowpeas, green grams, pigeon peas, beans and sorghum by intercropping. However, for the

purpose of this study, the researcher focused on providing information for each crop grown by the respondent for the purpose of clearly analyzing yields and acreage per a crop. These results (Table 16) therefore imply that maize is grown by majority of the respondents because it is a staple food while green grams and pigeon peas are highly preferred for the purposes of household income generation. Interviews with the Agricultural Officer in Kibwezi Sub-County confirmed that crop cultivation during the rainy season is a major livelihood supporting 80 % of food consumed by the households.

The findings (Table 16) of this study conform to a study by Mbuvi and Boon (2008) who concluded that in Mwala division of the then Machakos District, despite the fact that rainfall amounts and distribution rarely meet crop water requirements, rain fed crop production constitutes 70% of household food. This higher percentage relying on food crop production signifies the importance of rainfall as an ecosystem service in determining food crop production at household level in the division. These results further compares well with findings by (FAO, 2003) that small-holder subsistence farmers in Kenya make up some 80% of the active agricultural population and generate the most food in Kenya growing main subsistence crops like maize, wheat, rice, sorghum, millet, cassava, Irish and sweet potatoes, bananas, other fruits . Whereas this study established that 97.6% of households grew maize, 53.7% cow peas, 84.4% green grams, 77.7% pigeon peas and 58.1% beans, a study by FAO (1998) established that in Sub-Saharan Africa, nearly 80% of households grew millet, 50% maize, 65% chickpea and pigeon pea, 81% groundnut, 88% soya beans and 50% cotton. Despite the variations of food crop production noted in these study areas, rainfall is a source of water from ecosystems through ecological processes from which people rely on for livelihoods like crop farming.

Least squares regression analysis was further undertaken to establish the relationship between total rainfall amounts for short rains season (October, November, December) and total crop yields for rainfed crops(Maize, Cowpeas, Green grams, Pigeon peas, Beans, Sorghum, Millet) harvested by the respondents in Kibwezi Sub-County. The results are shown in Figure 9.

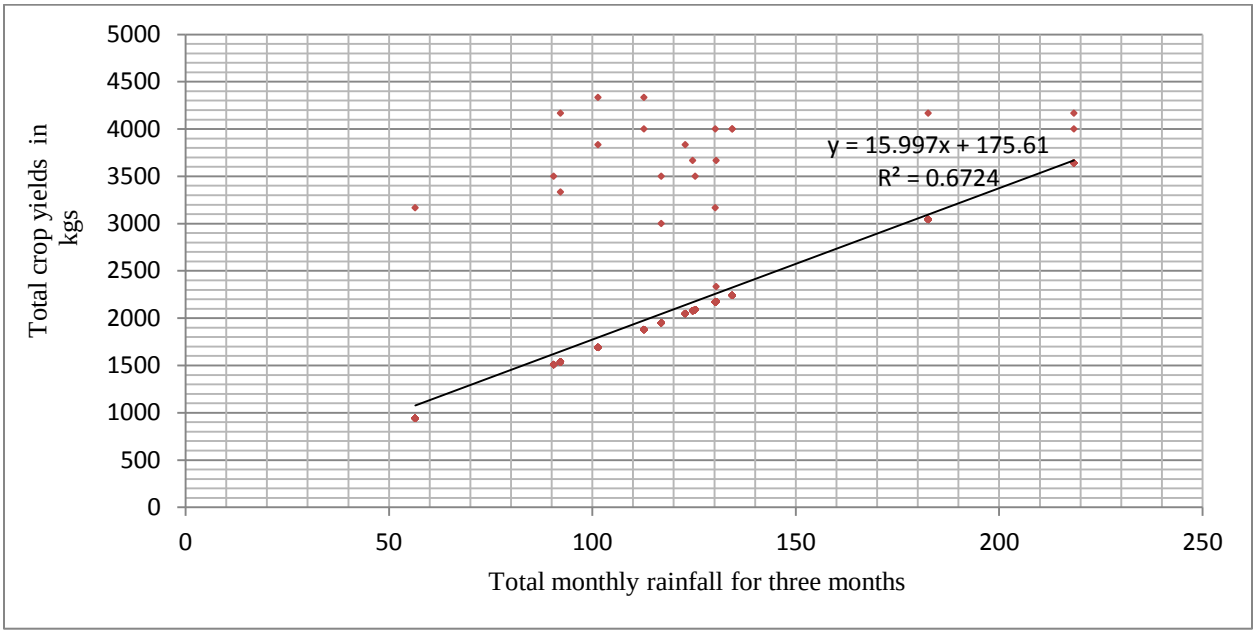


Figure 9: Relationship between total monthly rainfall amounts (October, November, December) and total crop yields for common rainfed crops (See Table 16) in one season (Short Rains- October, November, December 2014).

The results in Figure 9 shows the least square regression results of the relationship between the total rainfall amount for three months (October, November, December), and the total crop yields for common rainfed crops (Maize, Cowpeas, Green grams, Pigeon peas, Beans, Sorghum, Millet). The coefficient of determination r^2 yielded 0.672 (r^2 =0.672, p<.01). Rumsey (2009) asserted that where r^2 fell between 0.20 and 0.70, one variable (x) explained the variability in (y) variable. Therefore, this shows that 67.2% of the variation of total rainfed crop yields in Kgs in

Kibwezi Sub-County can be explained by total monthly rainfall for short rains for 3 months (October, November, December) during the year 2014 (see Appendix G). Apparently, 32.8% of the variation of the total crop yields can be accounted for by other factors which were not part of this study.

According to Alberto (2013), variations in subsistence food crop yields could also be accounted by other non climatic related factors such as application of fertilizers, timely planting, weeding, use of pesticides, and improved seeds to increase food crop production. Therefore, these results (Figure 9) are consistent with a study by Ayanlade et al. (2010), who observed a significant relationship between total seasonal rainfall amounts with subsistence food crop yields in Shaki, Ethiopia. In addition, similar results to the study findings (Figure 9) were reported by Yengoh, Armah, Onumah and Odoi (2010), that the amount of rainfall and its distribution in different seasons over the years largely influenced the productivity of food crops in semi-arid regions of Africa. The fact that the total amount of rainfall received in the region was as a result of ecological processes from ecosystem services was not clearly established by these studies. Basak (2009), reported that low rainfall amounts may lead to drought events which lead to either yield decline or crop failure. Usman and Reason, (2004) noted that the distribution and length of the period of rain during the growing season and the effectiveness of the rains in each rainfall event is the real factor that affects crop yields for different rainfed crops. This could be attributed to the fact that changes in rainfall amount are as a result of ecosystem processes which provide ecosystem services, for example, water regulation through which water is made available in form of rainfall affecting crops yields. UNEP (2012), observed that although irrigation in Africa has the potential to boost agricultural productivities by at least 50 per cent, food production is almost

entirely sustained through rainwater. Therefore, it can be deduced that rainfall which results from ecosystems processes is an important factor which influence food crop production in Kibwezi Sub-County. The rainfed crops grown in Kibwezi Sub-Countyare subsequently discussed below.

Maize (*Mbemba)*

According to 86.2% of the total respondents, maize is a staple food which is grown in the study area. Maize is grown for the purpose of consumption and local sales when there is sufficient rainfall. Interviews revealed that maize is majorly grown during the rainy seasons. Varieties of maize grown include Katumani, KDV1, KDV2, KDV 4, WE 1101, KH 500-21 A., DH02, KCB/DLC and Duma 43 (Sub-county Agricultural Officer). An interview with a key informant reported;

> We have sensitized people in this region to grow these varieties because they are early maturing, drought and heat resistant, disease and pest tolerant and take short time of 3 months to maturity. Maize contributes to livelihood of the households through supply of staple food for consumption and local sales. The response is good because the estimated average income for the two rainy seasons after sale is Kshs.50, 000 for an average harvest of 10 bags per household. The income is used for buying food supplements, paying fees, buying clothes, health care, and other basic needs (Male, 46 years old, Sub-County Agricultural Officer, Makindu)

This means that despite the noted rainfall fluctuations in the region, the residents grow variety of early maturing crops for consumption and local sale. A study by Baigorria, Jones and Obiew (2008) established that the amount of rainfall and maize crop production is correlated in that an increase in rainfall leads to high maize yields while a decrease in rainfall is associated with a decline in maize production. For example, in South East United States in 1988, the total rainfall amounts were 500 mm and 500 kg/ha maize yield was harvested, whereas, in 1989 there was about 550 mm of rainfall and 10,000 kg/ha1 of maize yield was harvested. Further, EIAR,

(2010) reported that maize production in the drylands is becoming increasingly important with about 40 percent of the national total maize produced in these drought-stressed areas. For example, a variety of Maize Melkasa- 1 matures 85 days, flowers in 48 days, and yields 2.5–3.5 t/ha in research center and 2.5–3.5 t/ha in farmer's field. This variety is well adapted to low rainfall semi arid areas of Ethiopia with rainfall ranging 450–570 mm and tolerant to rust. Therefore, within the same environmental conditions, maize is grown and the residents of Kibwezi Sub-County are able to get food for consumption and sale surplus for income to supplement other family basic needs.

Beans (*Mboso*)

The study established that beans are grown by 58.1% (Table 16) of the households in the study area. Beans are leguminous crops grown in all parts of the study area and are the cheapest source of plant protein for the households. This crop is intercropped with maize and in some rare cases grown separately. The different varieties of beans grown include Kat B; Kat B9; Kat X56. These varieties are early maturing, drought resistant and high yield. The crop is grown for consumption and local sale in the nearby market centres of Kibwezi, Makindu and Mtito Andei. The findings (Table 16) of this study conform to the study by World Bank (2007) that cereals and legumes constitute the main crops and basic food for 800 million people in drylands and that, large part of the dryland population depends on crop as a livelihood and contributes significantly to the gross domestic product and trade. Burke and Lobbell (2010) reported that farmers' choices about what crops to grow depended largely on rainfall distribution and amounts. Rainfall distribution is largely influenced by ecological processes from ecosystems by which through water regulation, water is made available through rainfall, rivers and streams which could be inadequate for crop farming. Therefore, due to high rainfall variability in semiarid areas

of Kibwezi Sub-County, the residents have to grow drought tolerant crops such as beans so as to ensure food availability for home consumption and local sale.

Green Grams (*Ndengu)*

The study established that green grams are grown by 66.1% (Table 16) of the respondents in the study area. The varieties grown are N26 (*Nylon*) and KS20 (*Uncle).* Household interviews revealed that this crop is highly preferred due to high yields, good nutritive value, early maturity and drought resilient features and its good prices at the market. Household questionnaires revealed that this variety is used commonly in paying of school fees. A study by Kidane et al. (2010), observed that several legumes exhibit good drought and heat resistance which makes them potentially very valuable for crop diversifications in low rainfall conditions.

Sorghum (***Muvya***)

The study established that sorghum is grown by 78.3 % of the households in the study area (Table 16). Sorghum (locally known as *Muvya)* species are *Seredu, Kari Mtama* I and *Gadam.* The study established that this crop is grown for consumption and local sales. The varieties preferred combine high yielding capacity with early maturity as well as disease and pest resistance. A study by Kidane et al. (2004), concurs that sorghum is a very important crop in Ethiopia with a high genetic potential grain yield of 7.0 to 9.0 T/ha. Alves and Setter, (2000) noted that sorghum requires a well distributed annual average rainfall between 450 mm and 650 mm. Other studies by Kikoti (2009); Butler and Kosura, (2006) established that the diversity of land and crop types used by different communities living in the same region reduces people's

vulnerability by providing fall back livelihood options when crops or landscapes are negatively affected by catastrophes.

Pigeon Peas (*Nzuu)*

According to 77.7 % of the respondents, pigeon peas are grown in the study area (Table 16). The species grown for both domestic consumption and sale include Mbaazi 1 and KAT 60/8. The study found that harvests range from 6-10 bags depending on the size of the farms. Those households with more than 3 Ha farms harvest more than 10 bags. The income generated from selling the extra harvests is used to cater for the family basic needs. The study established that pigeon pea is high value and multipurpose legume crop with similar uses as beans. It is a drought resistant crop which improves soil fertility by fixing nitrogen. Cow peas are also grown in the study area and the varieties include M66, K80, KVU 27-1. A study by Kidane et al. (2010), concur that pigeon pea is a preferred crop in arid and semi arid areas since it produces high yields, its drought tolerant and a multipurpose crop that can produce wood for energy supply, biomass for animal feeds in dry lands ecosystems. Therefore, the high percentage (77.7%) growing pigeon could be attributed to the fact that in addition to being drought resistant, the crop has multiple functions which could be source of extra household income, for example firewood selling.

Millet (*Wimbi*)

The study established that 84.4% (Table 16) of the respondents grow millet. Millet is grown for consumption the surplus is sold at the local market. The varieties grown include *pearl* millet and *finger* millet. A key informant reported;

> Harvest of millet range from 5-6 bags of millet per household per season. Each bag is equivalent to 90 Kgs. Each bag is sold at Kshs, 2,800 and this generates an income of approximately Kshs.168, 000 per year per household. This income is used by families to meet the costs of basic needs such as food, clothing, paying fees and to some extent paying the bride price (Male, 46 years old, Sub-County Agricultural Officer, Makindu)

The secondary data obtained from Kibwezi agricultural office showed that the most commonly grown rainfed crops were maize, beans, cowpeas, green grams, pigeon peas, sorghum and millet. The results are summarized in Table 17.

Table 17: Annual crop yields for common rainfed crops in Kibwezi Sub-County for a period of 3 years (2012, 2013, 2014)

Common Rainfed Crops			YEARS					
Local Name	Common Name	Botanical Name (Maundu and Tengnas, 2005)	2012		2013		2014	
			Area (Ha)	Tonnes	Area (Ha)	Tonnes	Area (Ha)	Tonnes
Mbemba	Maize	*Zea mays*	23,650	12,100	23,700	11,300	23,750	11,600
Muvya	Sorghum	*Sorghum bicolor*	1,550	650	1,745	785	1,750	790
Wimbi	Fingermillet	*Eleucine coracana*	19	15	21	15	20	13
Mboso	Beans	*Phaseolus vulgaris*	250	112	255	118	257	110
Nzuu	Pigeon Peas	*Cajanas cajan*	11,800	7,895	11,840	7,900	11,850	8,000
Nthooko	Cow peas	*Vigna unguiculata*	15,895	6,950	16,195	7,200	16,200	7,300
Ndengu	Green Grams	*Vigna radiata*	17,200	11,395	17,265	11,477	17,270	11,500
Totals			**70,364**	**39,117**	**71,021**	**38,795**	**71,097**	**29,313**

Source: Sub-County Agricultural Office Kibwezi, 2015

As depicted in Table 17, high crop yields were obtained from green grams, cowpeas and pigeon peas. Annual crop yields for the year 2012 were observed to be higher (39,117 tonnes) than the annual crop yields for 2013 (38,795 tonnes) and 2014 (29,313 tonnes). The annual crop yield changes could be attributed to rainfall variations since the year 2012 received high annual rainfall of 531.8 mm leading to high crop yields than the year 2013 (520.9 mm) and 2014 (498.7 mm) (see Appendix E). These findings (Table 17) support an earlier assertion by Thornton et al. (2007), that most parts of East Africa are likely to experience rainfall variability which affects crop yields. Funk et al. (2005), reported that from 1996 to 2003, there was a decline in rainfall from 50mm to 15mm per season that corresponded to a decline in maize crop yields across most of the East African countries. The findings (Table 17) are consistent with those of the ecosystems services framework (MEA, 2005) that water is a key product of the ecosystem process which is a principal input in enhancing food production in many parts of the world. Further, Basak (2009) reported that low or high rainfall leads to either a decline or an increase in yields. However, Burke and Lobbell (2010), reported that farmers' choices about what crops to grow depended largely on rainfall distribution and amounts. However, despite the noted rainfall fluctuations in the above studies, its worthy noting that ecosystems play a role in providing rainfall which supports crop farming and through water availability in the semi arid areas of Kibwezi, the residents are able to grow crops which are drought resistant. To ensure high crop yields are obtained, the residents are advised to convert their large tracts of lands for more crop farming so as to harvest yields.

Further, least square regression analysis was undertaken to establish the relationship between total annual crop yields for the common rainfed crops for three years (2012, 2013, 2014) and total annual rainfall for three years (2012, 2013, 2014). The results are displayed in Figure 10.

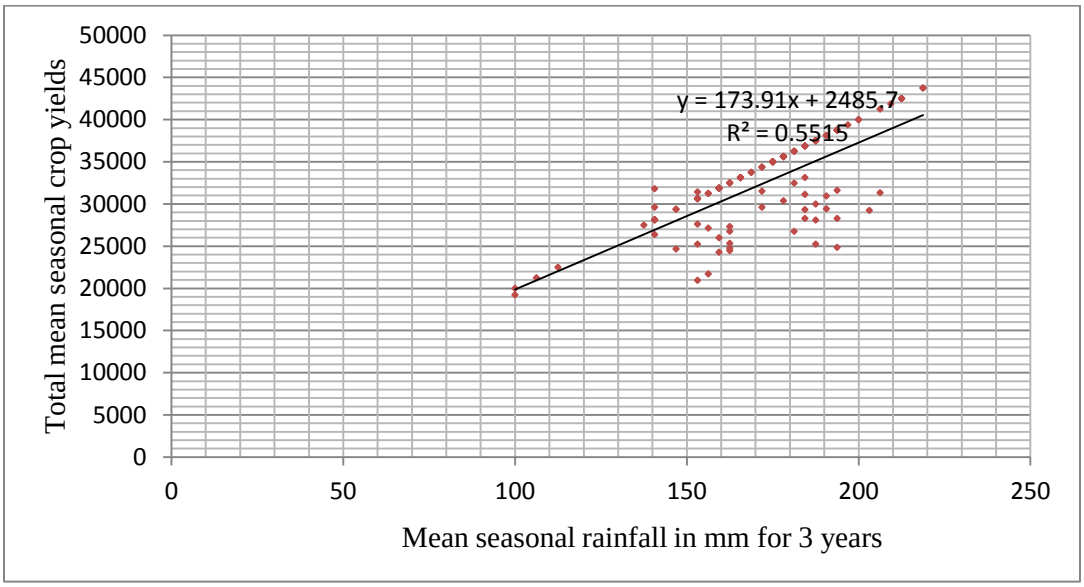


Figure 10: Relationship between total annual crop yields in tonnes for 3 years (2012, 2013, 2014) and mean seasonal rainfall for 3 years(2012, 2013, 2014) in Kibwezi Sub-County.
Source; Field data, 2015

The results in Figure 10 show that the coefficient of determination r^2 yielded 0.551. This can be interpreted that 55.1% of the variation of total annual crop yields for common rainfed crops in tones can be explained by total seasonal rainfall amounts received for 3 years (2012, 2013, 2014) in Kibwezi Sub-County. Apparently, 45.9% of the variation of the total annual crop yields can be accounted for by other factors which were not part of this study. Bowman and Paul,(1990) suggested that proper seed germination, timely opening and closing stomata, good photosynthetic activity, transpiration, application of fertilizer, pesticides and other several metabolic and physiological processes increase plant size and mass, leaf and seed yields.

While as the current study established that 55.1% of variations in crop yields was explained by rainfall, Lobell and Asner (2003) established that 60% of variations in crop yields among the 12 major Californian crops grown, was explained by rainfall. The difference in variations could be attributed to the fact that the major crops grown are fruits, tree nuts and vegetables which do well in an average seasonal precipitation of 330mm. A study by HarvestChoice (2010) concluded that rainfall ensures water availability for sustaining crop productivity in rainfed agriculture. In contrary, a study by Rao et al. (2011), noted that the total food grain production in India during El Nino years fluctuated between 9 million tons to 12 million tons up to the year 2002 although it ranged from about 9.5 to 15 million tons during the normal years. Probably, the excess rain caused crops to submerge in water affecting crop growth which affected the production in several ways. The current study therefore concludes that water for plant growth is a determinant for crop production and is made available through water regulation as an ecosystem process.

4.4.5 Irrigation

The current study established that the majority of the respondents (76.6%) were involved in carrying out irrigation in various parts of the study area as shown in Figure 11.

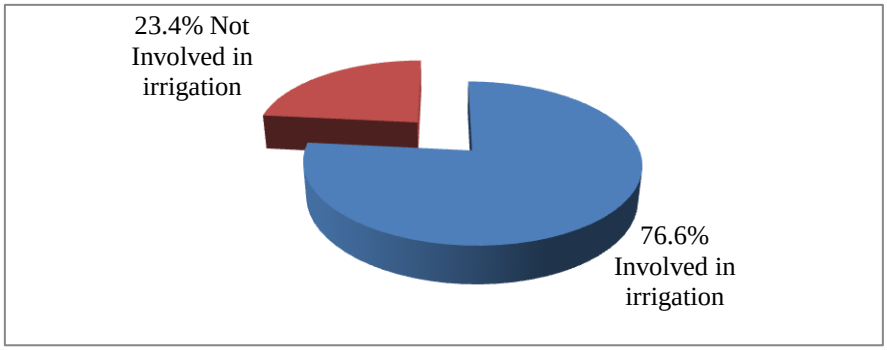


Figure 11: Percentage of respondents involved in irrigation in Kibwezi Sub-County
Source: Field Data, 2015

As depicted from Figure 11, 76.6% of the respondents carried out irrigation while those who were not involved were only 23.4%. The highest percentage involved in irrigation (76.6%) could be could be as a result of the majority of the residents living near the water sources as evidenced by results in Table 14 where majority (70.2%) covered a distance of less than a kilometre to reach water sources , for example, rivers. About 23.4% households were not involved in irrigation probably because they lived far from the rivers and other challenges experienced during irrigation as noted by Hussain and Hanjra, (2004) in India for example, income needed for fertilizers, adequate time to control water and water conflicts among others. These results implies that due to water availability from Kibwezi, Kiboko and Thange rivers in Kibwezi Sub-County, the respondents are able to engage in irrigation to grow various food crops for consumption and local sale. Therefore, the local communities in the region rely on water for crop farming as a livelihood. Through observation (Plate 10 a, b, c) and household interviews (76.6%), the study established that irrigation was done along permanent rivers of Kiboko, Maangi Uvungu, Thange and Kibwezi.

According to 76.6% of the respondents, different food crops are grown for example, Maize (*Zea mays*), Kales (*Sumuma wiki*), spinanch (*Spinacia oleracea*), cabbages (*Gloria f1 highbrid*), cucumber (*cucumis sativus*) sweet peper *(ndulu),* tomatoes (*roma*), pumpkins (*curubita*), baby corn (*Zea mays L),* fruits like paw paws (*Asimina triloba*), watermelon (*cirtrullus lanatus),*Ochre *(mbinda),*Asian vegetables for example *brinjal, ravaya, chilli, okra, karalla, guar, dudhi, turia,* curry leaves, *patra, saragua* and onions. The study established (Figure 11) that these food crops are grown for consumption and local sale at nearby markets and town centres Kibwezi, Emali, Makindu and Mtito Adei and others transported to major cities of

Nairobi and Mombasa. Therefore, the current study notes that there is need to encourage the 23.4% households not engaged in irrigation to practice it despite the long distance and other factors which could be discouraging them from practising irrigation so as to increase food production which can improve their well being.

A study by FAO (1998) established that past efforts to increase crop production in dryland regions in Africa have centred on the establishment of small scale and large-scale irrigation schemes such as the Gezira Scheme in Sudan and Chokwe Irrigation Scheme in Mozambique creating employment to those working on these farms. UNEP (2011) established that the services provided by ecosystems like water regulation are crucial to fulfilling the needs of a growing population such as food provision through irrigation agriculture. Further, FAO (1998) reported that many efforts in dryland sub-Saharan Africa have focused on large irrigation schemes, construction of dams as well as borehole construction to improve water supply mainly for agricultural production and improvement of livelihoods. Niemeijer et al. (2005), concluded that water provision service is critical for maintaining wetlands within the drylands, to enable these ecosystems to provide a package of services of great significance to the local communities.

Through observation (Plate 10 a, b, c), the study established that farmers along this river use gravity fed furrow irrigation. Water from Kibwezi River collects into a large dam (a) from where it is directed through a channel (b) to flow into cemented furrows (c) to reach the farms as shown in the Plates10 (a), (b) and (c).

(a) (b)

(c)

Plate 10 (a), (b) and (c): Dam for water collection from Kibwezi River, direction of water through a channel and a furrow from which the farmers get water.
Source: Field Data, 2015

Through irrigation, different crops (Table 19) are grown along the furrow where those with small farms use bucket kit to collect water for irrigating their crops while large scale farmers direct water to flow into their farms from openings from the main furrow. These crops are produced three times in a year (each season 3 months) and sold by the farmers directly to local residents for home consumption or to rural traders in nearby markets of Kibwezi, Mtito Adei, Kinyambu, Makindu and to large-scale traders who in turn sell them to large urban centers such as Voi, Makindu, Emali, Mombasa and Nairobi. A Key informant reported;

> Irrigation along Kibwezi River started in the1950s with 100 acres (40 hectares) under the name Kwa Kyai Irrigation Scheme. The water flows through a twelve (12) kilometer cemented furrow diverted from Kibwezi River. Small pockets of households use bucket kits to irrigate their kitchen gardens any time. Various vegetables are grown by the households living in this region. Currently, irrigation has extended to more than 200 acres (80 hectares) with an estimated 15 irrigation groups and above 300 individual households who grow a variety of crops and harvest every season for consumption and sale, thereby sustaining their lives. Maintenance of the main canal is carried out on a communal basis and occasionally work groups are organized to remove weeds from the dam. (Kwa Kyai Irrigation Vice Chairman)

Therefore, this means that water in the permanent rivers in Kibwezi Sub-County support crop production through irrigation where several crops are grown for consumption and marketed surplus. Further, through observation (Plate 10 a, b, c), the study established that Kiboko KALRO, a sub-centre of Katumani KALRO carries out irrigation along the Kiboko River to support the agricultural research activities carried by the organization in Kiboko location in Makindu division. This organization uses water from Kiboko River for irrigating crop varieties like maize, beans, sorghum, millet, cowpeas and pigeon peas. The total area under irrigation is 180 Ha. The organization was advised by WARMA to tap the water at night to enable the local farmers downstream to irrigate their farms during the day. Plate 11 (a) and (b) shows a section a wetland ecosystem which is the source of Kiboko River whereby Plate 11(a) is the point from which KALRO pumps water for irrigation and Plate 11 (b) shows the tank used to store for irrigation.

(a) (b)

Plate 11 (a) and (b): Water tapping for irrigation and storage tank at Kiboko wetland ecosystem by KALRO.
Source: Field Data, 2015

Water is pumped into three big tanks at night so as to ensure the water is available for irrigation daily during the day. This also ensures that water is left to flow downstream during the day for the community members to access it for irrigation and domestic uses hence reducing conflict.

The farm has employed people from the surrounding local communities from which they earn salary which they use differently to acquire basic family needs. Interviews with a key informant revealed;

> This farm operated by KALRO employs 300 people daily and pays the normal government rates of Kshs. 264 per day for the unskilled labour and those who work at night are paid Kshs. 300. Night duties involve carrying out the actual irrigation and guarding the farm against wild animals like Elephants. Day work includes weeding, guarding the farm against monkeys and other small rodents. Both men and women are employed in the farm and each worker serves for a minimum of 8 working hours. 1 acre is managed by 4 people from morning to noon and 4 people from noon to 6 pm. Thus in a day, 8 people are employed to work in acre of the farm. The workers are paid after every two weeks. In a year, a total of Kshs. 4 million is spent by the farm to pay the workers (Office in charge, KARLO-Kiboko).

This information confirmed that water available in wetland ecosystems in the region, for example, Kiboko River, supports food crop production through irrigation and the residents are also employed in these farms where they earn income to sustain their family basic needs. Plates 12 (a) and (b) show a group of casual workers employed in KALRO carrying out threshing as one of the activities in the farm.

(a) (b)

Plate 12 (a) and (b): Casual workers at KALRO threshing and packaging of sorghum seeds.
Source: Field Data, 2015

Threshing is a step in grain preparation after harvesting and before winnowing, which separates the loosened chaff from the grain. Through key informant interviews and observation (Plate 12 a,

b) the study established that gender is considered in employment. Women are preferred because they are faster in carrying out different farm activities and due to the fact that as mothers, they are cognizant of needs of their families. Gender also determines the kind of work allocated to the labourers in the farm. Men tend to be given heavier tasks such as offloading while women mostly take the relatively lighter duties such as sweeping, threshing, keeping birds at bay, winnowing, and packing.

A study by UNEP, (2012) concur that about 203 million people, or 56.6% of the total labour force were engaged in agricultural labour in 2002, while in most African countries agriculture supports the survival and well-being of up to 70 percent of the population. Further, studies by Lipton et al. (2003), in North Africa as well as Bhattarai and Pandy (1997) in semi aria areas of Nepal reported that irrigation leads to an increase in yield per hectare and subsequent increases in household income, consumption and food security. Hussain and Hanjra, (2004) observed that in dry lands of Punjab in India, irrigation can benefit the poor specifically through higher production, higher yields, lower risks of crop failure and all year round farm and non-farm employment. Rebelo et al. (2010), reported that communities living near wetlands of Nyamuriro in Uganda practiced irrigation with the intensive vegetables growing of kales, cabbages, and water melon being a major source of livelihood in the region. Therefore, this study concluded that wetland ecosystems in Kibwezi Sub-County provide water for irrigation thereby creating employment opportunities for the local people and the income earned there of used to meet basic household needs. In addition, water available from wetland ecosystems in Kibwezi Sub-County supports food crop production as a major source of livelihood for the local residents.

4.4.6 Amount of Water Used for Irrigation

The total amount of water used by the respondents for irrigation ranged from 0 to more than 1000 litres. All the respondents irrigated their farms a minimum of two times in a week. Irrigation is majorly done during dry season (January, February, March) when there is very little or no rainfall. Table 18 shows a summary of the approximate total amount of water used once during irrigation.

Table 18: Approximate amount of water used once for irrigation by the respondents

Number of Litres used once during irrigation	No. of respondents	Percentage (%)
0-100 Litres	3	1.1
100-200 Litres	42	14.3
300- 400 Litres	51	17.3
More Than 500 Litres	198	67.3
Total	**294**	**100.0**

Source; Field Data, 2015

As depicted in Table 18, a majority of the households (67.3%) use more that 500 litres of water per irrigation, 17.3% use 300-400 litres per one time irrigation, 14.3% use 100-200 litres while only 1.1% use 0-100 litres of water per one time irrigation. The highest number of respondents using more that 500 litres of water per one time irrigation could be as a result of several orifices made through the main canal which are diverted in to farms and this water flows for a period of up to four hours which is likely to approximately exceed the 500 litres. The lowest percentage of 18.4% using approximately 400 litres could be the farmers who do small scale irrigation using bucket kits and due to the small size of the plots, they do not require a lot of water compared to

those with large plots. This can be interpreted to mean that the available wetland comprising of rivers and streams provide water (Figure 5) which is be used for irrigating several food crops in the region. This study (Table 18) established that all farmers irrigated their farms two times in a week. Irrigation was done for a period of three months upon which the planted crops could be harvested for consumption and sale.

Similar results to the study findings (Table 18) were reported by Morton and Kerven (2013) who observed that large amounts of water supports irrigated agriculture as an important alternative livelihood increasingly practiced by people in the Horn of Africa. According to World Bank (2003), food crop production through irrigation is an important source of livelihood for the majority of rural people since about 1.5 billion people are involved in smallholder irrigation agriculture. Alves and Setter (2000) concluded that food crops require soils with moderate moisture during dry seasons hence it's important for subsistence farmers to protect their crops through utilizing the available water sources. Whereas these studies (Morton and Kerven 2013; World Bank, 2003 and; Alves and Setter, 2000) maintain that water is an important requirement for food crop production through irrigation, the current study has clearly revealed the total amount of water used for irrigation in Kibwezi Sub county concluding that, ecosystems in the region provide provisioning ecosystem services for example, water regulation which provide water for irrigation enabling the residents to grow variety of food crops for consumption and local sale.

4.4.7 Irrigated Crop yields

Total yield harvested from different crops grown by the respondents in one season was recorded in terms of 90 Kilogram sacks. The summary is shown in Table 19.

Table 19: Total crop yields obtained from crops grown under irrigation

Irrigated Crops	Yields in Sacks (1 sack=90 kgs)					Total Number of Respondents
	0-2 (1 acre)	3-4 (2 acres)	5-6 (3 acres)	7-8 (4 acres)	9 and above (5 and above acres)	
	(F) (%)	(F) (%)	(F) (%)	(F) (%)	(F) (%)	(F) (%)
Kales	43 (14.6)	53 (18.0)	57 (19.4)	64 (21.8)	77(26.2)	294 (100)
Maize	40 (13.6)	50 (17.0)	52 (17.7)	77 (26.2)	75(25.2)	294 (100)
Spinach	49 (16.7)	53 (18.0)	141 (48.0)	42 (14.3)	9 (3.1)	294 (100)
Orchards	42 (14.3)	35 (11.9)	78 (26.5)	87 (29.6)	52(17.7)	294 (100)
Baby corn	137 (44.6)	147(50.0)	10 (3.4)	00 (00)	00(00)	294 (100)
Asian Vegetables	239 (81.3)	46 (15.6)	5 (1.7)	2 (0.7)	2(0.7)	294 (100)
Fruits-pawpaw, watermelon	166 (56.5)	89 (30.3)	35 (11.9)	2 (0.7)	2(0.7)	294 (100)
Yields in Crates (Approximate weight =70 kgs/crate)						
Tomatoes	18 (6.1)	64 (21.8)	73 (24.8)	88 (29.9)	51(17.3)	294(100)
Onions	94 (32.0)	122(41.5)	62 (21.1)	10 (3.4)	6 (2.0)	294(100)

Key; f= frequency %= percentage of respondents.
Source: Field Data, 2015

As depicted in Table 19, about 21.8% harvested 7-8 sacks of Kales, 25.2% harvested 9 and above sacks of maize, 48.0% harvested 5-6 sacks of spinach, 29.6% harvested 5-6 sacks of Orchards, 50.0% harvested 3-4 sacks of babycorn, 81.3% harvested 0-2 sacks of Asian

vegetables, 56.5% harvested 0-2 sacks of fruits, 29.9% harvested 7-8 crates of tomatoes while 32.0% harvested a maximum of 2 sacks of onions in one season. The researcher noted that the respodents grew a combination of these crops in their plots. However, for the purpose of this study, the researcher only provided data on individual food crops grown so as to get approximate yields and acreage per crop (Table 19). Therefore, this implies that all respondents who planted food crops registered some harvest for either consumption or sale. The extra yields were sold in the nearby market or town centres of Kibwezi, Makindu, Mtito Andei and others like the Asian vegetables transported to big cities of Mombasa and Nairobi. Thus water available from Kiboko, Kibwezi, Maangi Uvungu and Thange Rivers in Kibwezi Sub-County have enabled the residents in the region to carryout irrigation for food crop production as a livelihood, harvesting different crop yield for consumption and sale.

The results of this study (Table 19) compares well with findings by Pantaleo et al. (2011), that in Western plains in Moshi, Tanzania, 67% of households irrigated maize, 83% kales, 77% variety of fruits, 86 % tomatoes and 65% orchards. A study by Rweyemamu (2009) established that 80% of traditional irrigation schemes in Tanzania depended on water from ecosystems like rivers with 95% of the crop produce being rice and vegetation while the current study established that variety of crops (Table 19) are grown under irrigation. Connor and Palta, (2001) noted that water deficit for at least two months or in the early growing period can reduce food crop yields. Further, FAO, (2002) crop yields globally are projected to increase by 100 and 400 percent with about 70% of the households in Africa harvesting cereals from irrigated lands. Evidence suggests that successful intensification of agriculture, including irrigated crop production, generates new farm income and helps reduce poverty in Sub -Saharan Africa (Peden et al., 2006). Thus,

irrigation in Kibwezi Sub-County is important in that it ensures constant supply of water which is essential for plant growth hence ensuring food crop production as a livelihood by the residents in the study area.

Least squares regression analysis was further undertaken to establish the influence of the total amounts of water used on crop yields obtained by the respondents carrying out irrigation. The results are summarized in Figure 12.

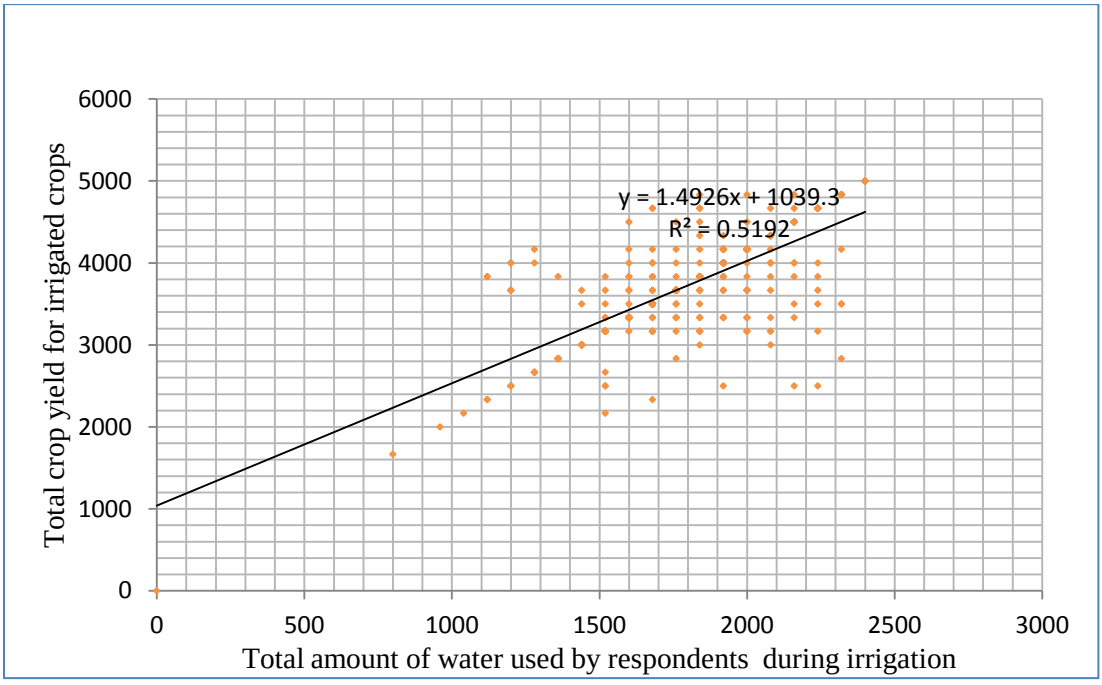


Figure 12: Relationship between the total amount of water used by respondents during irrigation (January, February, March) and the total crop yields for irrigated crops (kales, maize, spinach, orchards, baby corn, Asian vegetable and fruits).

From Figure 12, the coefficient of determination r^2 yielded 0.519 (r^2=0.519, p<.01). Rumsey (2009) asserted that where r^2 fell between 0.20 and 0.70, one variable (x) explained the variability in (y) variable. Therefore, this shows that 51.9% of the variation of the total crop yields in kilograms from irrigated crops can be explained by the total amount of water used by

the respondents during irrigation. Hence, 48.1% of the variation of the total irrigated crop yields can be attributed to other factors which were not considered in this study. According to Lal (2004), crop yields for irrigated crops can be achieved on agricultural land through the use of primary and secondary plant nutrients, liming of acid soils to raise Ph, use of herbicides and transgenic insect control among other factors. Therefore, it can be deduced that water availability accounts for 51.9% of the total crops yields for irrigated crops because agricultural crops are so dependent on water that purposely adding water beyond what naturally falls as rain is crucial to ensuring plant growth and increasing crop productivity.

These findings (Figure 12) compares well to findings by Ramesh and Goswami, (2007) that irrigated food crop yields in India was observed to be highly correlated with the amounts of water used during irrigation. In their studies, Molden et al. (2002), established that in irrigated agriculture in semi arid areas of Colombo 68.7% of the variation of total crop yields can be explained by the total amount of water taken up by crops while, the current study established a variation of about 51.9%. Further, Burke and Moench (2000) established a variation of 58% of the total annual irrigated maize crop yields in West Africa Sahel. Oweis and Hachum (2006) concur that irrigation ensures a constant supply of water, which is essential to not only crops growing but also to the quality of the crop although the study did not clearly establish any significant relationship between the amount of water used for irrigation and the harvested crop yields. According to FAO (2002), plant growth in dry regions of the world is dramatically affected by the amount of water used during production hence optimum growth and quality of plants leading to good produce can only be achieved if water is supplied throughout the growing period. However, the study did not report any significant relationship between any crop yields and the amount of water used during irrigation as revealed by the current study.

Further, HarvestChoice, (2012) reported that irrigation helps in raising a crop where nothing would grow, more profitable crops are grown and increases the yields of different crops grown. Therefore, irrigation is important since it ensures constant food availability which is an essential element for human wellbeing especially for the residents of Kibwezi Sub-County.

4.5 Livestock Kept in Kibwezi Sub-County

The types of livestock kept in the study area include mostly cattle, goats, sheep, donkeys, and poultry. Rabbits are also kept although they are not very popular because there is lack of market. Table 20 shows the types of animals kept in the study area and the respondents involved.

Table 20: Type of animal and number of respondents keeping the animals

Type Animal	Number of respondents keeping animals	Percentage (%) out of 384 respondents
Cattle, Goats, Sheep & Chicken	109	28.4
Cattle , Goats & Chicken	257	66.9
Goats & Chicken	203	52.8
Cattle	93	24.2
Donkeys	71	18.5
Chicken	109	28.4

Source: Field Data, 2015

Data in Table 20 revealed that 28.4% keep a combination of cattle, goats, sheep and chicken while 66.9% keep a combination of cattle, goats and chicken, 52.8% keep goats and chicken while only 24.2% keep cattle with 18.7% keeping donkeys and 28.4% chicken only. This could imply that those residents who combined more than one type of animals could obtain more

benefits than those who kept only one type of animal. The lower percentage (28.4%) of the residents keeping a combination of cattle, goats sheep and chicken could imply the need to encourage the respondents to increase the number of livestock kept so as to obtain more benefits from these livestock hence improving their well being. Despite the variations in the number of livestock kept (Table 20,) the results means that these animals are a living bank for households in the study area since they serve as insurance against crop failure and as a source of food and income for the animals can be sold to get cash in times of need. The animals kept are mostly indigenous which include cattle *(Short horns zebu*), goats (East *Africa small goats)*, sheep (*Dorper sheep*) and local chicken breeds. Those households (18.5%) that owned donkeys used them for transport purposes to ferry fuel wood, construction materials, fetching water and ploughing lands. Sometimes the households with no donkeys and carts for transport were offered free transport services by those who owned them and were expected to return them with jericans of water or firewood as a token of appreciation.

Some respondents (Table 20) said they slaughtered their livestock for socially important ceremonies such as weddings and funerals instead of buying meat and obtained income from the sale of their livestock. This was further confirmed by FGDs that livestock plays a great role on health care, school fees payment, purchase of basic needs such as food, clothing, shelter, payment of bride price, offering sacrifices to gods and buying other asserts like bicycles and motor cycles which also help in generating some income for the family. One of the discussant involved in buying and selling of livestock reported;

> Prices of livestock vary depending on the size, age and also the health of the animal. Prices of cattle range from Kshs, 15,000 to Kshs, 80,000. Donkeys are highly valued in the community due to the heavy work they do which include ploughing, ferrying water, and transporting goods like charcoal and firewood to the market. A donkey price ranges from Kshs. 20,000 to Kshs. 30,000. Goats and sheep price are found to be relatively cheaper with prices ranging from Ksh,

> 1,500 to Kshs. 6,000. However, high income is obtained from goats and sheep which are kept by a majority of households (Male, 29 years old).

This information confirms that livestock keeping is a livelihoods which has potentials of generating high income to the household since the livestock fetch varying prices in the market and thus, the more the number of livestock kept by the residents, the high the amount of income is to be generated. All these animals are kept in traditional ways whereby they depend on the bush areas and grass land within the ecosystems for their survival. Earlier in the morning, the herds of cattle accompanied with goats or sheep are taken to the pastures for grazing. The free range method is used to keep chicken which are often released to move around the farms and home compounds in search of food. Redda (2002) concurs that livestock keeping consists of many species and breeds of big and small animals that are raised worldwide in diverse livestock production systems. In India, 62.5% of the rural households in semi arid regions account for 74% of poultry rearing, and 65% of small ruminants and livestock keeping is the preferred means of wealth savings and an opportunity to further increase income through sales of animal products (Taneja & Brithal 2004 and; Peden et al., 2006).

Kidane et al. (2010), reported that the arid lands of Ethiopia are a centre of livestock genetic diversity, for example, the distinct breeds Borana, Jijiga cattle, the black headed Ogaden sheep, the Afar goat, the Somali goat and the camel breeds. Patil, Kakade and Shivarudrappa (2012) noted that the primary interest of livestock keeping for a family is insurance, security purposes and income. In good years, residents residing close to towns do sell livestock products such as milk and butter for income. Benjaminsen (2008) contends that livestock keeping in dry areas of Namaqualand is one of several livelihood sources of income while in their study on livelihoods in the drylands of Kenya and Botswana, Madzwamuse et al., (2007) and Mogaka (2007)

concluded that livestock was an indicator of social status, a source of food, means of establishing social ties with other communities, and provided a substantial source of income for many rural households. The current study has however identified that semi arid areas of Kibwezi Sub-County are capable of supporting variety of livestock breeds which are important to the local residents despite the low percentage of the residents keeping these animals as shown in Table 20. Therefore, there is need for the residents to be encouraged to increase the number of livestock they keep since they have large tracts of lands and wetlands ecosystems for grazing which can still support more animals. This will also improve the income generated hence improving their well being.

4.5. 1 Size of Herds and the Amount of Water used.

The number of cattle, sheep, goats and poultry per household varied from 1-5, 6-10, 11-15 up to above 50. The amount of water used also varied from 21-25 litres, 26-30 litres up to more than 68 litres as seen in Appendix F. The summary is presented in Figure 13.

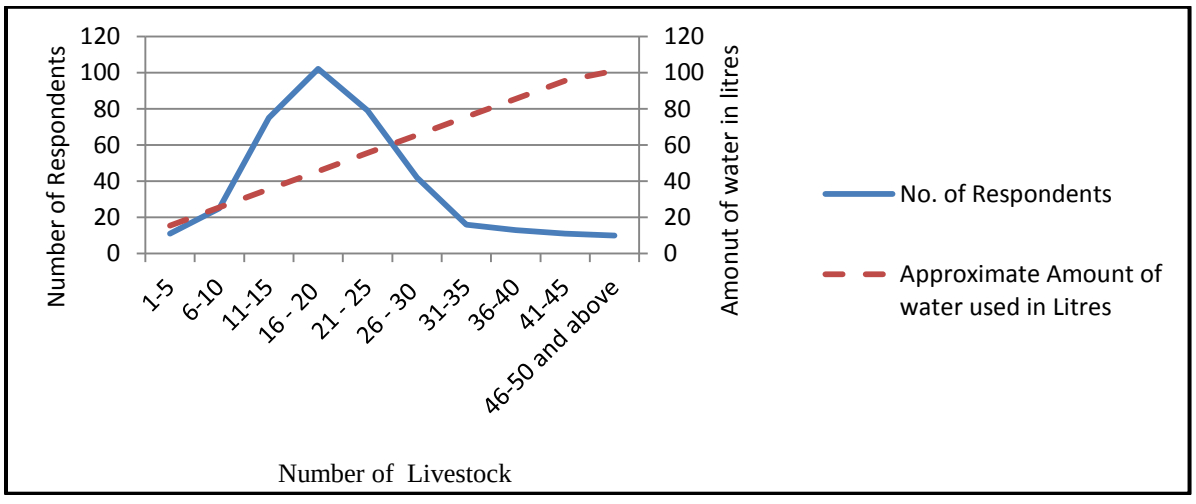


Figure 13: Number of animals and birds kept by respondents and approximate amount of water used.
Source: Field Data, 2015

As depicted in Figure 13, only 26.9% households indicated that they had 16-20 animals and birds in their homes and used approximately 41-50 litres of water while 20.6% of respondents had 21-25 animals and used approximately 51-60 litres of water, 19.5% of respondents had 11-15 animals and used 21-40 litres of water, 10.9% of respondents had 26-30 animals and used approximately 61-70 litres of water, 4.2% had 31-35 animals and used approximately 71-80 litres of water, 2.9% of respondents had 41-45 animals and used approximately 91-100 litres of water while only 2.6% of the respondents kept more than 46 animals and birds and used approximately above 101 litres of water (see Appendix G). This can be interpreted that those households which kept livestock in small numbers consumed little amount of water while those who kept large numbers of livestock consumed large amounts of water. This therefore implied that water is a determinant of livestock keeping as a livelihood in Kibwezi Sub-County since the higher the number of livestock kept, the more the amount of water used. The animals kept mainly included cows, goats, sheep, and donkeys while birds included poultry, especially chicken. All the interviewed respondents (Table 20) owning livestock considered livestock production as a form of savings. FGDs revealed that the respondents often used their livestock for socially important ceremonies such as weddings, birthdays and funerals as they found this more convenient and economical. Therefore, the current study concludes that water is an essential requirement for livestock keeping as a livelihood in the Kibwezi Sub-County.

A study by Faries and Reagor (1997) established approximately 60% of households in Sub Saharan Africa keep one to five cattle, sheep and goats with about 70% of the livestock per household consuming more than 100 litres of water in a day. Other studies noted that livestock drink about 20–50 litres per tropical livestock unit per day while beyond meat production and

consumption, water used to support animals provides great value (Sreeramulu, 2004 and; Landefeld and Bettinger, 2005). Elzaki (2005) concur that drinking water is an important requirement for animal production since most domesticated animals can survive for about 60 days without feed but less than a week without drinking water. According to UNEP (2012), about 70% of the rural poor in Africa own an average of 10-20 livestock consuming different amounts of water per day, contributing significantly to household income particularly in arid and semi-arid zones. Studies by Goodland and Pimental (2000); Nierenberg (2005) and; Ashley and Bazeley (1999) reported that water consumed by animals provides great value since livestock contribute to the livelihoods of at least 70% of the world's rural poor and strengthen their capacity to cope with income shocks. Other studies noted that while there is little agreement on the precise amount of water needed for milk and beef production, the literature does agree that it takes much more water in 1kg beef production than in 1 kg food crop production (Chapagain & Hoekstra 2003; Hoekstra & Hung 2003). Therefore, this study concluded that water availability in various ecosystems through ecological processes supports livestock production as a livelihood and that livestock are often an important source of wealth security to the people in semi arid areas of Kibwezi Sub-County.

4.5.2 Indigenous Grass Fed by Livestock in Kibwezi Sub-County.

The respondents were interviewed on the indigenous grass which is fed by the livestock in the study area. Table 21 summarizes the types of indigenous grass growing in the study area and the botanical names.

Table 21: Type of indigenous grass fed to livestock in Kibwezi Sub-County

Local Name	Botanical name	Frequency	Percentage (%)
Mbeetwa	*Eragrostis superba*	141	36.7
Mbwea	*Pananicum maximum*	68	17.7
Ikoka	*Eragrostis spp.*	45	11.7
Ndata kivumbu	*Cenchrus cilaris*	51	13.3
Nguu	*Enterobogon macrostachyus*	38	9.9
Kilili	*Chrloris roxburghiana*	30	10.2
Others (Vuvi)		11	2.8
Total		**384**	**100.0**

Source: Field Data, 2015

As observed from Table 21, rainfall enabled growth of different species of grass on the respondents' lands. Among the identified indigenous grass was Mbeetwa (*Eragrostis superba*) which grew in 36.7% of the households lands, Mbwea (*Pananicum maximum)* in 17.7% of the respondents lands while 13.3% had Ndata Kivumbu (*Cenchrus cilaris)* in their lands, 11.7% had Ikoka *(Eragrostis spp.)*, 9.9% had Nguu (*Enterobogon macrostachyus),* 10.2% had Kilili (*Chrloris roxburghiana)* grass species and other grass varieties like Vuvi grew in 2.8% of the respondents lands. Observation revealed that the indegious grass growing in protected lands is harvested and sold in bales (Plate 13 (a) and (b).

(a)

(b)

Plate 13 (a) and (b): A farmer holding a bale of Mbeetwa (*Eragrotis superba*) grass and Mbeetwa *(Eragrotis superb)* grass stored for sale and feeding livestock in Utithi sub location, Kibwezi location.
Source: Field Data, 2015

Mbeetwa (*Eragrotis superba*) grass is collected and tied in bales for sale to local customers to feed their livestock during dry seasons or for thatching houses. A discussant reported;

> I have preserved a section of my 20 acres piece of land where I harvest grass for sale. I sale a bale at Kshs.100 and raise a minimum of Kshs. 3000 in a week in dry seasons. This money is used to buy food for my family and acquire other essential needs. (Female, 32 years old)

This information confirmed that those respondents aware that grass can be harvested and sold for cash have embraced this livelihood by protecting sections of their large tracts of lands for indigenous grass growth. A study by Ellis (2000) reported that grass species in arid and semi

areas in Africa support 85% of livestock as a livelihood and important indigenous genera include *Aristida, Cenchrus, Chloris, Echinochloa, Eragrostis, Panicum, Pennisetum* and *Sporobolus*. The current study has established that in Kibwezi Sub-County, the indigenous grass include *Eragrostis superb, Pananicum maximum, Cenchrus cilari,s Eragrostis spp, Enterobogon macrostachyus*, and *Chrloris roxburghiana.*A study by Kitalyi and Kabatange (2002) reported that the common grass species fed by livestock in semi arid areas of Tanzania were; *Urochloa trichopus, Dactyloctenium* sp., *Aristida* sp., *Eragrostis* sp. and *Chloris virgata.* These grass species shows very good adaptation to drought and can grow with as little as 200 to 250 mm annual rainfall (Ellis, 2000 and; Kitalyi & Kabatange, 2002). Mengistu, Teketay, Hulten, and Yemshaw (2005) observed that the selling of indegionus grass in semi arid lands of Biyo Kalala in Ethiopia provided a source of income for many households with 93% of the respondents satisfied with the benefits estimated at 104 Ethiopian Birr.

Nyariki and Ngugi (2002) reported that an agro-pastoralist from Konegallo Rapsu, in the then Garbatulla District of North Eastern Kenya produced 26 bales of *Sudan* grass and 114 bales of indegionus pasture part of which he sold to the government for relief intervention at Ksh.200 per bale (about USD 3) generating a total of Ksh.27, 000 (USD-350) which he used to provide for family needs and expand his onion and pepper production. However, work done by Karue (2001) indicated that the common grass species are generally known for their low nutritive value hence inability to meet the nutrient requirements for ruminants making them not preferred for sale. He deduced that even the best of grasses notably *Cynodon dactylon* and *Digitaria setivala* could only supply about 30% of the protein required by the beef animal. Nevertheless, the current study concludes that the arid and semi arid ecosystems of Kibwezi Sub-County support

growth of shrubs, weeds, grass and other forage which play a big role in the nutrition of the animals and are sources of income to those involved in grass selling as a livelihood.

4.5.3 Irrigated Pasture

The study established that during irrigation, the household's plant pasture along the irrigated farms which are also used to feed the livestock as seen in Table 22.

Table 22: Pasture grown under irrigation

Pasture	Frequency	Percentage (%)
Napier grass (*Pennisetum purpureum*	178	60.5
Others (Ikoka, Mbwea, Kilili)	116	39.5
Total	**294**	**100.0**

Source: Field Data, 2015

As depicted in Table 22, Napier grass is grown by the highest number of respondents (60.5%) as they carry out irrigation while 39.5% of the households grow other types of grass for example, Mbeetwa *(Eragrostis superba),* Ikoka *(Eragrostis spp.)* and Ndata Kivumbu *(Cenchrus cilaris).* This implies that Napier grass can do well in a place like Kibwezi Sub-County through irrigation. Household interviews (60.5%) revealed that Napier grass is highly preferred because has a soft stem to cut and it propagates easily. The tender stems and leaves are palatable to livestock and it grows very fast. Through observation (Plate 14 (a) and (b), these grasses are grown along the watering furrows in the farms edges. This also ensures that water is not only used for irrigating food crops but also for supporting grass growth which enhances livestock production in the study area. The Plate 14 (a) and (b) shows Kitothya commonly known as napier grass (*Pennisetum purpureum*) and Mbeetwa grass (*Eragrotis superba)* grown along a furrow in an irrigation maize farm.

(a) (b)

Plate 14 (a) and (b): Napier grass (*Pennisetum purpureum*) and Mbeetwa grass *(Eragrotis superba)* planted along furrow for irrigating maize farm at Kwa Kyai irrigation scheme in Kibwezi sub location.
Source: Field Data, 2015

Napier grass (*Pennisetum purpureum*) and Mbeetwa grass *(Eragrotis superba)* is grown along the furrows in irrigated farms implying that water which is used for irrigation supports both food crop production and grass growth for feeding the livestock. The findings (Table 22) of this study conform to the assertion by Anindo and Potter (1994) that Napier grass has been the most promising and high yielding fodder giving dry matter yields that surpass most tropical grasses. Napier grass therefore supports dairy farming making it important in the livelihoods of many households in terms of generating income and employment. Integrating livestock production with irrigated agriculture in Gezira, Elzaki (2005) concur that adding fodder in the crop farms could provide animal feed, boost milk production and generate more household income. Further, a study by Orodho (2006) reported that the major cattle feeds are indegionus grass and planted fodder, mainly Napier grass (*Pennisetum purpureum*) which has become by far the most important due to its high yield and ease of propagation and management.

4.5.4 Area under Grazing

The study revealed that the households have varying sizes of lands in acres for use in grazing their livestock as shown in Table 23.

Table 23: Area under grazing in Acreages

Acres under grazing	Frequency	Percentage (%)
More than 4 acres	93	24.2
3-4 acres	109	28.4
2-3 acres	102	26.6
1-2 acres	58	15.1
0-1 acres	22	5.7
Total	**384**	**100.0**

Source: Field Data, 2015

From Table 23, majority (28.4%) of the respondents had 3-4 acres of grazing land, 26.6% had 2-3 acres, 24.2% more than 4 acres, 15.1% had 1-2 acres, and 5.7% had 0-1 acres of grazing land. This demonstrates that ecosystems in Kibwezi region supports livestock keeping as a livelihood since they provide grazing areas for the animals kept by the residents. Availability and quality of the feed for livestock fluctuates during the year between the wet and dry seasons respectively. While in the wet season forage is abundant, in the dry season it is both scanty and poor in quality. Various strategies are adopted by the livestock keepers in overcoming feed shortage problems in the dry season. These include cutting down branches of trees for easy of access by the animals, grazing in the crop fields after the harvest to utilize crop residues, grazing in Kibwezi Forest at a fee and along rivers, for example, Kibwezi, Kiboko and Thange and Maagi Uvungu. A key informant reported;

> We also allow those with livestock to graze inside Kibwezi Forest but at a fee. We allow grazing of only cows and sheep daily and the cattle owners are expected to pay Kshs. 100 for each animal per month while Kshs. 40 is charged for each sheep per month. Forest guards on daily patrol always ensure that those grazing in the forest have an official receipt. This helps in controlling movement inside the forest which can interfere with the springs especially if too many cattle are allowed in. The money raised goes towards maintaining the forest for example replacing broken sections of fence (Male, 36 years old Forest Guard-Kibwezi).

This report is evident that despite the arid and semi arid conditions in Kibwezi Sub-County which could affect livelihoods like livestock keeping, the forest ecosystem in the region support livestock keeping as a livelihood since the residents are allowed to access this protected area especially during dry seasons at a reduced fee to graze their animals. These findings compares with findings by Taneja and Brithal (2004) that in India, 62.5% of the rural households own less than 2 hectares (ha) of land for grazing livestock while Kikoti (2009) established that about 65% of the households living near Ugalla ecosystem own more than three acres of grazing lands. The current study has identified about 52.6% of the respondents owning more than three acres of grazing land and the difference in percentage could be attributed to ways of owning land near ecosystems which are sometimes common grazing areas but the rules may vary in each county. Perry (1994) concur that grasses in semi arid land ecosystems support large grazing areas of livestock and can withstand moderate grazing by virtue of the fact that leaves grow from the base rather than the tip, so removal of this does not stop growth but instead promote it by encouraging light penetration.

Kidane et al. (2010), observed that the rangelands in semi arid areas of Ethiopia provide important forage for livestock which is a major livelihood for the people in these areas. Further, Kikoti (2009) concur that Ugalla ecosystem in Tanzania and any other ecosystems of the world provide large grazing areas which support high number of livestock while the current study has established that ecosystems in Kibwezi Sub County, for example Kibwezi forest, large tracts of lands owned by the respondents, the rivers and streams provide grazing areas for animals thereby supporting livestock keeping as a livelihoods.

4.5.5 Livestock Products

The study established that various products obtained from the livestock kept by the respondents benefited them. These products include milk, meat, eggs, hides and manure as summarized in Table 24.

Table 24: Respondents benefiting from livestock products

Products	Number of Respondents who benefited	Percentage (%) out of 384 Respondents
Milk, Eggs, & Manure	300	78.1
Milk & eggs	289	75.3
Eggs	335	87.2
Manure	305	79.4
Hides	105	27.3
Meat	165	42.9

Source; Field Data, 2015

As depicted in Table 24 above, majority (87.2%) of the respondents benefited from the sale of eggs, with hides, milk and meat benefiting 27.3%, 75.3%, and 42.9% of the respondents respectively. Those who benefited from the combination of milk, eggs, and manure were 78.1%. This can be interpreted to mean that livestock kept by the residents of Kibwezi Sub-County provide a variety of products which are for both consumption and local sale. The sale of surplus products generates income that enables families to cater for the costs of supplementary food items, medicine, and school fees

A study by Patil et al. (2012), reported that in dry areas of Leisa in India, livestock products like meat, milk, butter, cheese, eggs and hides are sold to enable the households to purchase cereals

and other household food supplies, pay medical care, debts, taxes and social obligations. Where as a study by UNEP (2012) in semi arid areas of Africa established that 78.6% of households obtained income from the sale of milk, eggs and hides, Lancefield and Hettinger (2005) established that most in developing countries, 73% households obtained income from the sale of livestock products. The current study has established that 78.1% of households in Kibwezi Sub County benefited from milk, eggs and manure all products obtained from the livestock. In addition, Ashley and Bazeley (1999) concluded that livestock contribute to the livelihoods of at least 70% of the world's rural poor and strengthen their capacity to cope with income shocks since they provide milk, blood, manure and hides, although it is not clearly indicated from this study the percentage of households who benefited from each product obtained from the livestock as noted by the current study. Therefore, the current study concludes that water availability in Kibwezi region influences livestock keeping as a livelihood which provide various animals and their products whose sale generates household income.

4.6 The Influence of Socio-cultural Ecosystem Services on Livelihoods

The study investigated on the various social and cultural ecosystem services provided by the ecosystem of Kibwezi Sub-County and how they influence the livelihoods of the people in the study area. The results are subsequently discussed below.

4.6.1 Socio- Cultural Ecosystem Services in Kibwezi Sub-County

It is evident that questionnaires identified ecotourism, recreational, educational, inspirational and spiritual socio-cultural ecosystem services provided by ecosystems in Kibwezi Sub-County as presented in the Figure 14.

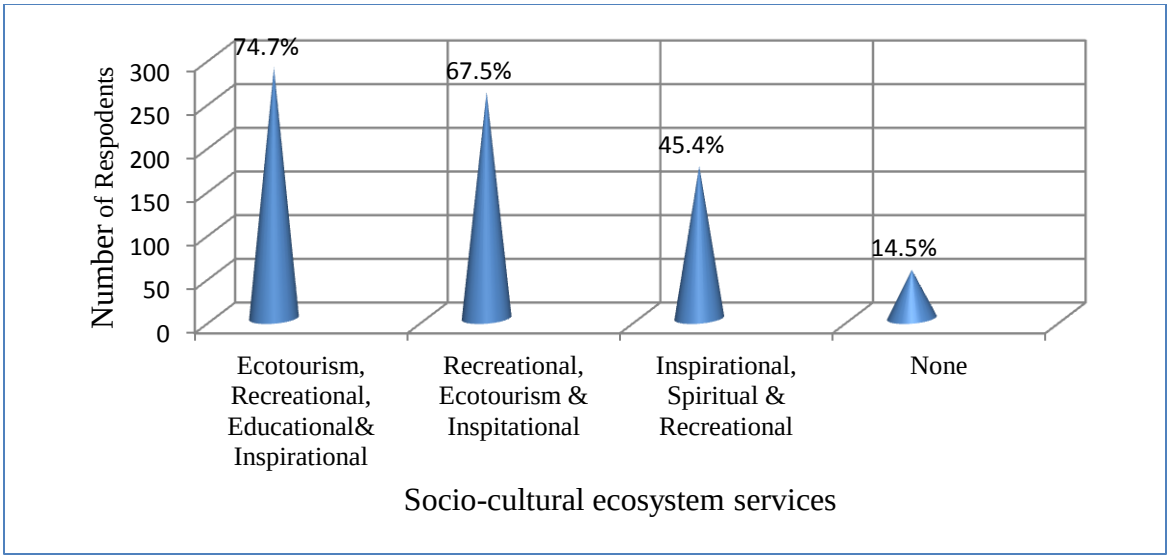


Figure 14: Socio-cultural ecosystem services in Kibwezi Sub-County
Source: Field Data, 2015

The findings (Figure 14) revealed that majority (74.7%) of the respondents were aware of ecotourism, recreational, educational and inspirational services which were provided by ecosystems in Kibwezi Sub county while, 67.5% were aware of recreational, ecotourism and spiritual services, 45.4% were aware of inspirational, spiritual and recreational services. Only 14.5% had no idea of the socio-cultural ecosystem services in the study area. The percentage of 14.5 who had no idea of any socio-cultural ecosystem service could have been attributed to lack of interest and time to visit and discover these essential services provided by these ecosystems as asserted by Elmqvist (2011) that, people have differentiated interests and abilities to recognize and benefit from ecosystem services. These results (Table 14) therefore means that people obtain diverse non-material benefits from ecosystems and that socio-cultural services may be less tangible than material services but they are nonetheless highly valued by the people of Kibwezi Sub-County. Whereas the current study established that ecosystems in Kibwezi provide ecotourism, recreational, educational, inspirational and spiritual services, a study by Pereira, Queiroz, Pereira, and Vicente (2004) established that ecosystems in Northern Portugal provide

socio-cultural services for example, recreational facilities tourism, aesthetic appreciation, inspiration, a sense of place, and educational values to the surrounding communities.

According to McMichael et al. (2005), people obtain diverse non-material benefits from ecosystems of the world for example, ecotourism, inspiration and educational services although from this study, it is not clearly highlighted about the percentage of the people aware of the existence of these socio-cultural ecosystem services as revealed by the current study. Loulia (2011) concur that world ecosystems are a source of a deep sense of belonging, cultural heritage, religious and spiritual significance, and their beauty provides immeasurable aesthetic value, popular destinations for recreation, ecotourism and educational values. The socio-cultural ecosystem services are subsequently discussed below.

4.6.1.1 Ecotourism Services

The study established that ecotourism is one of the major socio-cultural ecosystem services in Kibwezi Sub-County (Figure 14). This is because majority (74.7%) of the respondents confirmed this socio-cultural service was provided by the ecosystems in the Sub-County. Through interviews, the study established that some of the key ecotourism sites are Kibwezi Sorest, Umani springs, Kiboko Sanctuary and Chyullu Hills Game Reserve. Kibwezi Forest has a total area of 5,849.6 Ha while the ecotourism site covers a total of 15.0 Ha. The majority of the tourists are the locals. Umani Springs are located inside Kibwezi Forest and next to the spring is Umani Ecotourism Lodge for picnics. Schools and churches visit the place for commercial video shooting. The respondents interviewed (49.2%) confirmed that ecotourism had improved their livelihood economically and this confirms the assertion of Epler-Wood (2002) that ecotourism

brings economic benefits and direct income to the local people living within the ecosystems of protected areas like Game parks and Game reserves. In their study on promoting rural development in Wonchi ecotourism area in Ethiopia, Ogato et al. (2014), noted that 57% reported that ecotourism was a source of sustainable income for them, 22% said it improved their livelihood while 21% maintained that it was both a source of sustainable income and improved livelihood.

Drumm and Moore, (2005) attested that ecotourism is a responsible travel to natural areas that conserves the environment and improves the well-being of the local people. It is reputed to educate the traveller, provide income for those selling products to the visitors hence economically empowering the local communities and fostering respect for different cultures and for human rights (Khanal & Babar, 2007; Honey, 2000; Mann, 2006 and; Zambrano, Broadbent & Durham, 2010). Moreover, as Drumm and Moore (2005) contend, ecotourism is one of the alternative economic activities and viable strategies for simultaneously making money and conserving resources. Further, Manwa (2003) contended that ecotourism has been recommended as a sustainable development option particularly for the ecologically depressed and underdeveloped regions of the world with little potential for development.

4.6.1.2 Recreational Services

The study (Figure 14) established that recreational activities (74.7%) are some of the social cultural ecosystem services accessed by the people of the study area. Key informant interviews revealed that recreation activities are important sources of income and employment and the places visited include Umani Springs, Umani Ecotourism Lodge, and Kibwezi Forest. Some of the recreational activities done by people of the study area include hunting, swimming in Kiboko

and Kibwezi Rivers, viewing birds or other wildlife in Tsavo East National park, hiking through Kibwezi Forest and camping around Umani Springs and Kibwezi Forest. Recreational activities contribute to various livelihoods around the visited areas. For example, some people offer tour guide services while others are home stay operators both of which earn some income to those involved. However, it is worth noting that some recreational activities like hunting have negative impact on the ecosystems especially animal species. In their study on Conservation perspectives, Mbonde and Luke (2012) concluded that hunting of elephants in Tsavo National park has led to disturbance of the wildlife and general decline of their population. Nevertheless, McMichael et al. (2005), as well as Morton and Kerven, (2013) concur that recreational activities lead to income generation and also contributes to the health and social relations dimensions of well-being, as there is a correlation between green areas, good air quality, and human health. For example, the National Urban Park in Stockholm, Sweden, has an estimated 15 million visitors per year, most of whom visit the park for recreation purposes.

4.6.1.3 Inspirational Services

Ecosystems of Kibwezi Forest, Kibwezi River and Chyullu Hills Game Reserve provided inspirational ecosystem services (74.7%) to the people of study area as seen in Figure 14. Household questionnaires revealed that walking through Kibwezi forest, camping, viewing Mzima Springs, Shetani lava flow and Sheimo lava brings the sense of inspiration. Interviews with the head of civic education in Makueni County revealed that the handcrafts obtained from Kibwezi ecosystems, and Kenya at large, allow the preservation of traditional cultural heritage of the particular societies in question and this also brings a sense of inspiration to the residents of Kibwezi. Niemeirjir et al. (2005), concur that dryland peoples identify themselves with the use of

their surrounding ecosystem and create their own unique ecosystem inspired culture and that ecosystem brings sense of inspiration to the people accessing these ecosystems. While the current study established that ecosystems provide variety of socio-cultural services like sense of inspiration to the local people, a study by Elmqvist (2011) established that due to an increased level of globalization and high dependence on the global market, the level of authenticity and preservation of culture all attached to ecosystems is becoming distorted. Therefore, the current study concludes that inspirational services are socio-cultural ecosystem services provided by ecosystems in Kibwezi Sub-County.

4.6.1.4 Spiritual Services

Many tree species, shrubs, forests and individual trees have spiritual significance to dryland peoples due to their relative rarity, high visibility in the landscape, and ability to provide shade. The study established that spiritual services were accessed by 45.4% of the people of the study area as depicted in Figure 14. This percentage is low compared to the highest percentage (74.7%) of respondents aware of other socio-cultural services probably because only few people perform rituals and other sacrifices to gods in shrines found in forests, individual trees which all exist in ecosystems and therefore, majority of the people worship in churches due to spread of religion in many parts of the world (Mbonde and Luke, 2012). These results implies that forests, shrubs and sites of individual trees have been used for various spiritual services for example, anointing rulers, hosting legal hearings, burial of community and religious dignitaries, and religious rituals, and individual trees themselves have become sacred and named after deities. Interview with head of civic education Makueni County revealed that one of the well known traditional rainmaker living adjacent to Kibwezi forest has been visiting the wetlands inside the forest for over 50

years to perform rituals to appease the traditional snake spirits that protect the springs that have never dried out. A study by Nieimejir et al. (2005), concur that forests, shrubs and individual plant species have been used for spiritual purposes like the dominant species of the eastern Mediterranean shrub land and woodland biomes of *Quercus* and *Pistacia* by the Hebrews. A study by MEA, (2005) concluded that open spaces, landscapes and habitats can contribute to human wellbeing and many societies living in these ecosystems continue to define themselves in terms of the spiritual connection to their ecosystems, and to the knowledge that is generated through this. Therefore, the current study revealed that wetlands and forest ecosystems of Kibwezi region offer spiritual ecosystem services to the residents.

4.6.1.5 Educational services

The study (Figure 14) established that 74.7% of the respondents were aware that the ecosystems in Kibwezi Sub-County provided educational services to the people of the study area. Further, the respondents were interviewed on the type of educational service they get from the ecosystems they visit. Figure 15 shows the percentage of the respondents interviewed on the type of education they get.

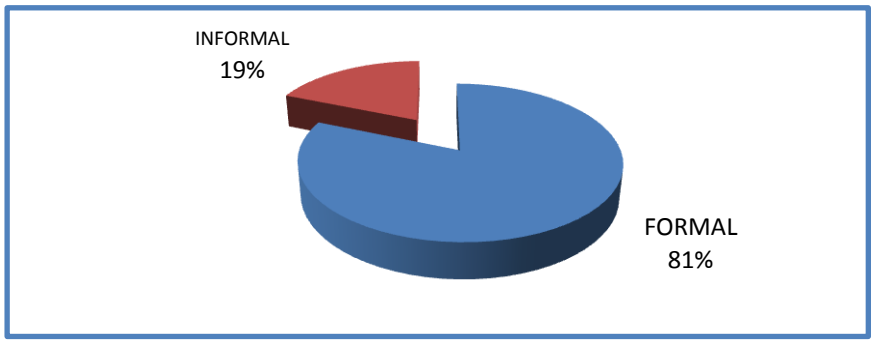


Figure 15: Type of educational services obtained from ecosystems in Kibwezi Sub-County.

Source: Field Data, 2015

As depicted in Figure 15, the study established that the majority of the households (81%) are aware of the formal type of education provided by the ecosystems within Kibwezi Sub-County whereby several schools in the Sub-County visit Kibwezi Forest, Chyullu Hills Game Reserve, Kiboko Sanctuary and Mzima Springs to gather information on the various functions and uses of the ecosystems. Interview with the head of civic education in Makueni County confirmed that several schools visited Kibwezi Forest to learn the importance of the forest. A study by UNESCO (2004) concurs that dryland ecosystems have generated significant contributions to global environmental sciences especially to human culture through both formal (''scientific'') and traditional knowledge systems. For example, arid cultural heritage sites such as Lake Turkana National Park and Ngorongo Conservation Area have generated knowledge of paleo-environments and of human evolution. Further, a study by Schmidt-Nielsen (1980) concluded that studies of desert plant species have revealed adaptations of human beings to extreme environmental stresses. Thus ecosystems in Kibwezi region are vital in providing formal and non formal education to the area residents and the country at large.

4.6.1.6 Diversity of Cultures

The people of the study area identify themselves with the use of their surrounding ecosystem and create their own unique ecosystems inspired culture. Table 25 shows a summary of diversity of cultures in Kibwezi Sub-County and the percentage of those respondents who were aware of these different cultures in the region.

Table 25: Diversity of cultures in Kibwezi Sub-County.

Diversity of cultures	Frequency	Percentage (%)
Maasai Culture		
Aware	306	79.7
Not Aware	78	20.3
Total	384	100.0
Kamba Culture		
Aware	384	100.0
Not aware	0	0.0
Total	384	100.0
Others (beyond Maasai and Kamba)		
Aware	324	84.4
Not aware	60	15.6
Total	384	100.0

Source: Field Data, 2015

As depicted on Table 25, the majority (79.7%) of the respondents interviewed were aware of the diversity of cultures as a cultural ecosystem service brought by the variety of ecosystems in the study area. The proportion of respondents aware of Maasai culture were 79.7%, while 100% were aware of Kamba culture and 84.4% were aware of other cultures. These reults mean that majority of the residents in Kibwezi are aware of the diversity of cultures in the region which has been brought about by presence of the ecosystems through employment services. For example, West Kenyan culture, the Luhyas and central culture- Kikuyus who worked in Umani Ecotourism Lodge, Kibwezi Forest and Chyullu Hills Game reserve respectively. Those respondents unaware of Maasai culture were 20.3%, Kamba culture 0.0% and not aware of other cultures were 15.6%. This can be interpreted to mean that people in the region identify themselves with the use of the surrounding ecosystems and create their own unique ecosystem inspired cultural diversity.

These findings compares well with the findings by Hillel (1991) that typical to drylands are the diverse nomadic cultures that have historically played a key role in the development of dryland livelihoods. It is often the cultural diversity that arises from different environments that offers high ecotourism potential (MEA, 2005) and there are many examples of communities gaining income from their cultural identity. In tightly-linked social-ecological systems, such as traditionally managed rangelands, forests or small-scale agricultural systems, socio-cultural ecosystem series are essential to cultural identity, wellbeing and even survival (Brown & Neil, 2011; Daw, Brown, Rosendo & Pomeroy, 2011). There is also strong evidence that green open space plays a positive role in enhancing cultural diversity associated with sense of place and the psychological benefits have also been shown (Elmqvist, 2011 and; CBD, 2012). Therefore, ecosystem functions and diversity generate cultural identity and diversity that in turn conserve ecosystem integrity, and enhance people's livelihoods.

4.6.2 Livelihoods Supported by Socio-cultural Services.

The findings of the study reveal that the ecosystem found in Kibwezi Sub-County support various livelihoods. These livelihoods are summarized in Table 26.

Table 26: Livelihoods supported by socio-cultural services in Kibwezi Sub-County.

Livelihood	Frequency	Percentage (%)
Tour Guiding	112	29.2
Hand Craft Selling	190	49.4
Cultural troupe performance	56	14.6
Others (home stay operators, trainers)	26	6.8
Total	**384**	**100.00**

Source: Field Data, 2015

As depicted in Table 26, the study established that handcraft selling was a livelihood highly (49.4%) supported by social-cultural ecosystem services with 51.5% not aware. About 29.2% and 14.6% were aware of tour guiding and cultural troupe performance being supported by socio-cultural ecosystem services respectively with 71.8% and 85.4% not aware. Only 6.8% of the respondents were aware that there are other livelihoods supported by the social cultural ecosystem services in the study area, for example, home stay operators and dance trainers. These results means that majority of the residents could be lacking adequate information on the importance of socio-cultural ecosystem services in supporting various livelihoods from which income can be generated. Those carrying out these activities extend their services to the visitors in return for cash/income. Such income is can be used to acquire basic materials for life like food, clothing, shelter, among other social obligations hence improving the well being.

These findings compares well with a study by Shah, (2000) that socio-cultural services can generate different types of local income, for example, from earnings from sale of crafts, casual labour and guide services. However, it is not evident clearly in this study from which livelihoods was the cash obtained from while the current study has clearly revealed that socio-cultural ecosystem services support livelihoods like Tour guiding, handcraft selling, cultural troupe performance among other livelihoods for example, dance trainers. Further, Ashley, (2000) concurs that ecosystems in Namimbia provide ecotourism services for about 45% of people with casual earnings per person being small, but much more widely spread and sufficient to cover, for instance, paying school fees. Thus, socio-cultural ecosystems services are vital in that some residents in Kibwezi region have been able to raise income through the various livelihoods hence

sustaining their families. The livelihoods supported by the socio-cultural ecosystem services are discussed below.

4.6.2.1 Tour Guiding

Tour guiding involves giving direction to people who have visited new places. The study established that 29.2% of the respondents were aware that socio-cultural ecosystems services in the study area support tour guiding as a livelihood (Table 26). This low percentage (29.2%) implies majority (71.8%) of the residents are not aware that tour guiding is a livelihood from which income can be obtained to acquire essential family requirement for survival and could be attributed to lack of awareness on the influence of socio-cultural ecosystem services to peoples' livelihoods. Interviews revealed that some tour guides are employed permanently, for example, Kibwezi Forest has two official tour guides. The majority of the visitors in the forests are those carrying our research on forest related issues. A minimum fee of Kshs.1000 is charged for international visitors per individual while the locals pay Kshs.500. This amount however is not fixed since some visitors claim they are on educational visits.

The tour guides earn an income hence confirming the assertion of Scholes and Biggs (2004) that ecosystems provide direct and indirect employment of nearly 2 million jobs. In Costa Rica, tourism generated $654 million in 1996, in Kenya, $502 million in 1997, and in Rwanda $1.02 million creating employment for the local residents. It is not clearly indicated from these studies on the types of livelihoods which could have resulted from the high income generated from tourism as evident in the current study that tourism as a socio-cultural ecosystem service supports tour guiding (29.2%) among other livelihoods from which income is generated.

Gossling (2000) further reported that in southern Africa as a whole, nature-based tourism is estimated to generate $5 billion per year, growing at a rate several times higher than that of other natural resource–based activities. Therefore, the current study concluded that tour guiding is one of the livelihoods supported by the socio-cultural ecosystem services in Kibwezi Sub-County.

4.6.2.2 Handcraft Selling

The study established that handcraft selling is a livelihood in the study area supported by the ecosystems in the region (49.4%) (Table 26). A higher percentage (51.5%) were not aware that sale of handcrafts is a livelihood supported by the socio-cultural ecosystem services in Kibwezi and this could have been attributed to inadequate information to the residents about the links between socio-cultural ecosystem services and livelihoods in Kibwezi Sub-County. However, these results means that this informal handicraft industry is one of the potential sources of employment where the households get income through the sale of curios to both local and international tourists who visit Tsavo West Game Reserve, Kiboko Sanctuary, Chyullu Hills Game Reserve and Umani Ecotourism Lodge. As this study established that about 49.4% households revealed that ecosystems in Kibwezi support handcraft selling as a livelihood, study in Vietnam by Ngo Duc Anh (2005) showed that 60% of craftsmen generated income from the sale of curios. This higher percentage generating income from sale of curios unlike the low percentage in Kibwezi could have been attributed to the awareness of the exixtence of ecosystem services by the residents of Vietnam. A study done by Croes and Vanegas (2008) reported that in destinations where tourism industry is a booming sector and unemployment rate is high, local people employ themselves in sale of curios. Further, according to Wherry (2006) established that most craft traders are in search of survival and therefore, they produce and sell products to obtain income for basic family needs. Peach (2007) noted that the handcraft industry does not

require extensive capital investment to start up and therefore gives both women and other marginalized groups an opportunity to engage easily in the industry and gain an income to sustain their livelihoods.

Binns and Nel (2002) observed that the tourism industry is increasingly becoming a provider of employment opportunities and a contributor to the growth of countries' revenue through various segments, including the sales of handicrafts to tourists. Tourism is one of the potential sectors that support handcraft industry enabling households to generate income as observed by Gaylard (2004) while Barber & Krivoshlykova (2006) reported that in developing countries tourism as an informal handicraft industry is flourishing and is perceived to be a productive sector that generates employment opportunities from the studies, it is not well linked on whether tourism as a socio-cultural ecosystem service supports handcraft selling as a livelihood as revealed by the current study.

4.6.2.3 Cultural Troup Performance

As depicted in Table 26, cultural troupe performance is a livelihood for some of the inhabitants of the study area as asserted by 14.6% of the respondents that the social cultural ecosystem services in Kibwezi Sub-County support this livelihood (Table 26). About 85.4% of the respodents were not aware of cultural troupe performance as a livelihood and this could be due to inadequate visits to the ecosystems where these cultural troupe performances are mostly performed and lack of awareness by the residents that social cultural ecosystem services support livelihoods from which income can be generated for purchase of basic needs. Examples of the troupes include Ilovoto Dance Troupe and Ngulia Bandas who entertain visitors in Umani

Ecoturism Lodge. They also recite the Kamba history/folklore and story tales about the Kamba culture. Visitors often reward them in cash. A discussant reported;

> Our dance group is called Ilovoto dancers and we entertain both local and international visitors. The charges are not fixed. International visitors pay us about Kshs.2, 000 - Kshs 3,000 per song and in a day we can raise about Kshs10,000. We share Kshs. 8,000 among 12 members who constitute the group and the balance Kshs, 2000 is saved to raise enough money to start a group project like poultry farming and bee keeping. Local visitors pay Ksh.500 to Kshs. 1,000 per entertainment. So far, we have three poultry farming projects running in the homesteads of our three members. Plans to start a bee keeping project and a honey collection center in Mtito Andei and Kibwezi towns are ongoing. (Female- Ilovoto dance leader)

This confirms that cultural troupe performance is a livelihood since the few people involved in this obtain income which they use to buy food and other basic needs of the families hence sustaining their lives. Whereas the current study noted that 14.6% of the respondents were aware of cultural troupe performance is a livelihood being supported by socio-cultural ecosystem services in Kibwezi Sub-County, Wuleka et al. (2013) established that 88% of the respondents interviewed attested that visitors at Mognori Ecovillage near Mole National Park, Damongo in Ghana were ever willing to pay to access their cultural troupe's performance hence supporting this livelihood. The high percentage variation between Kibwezi Sub County and Danongo in Ghana could be attributed to lack of awareness of the existence of cultural troupe performances in Kibwezi Sub-County which are as a result of inspirational ecosystem services. While ecosystem services provide non material benefits including income generation to the surrounding communities (Ellis, 2000), studies by Carney, (1998) and Rakodi and Lloyd- Jones, (2002) argue that socio-cultural benefits from ecosystems can be used for livelihood enhancement possessed by the rural people. Thus, ecosystems are vital in that activities like entertaining tourists who visit these ecosystems leads to generation of income by the troupe performers which they use in various ways to sustain their lives.

4.6.2.4 Other Livelihoods

The study established that other forms of livelihoods (6.8%) (Table 26) were supported by the social and cultural ecosystem in the study area. Interviews revealed that these livelihoods included handcraft making trainers, home stay operators for example Umani Ecotourism Lodge, and dance trainers. A key informant interview with a forest officer in Kibwezi Town indicated that Kibwezi forest has a total of five guards who protect forest against encroachment activities like charcoal burning, deforestation and illegal firewood collection. The Forest estate has a total area of 5849.6 Hectares and each forest guard is expected to cover 1, 169. 92 Hectares. Therefore, this means that these ecosystems provide services which directly or indirectly influence people's livelihoods. A study by Wiren (2002) established that 90% the population in Stockholm visits the city's Green Park at least once a year and about half of those visit at least weekly. The park has several teaching facilities specializing in nature-related subjects and those involved in teaching get some income for their services. The current study has established that only 6.8% of the respondents are aware of other livelihoods for example, dance trainers who earn income from the people visiting ecosystems in Kibwezi Sub-County. This low number could be as a result of lack of adequate information on the link between socio-cultural ecosystem services and livelihoods supported by these services.

There was need to establish if there was a relationship between the socio-cultural ecosystem services identified by the residents of Kibwezi Sub-County and the livelihoods supported. Therefore, the researcher carried out a cross-tabulation between the socio-cultural ecosystems services in the region and the livelihoods supported by these services. The results are summarized in Table 27.

Table 27 (a): Cross- Tab of influence of socio-cultural ecosystem services on livelihoods

Socio-cultural Ecosystem Services	Influence on Livelihoods				Total	
	Yes		No			
Ecotourism	353	(91.9)	31	(8.1)	384	(100)
Recreational	270	(70.3)	114	(29.7)	384	(100)
Inspirational	353	(91.9)	31	(8.1)	384	(100)
Spiritual-Shrines	195	(50.8)	189	(49.2)	384	(100)
Educational Visits	368	(95.8)	16	(4.2)	384	(100)

Source; Field Data, 2015

From the findings in Table 27 (a), 91.9% of the respondents indicated that ecotourism and Inspirational services influenced livelihoods, 95.8% indicated that educational visits influenced livelihoods while, 70.3% and 50.5% indicated that recreational and spiritual services respectively influenced livelihoods in the study area. About 29.7% and 49.2% were not aware of whether recreational and spiritual services respectively, influenced livelihoods. This could have been attributed to lack of interest in visiting these ecosystems to observe and be aware of the people who could be offering goods and services to the people visiting these ecosystems thereby obtaining some cash or income in return. However, from these results (Table 27 a), it can be deduced that generally, the residents of Kibwezi Sub-County are aware of ecotourism, recreational, inspirational, spiritual and educational visits as socio-cultural ecosystem services influencing livelihoods of the people of Kibwezi as evidenced by the chi square test results in Table 27 (b) below.

Table 27 (b): Chi-Square Test (0.05 confidence level)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	6.521[a]	1	.011	
Continuity Correction[b]	5.539	1	.019	
Likelihood Ratio	6.003	1	.014	
Fisher's Exact Test				.015
Linear-by-Linear Association	6.504	1	.011	
N of Valid Cases[b]	384			

Source: Field Data, 2015

The Chi-Square test results (Asymp. Sig.) of 0.011 Table 27 (b) shows that the two variables are related. It can therefore be deduced that socio-cultural ecosystem services influenced livelihoods in Kibwezi Sub-County whereby the resident gain some income to acquire basic needs for their well-being. The findings of the current study (Table 27 b) compare favourably with findings of other researchers. For example, a study by Gaylard (2004) reported that tourism supports handicraft industry as one of the potential sectors that can generate income with low barriers to entry for the marginalised population and empowers large numbers of women in particular. Barber, Dalziel, Derks, and Kula (2006) concluded that numerous benefits are derived by informal traders from the sale of curios to tourists in many developing countries. Barber and Krivoshlykova (2006) reported that in developing countries tourism informal handicraft industry is flourishing and is perceived to be a productive sector that generates employment opportunities and often forms part of the export economies. Further, Croes and Vanegas (2008) reported that local people employ themselves in curio industry especially in areas with tourism services and high rates of unemployment. Likewise, in a country like Ethiopia, $12.7 million is generated each year from tourism related handicrafts sales as observed by Krivoshlykova (2006). Croes and

Vanegas (2008) highlight the fact that tourism handicraft related business is a mechanism for poverty reduction and for improvement of the livelihoods of the poor with minimal barriers to entering into the business.

However, the above researchers (Gaylard 2004; Barber and Krivoshlykova 2006 and; Ngo Duc Anh, 2005) concentrated on handcraft selling as a livelihood supported by tourism and rarely highlighted any link between ecosystem services and livelihoods. The chi square test results of the current study have revealed that there is a relationship between socio-cultural ecosystem services and livelihoods in Kibwezi Sub- County. Therefore, the residents of Kibwezi Sub-County are encouraged to visit ecosystems in the study area so as to be aware of socio-cultural ecosystem services from which more livelihoods will be supported hence improving the well being of the people in the Sub-County.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of the Findings

The first objective of the study aimed at determining the influence of higher plant species richness on livelihoods. The results indicated that Kibwezi Sub-County is endowed with 60 higher plant species supporting livelihoods in the region. The dominant higher plant species identified from the study are represented by the highest number of households include; Kithiia/Muthiia (*Acacia mellifera)* (89.1%), Mwaa (*Acacia tortilis*) (87.8%), Ndau (*Euphobia spp.*) (95.6%), Yiulu *(Commiphora spp.)* (89.0%), Mikuswi (*Acacia brevispica*) (88.3%), Mukokola (*Combretum exalatum*) (62.2%) and Mukau (*Melia volkensii*) (58.3%), Livelihoods supported include timber /post selling (22.4%) and livestock keeping (22.4%) which are majorly supported by plant species, bee keeping (10.2%), firewood selling (8.1 %), handcraft selling (9.4%), planted fruit selling (6.8%), wild fruit selling (8.1%), brick making (5.7%), herbal medicine selling (3.6%) and charcoal burning (3.6%). There was a strong positive correlation between the higher plant species richness and the area dominated by the plant species and the number of livelihoods supported by the plant species respectively ($r=0.721$, $p<.05$; $r=0.896$, $p<0.5$). This therefore implies that higher plant species richness in the region influenced the livelihoods done by the residents of in Kibwezi Sub-County.

The second objective the study aimed at determining the influence of water availability on food crop and livestock production in the study area. The results indicated that 70.3% accessed

rainwater, 79.2% obtained water from boreholes, and 23.4% from streams, 29.7 % accessed tap water, while only 2.6 % accessed water from springs. Further, 76.6% of the households practiced irrigation out of which 67.3% used more than 500 litres of water. Crops grown under irrigation include maize, spinach, kales, Asian vegetables, fruits, babycorns, tomatoes and onions. Least squares regression analysis was employed to determine the influence of water availability on food crop yields. The results showed that 67.2% of the variation in total rainfed crop yields in Kgs was explained by the total monthly rainfall amounts for short rains (r^2= 0.672, p< .01) while 51.9% of variation in the total irrigated crop yields in kilograms was explained by the total amount of water used for irrigation in one season (r^2=0.519, p<.01).

The study concluded that water availability majorly influence the variation of the total food crop yields for both rainfed and irrigated crops in Kibwezi Sub-County. The livestock kept in the region include cattle *(Short horns zebu*), goats (East *Africa small goats),* sheep (*Dorper sheep*) and local chicken breeds. Livestock keeping is considered as a form of savings and the households obtain income which is used for health care, paying school fees and purchasing basic needs for the family. Water from ecosystems like rivers, springs and streams in Kibwezi Sub-County is used for drinking by the livestock, supports both indigenous and exotic grass growth through irrigation and wetland areas are grazing areas for the local communities in the region.

The third objective of the study aimed at examining the influence of social-cultural ecosystem services on livelihoods. The study established 74.7% of the respondents were aware of ecotourism, recreational, educational and inspirational services which were provided by ecosystems in Kibwezi Sub county while, 67.5% were aware of recreational, ecotourism and

spiritual services with 45.4% aware of inspirational, spiritual and recreational services. Only 14.5% had no idea of the socio-cultural ecosystem services in the study area. These socio-cultural ecosystem services support various livelihoods for example, handcraft selling (49.4%), tour guiding (29.2%) cultural troupe performance (14.6%) and other livelihoods (6.8%) such as home stay operators and trainers. The Chi-Square test results (Asymp. Sig.) of 0.011 table 27 (b) showed that socio-cultural ecosystem services and livelihoods were related. Therefore, socio-cultural ecosystem services influenced livelihoods in Kibwezi Sub-County whereby the resident gain some income to acquire basic needs for their well being.

5.2 Conclusions

Higher plant species in Kibwezi Sub-County provide consumptive and non consumptive uses supporting various livelihoods for example, livestock keeping, sale of wild fruits, sale of handcrafts, bee keeping, timber and posts selling, charcoal burning and firewood selling. However, the available higher plant species are not sufficiently utilized by the residents of Kibwezi since only few people are involved in carrying out the above livelihoods while the majority do not utilize the higher plant species to improve their livelihoods for consumptive and income generation to improve their well being.

Water available from various sources in Kibwezi sub-county influences food crop and livestock keeping as livelihoods by the residents. Rainfall is unreliable for food crop production while permanent rivers are potential sources of water used for irrigation through which more food crops are grown and harvested for home consumption and marketed surplus. The income realized from these sales is used to purchase of goods and services such as supplementary food items, clothing, shelter, educational fees hence improved family well being. Therefore, those residents

utilizing both water for food crop production and livestock keeping for consumption and income generation have improved wellbeing.

Socio-cultural ecosystem services in Kibwezi Sub-County include ecotourism, recreational services like hiking, inspirational services, spiritual services and educational visits. These services influence tour guiding, handcraft selling, cultural troupe performance and home stay operators as livelihoods by the people of Kibwezi Sub-County. However, the majority of the residents in the Sub-County are not aware that socio-cultural ecosystem services influence the above livelihoods.

5.3 Recommendations

There is need to create awareness on the need to utilize the available higher plant species so as to increase the number of people engaged in livelihood activities supported by these higher plant species thereby improving the well being. In order to ensure sustainable utilization of higher plant species in the region, there is need for the residents to use their large tracts of lands to plant more trees. In addition, regeneration and agro forestry is recommended so as to increase the higher plant species which will further support more livelihoods.

The residents of Kibwezi Sub-County are advised to intensively enhance water harvesting and do retention systems through improved harvesting technologies to ensure adequate water availability for humans, crops and livestock. High crop yields and more products from livestock can be achieved through intensified irrigation and adoption to new varieties of crop seeds and improved breeds of animals. In addition, livestock feeds need to be preserved when available in plenty through improvised farmer friendly methods of feeds preservation like the hay box.

Finally, the maintenance of healthy ecosystems to ensure the availability of water and other ecosystem services is essential for long-term food crop and livestock production as livelihoods in the Sub County.

The local communities should be made aware of ecotourism, recreational, inspirational, spiritual, and educational services as socio cultural ecosystem services in Kibwezi sub-county. Educating the community on the value of socio-cultural ecosystem services would help in protecting ecosystems, local identity and cultural heritage and supporting more livelihoods hence improving the communities well being. In addition, there is need to promote the growth of handicraft and ecotourism industry as a livelihood since it is not a capital intensive investment.

5.4 Areas for further research

1. There is need to investigate on the influence of non-woody plant species on the livelihoods of the people of Kibwezi Sub-County.
2. The study suggests further investigation to be conducted on factors influencing water availability and use on the livelihoods carried out by the residents of Kibwezi Sub-County.
3. Accessing socio-cultural ecosystem services can also have an impact on the ecosystem services. Therefore, there is need to carry out a study on the impact of accessing socio-cultural services on ecosystems of Kibwezi Sub-County.
4. Supporting ecosystem services are those that are necessary for the production of all other ecosystem services and their impacts on people occur over a long time. Therefore, a similar study needs to be conducted on how supporting ecosystem services contribute to the livelihoods of the people of the study area.

REFERENCES

Achola, P., & Bless, C. (2006). *Fundamentals of Social Research Methods- An African Perspective,* Juta and Co.Ltd, Mercury Cresent; Cape Town, South Africa.

Adhikari, B. (2011). *Poverty Reduction Through Promoting Alternative Livelihoods:* Implications for Marginal Drylands: International Development. DOL:1002/jid.1820.

Akhtar, F. (2001). *Uncultivated food in the context of poor people's livelihood: A Nayakrishi experience*. Pp. 8-17 in Johnston, M. M. & Kathmandu, N. (Eds) (2001). The Proceedings of the Regional Workshop on Uncultivated Foods and Biodiversity. USC Canada-Nepal.

Akinnifesi, F.K., Kwesiga, F., Mhango, J., Chilanga, T., Mkonda, A., Kadu, C.A.C., Kadzere, I., Mithofer, D., Saka, J.D.K., Sileshi, G., Ramadhani, T. & Dhliwayo, P. (2006). Towards the development of Miombo fruit trees as commercial tree crops in southern Africa, *Forests, Trees and Livelihoods* 16:103-121.

Anang, B., Akuriba M., & Adongo, A. (2011) Charcoal production in Gushegu District, Northern region, Ghana: Lessons for sustainable forest management. *International Journal of Environmental Sciences*, Vol.1 No.7, 2011.

Anderson, A., Bryceson, D. & Campbell, B. (2004). *Chance, change and choice in Africa's drylands: A new perspective on policy priorities in the drylands of Africa*. CIFOR Policy Brief. CIFOR, Bogor.

Anne, V.D., Kipkemboi, J.M., M. Rahman, M. & Gretchen, M. (2013). Linking Hydrology, Ecosystem function and livelihood outcomes in Nyando papyrus Wetland in Western Kenya. *Ecosystems and Livelihoods Approches* Vol.3:234-254.

Arku, R., E, Vallarino, J., Dionisio, K., L, Willis, R., Choi, H., Wilson, J.,G, Hemphill, C. & AgyeiMensah S. (2008). Characterization of air pollution in two low income neighborhoods in Accra, Ghana. *Science of the Total Environment*, 402(23), 217 – 231

Ary, D., Jacobs, C.L. & Gall, M. D. (1996). *Introduction to Research in Education* 5th Ed. Florida Harcourt Brace College Publisher.

ASARECA, (2006). Anthropogenic Risks factor and Management of Biodiversity for rural livelihood around East African rainforest in Kakamega. *Western Kenya Biodiverisy Project Programme.*

Ashley, C. (2000). 'The impacts of tourism on rural livelihoods: Experience in Namibia'. *ODI Working Paper* No. 128, London: ODI.

Ashley, C. (1995). Tourism, communities, and the potential impacts on local incomes and conservation. *Research Discussion Paper*, Number 10, November 1995. Windhoek, Namibia: Ministry of Environment and Tourism.

Ashley, S., Holden, S. & Bazeley, P. (1999). *Livestock in Poverty-focused Development.* Livestock in Development. Crewkerne: United Kingdom.

Babatunde, R.O. & Qaim, M. (2009). *The Role of Off farm Income Diversification in Rural Nigeria: driving forces and household access.* Conference paper presented on 23rd 2009, at the Centre for the Study of African Economies (CSAE), Economics Department, Oxford. http /conferences/2009- EDIA/papers/051-Babatunde.pdf.

Babulo, B., Muys, F., Nega, E., Tollens, J., Nyssen, J., Deckers & Mathijis E. (2008). Household livelihood strategies and forest dependence in Tigray, Northern Ethiopia. *Agri- Systems*, 98: 147-155.

Backeus, I, Pettersson, B., Stromquist, L. & Ruffo, C. (2006). Tree communities and structural dynamics in Miombo (*Brachystegia-Julbernadia*) Woodland, Tanzania. *Forest Ecology and Management*, 230: 171 - 178.

Baigorria, G. A., Jones, W. & Obiew J. J. (2008). Potential predictability of crop yield using an ensemble climate forecast by a regional circulation model. *Journal of Agricultural Forecast meteorology 148:1353-1361.*

Balla, M.K., Awasthi, K.D., Shrestha, P.K., Sherchan, D., P. & Poudel, D. (2002). *Degraded Lands in Mid-hills of Central Nepal: A GIS appraisal in quantifying and planning for sustainable rehabilitation;* LI-BIRD, Pokhara, Nepal.

Baker, N. J. (2008). Sustainable wetland resource utilization of Sango Bay through Eco-tourism development. *African Journal of Environmental Science and Technology,* Vol. 2 (10). pp. 326-335.

Barber, T. & Krivoshlykova, M. (2006). *Global Market for Assessment for handicrafts.* Hiti: USAID.

Barber, T., Dalziel, E., Derks, E., & Kula, O. (2006). *Haitian Handicraft Value Chain Analysis.* Haiti: United States Agency for International Development(USAID).

Barrow, E., Fisher, R.J., Emerton, L. & Ingles, A. (2007). *Forests, livelihoods and MDGS in Tanzania*: Forests and the Millennium Development Goals ETFRN News 47 http://www.etfrn.org/ETFRN/newsletter/news4748/nl47_oip_03.htm.

Beaumont, P. (2001) '*Water Management Issues in Drylands in the Twenty-First Century'. In Water and Development*. UNESCO – Encyclopaedia of Life Support Systems

Benjamin, T. A., Margaret, A. A., Aaron & Adongo, A. (2011) Charcoal production in Gushegu District, Northern Region, Ghana: Lessons for sustainable forest management International *Journal of Environmental Sciences* Volume 1, No 7, 2011

Benjaminsen, T. A., Kepe, T. & Bråthen, S. (2008). Between global interests and local needs: Conservation and land reform in Namaqualand, South Africa. *Africa,* 78 (2): 223-244.

Bene, J.G., Beall, H.W. & Cote, A. (2000). *"Trees, Food and People: Land Management in the Tropics"* - International Development Research Centre, Ottawa.

Bennett, E. M., Peterson, Garry D. & Gordon, Line, J. (2009*).* "Understanding relationships among multiple ecosystem services." *Ecology Letters* 12: 1394-1404.

Bhattarai, M. & Pandy, S. (1997). *The Economics of Wheat Production in the Rice-Wheat System in Nepal.* In: Teng, P. S. and Van Laar, H. H. (Eds) (1997). Application of Systems Approach at the Farm and Regional Levels 1: 45-57. Kluwer Academic Publishers. The Netherlands: IRRI, ICASA.

Binns, T. & Nel, E. (2002). Tourism as a local development strategiy in South Africa. *The Geographical Journal*. 168:235-247.

BowenJones, E., Brown, D., & Robinson, E., J. (2003). Economic commodity or environmental crisis? An interdisciplinary approach to analyzing the bush-meat trade in central and West Africa Area, *The Rangeland Journal,* 35: 390–402.

Bridget, S., & Lewin, C. (2005). *Research Methods in the Social Sciences*. London: Sage publications Inc.

Brown, J. & Neil, M. (2011). A site-based approach to delivering rangeland ecosystem services. *The Rangeland Journal,* 33:99-108.

Burke, J., J. & Moench, M. (2000). *Groundwater and Society, Resources, Tensions and Opportunities: Themes in Groundwater Management for the 21st Century*. New York, United Nations

Butler, C. & Oluoch-Kosura, W. (2006). Linking future ecosystem services and future human well-being. *Ecology and Society* 11 (1): 30.

Carney, D. (1998). *Sustainable Rural Livelihoods: What Contribution can we make*? London: Penguin.

Cavendish, W. (2000). Empirical irregularities in the poverty-environment relationships of rural households: Evidence from Zimbabwe. *World Development,* 28 (11): 1979-2003

Central business statistics (CBS) (2005). *Ministry of Planning and National Development. Economic Survey 2005.* Nairobi :CBS.

Chambers, R. & Conway, G. R. (1991). Sustainable Rural Livelihoods: Practical Concepts For The 21st Century. *IDS Discussion Paper* 296.

Chapagain, A. & Hoekstra., A. (2003). "Virtual Water Trade: A Quantification of Virtual Water Flows between Nations in Relation to International Trade of Livestock and Livestock Products." In A.Y. Hoekstra, ed. (2002), *Virtual Water Trade. Proceedings of the International Expert Meeting on Virtual Water Trade*. Value of Water Research Report Series 12. Delft, Netherlands: United Nations Educational, Scientific and Cultural Organization, Institute for Water Education.

Chaposa, M. (2002). *Charcoal Potential in Southern Africa*. Final report. EU/Sida. 304:47-77

Chhabra, D., Healy, R., & Sills, E. (2003). Stage Authenticity and Heritage Tourism. *Journal of Tourism Research. 30* :702-719.

Chirwa, P. W., Syampungani, S. & Geldenhuys, C. J. (2008). The ecology and management of the Miombo woodlands for sustainable livelihoods in southern Africa: The case for Non-timber forest products. *Southern Forests,* 70, 237- 245.

Cleaver, F. (2005). 'The Inequality of Social Capital and the Reproduction of Chronic Poverty', *World Development* Vol 33, No. 6, pp. 893-906.

Comprehensive Assessment (CA) (2007). *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture.* London: Earthscan, Colombo: International Water Management Institute.

Consortium for Ecosystem Services and Poverty Alleviation in arid and semi-arid Africa (CEPSA) (2008). *Situation Analysis of Ecosystem Services and Poverty Alleviation in arid and semi- arid Africa;* African Institute for community driven development.

Convention on Biological Diversity (CBD) (2012). *Cities and biodiversity outlook action and policy: a global assessment of the links between urbanization, biodiversity, and ecosystem services.* Secretariat of the Convention on Biological Diversity: Montreal, Canada.

Convention on Biological Diversity (CBD) (2002). *Proceedings of the 7th Conference of Parties to the Convention on Biological Diversity*. Secretariat of the Convention on Biological Diversity, Montreal.

Costanza, R., D'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskins, R.G., Sutton, P. & Van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature* 387: 253-259.

Creswell, J.W. (2003). *Research Design: Qualitative, Quantitative and Mixed Methods Approches.* 2nd Edition. Sage, Thousand Oaks. USA.

Croes R. & Vanegas M. (2008), "Co-integration and Causality between Tourism and Poverty Reduction", *Journal of Travel Research*, Vol. 47, No. 94

Cronbach, L. J. (1971). *Test validation*. In Educational Measurement, R. L. Thorndike (Ed.) (1970) Washington, D. C.: American Council on Education.

Daily Nation, 5 th July, (2013). Friday: Kenya Elections; *County Economy Tops Agenda.*

Daily, G. (1997). *Nature's Services: Societal dependence on Natural Systems*, pp.1-10 Island, Washington DC.

Daily, G., S. Polasky, J., Goldstein, P.M Kareiva, H.A., Mooney, L., Pejchar, Ricketts, T.H, Salzman & Shallenberger, R. (2009). Ecosystem services in decision- making: Time to deliver. *Frontiers in Ecology and the environment* 7(1):21-28

Dasgupta, P. (2001). *Human Well-Being and the Natural Environment.* Oxford University Press, Oxford.

Daw, T., Brown, K., Rosendo, S. & Pomeroy, R. (2011). Applying the ecosystem service concept to poverty alleviation: the need to disaggregate human well-being. *Environmental Conservation*, 38(4): 370-379.

De Groot, R., Brander, L., vanderPloeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L.C, Tenbrink, P. & Vanbeukering, P. (2012). Global estimates of the value of ecosystems and their services in monetary units. *EcosystemServices1:50–61*.

De Groot, Rudolf, S., Matthew, A. Wilson, R. & Boumans, M.J. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services; The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives, *Ecological Economics; 41: pp 394-404*.

Deccan Development Society (DDS) (2002). *Uncultivated Food and Poor*. www.indiatogether.org/agriculture/dds/uncultivated. htm Accessed 13 May 2014.

Department of Treasury, Ministry of Finance (2010) *Annual Report 2010*: Nairobi, Kenya.

Deutsch, L., Folke, C. & Skanberg, K. **(**2003). The critical Natural Capital of Ecosystem Performance as Insurance for Human well-being. *Ecological Economics* 44:205-217.

Drumm, A. & Moore, A. (2005). *Ecotourism development – A manual for conservation planners and managers, Volume 1: An introduction to ecotourism planning*, 2nd Edition. Arlington, Virginia: The Nature Conservancy. D.C: The World Bank.

Egoh, B. N., Patrick J., Charef A., Josephine G., Koellner T., Henry N.A., Egoh M., & Willemen, L. (2012). An African account of ecosystem service provision: *Use, threats and policy options for sustainable livelihoods; Ecosystem Services vol.2:71-81*

Ekong, E. (2003). *Rural sociology: An introduction and analysis of rural Nigeria*. Dove Educational Publications, Uyo, Nigeria.

Ellis, F & Allison, E. (2004). *Livelihood Diversification and Natural Resource Access. Working Paper*. Rome: Food and Agriculture Organisation of the UN.

Ellis, F. (2000). The determinants of rural livelihood diversification in developing countries. J. *Agric. Econ*. 51(2):289-302

Elmqvist, T. (2011). Ecosystem services and social systems in urban landscapes. In*:* Niemela, J., Breuste, J.H., Guntenspergen, G., McIntyre, N.E., Elmqvist, T. & James, P. (eds) (2010) *Urban ecology: patterns, processes, and applications.* Oxford University Press: Oxford. Pp. 189-192.

Erskine, W. & Ashkar, F. E. (1993). "Rainfall and Temperature Effects on lentil (Lens culinaris) seed yield in Mediterranean environments," *Journal of Agricultural Science*, vol. 121, no. 3, pp. 347–354

Ethiopian Institute of Agricultural Research (EIAR), (2010). Unpublished data, workshop

Faries, F., J. Sweeten, and Reagor, J. (1997). *Water Quality: Its Relationship to Livestock*. College Station, Tex.: Texas A&M University System, Texas Agricultural Extension Service.

Fisher, M. (2004). Household welfare and forest dependence in Southern Malawi. *Environment and Development Economics,* 9 (2):135-154.

Food and Agricultural Organization (FAO) (1998). *The State of the Worlds Plant Genetic Resources for Food and Agriculture*. Food and Agriculture Organization of the United Nations, Rome, Florida Harcourt, Brace College Publishers.

Food and Agricultural Organization (FAO) (2002). *World Agriculture: Towards 2015/2030 - Summary Report.* Food and Agriculture Organization of the United Nations, Rome

Franks, P. (2008). *Promoting equity in the management of protected areas:* New Evidence of The Need for Action. CARE International, Nairobi, Kenya.

Funk, G., Senay, G., Asfaw, A., Verdin, J., Michaelsan, J., Eilets, G., Korech., D & Choularton, R., (2005). *Recent drought tendencies in Ethiopia and Equatorial –subtropical Eastern* African. Wshington DC.

Gaylard, J. (2004). The Craft Industry in South Africa: A Review of Ten Years of Democracy. *African Arts*. 37:26-94.

Georgiadis, N., Ihwagi, F., Olwero, J.G.N. & Romanach, S. (2007). Savanna herbivore dynamics in a livestock-dominated landscape. II: Ecological, conservation, and management implications of predator restoration. *Biological Conservation,* 137, 473-483.

Ghosh, N., Goldar, B. N. & Mitra, A. (2010). Population ageing and its implications on the labour market: the South Asian experience, in: M. Alam and A. Barrientos (Eds) (2010) *Demographics, Employment and Old Age Security: Emerging Trends and Challenges in South Asia* Delhi, Macmillan.

Giliba, R. A., Boon ,E. K., Canisius, J. K., Musamba,,E.,B., Kashindye, A, M., & Philipina, F. S. (2011). Species Composition, Richness and Diversity in Miombo Woodland of Bereku Forest Reserve, Tanzania. *Journal of Biodiversity J Biodiversity,* 2(1): 1-7

Goodland, R. & Pimental, D. (2000). "Environmental Sustainability and Integrity in Natural Resources Systems." In D. Pimental, L. Westra and R. Noss, eds. (2000), *Ecological Integrity*. Washington, D.C.: Island Press.

Gossling, S. (2000). Ecotourism: A means to safeguard biodiversity and ecosystem function? *Ecological Economics,* 29(2), 303–320.

Ham, C. (2005). Plant for food and drink. In: M. Mander and M. Mckensie (Eds) (2005) *Southern African trade directory of indigenous natural products. Commercial products from the Wild Group.,* South Africa, S.A Printing Press pp.17-22.

Harjes, T., (2007). Globalization and income inequality: An European perspective," IMF Working Paper 07/169,Washington: International Monetary Fund.

Harris, F. M. & Mohammed, S. (2003). Relying in nature: Wild foods in Northern Nigeria. *Ambio* 32:24-29.

HarvestChoice, (2010). *"Rainfall Variability and Crop Yield Potential."* International Food Policy Research Institute, Washington, DC., and University of Minnesota, St. Paul, MN. Available online at http://harvestchoice.org/node/2240.

Hesse, C. (2011). *'Ecology, Equity and Economics: Reframing Dryland Policy: Lessons for Adaptation in Practice'* – Opinion. November. IIED, London.

Hoekstra, A., & Hung, P. (2003). *Virtual Water Trade: A Quantification of Virtual Water Flows between Nations in Relation to International Crop Trade*. Value of Water Research Report Series 11. Delft, Netherlands: United Nations Educational, Scientific and Cultural Organization, Institute for Water Education.

Honey, M. (2000). *Ecotourism and sustainable development: Who owns paradise?* Washington D.C.: Island Press.

Hopkins, W. G. (2002). *A New view of statistics*. Retrieved from *http://www.sportsci.org/resource/stats/effectmag.html* on March 23, 2015.

Hussain, I. & Hanjra, A. (2004). Irrigation and Poverty Alleviation: Review of the Empirical Evidence. *Irrigation and Drainage* 53: 1-15.

Hutchinson, C.F. & Herrman, S.M. (2008). *"The Future of Arid Lands – Revisited – A Review of 50 years of Dryalnds Research".* Advances in Global Change Research No 32, Springer, Hamburg.

Ibekwe, U.C., Eze, C.C., Ohajianya, D.O., Orebiyi, J.S., Onyemauwa, C.S. & Korie, O.C. (2010). Determinants of non-farm income among farm households in South East Nigeria. *Researcher* 2(7):49-52.

IFAD, (2010). *International Fund for Agricultural Development: Rural Poverty in Kenya,* Nairobi.

IUCN (2004). *The Durban Action Plan*, 5th ICUN World Parks Congress, Durban, South Africa, 8-17 September 2003. IUCN, Gland.

Johnson, D.G. (2000). Population, Food and Knowledge. *American Economic Review* 90(1): 1-14.

Jones, B., & Murphree, M.W. (2004) Community-based Natural Resource Management as a Conservation Mechanism: lessons and directions, In Child B. (Ed.) (2003), *Parks in Transition: Biodiversity, Rural Development and the Bottom Line,* Published for IUCN and SASUSG by Earthscan Publications Limited, London, UK (2004)

Kalaba, K. F., Chirwa, P., Syampungani, S. & Ajayi, C. O. (2010). Contribution of Agroforestry To Biodiversity and Livelihoods Improvement in Rural Communities of Southern African Regions. Tropical Rainforests and Agroforests under Global Change: *Ecological and Socio -economic Valuations* 25: 461- 476.

Kamanga, P., Vedeld, P. and Sjaastad, E. (2008). Forest incomes and rural livelihoods in Chiradzulu District, Malawi. *Ecological Economics*, 68 (3): 613-624.

Kamal, P., Aryal, B. & Britta, O. (2009). *Uncultivated Plants and Livelihood Support –A case study from the Chepang people of Nepal*. Ethnobotany journal.org/vol7/i1547-3465-07-409.pdf

Karanja, F., Kalege, K., & Moi, K. (2002). *Integrating Economic Instruments for the Reduction of Forests Biodiversity loss into Sectoral Policies and Strategies in East Africa.;* Workshop Report Moshi, Tanzania.

Karue, C.N. (2001). The nutritive value of herbage in semi-arid lands of East Africa. 1. Chemical composition. *East Africa Agricultural Journal*. 40:89-95.

Karumbidza, J. (2005). *'Green Gold or Green Deserts?' Contestation between the choice of poverty or commercial tree planting by rural communities in KwaZulu- Natal. KwaZulu-Natal:* University of KwaZulu-Natal South Africa.

Khan, M. S., Haq, E., Rahman, A.A., Rashid, S.M., & Ahmed, H. (1994). *Wetlands of Bangladesh.* BSCAS, Dhanmondi.

Khanal, B. R. &Babar, J. T. (2007). *Community based ecotourism for sustainable tourism development in the Mekong Region.* Policy Brief. Hanoi, Vietnam: Hanoi Resource Centre.

Kidane, G., Dejene, A. & Malo, M. (2010). *Agricultural based Livelihood Systems in Drylands in the Context of Climate Change;* Inventory of Adaptation practices and Technologies of Ethiopia Ethiopian Institute of Agricultural Research (EIAR) Ethiopia, Adis Ababa.

Kiess, H.O., and Bloomquist, D.W. (2000). Psychological research methods E. Bay city and published by: Allyn and Bacon, London.

Kikoti, Z. (2009). *Livelihoods and Ecosystem Services around Protected Areas. A case study from Ugalla Ecosystem, Tabora, Tanzania*. A Thesis submitted for Master of Science (M.Sc.) in Management of Protected Areas at the University of Klagenfurt, Austria.

Kisangau, P. & Herrmann, M. (2007). Utilization and conservation of medicinal plants used for primary health care in Makueni District; *International Journal of Biodiversity Science and Management 3:(3).*

Kitalyi, A.J. & Kabatange, M.A. (2002). *Livestock feeding potentials, constrains and possible improvements in the semi-arid areas of Central Tanzania*. Department of Animal Nutrition, Tanzania; Livestock Research Organization P/Bag, Mpwapwa

Kiteme, B., & Thenya, T. (2011). *Assessment of Ecological Status and Socio-economic Dynamics of Upper Ewaso Ng'iro Basin Wetlands;* Search for Sustainable Use of Wetlands in Ewaso Ng'iro North River Basin Centre for Training and Integrated Research for ASAL Development (CETRAD), Nairobi.

Korem, A. (1985). *Bushfire and agricultural development in Ghana.* Ghana Publishing Corporation, Tema.

Lacity & Jansen (1994). *Validity and Reliabilty.* NY Spring, Garden Press.

Landefeld, M., & Bettinger J. (2005*). "Water Effects on Livestock Performance."* Fact Sheet ANR-13-02. Ohio State University, Agriculture and Natural Resources. Columbus, Ohio.

Leakey, R.B., Tchoundjeu, Z., Schreckenberg, K., Shackleton, S.E. & Shackleton, C.M. (2005). Agroforestry Tree Products (AFTPs): Targeting poverty reduction and enhanced livelihoods. *International Journal for Agricultural Sustainability* 3, 1-23.

Lemessa, D. (2007). *Beekeeping: A Livelihood Strategy In Pastoral And Agro–Pastoral Dry Land Areas of Southern Oromia (Liban District) and Somali Regional States (Filtu And Dollo Ado Districts),* M.Sc. Thesis. Wondo Genet College of Forestry, School of Graduate Studies, Hawasa University, Hawassa, Ethiopia.

Limburg, K.E., O'Neil, R.V., Constanza, R. & Farber, S. (2002). Complex systems and valuation. *Ecological Economics* 41: 409-420.

Lipton, M., Litchfield, J. & Faures, M. (2003). The Effects of Irrigation on Poverty: A Framework for Analysis. *Water Policy 5*: 413-427.

Little, P. D., Aboud, A. & Lenachuru, C. (2009). Can formal education reduce risks for drought-prone pastoralists? A case study from Baringo District, Kenya. *Human Organization* 68 (2):154–165.

Lobell, D. B., & Asner, G. P. (2003). "Climate and management contributions to recent trends in U.S. Agricultural yields," *Journal of Science*, 299, 1032- 2003.

Loulia, F. (2011) *State of the World; Innovations that Nourish the World.* World Watch Institute.

Luoga, E. J., (2000). *The Effect of Human Disturbances on Diversity and Dynamics of Eastern Tanzania Miombo Arborescent Species*. Ph.D. Thesis, Unpublished. Johannesburg: University of Witwaterrand.

Machakaire, V. (2001).*Comparing and Contrasting Different Research Approaches on Semi- and Uncultivated Food Plants;* Proceeding of a workshop held in Harare, Zimbabwe, 4-6 Sept. 2001.

Maclean, I. M. D., R. Tinch, M. Hassal & Boar, R. (2003). *Towards optimal use of tropical wetlands: an economic valuation of goods derived from papyrus swamps in southwest Uganda.* CSERGE Working Paper ECM 03-10. University of East Anglia, Norwich.

Mad, R.N., N. S., Radam, A., & Shuib, A. (2009). Willingness to pay towards the conservation of ecotourism resources at Gunung Gede Pangrango National Park, West Java, Indonesia. *Journal of Sustainable Development*, Vol 2:173-186.

Madzwamuse, M., Schuster, B. & Nherera, B. (2007). *The Real Jewels of the Kalahari: Drylands Ecosystem Goods and Services in Kgalagadi South District, Botswana*. IUCN, Gland, Switzerland.

Maltby, E. (2009). *Functional Assessment of Wetlands*. Towards Evaluation of Ecosystem Services. Woodhead Publ., Abington, Cambridge.

Mann, S. (2006). *Ethiopia: Towards a Strategy for Pro-Poor Tourism Development*. Washington, D.C: World Bank.

Manyatsi, A.M & Hlophe E.T. (2010). Contribution of Sale of Firewood Towards Rural Livelihood in Swaziland, and its Environmental Sustainability, *Current Research Journal of Social Science* 2(4): 226-232.

Manwa, H. (2003). Wildlife-based tourism, Ecology and sustainability: A tug-of-war among competing interests in Zimbabwe. *The Journal of Tourism Studies* (14), 2, 45-54.

Mati, M. B., Simon, M., Hussein, G., Patrick, H., & Felix, M. (2008). *Lakes & Reservoirs: Research and Management; Impacts of land-use/cover changes on the hydrology of the trans-boundary Mara River,* Kenya/Tanzania 13: 169 -171.

Matthews-Njoku, C.E., & Adesope, C.O. (2007). Livelihood diversity strategies of rural women in Imo State, Nigeria. *The Nigerian Journal of Agricultural Extension* (10):117-123.

Maundu, P. & Tengnas, B. (2005). *Useful trees and Shrubs of Kenya;* World Agroforestry Centre, Eastern and Central Africa Regional Programme, Nairobi-Kenya.

Maydell, H.J. (2001). *Trees and Shrubs of the Sahel-Their Characteristics and Uses*. GTZ, Federal Republic of Germany.

Mbata, K. J., Chidumayo, E. N. & Lwatula, C. M. (2002). Traditional Regulation of Edible Caterpillar Exploitation In The Kopa Area of Mpika District in Northern Zambia. *Journal of Insect Conservation,* 6, 115 -130.

Mbonde , O. & Luke, Q. (2012). *Conservation; Kibwezi Forest and Umani Springs; Pipe Dream or Innovative Conservation;* Swara, June, 2012.

Mbuvi, H. & Boon, E. (2009). Livelihood Potential of Non- Wood Forests Products Environment: *Development and Sustainability* 11(5): 989-1004.

McClean, C., Lovett, J., Hanna, W., Sommer, J., Barthlott, W., Termansen., M., Smith, G., Tokumine, S., & Taplin, J. (2005). *African Plant Diversity and Climate Change*. Missouri Botanical Garden Press.

McMichael, T., B. Scholes, M. Hefny, E. Pereira, C. Palm, & S. Foale, S. (2005). Linking ecosystem services and human well-being in sub global Ecology and Society assessments 10(2): 14. In Capistrano D. & Samper, C.; (Eds). *Sub-global assessments of the Millennium Ecosystem Assessment.* Washington, D.C., Island Press.

Mengistu, T., Teketay, D., Hulten, H & Yemshaw, Y. (2005). *The role of Communities in Closed Area Management in Ethiopia,* Mountain Research Development Vol. 25, No. 1, Pages, 44-50.

Meyer, W. N. (2007). *The economics of water: Water for life: sanitation for dignity*. Pretoria: Van Schaik.

Michaelidou, M., Decker, D. & Lassoie, J. (2002). The Interdependence of Ecosystem and Community Viability: a theoretical framework to guide research and application. *Society and Natural Resources* 15:599-616.

Mitchell, J., & Faal, J. (2008). *The Gambian tourist value chain and prospects for pro-poor tourism.* Working Paper 289. London: Overseas Development Institute (ODI).

Millennium Ecosystems Assessment (MEA) (2005). *Ecosystems and human well-being: Synthesis.* Island Press, Washington, DC., USA.

Millennium Ecosystems Assessment (MEA) **(**2003). *Ecosystems and human well-being; a framework for assessment.* Island Press, Washington, D.C., USA.

Mithofer, D. & Waibel, H. (2003). Income and labour productivity of collection and use of indigenous fruit tree products in Zimbabwe. *Agroforestry Systems* 59: 295-305.

Mithofer, D., Saka, J.D.K., Sileshi, G., Ramadhani, T. & Dhliwayo, P. (2006). Towards the development of Miombo fruit trees as commercial tree crops in southern Africa, *Forests, Trees and Livelihoods* 16:103-121.

Mithofer, D., Waibel, H. & Akinnifesi, F.K. (2006). *The role of food from natural resources in reducing vulnerability to poverty: a case study from Zimbabwe*. Paper accepted for the 26thConference of the International Association of Agricultural Economists (IAAE), August 12-18, 2006, Queensland, Australia.

Mogaka, H. (2002). Economic instruments for the reduction of forest biodiversity loss in Kenya. GEF/UNDP/FAO cross border biodiversity project. *Reducing biodiversity loss at selected cross border sites in East Africa*. Economics Component Technical Report: pp 16-43.

Molden, D., Amarasinghe, U., Bhattarai, M., Wang, J. & Makin, I. (2002). *Water and food security: Background paper for the World Water Development Report*. Comprehensive Assessment Research Paper 2 (draft). Colombo, Sri Lanka, Comprehensive Assessment Secretariat.

Monela, G. C., Chamshama, S.A, Mwaipopo, R., & Gamassa, D.M. (2005). *A Study on the Social, Economic and Environmental Impacts of Forest Landscape Restoration in Shinyanga Region, Tanzania:* Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism, United Republic of Tanzania , and IUCN - The World Conservation Union Eastern Africa Regional Office, Dar-es- Salaam , Tanzania.

Morduch, J., Sicular, T. (2002). Rethinking inequality decomposition with evidence from rural China. *The Economic Journal* 112:93-106.

Mortimore. M, Anderson S., Cotula L., Faccer K., Hesse C., Mwangi A., Nyangena J. & Skinner, J. (2008) *Drylands- an Economic Asset for Rural Livelihoods and Economic Growth.* Draft Report f other Drland Challenge Paper Series of the Global Drylands Imperative UNDP/DDC (2008) available at: http://cmsdata.iucn.org/downloads/draft_drylands_challenge_paper_29sept 08.pdf

Morton, J. & Kerven, C. (2013). *Livelihoods and basic service support in the drylands of the Horn of Africa*. Brief prepared by a Technical Consortium hosted by CGIAR in partnership with the FAO Investment Centre. Technical Consortium Brief 3. Nairobi: International Livestock Research Institute.

Moscardo, G. (2008). Sustainable tourism innovation: Challenging basic assumptions. *Tourism and Hospitality Research* (8), 1, 4–13.

Mugenda, O.N. & Mugenda, A.G. (2003). *Research Methods; Quantitative and Qualitative Approaches* . Nairobi: African Centre for Technology Studies Press.

Mujwahuki F.K. (2013). *Analysis of domestic water supply and demand in Muleba District, Kagera Region, Tanzania;* A Thesis submitted for Master of Art degree in Geography, Maseno University, Kenya.

Muller, F., & Burhand, B. (2012). The Indicator side of Ecosystem Services. *Ecosystem Services* 1: (26) 30.

Mwakatobe, A. & Mlingwa, C. (2005). *The Status of Tanzanian Honey Trade- Domestic and International Markets Tanzania.* Wildlife Research Institute.

Mwamburi, A. & Musyoki, J. (2011). *Investing in Trees; Information* Leaflet No. 1 Kenya forest research Institute, Nrb, Kenya.

Nasi, R., D. Brown, D. Wilkie, E. Bennett, C. Tutin, G. van T., & Christophersen T. (2008). *Conservation and use of wildlife-based resources: the bushmeat crisis.* CBD Technical Series Number 33. Secretariat of the Convention on Biological Diversity, Montreal, Canada, and Center for International Forestry Research, Bogor, Indonesia. Available online at: www.cbd.int/doc/publications/cbd-ts-33-en.pdf.

Ndengwa, G. (2013). *Evaluating Mukau Wood*; Kenya Forestry Research Institute, Karura Regional Research Centre Miti April-June 2013

Ngo Duc A. (2005) Is Tourism-based Development Good for the Poor?: A general equilibrium analysis for Thailand', *Journal of Policy Modeling* 30(6): 929-55

Ngugi, R., K. & Nyariki, D.M. (2002*). Rural livelihoods in the arid and semi-arid environments of Kenya: Sustainable alternatives and challenges Agriculture and Human Values* (2005) 22: 65–71 DOI 10.1007/s10460-004-7231-2

Ngugui, M. & Conant, R. (2008). Ecological and social characterization of key resource areas in Kenyan rangelands. *Journal of Arid Environments* 72: 820-835

Nielsen, S. K. (1980). *Desert Species: Physiological Problems of Heat and Water.* Dover Publications, New York.

Niemeijer, D., Puigdefabregas, J.,White, R., Lal, R., Winslow, M., Ziedler, J.,Prince, S., Emma Archer, E. & King, C. (2005). Dryland Systems. In R. Hassan, R. Scholes, & N. Ash (Eds.)(2004), *Ecosystems and Human Well-being: Current State and Trends: Findings of the Condition and Trends Working Group.* (Vol. 1, pp. 623-662). Island Press.

Nierenberg, D. (2005). *Happier Meals: Rethinking the Global Meat Industry*. World watch Paper 171. Washington, D.C.: World Watch Institute.

Nkem, J., Daniel, M., Maria, B., & Markku, K. (2007). *Using Tropical Forest Ecosystem Goods and Services for Planning Climate Change Adaptation with Implications for Food*

Security and Poverty Reduction; Centre for International Forestry Research (CIFOR) Situgede, Bogor 16115 Indonesia Volume 4, issue 1.

Norsida, M., & Sadiya, S. I. (2009). Off-farm employment participation among paddy farmers in the Muda Agricultural Development Authority and Kemasin Semerak granary areas of Malaysia. *Asia-Pacific Development.* J. 16(2):141-153.

Nyariki, D. M. (2004). *The contribution of pastoralism to the local and national economies in Kenya.* A report for RECONCILE.

Nyariki, D.M. & Ngugi R., K. (2002). A review of African pastoral production system: Approaches to their understanding and development. *Journal of Human Ecology,* 13(3):137-250.

Nyariki, D. M., Wiggins, S. & Imungi, J. K. (2004). ''Levels and causes of household food and nutrition insecurity in dryland Kenya.'' *Ecology of Food and Nutrition* 41(2): 155–176.

Ogato, G.S., Abdise, F., Gammie, T. & Abebe, W. (2014). Promoting rural local development; the case of Wonchi ecostuirsm society, West Shoa Zone, *Ethiopia Prime Journal of Social Science* Vol 3(4) 662-673.

Ojwang', G. O., & Wargute, P.W. (2009). *The population trends and distribution of large herbivores in Laikipia District.* Department of Resource Surveys and Remote Sensing, Nairobi, Kenya.

Orodho, A.B. (2006). *The Role and Importance of Napier Grass in the Smallholder Dairy Industry in Kenya*, Kitale-30200, Kenya.

Pantaleo, K.T., Munishi, Nice, N. W., Nshare, J.S., Stein, R. M, Deo, D. S. & Halima, H. K., (2011). Valley Bottom Wetlands Can Serve for Both Biodiversity Conservation and Local Livelihoods Improvements, Ecosystems Biodiversity, In Oscar Grillo (Ed.) (2011), ISBN: 978-953-307-417-7, InTech, Available from: http://www.intechopen.com/books/ecosystems-biodiversity/valley-bottom-wetlands-can-serve-for-bothbiodiversity-conservation-and-local-livelihoods-improvement.

Patil, P., Kakade, B., & Shivarudrappa, B. (2012). *Improving livelihoods in dryland areas*: Leisa India, December 2012. Volume 14 no. 4.

Paumgarten, F. & Shackleton, C. M. (2011). The Role of Non -Timber Forest Products In Household Coping Strategies In South Africa: The Influence Of Household Wealth And Gender. *Population and Environment*, 33,108- 131.

Peach, A. (2007). Craft, Souvenirs and the Commodification of National Identity in 1970's Scotland. *Journal of Design History*. *20:*243-257.

Peden, D., A. Freeman, A. Astatke, & Notenbaert, A. (2006). *"Investment Options for Integrated Water-Livestock-Crop Production in Sub-Saharan Africa."* Working Paper 1. Nairobi: International Livestock Research Institute.

Pereira, E., C. Queiroz, H.M. Pereira, & L. Vicente, H. (2004). Ecosystem Services and Human Well-Being: A participatory study in a mountain community in Northern Portugal. Submitted to *Ecology and Society 3: 257-309.*

Perry, D.A. (1994). *Forest Ecosystem*; John HIPKINS University Press, Baltimore, USA

Persha, L., Harry, F. B., Ashwini, C. B., Arun, A. A., & Catherine, B. (2009). *Biodiversity conservation and livelihoods in human-dominated landscapes*: Forest commons in South Asia .*Biological Conservation* 143 (2010) 2918–2925.

Petheram, L., Campbell, B., Marunda, C., Tiveau, D., & Shackleton, S. (2006*). The Wealth of the Dry Forest: Can Sound Forest Management Contribute to the Millennium Development Goals in Sub-saharan Africa?* CIFOR No.5, 1-4.

Potts, T. D. & Harrill, R. (1998). Enhancing communities for sustainability: A Travel ecology approach. *Tourism Analysis*, 3, 133-142.

Pullin, A. S. & Knight, T. M. (2001). Effectiveness in conservation practice*:* Pointers from medicine and public health. *Conservation Biology*, 15, 50-54.

Pullin, A. S., Knight, T. M., Stone, D. A. & Charman, K. (2004). Do conservation managers use scientific evidence to support their decision-making? *Biological Conservation*, 119, 245-252.

Rainforest Conservation Fund (RCF) (2015). *Characteristics of Tropical Rainforests*. Retrieved from www.rainforestconservation.org.

Rakodi, C. & Lloyd-Jones, T. (2002).*Urban Livelihoods: a People Centered Approach to Reducing Poverty.* London: Earthscan.

Ramadhani, T. (2002). Marketing of indigenous fruits in Zimbabwe. *Socio-economic Studies on Rural Development*, Vol 129. Wissenschaftsverlag Vauk. Kiel, Germany.

Rao, V.U.M., Subba, A.V., Bapuji, R. B., Ramana, B.V., Sravani, C. & Venkateswarlu, B. (2011). *El Niño Effect on Climatic Variability and Crop Production : A Case Study for*

Andhra Pradesh, Research Bulletin No. 2/2011. Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad, Andhra Pradesh, India.

Rebelo, L. M., McCartney, M. P. & Finlayson, C.M. (2010). Wetlands of Sub-Saharan Africa: distribution and contribution of agriculture to livelihoods*; Wetlands Ecology and Management*, 8, 557–572.

Redda, T. (2002). "Small-scale Milk Marketing and Processing in Ethiopia." In D. Rangnekar and W. Thorpe, (eds.) (2002), *Smallholder Dairy Production and Marketing Opportunities and Constraints*. Proceedings of a South-South Workshop, 13–16 March 2001. Anand, India and Nairobi: National Dairy Development Board and International Livestock Research Institute.

Republic of Kenya Economic Survey (2012). Kenya National Bureau of Statistics, Ministry of finance and planning Government printer.

Republic of Kenya (2009) *Makueni District Development Plan*, Kenya Government Printers, Nrb.

Republic of Kenya (RoK) (2006). *Medium term Expenditure Framework* 2006/2008-2008/2009 Report for the agriculture and rural development sector. Final draft, February 2006. Nairobi.

Reyers, B., O'Farrell, P., Cowling, R.M., Egoh, B.N., Maitre, D.L. & Vlok, J.H. (2005). Ecosystem services, land cover change, and stakeholders: finding a sustainable foothold for a semiarid biodiversity hotspot. *Ecology and Society*, *14:p. 38.*

Richard, N. (2007). *Handicrafts and Employment Generation for the Poorest Youth and Women.* France: UNESCO.

Ruiz-Perez, M., Belcher, B., Achdiawan, R., Alexiades, M., Aubertin, C., Caballero, J., Campbell, B., Clement, C., Cunningham, T., Martinez, A., Jong, W. de, Kusters, K., Kutty, M.G., Lopez, C., Fu, M., Alfaro, M.A., Ndoye, O., Ocampo, R., Rai, N., Ricker, M., Schreckenberg, K., Shakleton, S., Shanley, P., Sun, T. & Young, Y.C. (2004). Markets drive the specialization strategies of forest peoples. *Ecology and Society* 9, 1-9.

Rumsey, D. (2009). *Statistics II for Dummies*. Hoboken, New Jersey: Wiley Publishing Insurance Co.

Ruddell, S., R. Sampson, M . Smith, R. Giffen, J. Cathcart, J. Hagan, D. Sosland, J. Gobee, J. Heissenbuttel, S. Lovett, J. Helms, W. Price & R. Simpson, (2007). *The role of*

sustainable managed forests in climate change mitigation. J. Forestry, September, pp: 314-319.

Rweyemamu, R. (2009). *The Role of Bahi Swamp Wetlands in Enhancing Household Food Security and Income of Adjacent Communities*. Unpublished MSc Thesis Sokoine University of Agriculture Tanzania pp 74.

Salafsky, N., Wollenberg, E. (2000). Linking Livelihoods and Conservation: A conceptual framework and scale for assessing the integration of human and biodiversity. *World development* vol. 28(8):1421-1438.

Salzman, J., Thompson, B. & Daily, G. (2001). *Protecting Ecosystem Services*: science, economics, and policy. *Stanford Environmental Law Journal* 20:309-332.

Saunders, M., Lewis P.,& Thornhill, A. (2009). *Research Methods for Business Students* (5th ed.). New Jersey: Prentice Hall.

Scoones, I. (1998). *Sustainable rural livelihoods: A framework for analysis*. Brighton: Institute of Development Studies.

Scoones, I. Melnyk, M. & Pretty, J. N. (1992). *The hidden harvest: Wild foods and Agriculture systems.* A literature review and annotated bibliography. WWF, SIDA, IIED, London.

Sekaran, U. (2003). *Research methods for business: A skill building approach* (4th ed.). New Jersey: John Wiley and Sons.

Shackleton, C. & Shackleton, S. (2004). The importance of non -timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. *South African Journal of Science*, 100, 658-664.

Shackleton, C. M. & Shackleton, S. E. (2006). Household wealth status and natural resource use in the Kat River valley, South Africa. *Ecological Economics,* 57, 306- 317.

Shackleton, S. & Gumbo, D. (2010). Contribution of Non- Wood Forest Products to Livelihoods and Poverty Alleviation In: Chidumayo, E. N. & Gumbo, D. J. (eds.)(2008) *The dry forests and woodlands of Africa: managing for products and services.* London: Earthscan.

Shackleton, S., Campbell, B., Lotz-Sisitka, H. & Shackleton, C. (2008). Links between the local trade in natural products, livelihoods and poverty alleviation in a semi-arid region of South Africa. *World Development,* 36 (3): 505-526.

Shah, K. (2000). 'Tourism, the poor and other stakeholders: Asian experience' *ODI Fair-Trade in Tourism Paper*. London: ODI.

Shahidullah, A.K., & Emdad H.C. (2010). Linking Medicinal Plant Production with Livelihood Enhancement in Bangladesh: Implications of a Vertically Integrated Value Chain, *The Journal of Trans disciplinary Environmental Studies vol. 9, no. 2, 2010.*

Shore, K. (2000). *Protecting uncultivated food sources in south Asia* (http://www.idrc.ca/en/ev-5295-201-1-DO_TOPIC.html (Accessed 15th March, 2015).

Shrestha, S.R. (2001). The State of Uncultivated Foods in Nepal Biodiversity and Uncultivated Food Plants, In Johnston, M.M. & Kathmandu, P. (Eds) (2001) *The Proceedings of the Regional Workshop on Uncultivated Foods and Biodiversity* N. USC Canada-Nepal.

Silvestri, S., Zaibet L., Said M.Y., & Kifugo C.S. (2013*).* Mapping and Valuing ecosystem services for conservation and development purposes; A case study from Kenya by *Environmental Science and Policy* 31, 23-33.

South Asia Enterprise Development Facility (SEDF) and Intercooperation (IC). (2003). *Medicinal Plants Marketing in Bangladesh*. A market study report. SEDF-Inter-cooperation.

Spring, A. (2000). Agricultural Commercialisation and Women Farmers in Kenya, in *Women Farmers and Commercial Ventures: Increasing Food Security in Developing Countries* edited by Anita Spring, Boulder, Lynne Rienner, pp. 317-342.

Sreeramulu, P. (2004). *"Fodder, Water and Livestock Issues in Andhra Pradesh, India."* Paper presented at a workshop on Fodder, Water and Livestock for Better Livelihoods, 27th August, cosponsored by the Department of Animal Husbandry, Andhra Pradesh, and Water Conservation Mission, Andhra Pradesh. State Management Institute for Livestock Development, Directorate of Animal Husbandry, Hyderabad, India.

Stone, M.P. & Stone, G.D. (2000). 'Kofyar Women Who Get Ahead: Incentives for Agricultural Commercialization in Nigeria,' in Spring, A., Boulder, R. & Lynne R. (eds) (2000) *Women Farmers and Commercial Ventures: Increasing Food Security in Developing Countries,* Nigeria. Abbey Publishing Limited, pp.153-189.

Sukhdev, P. (2008). *The Economics of Ecosystems and biodiversity, an interim report*. European Communities.

Taneja, V.K., & Birthal, P. S. (2004). "Role of Buffalo in Food Security in Asia." *Asian Buffalo* 1 (1): 1–13.

The Economics of Ecosystems and Biodiversity (TEEB) (2008). *The Economics of Ecosystem and Biodiversity:* An Interim report. Available online at www.teebweb.org, accessed on 21st October, 2014.

Thompson, D.M. (2002). *Livestock, cultivation and tourism: Livelihood choices and conservation in Maasai Mara buffer zones*. PhD Thesis, University college of London.

Thornton, P., Herrero, M., Freeman, A., Mwai, O., Rege, E., Jones, P.M., & Dermott, J. (2007). *Vulnerability, Climate Change and Livestock Research. Opportunities and Challenges for Poverty Alleviation*, ICRISAT. Livestock Research Institution. Nairobi, Kenya 4(1).

Timilsina, L.B. (2007). *Contribution of Buffer Zone Management on Livelihood Support. A case study from Chitwan National park, Nepal*. A Masters thesis submitted for the degree of Master of Science (M.Sc.) in Management of Protected Areas at the University of Klagenfurt, Austria.

Turpie, J. & van Zyl, H. (2002). Valuing the environment in water resources management. In: Hirji, R., Johnson, P., Maro, P (eds.) (2000) *Defining and Mainstreaming Environmental Sustainability in Water Resource Management in Southern Africa*. World Bank, SADC, IUCN, SARDC. pp. 85-110.

UNDP, (2003). *Human Development Report*. United Nations Development Programme: Newyork, USA.

UNDP, UNEP, World Bank, & WRI (2000). *People and Ecosystems—The Fraying Web of Life*. Elsevier Science, New York, pp.389.

UNEP, (2011). *Ecosystems for water and food security;* In Boelee, E. (ed) (2011) Nairobi: United Nations Environment Programme; Colombo: International Water Management Institute.

UNEP, (2004). *Human well-being, Poverty and Ecosystem Services*. Exploring the links. International Institute for Sustainable Development, Winnipeg.

UNEP, (2012). *Agriculture and development in Africa.* Retrieved from http://www.eoearth.org/view/article/149914.

UNEP, (2012). *The Role and Contribution of Montane Forest and Related Ecosystem Services to the Kenyan Economy*; UNEP. Nairobi, Kenya.

UNESCO, (2004). *World Heritage List*. Available at http://whc.unesco.org/pg.cfm?cid_31.

Vera-Sanso, P. (2010). *Gender and ageing in India: conceptual and policy issues*, in: S. Chant (Ed.) (2009) International Handbook on Gender and Poverty (Cheltenham: Edward Elgar), pp. 220–225.

Vermeulen, W.J. (2000). *Management of Natural Forests*. In: South Africa Forestry Hand book edited by: D.L Owen. Menlo Park: South African Institute of forestry.

Wainger, L. A., & Price, E.,W. (2004). Evaluating quality of life, economic vulnerabilities, and drivers of ecosystem change. *Environmental Monitoring and Assessment* 94:69-84.

Warinwa, F. (2000). Global Overview. In Grosskinsky, B. & C. Gullick, L.(eds.) (2000) *Proceeding of the Workshop in Exploring the Potential of Indigenous Wild Food Plants in Southern Sudan*, Kenya, June 3-5, 1999. The Mitchell Group, Inc., Washington, D.C.

Western, D. (2003). Conservation Science in Africa and the Role of International Collaboration *Conservation Biology, 17: 11–19.*

Westman, P. (2000). *Trees and Shrubs of Babati District, Tanzania*. Working Paper 134. Swedish University of Agricultural Sciences, Uppsala. 2000.

Whitehead, A., (1994). 'Wives and Mothers: Female Farmers in Africa', In Adepoju A. & C. Oppong (eds) (1992) *Gender, Work and Population in Sub-Saharan Africa,*) pp. 35-53.

Wherry, F.F. (2006) The social sources of authenticity in global handicraft markets evidence from northern Thailand. *Journal of Consumer Culture* 6(1): 5–32.

Wilkison, A.M. (1991). *The Scientist's handbook for writing papers and dissertations*.

World Bank, (2003). *African Development Indicators*. World Bank, Washington, D.C.

World Health Organization (WHO) (2005). *Ecosystems and Human Well- Being*: Health Synthesis: A report of the Millennium Ecosystem Assessment; WHO Press, 20 Avenue Appia, 1211 Geneva, Switzerland.

World Resource Institute (WRI) (2003). *Earthtrends:* Country Profile: Biodiversity and Protected Areas: Kenya.

World Resource Institute (WRI), (2007*). Nature's benefits in Kenya, an Atlas of ecosystems and human well-being*. Washington DC and Nairobi, World Resources Institute.

World Resources Institute, Department of Resource Surveys and Remote Sensing, Ministry of Environment and Natural Resources, Kenya; Central Bureau of Statistics, Ministry of Planning and National Development, Kenya; & International Livestock Research Institute. (2007). *Nature's Benefits in Kenya, An Atlas of Ecosystems and Human Well-Being*. Washington, DC and Nairobi: World Resources Institute. *Published by:* World Resources Institute, 10 G Street NE, Washington, DC 20002, USA. The full report is available online at www.wri.org.

Wuleka, G. K., Earnest, B., & Oscar, A. (2013). Livelihood Enhancement through Ecotourism; A case of Mognori Ecovillage near Mole National Park, Damongo, Ghana *International Journal of Business and social sciences; Vol. 4 No. 4; April, 2013.*

Wuensch, K. L. (2012). A Brief Introduction to Reliability, Validity, and Scaling. Retrieved from *http://core.ecu.edu/psyc/wuenschk/MV/FA/Reliability-Validity-Scaling.docx* on March, 2014.

Wuver, A., & Attuquayefio, D. (2006). The Impact of Human activities on Biodiversity Conservation in a Coastal Wetland in Ghana; *West Africa Journal of Applied Ecology* (WAJAE) - ISSN: 0855-4307 Volume 9.

Yemiru, A., Roos, B. M., Campbell, F. & Bohlin, K. (2010). Forest Incomes and Poverty Alleviation under Participatory Forest Management in the Bale Highlands, Southern Ethiopia, *International Forestry Review*, 12:66.

Yengoh, G.T., Armah, F.A, Onumah, E.E., & Odoi, J.O. (2010). Trends in agriculturally relevant rainfall characteristics for Small-Scale Agriculture in Northern Ghana. *Journal of Agricultural Science, 2:3-16.*

Zambrano, A.M. A., Broadbent, E. N., & Durham, W.H. (2010). Social and environmental effects of ecotourism in the Osa Peninsula of Costa Rica: the Lapa Rios case. *Journal of Ecotourism* (9), 1, 62–83.

Zanele, J. (2012). *The Contribution of Small-scale Timber Farming in Enhancing Sustainable Livelihood at Sokhulu,* University of South Africa, Pretoria, http://hdl.handle.net/10500/6546.

Appendix A: Participants Consent Form

IRENE NZISA MUTAVI,

MASENO UNIVERSITY

DEPARTMENT OF GEOGRAPHY & NATURAL RESOURCES MANAGEMENT,

SCHOOL OF ENVIRONMENT AND EARTH SCIENCES,

P.O BOX, 333

MASENO, KENYA

TO RESEARCH PARTICIPANTS;

Dear Respondent

RE: PARTICIPANT'S CONSENT FORM

You are requested to participate in a research study on 'Contribution of Ecosystem Services on Livelihoods in Kibwezi Sub-County of Makueni County Kenya.' All your responses and information will be treated with utmost confidentiality and your identity remain anonymous. You are free to ask any questions before agreeing to take part.

I have been briefed on what the study is about. I am assured that the information I give is confidential and I therefore agree to participate in the above study.

_____ _____

Signature Date

Appendix B: Questionnaire

TITTLE: CONTRIBUTION OF ECOSYSTEM SERVICES TO LIVELIHOODS IN KIBWEZI SUB-COUNTY OF MAKUENI COUNTY, KENYA

DIVISION…….LOCATION…...…….SUBLOCATION……..…DATE….....…

The purpose of this questionnaire is to gather information on the contribution of ecosystem services to rural livelihoods. All your responses and information will be treated with utmost confidentiality and the results of the study are only for academic purpose only. Please answer the questions as honestly as possible. Give your answer by filling the blank spaces or ticking (√) the boxes. Every answer you give is accepted.

Part A. Background Information

1. Personal details;
a) Gender (√) (i) Male ☐ (ii) Female ☐
b) Respondent's age

(i). Less than 19years ☐ (ii). 20 – 29 years ☐ (iii). 30 – 39 years ☐ (iv). 40 – 49 years ☐

(v). 60 and above ☐

c) House hold size .....
d) Level of education

(i) Primary ☐ (ii) Secondary ☐ (iii) Advance level ☐ iv) Diploma/ Certificate ☐
iv) University ☐

e) Period lived in Kibwezi Sub-County
(i) Less than 1 year ☐ (ii) 1-5 years ☐ (iii) 5-10 years ☐ (iv) More than 10 years ☐

f) Main occupation

i) Formal employment ☐ (ii) Casual labourer ☐ (iii) Business ☐ (iv) Farming ☐

(v) Others (specify).....

g) Approximate Size of Land i) 1-3 Ha ☐ ii) 4-6 Ha ☐ iii) above 7 Ha ☐

h) Main source of livelihood

(i) Crop farming ☐ (ii) Livestock farming ☐ (iii) Employment ☐ (iv) Handcraft selling ☐

(v). Charcoal burning ☐ (vi) Brick making ☐ (vii). Sand harvesting ☐

(viii) Others (specify).....

i) Approximate income per month i) Ksh.0 - 5,000 ☐ ii) Ksh.5, 001-10,000 ☐

iii) Ksh. 10,001-15,000 ☐ iv) Above Ksh. 15,001 ☐

Part B. Plant Species Richness and their influence on livelihoods

2. Fill the Table below

Plant Species	Area dominated by the species Approximate in acres	Uses	Livelihood/ activities supported by the plant species

PART C: Influence of Water Availability on Food Crop and Livestock Production.

Fill the table below

Water availability	Food crop production						
Sources of water Rainfall ☐	Rain fed crops	Irrigated crops	Amount of water used in Litres	Size of land used	Growth period	Yield in kgs	Uses of yields
Stream ☐ Borehole ☐ spring ☐ Others- specify ……..							
Distance covered in Km River …… Stream …… Borehole ……. Spring …..…..							
Uses of water Cooking human Drinking ☐ Watering animals ☐ Kitchen garden Irrigation ☐ Washing ☐							

Water availability	Livestock production							
Water sources Rainfall ☐	Animal species	Rain fed pasture	Irrigated pasture	Amount of water used (Ltrs)	Area under grazing (acres)	Sizes of herds	Livestock products	Uses of products
River ☐ Stream ☐ Borehole ☐ spring ☐ others specify ……								
Distance covered in KM River ……..……. Stream…… Borehole…… Spring…… others specify …….....								
Uses of water Watering animals ☐ Watering pasture ☐ Cooking ☐ Washing ☐ Human Drinking ☐								

D. Effects of Socio-cultural Ecosystem Services on livelihoods

5. Are there socio-cultural ecosystem services from the ecosystems in your community?
a) Yes ☐ b) No ☐ c) Not Aware ☐

6. If yes, name them

a)……. e) …….
b)……..……..…… f) ……
c)…….…… g)……
d)…….…….……. h)……..

7. State whether the educational services provided are either formal or informal
a) Formal ☐ b) Informal ☐

8. Do the ecosystems services in the region influence cultural diversity?
a) Yes ☐ b) No ☐ c) Not Aware ☐

9. If Yes, name the different cultures in the region
a)……..…… c)……...……
b)…… b)…….…….…….
e) …… f)……..

10. List the activities supported by the above socio-cultural ecosystem services

a)……..…… c)……...……
b)…… b)…….…….…….
e) …… f)……..
11. a) Do the ecosystem services influence livelihoods?
b) If yes, in your opinion indicate how the socio-cultural services influence livelihoods in Kibwezi Sub-County.
a)……..…… c)……...……
b)…… b)…….…….…….
e)…… f)…….

Appendix C: Key Informant Interview guide

TITTLE: CONTRIBUTION OF ECOSYSTEM SERVICES TO LIVELIHOODS IN KIBWEZI SUB-COUNTY OF MAKUENI COUNTY, KENYA

Division…….Location…….Sublocation……..…….……
Date …… Gender of respondent…….....…..
Period lived in the area……..…Main Occupation……..……..

1. List higher plant species found in your area
2. What is the size of the areas in acres dominated by these plant species?
3. How do communities use these plant species?
4. What livelihood activities are supported by these plants species?
5. Identify the water sources from your region.
6. What is the approximate distance covered to reach the water sources in KM?
7. List various water uses by the communities in the region
8. Identify the crops grown under rainfall in the region and the total yields obtained
9. Identify the crops grown under irrigation in the region and the total yields obtained
10. What is the growth period of the crops grown in 7 and 8 above?
11. Identify how the communities use the crop produce.
12. What are the various livestock kept by the communities in the region?
13. What is the importance of the livestock to the communities?
14. State how water availability influence food crop and livestock production in the region
15. What socio-cultural services do you think ecosystems in the region provide?
16. What socio- cultural services do you think are most important in the region?
17. What type of livelihood activities do you think they support?
18. State how socio- cultural ecosystem services named in (12) above influence livelihood activities in the region?

Appendix D: Guideline for Focused Group Discussion

TITTLE: CONTRIBUTION OF ECOSYSTEM SERVICES TO LIVELIHOODS IN KIBWEZI SUB-COUNTY OF MAKUENI COUNTY, KENYA

Plant species richness and livelihoods

1. a) Discuss the dorminant higher plant species found in the region and their uses

b) What is the approximate area in acres is dominated by these plant species?

c) What livelihood activities do you think are supported by the above species?

Water availability and crop production

2. a) what are the main sources of water in the region?

b) What are the sources of water used for irrigation?

c) What is the approximate distance covered to reach the water sources in Km?

d) Which crops are grown under irrigation and what is the growth period?

f) What types of crops are rainfed in the region and what is the growth period?

g) Estimate the total yields in Kgs obtained from rain fed and crops grown under irrigation

h) How do the communities use the yields obtained from the above crops?

Water availability and livestock production

3. a) What are the water sources for watering animals in the region?

b) What are the types of livestock kept by the communities and for what reasons?

c) What is the approximate distance covered in Km to reach the water sources?

d) How else do you use water for livestock production in the region?

g) Which ecosystems support these water sources for livestock in the region?

e) Where do the animals graze and what is the approximate size of land under grazing?

f) What are the products obtained from the livestock and their uses?

Socio-cultural ecosystem services and livelihoods

4. a) What are the socio- cultural services provided by ecosystems in the region?

b) What type of livelihood activities do they support?

c) In what other ways do the communities benefit from social and cultural ecosystem services in the region?

d) State how the socio-cultural ecosystems services have influenced the livelihoods of the communities in the region.

Appendix E. Observation Schedule

The following observations are to be made as the interviewing process is ongoing:

1. The common higher plant species found on farm lands, homesteads and wetlands
2. The common uses of different higher plant species in Kibwezi Sub-County
3. Activities supported by these higher plant species
4. Water sources in Kibwezi Sub-County
5. Activities supported by water available in Kibwezi Sub-County
6. Types of crops grown under rainfall and through irrigation
7. Type of livestock kept by the respondents in Kibwezi Sub-County
8. Socio- cultural services from the ecosystems in Kibwezi Sub-County
9. Activities supported by these socio-cultural ecosystem services.
10. Observable livelihoods like farming, charcoal burning, fuelwood harvesting and selling, timber/ post selling, bee keeping among others.

Appendix F: **Land Area (Acres) Occupied by Higher Plant Species**

Plant species in Local Names	Area Covered by Plant Species In Acreages						Total number of households having the species F (%)
	Below 0.25 acres	0.25-5.0 acres	0.6-1.0 acres	1-2 acres	2-3 acres	Above 3 acres	
Ikuu	0	14	47	157	23	11	224 (59.3)
Itiithi	5	15	57	77	85	15	130 (33.9)
Itula	1	20	10	74	13	11	219 (57.0)
Kiamba/Muamba	1	45	31	80	4	1	162 (42.2)
Kiembe	1	20	109	64	13	11	218 (56.8)
Kikwasu	1	10	18	24	5	0	58 (15.1)
Kilawa/Mulawa	0	7	25	177	36	55	300 (78.1)
Kiluli	1	1	16	9	3	0	30 (7.8)
Kilului	1	6	57	79	22	11	176 (46.0)
Kiongoa	1	11	36	187	35	46	316 (82.3)
Kisambalau	1	14	18	24	5	0	64 (16.7)
Kisaya	0	3	16	9	1	1	30 (7.8)
Kithea	1	14	18	24	5	0	64 (16.7)
Kithiia/Muthiia	0	8	56	179	14	85	342 (89.1)
Kitootoo	0	9	46	24	6	4	89 (23.2)
Kiusya	0	12	27	35	10	0	84(21.9)
Kivau	0	4	16	12		0	32 (8.3)
Kivavai	1	2	14	16	1	2	36(9.4)
Kyaa kyosi	1	8	20	12	0	4	45(11.7)
Kyooa	0	23	20	60	5	0	108(28.2)
Kyuasi	0	21	25	44	20	3	113(29.5)
Mbaiki/Kikaiki	2	8	40	32	11	5	98(25.5)
Mikuswi	1	8	20	12	0	4	339(88.3)
Moringa	0	12	46	32	4	7	101(26.3)
Muange/Kiange	0	12	73	56	12	12	165(43.0)
Muangi/Baboo	1	10	18	24	5	0	58 (15.1)

Muatine/Kiatine	0	6	5	0	0	0	11 (2.86)
Mukame	0	10	68	49	10	4	141 (36.7)
Mukau	7	12	83	52	48	22	224 (58.3)
Mukayau	2	28	76	123	21	25	275 (71.6)
Mukenea	0	21	47	33	10	5	116 (31.3)
Mukokola	3	30	82	100	12	8	235 (62.2)
Mukunasi	0	15	3	7	1	0	27 (7.0)
Mukuyu	1	4	16	4	0	0	26 (07.8)
Mulela	0	1	19	35	26	8	89 (23.2)
Mung'uthe	2	15	25	30	5	2	76 (19.8)
Munina	0	4	12	10	0	0	26 (07.8)
Munoa Mathoka	0	1	22	12	0	0	35(09.2)
Musanduku	10	36	79	60	15	9	209(54.4)
Musemei	0	9	40	34	6	8	97 (25.3)
Musukulu/Muchola	20	25	55	80	0	0	180 (46.9)
Muswaki	0	3	10	2	0	0	15 (04.0)
Mutandi	0	1	23	30	3	0	57 (15.0)
Muthuingi	0	6	28	107	5	8	65 (17.9)
Mutungu/Kitungu	4	19	65	34	22	10	154 (41.1)
Muuku	0	6	20	17	4	0	47 (12.8)
Muvingo	8	61	29	18	5	3	124 (32.3)
Muvuaia	2	18	37	29	22	1	109 (19.4)
Muvuavoi	0	0	2	8	4	1	15 (04.0)
Mwaa	40	38	58	109	78	15	337 (87.8)
Mwalandathe	0	12	73	56	12	12	165 (43.0)
Mwalula	0	5	24	35	20	2	86 (22.7)
Mwaluvaini	10	44	64	35	20	3	176 (46.0)
Ndau	20	88	46	137	51	25	367 (95.6)
Pine	1	9	64	35	9	7	125 (32.5)
Yiulu/Iulu	0	14	25	167	51	85	342 (89.1)
Yumbu	0	5	26	10	19	8	68 (18.4)

Appendix G: Rainfall (mm) Distribution in the Study Area.

Years	J	F	M	A	M	J	J	A	S	O	N	D	Annual Rainfall
2000	3.9	TR	14.5	123.2	2.5	2.4	0.7	3.4	5.1	TR	185.5	179.8	**521.0**
2001	160.1	1.8	50.9	89.0	0.2	1.9	0.0	0.0	TR	0.1	278.4	148.0	**730.3**
2002	22.3	7.2	108.1	43.1	30.1	0.4	TR	4.1	19.5	25.9	99.5	131.2	**491.4**
2003	0.3	34.6	79.5	79.1	34.6	0.0	0.0	TR	0.6	0.6	67.4	65.3	**362.0**
2004	169.3	63.4	72.2	45.7	0.0	0.3	0.0	0.2	1.2	26.0	33.6	89.3	**501.2**
2005	4.0	TR	51.6	44.5	28.8	TR	0.4	2.9	1.6	14.5	71.4	6.1	**225.8**
2006	2.2	0.2	42.5	103.5	45.1	0.0	0.0	TR	6.8	57.2	252.8	363.3	**873.6**
2007	103.2	5.6	51.7	44.7	5.9	1.1	0.3	TR	TR	12.0	130.5	112.9	**467.8**
2008	57.7	7.3	222.4	13.4	1.0	0.0	0.0	0.0	1.3	14.2	82.5	5.8	**405.6**
2009	29.3	13.4	1.2	38.2	13.1	0.3	0.0	TR	TR	75.6	54.5	161.1	**368.7**
2010	11.8	121.4	160.7	63.6	13.5	0.0	0.0	TR	1.2	3.6	109.0	52.8	**537.6**
2011	12.9	47.8	111.0	1.5	4.1	0.0	TR	0.1	0.3	26.1	133.0	114.0	**450.8**
2012	3.7	5.9	24.4	155.1	20.5	19.5	TR	2.5	0.3	1.5	144.7	153.3	**521.8**
2013	31.2	TR	52.2	83.5	32.1	0.0	0.0	0.0	15.0	0.4	204.9	101.6	**520.9**
2014	TR	49.0	201.4	42.2	7.2	TR	TR	TR	3.0	TR	117.0	78.1	**498.7**

Source: Makindu Weather Station, 2015 (TR=Trace, Un measurable Amount)

Appendix H. Number of Animals and Poultry Kept By Respondents and Approximate Amount of Water Used in Litres

Number of Animals and Poultry	No. of Respondents	Approximate Amount of water used in Litres	Percentage (%)
1-5	11	11-20	2.9
6-10	25	21-30	6.5
11-15	75	31-40	19.5
16-20	102	41-50	26.6
21-25	79	51-60	20.6
26-30	42	61-70	10.9
31-35	16	71-80	4.2
36-40	13	81-90	3.3
41-45	11	91-100	2.9
46-50 and above	10	101 and above	2.6
Total	**384**		**100.0**