# CONTRIBUTION OF CULTIVATED AFRICAN INDIGENOUS VEGETABLES TO AGRO-BIODIVERSITY CONSERVATION AND COMMUNITY LIVELIHOOD IN MUMIAS SUGAR BELT, KENYA

**BY**

**EVERLYN NAMBIRI CHITECHI WEMALI** (*B. Ed (Sci.), M. Env. S.*)

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## DECLARATION

**Declaration by Candidate:**

This thesis is my original work and has not been presented for a degree or award in any other university.

Signed: …… Date: ……

**Everlyn Nambiri Chitechi Wemali**
Reg. No: N85/20583/2010

**Declaration by Supervisors:**

We confirm that the work reported in this thesis was carried out by the candidate under our supervision.

Signed: …… Date: ……

**Amb. Prof. Michael K. Koech (Ed. D, MBS)**
Department of Environmental Education
Kenyatta University

Signed: …… Date: ……

**Dr. Juddy Kariuki (PhD)**

Department of Environmental Sciences
Kenyatta University

Signed: …… Date: ……

**Dr. James N. Maraga (PhD)**

Monitoring and Evaluation Learning Specialist
Management Systems International
USAID/SUWASA
Regional Office
NAIROBI

DEDICATION

This thesis is dedicated to my late parents Wilson and Wilbrodah Chitechi for their devotion to my education and their resolve to give me their best.

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To God be the glory for the great things He has done. He gave me the opportunity and favour to carry out this research.

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## ABSTRACT

Worldwide, agricultural activity causes great concern to conservation of natural biodiversity. In Kenya, agricultural expansion into natural habitats continues unabated, thus posing a threat to biodiversity. Research into the rate of loss of biodiversity and regain through agro-biodiversity practices are largely lacking. This study was carried out to examine how cultivation of African Indigenous Vegetables (AIVs) have contributed to agro-biodiversity conservation and enhanced community livelihood in Mumias sugar belt area of Kenya. The study set out to specifically isolate and analyse factors that promote cultivation and consumption of AIVs, determine the contribution of cultivated AIVs to community livelihood, assess indigenous knowledge (IK) that has sustained cultivation of AIVs and evaluate opportunities and challenges that exist in consumption and cultivation of AIVs. This study adopted a descriptive research design. It used 392 individuals sampled from sugarcane out-growers of the Mumias Sugar Company. Key informant interviews, structured questionnaires, checklist and Focused Group Discussions were used to collect data. The resulting data was statistically analysed, discussed and presented in graphs, tables and charts. Further, species diversity was determined using the Shannon–Weaver Diversity Index (SDI). From the resulting analysis, it was noted that farmers contribute to agro-biodiversity conservation by cultivation of 10 AIV species and by preserving genetic material in the cultivated AIVs. The vegetables cultivated were: *C. olitorius*, *V. unguiculata*, *G. gynandra*, *C. maxima*, *C. brevidens*, *C. ochroleuca*, *B. junceae*, *S. nigrum*, *A. hybridus* and *A. lividus*. Cowpeas were cultivated by 83.1% of respondents compared to African kales cultivated by only 2.4%. The highest SDI was 1.85 in Lubinu sub-location and the lowest was 0.69 in Bukaya sub-location. The types of cultivated vegetables were predicted from previous year data by the relationship: $y = 1.048 + 0.368x$. Factor analysis isolated five factors that motivated cultivation of AIVs: financial gains, diversification, household size to land-size ratio, availability of land and seeds, and vegetable sufficiency. There was a positive correlation between household size and cost of vegetables as explained by regression model: $y = 2.432 + 0.162x$. This study observed that AIVs contribute to livelihood of households through increased food security, diversification of sources of income and provision of sustainable natural resource base. Indigenous knowledge is important in sustenance of AIV cultivation. Cowpeas and pumpkin leaves are most preferred. The vegetables on decline are spider plant, bitter slender leaf, African kales and nightshades. Primary factors underlying the decline include scarcity of seeds, scarcity of land and divergent attitude. Challenges facing production of vegetables are intermittent production, market, drought, pests and access to seeds. Opportunities in production of AIVs are education, medicinal potential and preparation time reduction techniques. The study concluded that cultivation of AIVs conserves, sustains and improves biodiversity and livelihoods. It recommends inclusion of teaching of AIVs in formal and non-formal education curricula, creation of awareness through special days, development of county seed banks, and feeding program initiatives that incorporate AIVs.

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | | |
|---|---|---|
| **AEZ** | **:** | Agro Ecological Zone |
| **AIVs** | **:** | African indigenous vegetables |
| **ASARECA** | **:** | Association for Strengthening Agricultural Research in Eastern and Central Africa |
| **ASOS** | **:** | Amount spent on seeds; |
| **AVRDC** | **:** | Regional World Vegetable Center for Africa |
| **CBO** | **:** | Community Based Organization |
| **COIDEV** | **:** | Amount of money spent on buying vegetables; |
| **DAO** | **:** | District Agricultural Officer |
| **ECA** | **:** | East and Central Africa |
| **FAO** | **:** | Food and Agriculture Organisation of the United Nations |
| **FGD** | **:** | Focus Group Discussion |
| **FGIDEV** | **:** | Financial gains from indigenous vegetables; |
| **FLSE** | **:** | Farmer Led Seed Enterprises |
| **GTZ** | **:** | German Agency for Technical Cooperation |
| **HH** | **:** | Household Head |
| **HPS** | **:** | Household Population Size; |
| **IK** | **:** | Indigenous Knowledge |
| **IPGRI** | **:** | International Plant Genetic Resources |
| **KARI** | **:** | Kenya Agricultural Research Institute - |
| **KEPHIS** | **:** | Kenya Plant Health Inspectorate Service |
| **MSC** | **:** | Mumias Sugar Company |
| **NGOs** | **:** | Non-Governmental Organizations |
| **PCIDEV** | **:** | Percentage Contribution of Indigenous Vegetables to household income. |
| **PROTA** | **:** | Plant Resources of Tropical Africa |
| **R and D** | **:** | Research and Development |
| **ROP** | **:** | Rural Outreach Program |
| **SHG** | **:** | Self Help Group |
| **SLUIVEG** | **:** | Size of Land Under Indigenous Vegetables; |

| | | |
|---|---|---|
| **SOFA** | **:** | Size of Household Farm; |
| **SSA** | **:** | Sub-Saharan Africa |
| **SSHG** | **:** | Shallomat Self Help Group |
| **TATRO** | **:** | Technical Adoption Through Research Organization. |
| **TLY** | **:** | Total number of vegetable species on farm previous year; |
| **TPLY** | **:** | Total number of vegetable species on farm present at the time of field survey; |
| **WHO** | **:** | World Health Organization |

## DEFINITION OF OPERATIONAL TERMS

**Agro-ecosystem:** A collection of biophysical and socio-cultural factors involved in agricultural production.

**African Indigenous Vegetable**: Indigenous or exotic species which due to long use have become part of the culture of a community (Abukutsa cited in Keller *et al.,* 2005). The study used the terms African Indigenous Vegetables and indigenous vegetables interchangeably.

**Agro-biodiversity**: Variety and variability of genetic resources and the manner in which they are used to increase production, reduce risk and enhance conservation in agro-ecosystems (Brookfield *et al.,* 2003).

**Biodiversity:** Variety and diversity of life forms in a given environment.

**Community livelihood**: all activities, events and assets by which people make a living.

**Household:** A social unit made up of an individual or a group of persons, living together under the same roof(s) within the same compound or homestead, depending on a common holding as a source of income and food which usually but not necessarily involves them eating from a ‘common pot’.

**Indigenous knowledge:** The knowledge used by local people to make a living in a particular environment (Langill, 1999).

**Sustainable livelihood:** A livelihood that can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Carney, 1998).

**Sustainable livelihood Approach:** A way of thinking about the objectives, scope and priorities for development composed of development objective, analytical framework and a set of principles (Salam, 2009).

**Size of household:** The average number of people who share a community of life in the household.

**Sub-location**: Units of sugarcane farming administration for MSC. Sub-location boundaries may or may not be aligned to the sub-location administrative units.

# CHAPTER ONE: INTRODUCTION

## 1.1 Background to the Study

African indigenous vegetables form a significant source of food in both rural and urban areas. Their production and consumption is, however, challenged with decline. Mac Calla (1994) observed that there are more than 45,000 species of plants in Sub-Saharan Africa (SSA) and about 1000 of these species can be eaten as green leafy vegetables. It is observed that the age of discoveries and colonialism brought new species of crops and weeds, some of which became important sources of vegetables. Intercommunity exchange occurred mainly during intermarriages, trade and during famine. These early interactions not only increased the range of species but also the practice of eating vegetables (Maundu, 1993).

According to Plant Resources of Tropical Africa (PROTA), an estimated 6,376 useful indigenous African plants exist; and 397 of these are vegetables (PROTA, 2004). Africa's annual per capita production of vegetables approximated at 50kg is lower than the rest of the world, and is declining (Kamga *et al.,* 2013). Onim and Mwaniki (2008) observed that there are large differences in the amount of vegetables consumed in different Sub-Saharan African (SSA) countries. The level of vegetable consumption is very low in some countries. For instance, Ethiopia has 20kg/person/year, Malawi, Tanzania and urban Guinea has 40kg/person/year and Ghana has 50kg/person/year. Kenya stands out with an average vegetable consumption of 147kg/person/year in urban areas and 73kg/person/year in the rural areas.

Cultivation of indigenous vegetables leads to a variety of genes and plant species. The practice is dynamic, ecologically based natural resource conservation whose presence or lack of it depends on human activity, local knowledge and their culture (Brookfield *et al.,* 2003; Maffi and Woodley, 2010). The vegetables are characterised by fast growth, tolerance to ecological conditions and provision of nutrients (Adebooye and Opabote, 2004;

Mac Calla, 1994; Abukutsa and Onyango, 2003; Oniang'o *et al.,* 2005; Kamga *et al.,* 2013). These attributes make them a suitable cheap source of essential nutrients that most of the population in both rural and urban areas can afford. Research points out that the vegetables are important sources of the much needed nutrients in the body. For instance, according to the WHO Report (2002), a diet lacking in fruits and vegetables is a major independent risk factor in non-communicable diseases such as cardio-vascular disease and cancer. Their cultivation and consumption is thus a key step in resolving health issues in the community.

With intensified commercial agriculture and increased population, among other factors, more land is converted to commercial agricultural production at the expense of the indigenous vegetables (Netondo *et al.,* 2010). Diversity of indigenous vegetables has been seriously eroded due to environmental, political and socioeconomic factors. As a result, most African countries have not prioritised these indigenous vegetables in crop development (Adebooye and Opabote, 2004; Abukutsa and Onyango, 2005; Ngugi *et al.,* 2007). This does not only negate the benefits that the vegetables have in serving human communities that depend on them but also erodes IK that was known to sustain their cultivation (Cienci Agro,2010). This progressive erosion of genetic and species diversity, knowledge that sustained production and value system also represents a depletion of adaptive solutions developed by the community in responding to social and environmental problems (Maffi and Woodley, 2010).

In Kenya, there are about 210 species of indigenous vegetables used as leafy vegetables (IPGRI, 2006). In a study done in Western Kenya, Abukutsa (2007) observed that indigenous vegetable cultivation continue to face challenges of optimal production. Their cultivation is confined to subsistence levels, hence their potential for commercial production has not been tapped into adequately enough yet the region continues to face high poverty levels.

In the study area, sugarcane farming is the main economic activity, with almost 80% of the land area occupied by sugarcane (Republic of Kenya, 2009). Most

of the farmers are said to have more than 56% of their total land under sugarcane farming (Waswa *et al.,* 2011). The risk of hunger and famine is high, given the long cropping cycle of sugarcane and its low net income. Sugarcane, produced under the monoculture system, has been a predominant source of livelihood to farmers in the study area. Waswa *et al.,* (2011) note that where monoculture crop cultivation is practised, it is bound to cause a decline in land area for other crops, including indigenous vegetables. Indeed, Netondo *et al.,* (2010) noted that most of the land available for arable farming in Mumias area has been devoted to sugarcane growing, leaving farmers with limited land parcels for cultivation of food crops, including indigenous vegetables. Diverse vegetable species, along with indigenous knowledge that has sustained their production and utilisation, are currently on the decline (Netondo *et al., 2010).* This decline essentially is causing genetic erosion. A variety of AIVs were cultivated and consumed by people in this area for many years, playing a significant role in food security among local households (Ekesa *et al.,* 2009; Netondo *et al.,* 2010).

### 1.2 Statement of the Problem

African indigenous vegetables are an important livelihood resource that communities have depended on from time immemorial and in so doing they have conserved the resource. In the study area – Mumias Sub-County – sugarcane is an important cash crop. Indeed, 80% of the land area is under sugarcane cultivation (Republic of Kenya, 2009). This implies that other food crops, AIVs included, are produced on a limited scale. Studies have shown that land under sugarcane farming in the sub-county increased inversely with the size of land under individual indigenous crops which include AIVs (Netondo *et al.,* 2010). Although intercropping of indigenous food crops with sugarcane is practised by many households, indigenous vegetable cultivation continues to dwindle. The decline could be attributed to the monetary value attached to sugarcane as a cash crop compared to food crops. If left unabated, this decline could lead to loss of genetic and species diversity. This in turn could ultimately result into loss of indigenous vegetable species which are adapted to the

environmental stress of the region. Loss of species would not only undermine food security and biodiversity, but also interfere with environmental resilience and general livelihoods of the local communities. An understanding of the structure of cultivation of the vegetables, indigenous knowledge as well as embedded challenges and opportunities in indigenous vegetable cultivation and consumption significantly improve vegetable production, hence, conservation of various species amidst a monoculture production system of sugarcane. Knowledge on the structure of indigenous vegetable production from agro-biodiversity conservation viewpoint and community livelihood is limited, a gap that this study was designed to fill.

### 1.3 Research Questions

1. How does the cultivation of AIVs contribute to agro-biodiversity conservation?
2. Which factors promote cultivation and consumption of AIVs?
3. In what ways do cultivation and consumption of AIVs contribute to community livelihood in Mumias Sub-County?
4. Which indigenous knowledge has sustained cultivation and consumption of AIVs?
5. What challenges and opportunities exist in the cultivation and consumption of AIVs?

### 1.4 Objectives of the Study

The main objective of the study was to assess the contribution of AIVs to agro-biodiversity conservation and community livelihood in Mumias Sub-County, which is a predominantly sugarcane growing area.

The specific objectives of the study were to:

1. Examine how cultivation of AIVs has contributed to agro-biodiversity conservation.
2. Analyse factors that promote cultivation and consumption of cultivated AIVs.
3. Determine the contribution of cultivated AIVs to community livelihood.

4. Assess indigenous knowledge that sustains cultivation and consumption of AIVs.
5. Evaluate opportunities and challenges that exist in cultivation and consumption of AIVs.

### 1.5 Justification of the Study

Kenya endorsed and adapted Agenda 21 and also ratified the Convention on Biological Diversity (CBD). The former specifically calls for the development of national strategies for conservation of biological diversity and sustainable use of biological resources. The study findings are a contribution towards enabling strategies for conserving agro-biodiversity, an integral aspect of biological diversity.

The study addresses the gap between agro-biodiversity conservation and a monoculture cultivation in a largely sugarcane production landscape. The farming activities gravitate towards cash crop farming leaving farmers vulnerable to shocks and compromised livelihoods occasioned by delays or failure of the cash crop. In addition to addressing fundamental areas of vegetable production and consumption, these findings are useful to local farmers for their self-assessment and to help direct on farm conservation and revitalisation of efforts and values that promote cultivation and consumption of indigenous vegetables.

Understanding the contribution of indigenous vegetables towards agro-biodiversity conservation and community livelihood is important in creating awareness and securing effective participation by citizens, thus encouraging them to play an active role in devising of solutions that can be applied to the problems facing agro-biodiversity conservation and livelihood diversification. Participation of individuals towards this affords them an opportunity to contribute to conservation which is an important facet of environmental education.

Mumias Sub-County was chosen based on the fact that the sub-county is a predominantly sugarcane growing zone with almost 80% of the land occupied

by sugarcane and with an overall poverty level at about 50% of the sub-county's population (Republic of Kenya, 2009). Abukutsa (2007) noted that there is a high potential for vegetable production which has not been exploited in a region facing increased poverty levels. An understanding of factors that predispose cultivation and consumption of indigenous vegetables is important in improving indigenous vegetable production in the sub-county. The study has explored factors that promote cultivation of AIVs. These, if explored, will further help boost production. Increased production and consumption will go a long way to help in poverty control which is one of the action points for the sub-county's development plan (Republic of Kenya, 2009).

### 1.6 Scope and Limitations of the Study

The study was limited to four sugarcane growing zones: Eastern 1, Eastern 2, Western and Southern zones of MSC in Mumias Sub-County. Agro-biodiversity is considered at different levels; genetic, species and ecosystem. The study laid greater emphasis on species diversity of leafy cultivated AIVs. Biophysical data such as farm macro and micro fauna, chemical and physical characteristics of soil are important in describing agro-biodiversity. However, the study focused only on leafy AIVs as a component of agro-biodiversity. For a farming household, the obvious physical asset is land. Information on size of land was gathered from respondents. Some respondents for fear of unknown, even after being shown a copy of a research permit, were hesitant to state a definitive land size owned by the household. To minimise this source of error, the respondent would be probed to enhance accuracy of response given.

Land ownership is a complex matter as a household can own many parcels of land which can be spatially scattered at varying distances from the place of residence. The study considered and observed vegetables cultivated in the parcel of land where the respondent cultivated sugarcane. There was also a difference between ownership of land and access to land through renting or as a gift. The ownership of the latter is fluid; with continued ownership of the same bound to change without warning. The land would constitute a capital in one season and not in the next. The researcher had no control over the latter.

Conclusions were thus drawn on assumption that the ownership and access would persist. To reconstruct the past and come up with trends in cultivation of AIVs, the researcher heavily relied on reports of individual respondents. The degree of accuracy therefore depended on those who reported. It was, however, expected that some error would be incorporated. Various key informants were asked similar questions; their responses were corroborated with the responses in the questionnaire. Any anomalies in the reporting were discarded, minimising the error.

### 1.7 Conceptual Framework

Mumias sugar zone supports a large population, considering that the sugar factory has a large labour force in addition to the locals. The area is, however, faced with a decline in indigenous vegetables occasioned by an increase in population hence land subdivision and growing of sugarcane which involves large acreage of a single crop (Kimiywe *et al.*, 2007; Waswa *et al.,* 2009; Netondo *et al.,* 2010). There is little diversification of sources of income hence an over-dependence on proceeds from sugarcane growing. Lack of diversification of sources of income has led to increased rates of poverty despite the presence of the sugar factory. The proceeds from canes are far in between considering that mature canes take 18 months on the average to be harvested. The desired situation for this study was that of a sustained cultivation and utilisation of indigenous vegetables based on sustainable livelihood approach that would lead to agro-biodiversity conservation and an improvement in people's livelihood.

Carney (1998) described a livelihood as the capabilities, assets both material and social, and activities that one requires for a means of living. A sustainable livelihood should then enable the farmer to cope and recover from stresses such as drought both now and in the future without undermining the natural resource base. Sustainable Livelihood Approach (SLA) in the context of the study promotes a position where households think about the existing livelihood patterns as a basis for planning farming activities. It entails looking at the circumstances in which people live, their access to different types of assets like

land and finance among others. The assessment of the circumstances are done in consideration of the institutions, policies and organisations which shape households livelihoods and the different strategies that a household adopts in pursuit of its goals (Scoones, 1998; Salam, 2009).

In the context of this study, the farmer and his or her household are the entry point to agro-biodiversity conservation endeavour. The study was built on the understanding that a household's access to resources – in this case land for cultivation of AIVs – is an important outlook. Sustainable livelihood approach was adapted to view cultivation of AIVs as a day to day livelihood strategy; farmers do not cultivate AIVs for conservation as the main goal but they apply a more integrated and holistic perspective to the use of species varieties cultivated on their farms (Picone and Tassel, 2002). The success of conservation of AIVs and community livelihood improvement depend therefore on the benefits that people obtain form the cultivation activity. An understanding of the use value of the AIVs to the community is important to facilitate the making of conclusions as to the strategies to employ in conservation.

To contribute sustainably to community livelihood and agro-biodiversity conservation, it is important to empower the local people through information sharing and capacity building. This is possible if there are existing policies, institutions and processes that will help to transform assets and cushion farmers to produce positive outcomes. Assets are conceptualised in terms of natural capital, social capital, economic capital and human capital (Scoones, 1998). Human capital in the context of the study is the part of human resources that is determined by a household's qualities, including attitudes, aptitudes, skills and knowledge.

Social capital is that part of human resources determined by the relationships people have with others. These relationships may be between family members, households, friends and organisations. The relationships can be defined by their purpose and qualities such as trust, cohesion between members, strength and flexibility. Social capital increases well-being within the members. In

considering the role of social capital to agro-biodiversity conservation and community livelihood, the study considered the linkages between generations that facilitate the flow of information and knowledge. Involvement in self-help groups in cultivation of AIVs was also considered to contribute to social capital. Social capital was considered to be dynamic and depend on many factors, including composition of the social group and their level of awareness on the importance of AIVs to community livelihood, among others.

Natural capital in the context of the study was land and the cultivated AIVs is made up of the natural resources used by people. The cultivation of AIVs provide people with goods and services, either without their influence (such as; provision of soil cover thus reducing soil erosion and facilitation of pollination) or with their active participation through harvesting of the cultivated AIVs. Natural capital is important not only because of its general environmental benefits, but also because it is essential in the provision of food and the general livelihood (Scoones, 1998). In the context of the study, natural capital was considered in terms of acreage and diversity. In analysing the contribution of AIVs to agro-biodiversity and community livelihood, the study considered the physical capital such as infrastructure in place to enable transportation to markets. Also, financial position of the farmer was deemed important, in accessing seeds and hire of labour, where necessary.

The extent to which peoples' assets are built up, balanced and how they contribute towards their livelihood depends on a range of external factors that change people's abilities to gain a living; this is the vulnerability context (Scoones, 1998; Morse *et al.*, 2009; Salam 2009). Vulnerability context is viewed in terms of trends that relate to people's resource use, shocks such as extreme weather changes, outbreak of diseases and seasonality in terms of prices. Vulnerability to shocks like drought can vary, depending on the ability to engage irrigation and availability of water, whether through rainwater harvesting or use of on-farm water conservation techniques like mulching. Inability to devise ways of conserving water for use during droughts will impact upon cultivation of AIVs and in turn reduce crop yields. The capitals

will vary in terms of their resilience to different types of shocks and the intensity of shocks (Morse *et al.,* 2009). Understanding this context is important in designing ways that help to mitigate challenges of production.

The policies and institutional context within which these capitals operate is an important component to consider in SLA. Although some capitals may be vulnerable to some shocks, the authorities are able to act and limit damage which may occur or provide recompense depending on the policies in place (Scoones, 1992). Vegetables may fail to produce sustainable yields to the households, thus compromising livelihoods. However, with appropriate institutional structures in place, farmers can be cushioned hence enabling them to find a way through thus reduce the likelihood of a total loss. A public funded extension services structure would supplement the knowledge base of farmers or provide advice on cultivation of the vegetables to improve the yields and social networks. A positive interplay between policies governing land use and activities meant to produce positive livelihood outcomes is expected with resultant improvement in nutrition, agro-biodiversity conservation as a result of increased cultivation and consumption of the vegetables, and reduced poverty levels.

The study presupposed a situation where on-farm sustained cultivation of AIVs is enhanced through the production, consumption and selling of indigenous vegetables. The result of this approach would be an enhanced genetic diversity base, improved nutritional status of the population and a reduction in poverty levels. It is envisaged that when people are aware of the importance and uses of AIVs, methods of sustained production and marketing of the produce, they would take responsibility and control making the endeavour sustainable. The interplay of components and processes are captured in the framework in Figure 1.1. The conceptual framework is built upon these key concepts in the study and how they relate to one another.

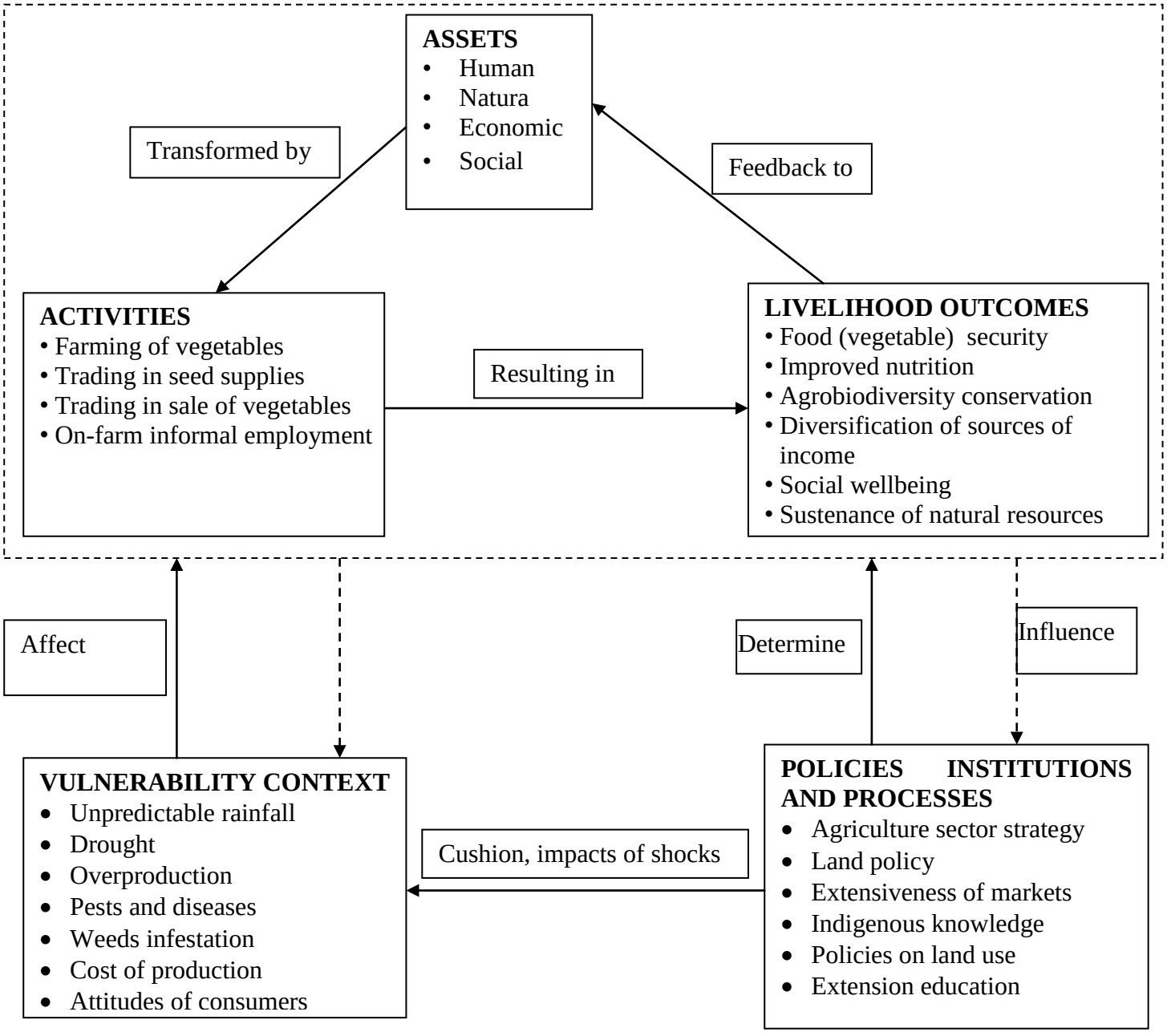


**Figure 1.1:** Conceptual framework (*Source:* Adapted from Salam, 2009)

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Introduction

Agro-biodiversity is said to be the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries (FAO, 1999). It comprises not only of the diversity of genetic resources and species used for food, fodder, fibre, fuel and pharmaceuticals, but also the diversity of non-harvested species that support production and those in the wider environment that support agro-ecosystems as well as the diversity of the agro-ecosystems (FAO,1999). Agro-biodiversity results from the interactions in the environment, genetic resources management systems and practices used by culturally diverse peoples (Brookfield *et al.*, 2003). Munzara (2007) notes that farmers, especially in developing countries, are responsible for managing agricultural biodiversity in agricultural ecosystems as a critical resource for providing them with food security, nutrition and sustenance of their livelihoods. Agro-biodiversity is important in the provision of food. It contributes to sound pest and disease management, conservation of soil and increase in soil fertility and health. Further, agro-biodiversity improves human nutrition and provides sources of human medicine. Indigenous vegetables together with processes involved in their production form part of agro-biodiversity (Adebooye and Opabote, 2004; Abukutsa and Onyango, 2003).

## 2.2 Diversity of Indigenous Vegetables

Various indigenous vegetables are cultivated worldwide. Surveys indicate that there are over 7,000 plant species across the world that are cultivated or harvested from the wild for food including the indigenous vegetables (Schönfeldt and Pretorius, 2011). According to Kiambi and Atta-krah (2003), of the 150 plant species commonly consumed by man, 115 are indigenous African species. Several studies including Adebooye and Opabote, 2004, Abukutsa, 2003, Keller *et al.,* 2004, Schönfeldt and Pretorius, 2011 among others, observe that these neglected and underutilised species could play a

crucial role in food security, income generation and food culture of the rural poor.

Plant Resources of Tropical Africa revealed an estimated 6,376 useful indigenous African plants of which 397 are vegetables (PROTA, 2004). East Africa has a variety of these vegetables. These include African nightshade, spider plant, vegetable amaranth, slender leaf, jute mallow, cowpeas, pumpkin leaves, African kales and African eggplant among many others (Abukutsa-Onyango *et al.,* 2007; Netondo *et al.,* 2010). In the rural areas of Tanzania, Lyimo *et al.,* (2003) recognised thirty types of indigenous vegetables commonly utilised. Abukutsa and Onyango, (2007) reports that African kales were popular in the three countries of East Africa and that the crop has been grown and consumed by the people for many years. Kenya has many, about 200, wild and weedy species of edible leafy vegetables (Ekesa *et al.,* 2009). The indigenous vegetables in Kenya are available across various counties and in many regions such as the Coast, Western, Lake Victoria and Kenyan highlands. While a few of these species have been domesticated or are semi-domesticated, it is revealed that most of them grew as weeds or wild in disturbed and cultivated areas (Maundu *et al.*, 1999; Kemei *et al.*, 1995). The diversity of AIVs is said to be influenced by cultural diversity and historical influence (Shackleton *et al.,* 2009). This can explain the many species of AIVs used as food. Indeed, a species can be food in one community and not in another community.

The consumption of indigenous vegetables in Western Kenya has long been reported. For instance, Karen (1992) reported that to supplement the supply of cultivated vegetables, women in Western Kenya gathered wild greens, especially during the dry season, while some vegetables such as ‘Inderema’ (*B. alba*) were gathered irrespective of the season due to their delicacy and popularity. Masayi and Netondo (2012) have confirmed that some indigenous vegetables grew in the wild, grew as weeds on farms or were cultivated by farmers in Mumias. A study conducted by Mathenge (1995) within the Abaluyia ethnic group indicated that more than 10 varieties of indigenous

vegetables were made into stew to go with *ugali.* Ekesa *et al.*, (2009) documented various indigenous vegetables available and popularly consumed among the Abaluyia in Matungu Division of Mumias. These included cowpeas leaves, jute mallow, amaranthus, pumpkin leaves, spider plant, African kales, African nightshades, slender leaf, mushroom and African vine. It was noted that AIVs in Mumias were readily accessed in the local markets and at household farm level. Among them, cowpeas were the most popular. This is because cowpeas can withstand harsh weather conditions and the yield is often higher than that of the other indigenous vegetables. In addition, both its leaves and seeds are used as food (Abukutsa-Onyango, 2003). The popularity of cowpeas was also observed in the eastern slopes of Mount Kenya, where it was used both as a vegetable and grain (Kabuye and Ngugi, 2001).

Slender leaf and jute mallow were also popular vegetables among the Abaluyia since it was a common practice amongst them to cook two to three vegetables together. Masayi and Netondo (2012) identified indigenous vegetables that were common before the introduction of commercial sugarcane farming in Mumias. These were spider plant, jute mallow, African nightshade, vegetable amaranth, pigweed, cowpeas, pumpkin leaves, slender leaf, African kales and vine spinach. The vegetables were found to be highly nutritious, have medicinal value and generated income to the farmers (Abukutsa, 2007). However, Waswa *et al.*, (2011) noted that after the introduction of sugarcane, some of the indigenous vegetable species have become rare. A species becoming rare implies that it is seldom cooked in households, a situation that can lead to erosion of knowledge about the vegetable species in question and a reduction in the number of vegetables options available to a household.

### 2.3 Vegetables and Nutrient Provision

Indigenous vegetables have been said to be inexpensive, easily accessible and provide health-promoting compounds such as vitamins, minerals, anti-oxidants and even anti-cancer; factors needed to maintain health and fight off infections (Schönfeldt and Pretorius, 2011; Abukutsa-Onyango, 2003; Engle and Altoveras, 2000). The vegetables account for 10% of the world's higher plants

(Odhav *et al.*, 2007). They represent inexpensive but high-quality nutrition sources for the poor segment of the population, especially where malnutrition is widespread (Abukutsa, 2007). Studies show that the minerals and vitamins found in indigenous vegetables exceed the levels found in most exotic vegetables (Odhav *et al.*, 2007). In a study done on indigenous vegetables for poverty alleviation and healthy diets, Asian Vegetable Research Development Centre (AVRDC) found that diversification of vegetables was related to diet diversification hence the possibility of optimal nutrition (Engle and Altoveras, 2000).

International Plant Genetic Resources Institute (2006) explains that the vegetables are good sources of micronutrients. Such include iron and calcium as well as vitamins A, B complex, C and E. For instance, vegetable amaranth has been said to be much more nutritious than green cabbage, which is exotic to Kenya and is increasingly replacing traditional vegetables in the diet. Uusiku *et al.*, (2010) also state that indigenous leafy vegetables contain significant levels of micronutrients that are essential for human health. Vegetables are a rich source of vitamins and other components that contribute to anti-oxidant activity in the diet. Indeed they provide the most affordable dietary sources of bioactive compounds (Schönfeldt and Pretorius, 2011). Consumption of plant products is a fundamental requirement for human well-being; indigenous leafy vegetables play a crucial nutritive role in this regard (Moyo *et al.*, 2013). According to Uusiku *et al.*, (2010) the consumption of indigenous leafy vegetables helps in maintaining a balanced diet and averting the chronic effects of malnutrition. Smith and Eyzaguirre (2007) highlight that in Sub-Saharan African countries, indigenous vegetables could play an important role in the WHO global initiative on increased consumption of vegetables and fruit.

### 2.4 Desirable Attributes of Indigenous Vegetables

Ekesa *et al.*, (2009) observed that indigenous vegetables are often easier to grow, resistant to pests and diseases and are quite acceptable to local tastes. Moyo *et al.*, (2013) noted that indigenous leafy vegetables possess high horticultural potential based on their long utilisation history by local

communities across Africa. Indigenous vegetables are noted to represent a cheap but quality nutrition to the poor both in urban and rural areas where malnutrition is widespread (Maundu, 1997). The vegetables are regarded as significant among low income, especially in addressing malnutrition and loss of biological diversity (Vorster *et al.,* 2007; Habwe *et al.,* 2009; Netondo *et al.,* 2010). In a study done to determine the importance, status, preference, cultivation and conservation of indigenous vegetables in South Africa, the vegetables were found to be significant in food security, especially as a dried food source during winter and in providing security against pests, diseases and varied environmental conditions (Vorster *et al.,* 2007).

Vegetables are gathered when in season, grown in home gardens or intercropped with other food crops. Indigenous vegetables have agronomic advantages which include production of seed under tropical conditions, a short growth period and ability to withstand both abiotic and biotic stresses. They have potential for income generation and for self-employment and are suited to environmental-friendly farming systems such as intercropping and organic farming. Preserved vegetables contribute to household food security (Vorster *et al.,* 2007; Abukutsa-Onyango, 2003; Habwe *et al.,* 2009). Households with many members who do not supplement income for the household tend to rely more on indigenous vegetables. The vegetables are, however, seen as weeds in some communities; in fact, some extension officers label the crops as not worth the space they occupy (Vorster *et al.,* 2007).

## 2.5 Factors Affecting Cultivation and Consumption of Indigenous Vegetables

A steady trend has been observed on the loss of agro-biodiversity worldwide (Jackson *et al.,* 2007). Khumalo *et al.,* (2012) links the significant loss of agro-biodiversity to human population pressure and the transition from traditional mixed farming systems characterised by high agro-biodiversity to modern monoculture farming system. This argument was earlier advanced by Kiremire *et al.,* (2006) who stated that apart from lack of investment in African farming systems, there are changes in agricultural production systems shifting from

diversified cropping systems towards ecologically more simple cereal based systems which have contributed to poor diet and crop diversity. This has, thereby, inadvertently impacted on biodiversity. For instance, on the global scale, 20-30% of the world's forest areas have been converted to agriculture, resulting in extensive species and habitat loss (WRI, 1992).

Brussaard *et al.*, (2010) suggest that feeding the world is possible without further encroachment of agriculture into natural ecosystems. Increasing specialisation and intensification of production systems has led to reduction in crop and livestock biodiversity, increasing genetic vulnerability and erosion (Gepts, 2006; FAO, 2007). Concurrently, wild biodiversity is still declining rapidly (IUCN, 2009). This is because of the expansion of agricultural areas (MEA, 2005). The reduction of this biodiversity has been an inevitable consequence of human development as species-rich forests and wetlands are converted to relatively species-poor farmlands and plantations (Shiundu and Oniang'o, 2007). Picone and Tassel (2002) describe decline of traditional varieties of vegetables and crops as genetic erosion. Such erosion leads to loss of genetic diversity which has the impact of loss of genes necessary for improvement of food crops against pests, diseases and environmental stresses such as water deficit.

Indigenous vegetables are threatened by rapid adoption of highly improved varieties of commercial crops. Their loss will, however, further result to the loss of IK associated with the cultivation, utilisation and conservation of indigenous vegetables (Cienci Agro, 2010). UNEP (1995) observes that intensive cereal production has led to reduction in the number of species. In reviewing the impact of modern agriculture on environment, Biswas (1994) observed that modern intensive agriculture has had an adverse impact on the physical environment through the degradation of land, depletion of water resources and the loss of genetic biodiversity. Muriuki (2008) noted that agricultural patterns that remove hedgerows and farm larger areas tend to interfere with species diversity and abundance. Biodiversity is being destroyed irreversibly by human activities; species are being lost at a rate that is more

than 1000 times faster than background rates typical over the planet's history (MEA, 2005). Many species are threatened by habitat loss caused by anthropogenic factors. The MEA report predicts that due to intense expansion of agriculture and the farming systems, there will be rapid conversion of grassland and forestland by 10-20% of current areas through to 2050.

Consumption of AIVs could either be low or high depending on the perception held by people. The frequency of consumption of indigenous vegetables has decreased over the years, as noted by various researchers (Keller *et al.,* 2005; Masayi and Netondo, 2012; Abukutsa, 2007). It is noted that this situation results from the perception that indigenous vegetables are considered to be inferior in their taste and nutritional value compared to exotic vegetables such as spinach and cabbage. Gari (2004) argued that the low level of gathering of indigenous vegetables could arise from their association with poverty and primitive practice. According to Cruz-Garcia and Howard (2013), the consumption of local wild food plant species and other indigenous foods is coming under increasing pressure since these are linked with concepts of social backwardness and poverty. Vorster *et al.,* (2007) point out that the general impression of these traditional vegetables as 'poverty food' or 'backward' explains why the youth are not readily inclined to them.

Consumption of indigenous vegetables is influenced by many other factors, including the consumers' gender and age, Men, for instance, generally have less preference for consumption of vegetables in comparison to women (Vorster *et al.,* 2007; Kimiywe *et al.,* 2007). Research has also indicated that the youth lack interest in consuming these vegetables as they are considered traditional and out-dated. Limited methods of cooking indigenous vegetables have made them less appealing to the young. In addition, preference of indigenous vegetable species varies depending on the geographical location and cultural background (Kimiywe *et al.,* 2007; Uusiku *et al.,* 2010). Other determining factors include availability of seeds, distance from market, good transport network and the short shelf-life of the vegetables (Vorster, *et al.,* 2007; Abukutsa-Onyango, 2007).

Commercialisation of agriculture is viewed to be the main cause of food crop diversity loss (FAO, 2001). Waswa, *et al.,* (2011) noted that sugarcane farming is monoculture in nature; where practiced, it is bound to decrease land area for other crops. A shift towards sustainable agricultural production entails the adoption of more system-oriented strategies that include farm-derived inputs and productivity based on ecological processes and functions (Garrat *et al.,* 2011). Today, agriculture faces the unprecedented challenge of securing food supplies for a rapidly growing human population, while seeking to minimise adverse impacts on the environment and reducing use of non-renewable resources and energy (Forster *et al.*, 2013).

The consumption pattern and preferences for indigenous vegetables vary among households within different countries (Uusiku *et al.,* 2010). Occupation is one of the determining factors with regard to choice and consumption of indigenous vegetables. More casual labourers and/or non-employed people have been found to consume indigenous vegetables more than those in full-time employment and business (Kimiywe *et al.,* 2007). The authors note that occupation determines the time one has for buying, preparing and cooking indigenous vegetables. Income level and poverty levels of households determine the consumption rates of indigenous vegetable. Accordingly, those with low income levels consume indigenous vegetables more than their wealthier counterparts (Vorster *et al.,* 2007). Availability and accessibility of the indigenous vegetables affects their consumption. Acipa *et al.,* (2013) observed that consumption of wild food plants was limited to casual encounters, periods of food shortages and use as supplements to major food crops. When available, the indigenous vegetables are preferred to exotic vegetables (Dweba and Mearns, 2011). The low level of accessibility to indigenous vegetables could be explained by the increasing pressure on both wild habitats and agricultural land. Due to demographic and socioeconomic changes, the ecological niches of many indigenous leafy vegetables are fast disappearing, and genetic erosion is therefore rapid. Poor road infrastructure also hampers physical accessibility to the markets, supermarkets or restaurants

avenues where the vegetables would be sold (Kemei *et al.*, 1995; Keller *et al.*, 2005).

In a study to determine effects of sugarcane farming on agro-biodiversity in Mumias and Nzoia sugar belts in Western Kenya, Netondo *et al.,* (2010) observed that traditional food crops, including indigenous vegetables, were abundant before sugarcane farming was introduced. However, declines of certain types of these vegetables have occurred in the sugarcane belt due to land fragmentation and sugarcane growing. Indigenous vegetables most affected are African nightshades, vegetable amaranth, African kale, jute mallow, spider plant, pumpkin leaves and pigweed. Abukutsa (2007) intimates that the growing of indigenous vegetables is on the increase following increased demand and awareness campaigns. However, a later study by Netondo *et al.* (2010) indicates that expansion of sugarcane farming poses a high risk to the existence of a variety of indigenous vegetables as well as food crops such as sorghum, finger millet, cassava and sweet potatoes.

In Mumias – the study area – land under indigenous food crops and vegetables has been declining since the introduction of sugarcane (Netondo *et al.*, 2010). The cultivation of the vegetables is hampered by poor seed quality, habitat loss and inadequate research, among other constraints (Abukutsa-Onyango, 2007). Ekesa *et al.,* (2009) noted the low accessibility to and consumption of indigenous vegetables among rural households, a major nutrition problem that was likely to lead to poor dietary diversity and micronutrient deficiencies. Prior to the introduction of sugarcane, agriculture among the Abaluyia was characterised by mixed cropping system: various crops were cultivated and livestock reared. The livestock provided manure to boost soil fertility. Indigenous knowledge was crucial in conserving the vegetable species. Indigenous vegetables were grown mainly for local consumption and were also of medicinal value (Netondo *et al.,* 2010). Clearing of forests was minimal. However, the introduction of sugarcane plantation seriously eroded the cultivation of AIVs (Masayi and Netondo, 2010). The decline in cultivation of

crops in general may have partly been due to the wrong perception that sugarcane farming is more profitable than the food crops (Waswa *et al.*, 2009).

### 2.6 Indigenous Vegetables and Community Livelihoods

Adebooye and Opabote (2004) acknowledge the importance of African indigenous leafy vegetables and fruits to human nutrition. African Indigenous Vegetables (AIVs) have the potential to improve nutrition and generate income for small holder farmers in Eastern and Central Africa (ASARECA, 2012). The vegetables are observed to play a key role in income generation and subsistence (Adebooye and Opabote, 2004). For instance, in South-West Nigeria, AIVs have been reported to play a vital role in generating income for communities since they are sold at prices much higher than their introduced counterparts, particularly during dry seasons (Adebooye and Opabote, 2004). In Limpopo, KwaZulu-Natal and the Eastern Cape, AIVs are sold to generate income for households (Vorster, *et al.*, 2007).

African Indigenous Vegetables tend to have short production cycles, require intensive labour but few purchased inputs; they produce high yields with strong nutritional value, thereby ensuring food security (Kimiywe, 2007). They can therefore support rural, peri-urban and urban populations both in terms of subsistence and income-generation, without requiring large capital investments. In some areas, AIVs are becoming popular with commercial growers (Shippers, 2000). Abukutsa-Onyango (2003) noted that AIVs could make a positive contribution to world food production because they adapt easily to harsh or difficult environments; the input required for growing them is lower compared with other crops. Further, they are highly resistant to pathogens, thus requiring fewer chemicals and pesticides. The authors observed that AIVs are suitable and advantageous for people living in areas with high population density. Adebooye and Opabote, (2004) affirmed that AIVs play a key role in income generation and subsistence. Food production in most of Africa is through subsistence and traditional agriculture by small scale farmers who constitute over 70% of the population. In a paper presented at the UN/Trondheim Conference on Biodiversity and Ecosystems, Munzara (2007)

observed that cultivated agro-biodiversity together with wild relatives provide humanity with genetic resources for food and agriculture. The author further argued that global food supply rests essentially on the biological diversity developed and nurtured by farming communities. A survey by Abukutsa-Onyango (2003) showed that because they require minimal capital investment, indigenous leafy vegetables offer a significant opportunity for the poor people in Western Kenya to earn a living. Consequently, these vegetables provide employment opportunities for those that are outside the formal sector (Adebooye and Opabote, 2004).

The diversity of indigenous plants and wild plants available in most tropical countries is quite beneficial: besides providing essential nutrients, they presumably are integral health boosters. Studies on chemical composition of indigenous leafy vegetables and fruits have shown that the vegetables contain invaluable amounts of crude protein, fat and oil, energy, vitamins and minerals (Adebooye and Opabote, 2004; Uusiku *et al.*, 2010).

## 2.6 Challenges in the Cultivation and Consumption of Indigenous Vegetables

Cultivation and consumption of indigenous vegetables and fruits is marred by various constraints worldwide. Abukutsa-Onyango (2003) noted that Kenya is experiencing a decline in the consumption of indigenous African leafy vegetables; the main reason being lack of knowledge of correct choice of foods, hence reduced dietary diversity.

Accessibility and availability could be the major factors that might have triggered reduced use of AIVs. Dweba and Mearns (2011) observed that availability determines what is eaten and that people eat to survive before proceeding to eat for status and actualisation according to Maslow's hierarchy of needs. Based on this, the authors argued that habitat loss affects availability of indigenous vegetables and hence their consumption. There is reluctance among people to walk long distances to gather vegetables, as mentioned in studies conducted by Keller *et al.* (2004), and Vorster *et al.* (2007). The

availability of AIVs is mostly seasonal with many being abundant during rainy seasons. Consumption and utilisation of indigenous leafy vegetables are highest when the vegetables are in season and prices are lower (Kimiywe *et al.*, 2007). Owing to habitat loss, availability of AIVs is not guaranteed (Vorster *et al.*, 2007).

In a study about utilisation and medicinal value of indigenous leafy vegetables consumed in urban and peri-urban Nairobi, Kimiywe *et al.,* (2007) noted that erosion of culture and breakdown of traditional systems of plant resource management result in the loss of AIVs. Uusiku *et al.,* (2010), as well as Adebooye and Opabote (2004) shared similar sentiments; arguing that the introduction of exotic species decreased consumption of AIVs. This was largely attributed to the change in food preferences, which in practice translates to a change in food habits. According to Masayi and Netondo (2012), change in tastes and preferences have been experienced in Mumias; with exotic vegetables such as 'sukumawiki' (kales) being preferred to the AIVs such as vine spinach and African nightshade. Indigenous knowledge on how and where to collect, cultivate and prepare traditional vegetables was viewed by Keller *et al.,* (2004) to be disappearing. Mwai *et al.,* (2007) underlined that lack of appropriate knowledge on differentiating between toxic and non-toxic AIVs constrain their consumption.

Most traditional leafy vegetables are nutritious if well cooked (Kimiywe *et al.*, 2007). AIVs are cooked using traditional methods, usually involving boiling in water for a long time. The excess is often dried and stored for consumption during the off-season (Vorster *et al.*, 2007). The cooking methods and period of cooking may affect the nutritional value as well as the bio-availability of many nutrients. This is likely to cause nutrient loss, especially where the water soluble vitamins such as Vitamin B complex and Vitamin C are discarded with the drained water (Kimiywe *et al.*, 2007). Lack of variety in preparation of AIVs has led to the suspicion that the 'poverty food' label attached to AIVs is linked to the monotonous way in which they are prepared (Vorster *et al.*, 2007).

Pachpute (2010) observed that vegetable production in rural areas of Sub-Saharan Africa is constrained by low and unpredictable rainfall, besides lack of irrigation facilities. Most of the vegetable crops are extremely susceptible to water stress, frequent rain showers and/or irrigation applications are therefore a basic necessity in their cultivation. Seed production system of spider-plant, slender-leaf and African nightshades in Kakamega County of western Kenya was found to be largely informal (Ndinya, 2005). Farmers, it was observed, lack adequate knowledge on how to produce, store and distribute seeds among themselves (Abukutsa, 2007). The high cost of seeds for some species was also found to discourage massive production of AIVs (Masayi and Netondo, 2012).

The cultural status of AIVs has declined as official policy has placed more premiums to the growing of crops that suit urban tastes and have higher yields. A case in point is the introduction of exotic vegetables, which despite their inferior nutrient content have become more prestigious than local vegetables, slowly causing the latter to disappear (Masayi and Netondo, 2012). Kemei *et al.,* 1995 observed that modern agricultural approaches in Kenya often discourage farmers from growing their indigenous crops and cultivars and as a result, the genetic resource base of food security is gradually being undermined.

## 2.7 Opportunities in the Cultivation and Consumption of Indigenous Vegetables

African Indigenous Vegetables (AIVs) have been found to be better adapted to the low-input environment of small holder agriculture (Keller *et al.,* 2004). They have a short growth period; some of them are ready for harvest within 3-4 weeks; they can produce seed under tropical conditions; they respond well to organic fertilizers; and can tolerate both biotic and abiotic stress (Abukutsa-Onyango, 2007). In many traditional farming methods, AIVs have basically been grown at a subsistence level using organic sources of manure that are normally available on-farms, although potential for commercial production exists (Mwai *et al.,* 2007). Besides, most of these vegetables are grown in mixed cropping systems which have several merits with regard to land

productivity, soil fertility, sustainable production and crop diversification (Keller *et al.,* 2004).

Some AIVs have been found to be of medicinal value in addition to serving as food. In South-west Nigeria, Adebooye (2003) documented the traditional medicinal uses of twenty-four indigenous leafy vegetables. Modern science has isolated many natural products with active principles of medicinal importance from many indigenous plants. According to Kimiywe *et al.,* (2007), the most common illnesses treated by AIVs were malaria, diarrhoea, anaemia, colds and coughs, skin infections, malnutrition, diabetes and high blood pressure. AIVs also improve blood flow and are able to cleanse blood. The AIVs species have been found to be adapted to many tropical conditions and are resistant to pests and diseases as well. This fact makes them good sources of genes for genetic improvement of cultivated species, especially in the area of pests and diseases resistance (Adebooye and Opabote, 2004).

**2.8 Role of IK on Cultivation and Consumption of AIVs**

Indigenous Knowledge – mostly interwoven with local religious beliefs, customs, folklore and land use practices – plays an important role in sustainable natural resource management, traditional culture and livelihoods. However, despite its importance and contribution to sustainable rural livelihood and natural resource management, the IK and practice are fast disappearing in many parts of the world. In a study set out to understand IK in sustainable management of natural resources in China, Juanwen *et al.*, (2012) indicated that IK was disappearing and globalisation accelerating its erosion and depletion.

The basic component of any country's knowledge system is its IK (Rao, 2006). Indigenous Knowledge also referred as traditional or local knowledge include the skills, experiences and insights of people, that is applied to maintain or improve their livelihood. Local knowledge is unique to a given culture or society and forms basis for local-level decision-making in several aspects such

as agriculture and natural-resource management among others activities in rural communities, Kaya (2007).

Guthalanga Makaudze (2012) observed that the mixed cropping and intercropping practiced by farmers ensures that soil is under crop cover thus reducing exposure to the sun, while the different root systems ensure a better utilisation of soil volume. The transfer of IK on AIVs is important to ensure the availability and utilisation of this important food source for resource-poor rural communities (Dweba and Mearns, 2011). Like many other types of IK systems, the knowledge about traditional vegetables is vanishing and this situation warrants immediate action to retain or regain it. Lwoga *et al.,* (2010) noted that traditional vegetables are gathered from both cultivated and uncultivated lands and that the knowledge about the vegetables was passed on from generation to generation as part of the IK system of the community. The authors further observed that IK is socioeconomically viable and effective, involves minimum risks to rural farmers, and is an important asset for their livelihood and for conserving natural resources. Dweba and Mearns (2011) argued that the transfer of IK on AIVs will ensure that their availability and utilisation would be maintained as an important food source for resource-poor in rural communities. Furthermore, the transfer of the IK associated with AIVs to the younger generation holds the key to the potential future use of these vegetables.

## 2.9: Concept Underpinning the Study

### *2.9.1 Sustainable Livelihood Approach (SLA)*

Sustainable Livelihood Approach takes an assets/vulnerability approach to analysis of the livelihoods of people. It emphasises understanding of the vulnerability context and the organisational environment within which people utilise assets of different types in order to implement a livelihood strategy (DFID, 2001). The approach is centred on people, their livelihood strategies and on developing an understanding of them: of how they change and develop; of the impact of different policy and institutional arrangements upon them; and

to tailor development that effectively build on them. Sustainable Livelihood Approach is holistic, people-centred and integrates multiple actors including communities, private sector, NGOs and government authorities (Scoones, 1998).

The approach analyses ways in which activities affect people's livelihoods and the framework that shapes them. Further, it focuses on whether or not people's own livelihoods are being addressed, how people's livelihood strategies affect their participation in and benefit from an activity and, how activities can be adapted to enhance livelihood impacts for target groups (DFID, 2001). The sustainable livelihood approach is relevant to this study because the promotion of cultivation of AIVs can best be achieved if the farmer is seen as a facilitator of change. In addition, external support (county government, NGOs and private sector) and the local communities need to network in order to develop intervention strategies that address households' livelihood needs. This should be done in view of their socio-cultural, financial and the biophysical environment in which they operate.

The SLA visualises that people use assets to make a living. In the context of this study, the assets at the disposal of the farmer are the land and the natural resource, AIVs. A household has to cope as best as it is possible with factors beyond their control that render their livelihoods vulnerable. These factors include unpredictable rain, drought, over production, pests and diseases. Besides, they are affected by existing policies, institutions and processes; included in this category are agricultural land policy, poverty eradication policy, market and their access to extension education .The policies, in place, existing institutions and processes affect access to various types of capital, which in turn affect livelihood strategies , decision-making bodies and sources of influence; in this way, shaping livelihoods. Scoones (1998) observed that formal and informal institutions affect the composition of portfolios of livelihood strategies. This background helps in designing interventions which improve livelihood outcomes.

### *2.9.2 Key Points on Sustainable Livelihood Approach in the Context of the Study*

The entry point to sustainable production of AIVs is the people themselves. Cultivation is seen as part of the day-to-day of a household's livelihood strategies. Creating awareness and empowering households through information sharing and capacity building is viewed as a way of meeting people's needs. The SLA is hinged on five basic outcomes (Scoones, 1998). The priority given to each depends on the individual's perception of his or her circumstances. Let us briefly discuss them.

1. *Increase in food security*

A basic requirement for any livelihood is to achieve food security. There must be a secure supply of food all year round. The farmer will plant different types of AIVs to diversify and enhance availability and hence vegetable security, thereby increasing nutritional requirements of the diet.

2. *Improved well-being*

An increased feeling of well-being is an important and basic need. This depends on other needs being met. The study observed that cultivation of AIVs increases a person's well-being in that the farmer is able to provide for the family through cultivation for home consumption and sale of the vegetables.

3. *Reduction in vulnerability*

The study observed that diversification of vegetable species especially for commercial purposes satisfy the biophysical and economic elements of vegetable production, reducing vulnerability to weather and income related uncertainties.

4. *Increased income*

With increased vegetable production, households have their income increased to an adequate level, and also have the flexibility in meeting their household needs.

5. *Sustainability of natural resource use*

Sustainable livelihood strategies lead to more sustainable use of natural resources and vice versa. For sustainable cultivation and consumption of AIVs, IK that sustains land preparation, seed production, cultivation and harvesting need to be understood and applied.

## 2.10 Research Gaps

There is a research gap on how to sustain production and utilisation of AIVs amidst competing cash crop such as sugarcane which requires a lot of land and in a scenario where land as a resource is inadequate. Although there are various studies on utilisation of AIVs, knowledge on the factors that promote specific vegetables species in the study area is still scarce. The present study filled this gap.

Conservation approaches often routinely take an interventionist approach and tend to design projects that target the endangered species rather than the people's livelihood, creating room for possible alienation of the people from the conservation effort. *In-situ* conservation *per se* without considering the livelihood aspects of the target group would be incompatible with the social and economic needs of a people who should combine conservation with cultivation. This study considered livelihood approach to conservation, an area whose body of knowledge is still scarce.

Several studies have generated valuable data on AIVs, emphasising the variety of AIVs and their nutritional value. This study, however, observed that conservation of diverse vegetable cultivars through use of IK exemplifies the ways in which cultural values, behaviours and practices contribute to maintaining high agro-biodiversity and ecological value. IK offers valuable experiences and techniques of producing AIVs, an area of research not adequately addressed. To build a body of knowledge herein, however, needs understanding and rationalisation for an enhanced vegetable production. This study sought to bridge this gap.

The present study has viewed AIVs as a natural resource whose cultivation is a day to day livelihood strategy maintained on-farm for multiple functions depending on the knowledge, skills, attitudes and values held by farmers. These abilities are important in the cultivation and consumption of the vegetables; they are a pointer to the conservation likelihood to be accorded to the vegetable species. This is a knowledge gap that this study sought to bridge. Need arises to diversify economic activities in the study area and help reduce poverty levels. This is possible when opportunities and challenges embedded in the cultivation of AIVs are understood, especially from a farmer's position in the framework of sustainable livelihood approach. This study filled this felt gap.

# CHAPTER THREE: METHODOLOGY

## 3.1 Study Area

### *3.1.1 Location*

Mumias Sub-County is one of the sub-counties that constitute Kakamega County. It covers a total area of 586.2 $km^2$. It borders sub-counties of Butere to the South, Matungu to the West, and Navakholo and Lurambi to the East (Republic of Kenya, 2009). It lies between latitudes 1º 30' N and 0º 05' S, and longitudes 34º and 35º 45' E. The altitude ranges from 1240 m to 1641 m above sea level. The sub-county is made up of three divisions; Mumias, Etenje and East Wanga (Figure 3.1). The economy of the region is largely rural, with more than 90% of the population earning its living from agriculture (Republic of Kenya, 2009).

### *3.1.2 Climate of the Study Area*

The climate of the study area is mainly tropical humid, characterised by day temperatures varying between 23° C and 33° C. The sub-county has high rainfall almost throughout the year, with the minimum rainfall being received between December and February. Mean annual rainfall varies from a minimum of 1100 mm to 2700 mm and a maximum of 1597 mm to 2873 mm. There are variations across the sub-county. The high temperatures and rainfall allow for crop development all year round. Agriculture is considered an economic activity to alleviate poverty in the sub-county (Republic of Kenya, 2009).

### *3.1.3 Economic Importance of the Study Area*

The study area is of great economic importance at local as well as national levels, especially with regard to the agricultural sector. One of the most prevalent industrial developments in the area is Mumias Sugar Factory. There are also some small sugar factories (jaggeries). The locals are engaged in sugarcane farming as the main cash crop farming. Some of them also provide labour to these industries from which they obtain income to supplement what they earn from their subsistence activities. The Sub-County Development Plan (2008-2012) cites the main challenges in the area as poverty, with the rural

absolute poverty standing at 51.6%, food poverty at 46.7% and rural hard-core poverty at 21.6% (Republic of Kenya, 2009). Soil erosion, sedimentation, deforestation, wetland degradation, river bank cultivation and poorly developed infrastructure are also outstanding challenges.

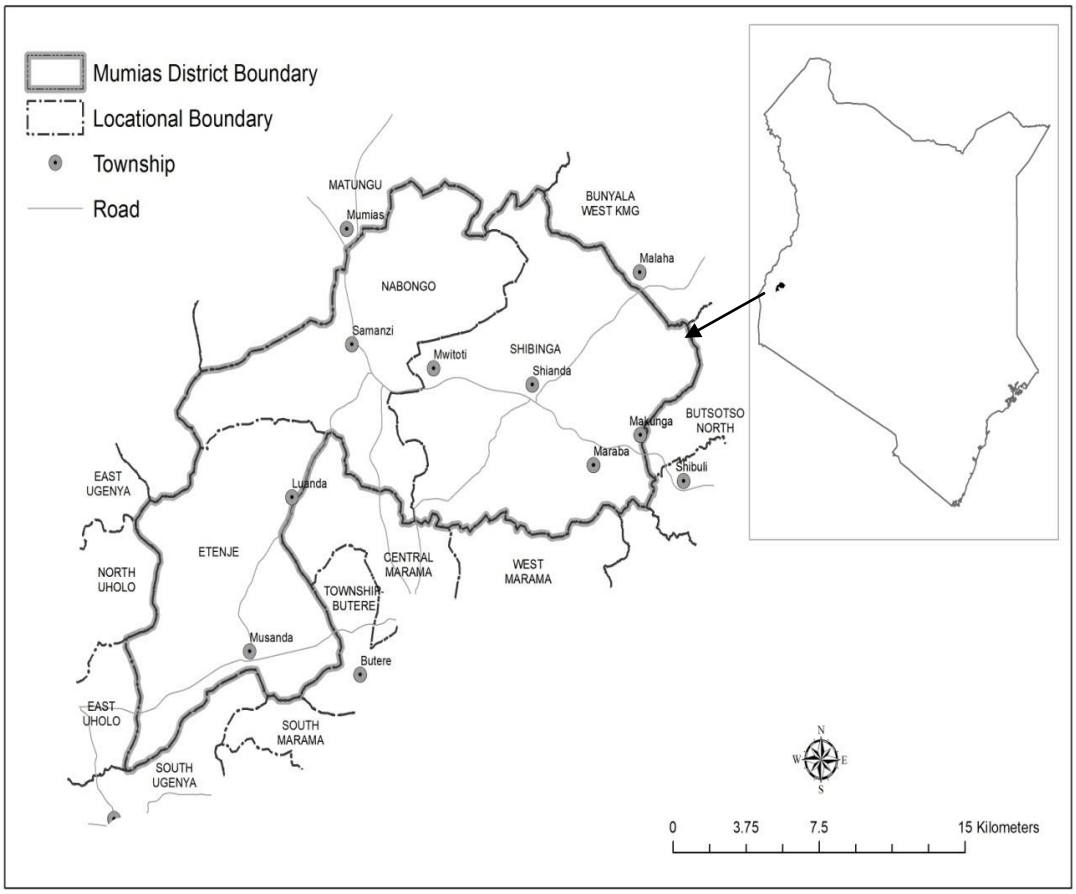


**Figure 3.1:** Map of study area (*Source:* Mumias District Development Plan, 2008 - 2012).

### *3.1.4 Population*

The sub-county has a population of 340,774 persons, with the majority of the population being under 20 years. Mumias Town is the largest urban centre in the sub-county, with a large population of 53,578 persons (Republic of Kenya, 2009). According to the projections for the Mumias Sub-County Development Plan (2008-2012), the urban population is expected to increase (Republic of Kenya, 2009).

### *3.1.5 Soils and Land Use*

The sub-county has rocks of post Kavirondian granites and pre-Cambrian volcanic and sedimentary rocks (Republic of Kenya, 2009). Most of the sub-county lies mainly in the Agro-Ecological Zone (AEZ) lower midland (LM) 1, with a small portion in the Northern part of the sub-county in lower midland (LM) 2. Land use in the sub-county is below optimal level, although the land is extensively cropped (Republic of Kenya, 2009). The soils are suitable for sugarcane farming: the yields from the crop are apparently declining due to degenerating fertility and population pressure (Jaetzold *et al.*, 2005). The main food crops are maize, sorghum, millet, bananas, groundnuts, beans, potatoes and cassava. The main cash crop is sugarcane. Waswa *et al.*, (2012) observed that the cultivation of indigenous food crops is declining in favour of sugarcane. The sub-county is home to the MSC. The Sub-County Development Plan advocates for the need to diversify sources of livelihood to curb instances of poverty in the sub-county (Republic of Kenya, 2009).

### *3.1.6 Hydrology*

The sub-county has three main rivers, 234 shallow wells, 200 boreholes and 500 protected springs (Republic of Kenya, 2009). The main rivers in the study area are Nzoia, Lusumu and Liyondwe.

## 3.2 Study Design

### *3.2.1 Research Design*

The study adopted descriptive survey design as no attempt was made to manipulate the variables of the study. Mugenda and Mugenda (2003) define descriptive research as a process of collecting data in order to test hypothesis or to answer questions. The concern of the study was to examine the contribution of cultivated AIVs to agro-biodiversity conservation and community livelihood in Mumias sugar belt. The survey was carried out to collect data that would enable the researcher obtain insight concerning the study population regarding the cultivation of AIVs and their contribution to agro-biodiversity conservation and community livelihood. Present facts and current conditions concerning the phenomenon were investigated. The methods employed for data collection were non-experimental; they dealt with associations among non-manipulated variables. The phenomenon already existed; the researcher thus only selected the relevant variables to find out associations from which causal relationships could be made (Robson, 2002). The field survey was done in three discrete stages.

Stage I involved the administration of questionnaires to sampled respondents in the 14 sub-locations of MSC in the sub-county, observations and quadrat sampling of indigenous vegetable farms. This was done to sample, document and understand the diversity at household level reasons for species and varietal cultivation or non-cultivation, preferred traits landraces as well as recording the cropping patterns. Stage II involved Focus Group Discussions (FGDs) with purposively selected women groups involved in the production of indigenous vegetables. Discussions mainly focused on the type of indigenous vegetables grown, cultivation processes, market preferences and challenges experienced in the cultivation and selling of the indigenous vegetables. Stage III involved interviews with purposively selected key informants; the Sub-County Crop and Home Economics officers in the Ministry of Agriculture, manager in charge of Out growers Department in MSC and selected elderly women involved in the cultivation and selling of the vegetables. Pretesting of the instruments was done

with 10% of the target population who had not been sampled. The pre-testing was meant to allow the researcher meaningful observation regarding time taken for giving responses, clarity of questions and possible repetitions, hence, subsequent mitigation of the same during actual fieldwork (Robson, 2002; Mugenda and Mugenda, 2003).

### *3.2.2 Target Population*

The target population comprising of 24,393 persons were sugarcane out grower farmers contracted by MSC. These were sampled, the Household Head (HH) or spouse interviewed and their farms observed and sampled for the type(s) and density of indigenous vegetables ascertained. The household was a primary unit of measurement and analysis because in most rural homes, decisions on how, where, when and what to produce are usually made at this level (Brookfield *et al.,* 2003).

### *3.2.3: Sample Size and Sampling Procedure*

The required sample size of 384 was calculated using the formula:

$$n = z^2pq \ / \ d^2$$

where $n$ is sample size, $z$ is the standard normal deviate at the required confidence level, $p$ is the proportion in the target population estimated to have characteristics being measured at 0.05, $q$ is the proportion in the target population estimated not to have characteristics being measured at 0.05 and $d$ is the level of statistical significance required and in this case was 0.05. For the study, the $z$ statistic is 1.96 and the proportion of the target population assumed to have the characteristics of interest being 50%. The actual number used was however 392, a number slightly above the calculated figure. The 392 farmers were sampled from a target population of 24,393 farmers (figures and sampling frame was provided by the ODS section of MSC).

Stratified random sampling technique was used to obtain the sample. The sampling unit was a household and their indigenous vegetable farm. The population was divided into strata. The strata were formed based on geographical and administrative units of the MSC sugarcane sub-locations.

Stratification in sub-locations ensured homogeneity within and heterogeneity among different strata. Proportional sample sizes were obtained for each of the stratum based on the target population in the stratum. The formula below was used.

$$ni = n/N*392$$

Where *ni* is sample size for sub-location, *n* is total number of farmers in the sub-location and *N* is the total number of farmers in the sub-county. Proportional allocation was considered most efficient to make the probability of selecting a farmer in any strata to be equal and minimise within stratum, variances hence increasing reliability. The sample size for each sub-location is shown in Table 3.1 below.

**Table 3.1:** Sampling frame

| MSC 'sub-location' | No. of farmers | sample size | percentage |
|---|---|---|---|
| Lubinu | 2994 | 47 | 12.0 |
| Eluche | 1325 | 23 | 5.9 |
| Ekero | 1603 | 26 | 6.6 |
| Shikalame | 1255 | 21 | 5.4 |
| Musanda | 1121 | 19 | 4.8 |
| Khaunga | 2646 | 41 | 10.5 |
| Isongo | 3202 | 47 | 12.0 |
| Lureko | 2159 | 34 | 8.7 |
| Imanga | 1465 | 24 | 6.1 |
| Bungatsi | 420 | 9 | 2.3 |
| Mung'ang'a | 1394 | 23 | 5.9 |
| Malaha | 1672 | 27 | 6.9 |
| Bukaya | 1186 | 20 | 5.1 |
| Buchifi | 1951 | 31 | 7.9 |
| **Total** | **24393** | **392** | **100.0** |

The source list or sampling frame which was also the plot number for each sub-location was obtained from the MSC field staff in charge of sub-locations. The farmers visited were systematically sampled from a sampling frame for each of the sub-locations according to the sample size of the sub-location (see Table 3.1).

The assistance of the Assistant Chief was sought to locate the plot and farmer for administration of the questionnaires and sampling of the vegetable farms. Four research assistants were trained on how to administer the questionnaires and sampling the farms using a farmer and farm that was not in the selected sample. Part of the research work was based on observation of the vegetable farms, a method that is prone to subjectivity. To reduce on the adverse effects of this, research assistants worked in pairs. The researcher randomly worked with each of the pairs on different occasions for quality control.

## 3.3 Data Collection Methods and Tools

### *3.3.1 Structured Questionnaires*

Household survey was conducted to determine the socioeconomic data, types of indigenous vegetables, cropping patterns and current cultivation status of indigenous vegetables in the sugarcane zones in the study area (Appendix I). Selection of households was done using stratified random sampling. Households from within a stratum were systematically sampled using a sampling frame for the respective sub-location. Questionnaires were administered to the selected households in each stratum.

### *3.3.2 Interview Schedule*

The researcher held key informant interviews with Sub-County Crop and Sub-County Home Economics officers. These officers are responsible for the production of indigenous vegetables for the sub-county (Republic of Kenya, 2009). An interview schedule (Appendix III) was used. Informal interviews were also conducted with the manager in charge of ODS of the MSC and Assistant Field staff officers to gauge their understanding on the role of indigenous vegetables in enhancing community livelihood and agro-biodiversity conservation. The interviews also helped to bring out prerequisites for a farmer to be enlisted as a contract holder with the sugar company. Eight (two from each of the Sugarcane Zones) elderly women of fifty years and above were purposively sampled and also interviewed as key informants. Key informant interviews were done to corroborate primary data collected. The

elderly women were key informants particularly for the corroboration of indigenous knowledge on cultivation of indigenous vegetables. Indigenous knowledge is based on experience, adapted to the local culture and environment and embedded in community practices, institutions, relationships and rituals (FAO, 2001). The elderly women were thus seen as custodians of such knowledge and their involvement helped enrich the data collected.

### *3.3.3 Focus Group Discussion (FGD)*

With the help of Home Economics officer, Mumias Sub-County, two Self Help Groups (SHGs) were purposively sampled: Ebwaliro and Shallomat. The two were found to be actively involved in the cultivation of indigenous vegetables. The researcher held two FGDs on separate occasions with the groups. This was done to collect information on the diversity of the indigenous vegetables, cultural ways of production, challenges and opportunities for sustainable production and consumption of indigenous vegetables.

### *3.3.4 Biodiversity Data Sampling*

A major objective of this study was to examine the contribution of AIVs to agro-biodiversity conservation. Conservation aims at maintenance of genetic diversity, preservation of ecosystem processes, prevention of species extinction and preservation of particular species (Newman, 2000). This study sought to find out how cultivation of AIVs contributes to conservation by way of maintaining species level diversity of AIVs, an aspect of conservation. The number of vegetable species that a farmer had established on the farm at the time of the field research which spanned from April to August 2012 was ascertained using an item in the questionnaire and by direct observation and quadrat sampling. Five quadrats were randomly sampled. The number of individuals of a vegetable species covered within a quadrat was counted and recorded each time of quadrat sampling. The totals were worked out and an average determined to quantify the average number per $1m^2$. The figure obtained was used to enable calculation of diversity index per sub-location. Samples of the different cultivated AIVs collected were identified in vernacular

and scientific names later established at the East African Herbarium National Museums of Kenya.

### 3.4 Data Analysis

The study generated both qualitative and quantitative data. Both types of data were sorted, coded and then summarised using matrices. Statistical Package for Social Scientists (SPSS) version 16 was used in analysing the coded data; whereby percentages and frequencies of various responses were calculated and presented in form of tables and graphs. Closed-ended questions in the questionnaires were coded and variable names and labels created in the system. Responses were then entered into SPSS matrix one by one according to the established codes. For the open-ended questions which formed part of qualitative data, after deciding on the level of detail required for the analysis, the researcher read through the responses, establishing broad categories, which were further subdivided into more specific sub-categories (Saunders and Brandon, 2008). Sub-categories such as gathered (wild) indigenous vegetables and domesticated indigenous vegetables were isolated for certain items in the questionnaire. These sub-categories were then coded and the responses for each code entered in the code sheets which were then entered in the SPSS matrix. Content analysis and recurrent themes in the texts were then isolated and presented as narrative or as frequencies in charts and tables.

#### *3.4.1. Variables in the Study*

Independent variables in the study were of measurement type. The Socioeconomic variables observed were: gender of the respondents/household head, age of respondents, family size, marital status, type of land ownership, size of household farm, level of education, main occupation of household head/spouse and other crops grown apart from sugarcane.The dependent variable or criterion variable for the study was the number and types of indigenous vegetables on one’s farm. The extraneous variable ‘sugarcane’ farming was inbuilt in the study to enable generalisation of findings.

### *3.4.2: Socioeconomic Data Analysis*

Farmers responded to a questionnaire in which their socioeconomic profile was sought. It was necessary to analyse aspects of the socioeconomic background of the farmer since the background of the farmer influences farm productivity levels (Onil, 2010). The household head and spouse responded to the questionnaires depending on the nature of questionnaire item.

Socioeconomic data was analysed using descriptive statistics which focused on frequency distribution, totals and percentages. These data was then interpreted in relation to agro-biodiversity conservation and community livelihood. Inferential statistics regression, correlation and factor analysis were used to infer presence or absence of relationships between variables. These also helped to come up with models to explain socioeconomic determinants of cultivation of indigenous vegetables, hence agro-biodiversity conservation and community livelihood. Factor analysis technique helped to describe the factors that motivate farmers to cultivate indigenous vegetables against the odds of land scarcity, competing cash crop and land subdivision amongst other odds.

#### *3.4.2.1 Correlation and Regression Analyses*

Correlation and regression analyses were used to analyse and determine whether there was a relationship between selected variables direction of that relationship and the strength of the relationship among several variables observed among the respondents (Kothari, 2004; Acton *et al.,* 2009; Saunders and Brandon, 2008). Regression analysis assumes that the independent variable ***x*** is at least in part a cause or a predictor of the dependent variable ***y*** (Acton *et al.,* 2009). These relationships were used to draw conclusions on the Socioeconomic factors that influence diversity of AIVs on the farm. Regression models obtained were used to explain the determinants of variability of AIVs on farms of sugarcane farmers.

#### *3.4.2.2 Factor Analysis*

The study used Factor Analysis to derive factors that explain what motivates cultivation of AIVs in the study area. The statistical technique was used to

simplify the correlation relationships among numbers of continuous and resolved a large set of measured variables to come up with factors (Acton *et al.*, 2009; Robson, 2002). There are two main features of Factor Analysis technique; extraction and rotation (Kothari, 2004). The former was done to determine the factors underlying the relationships between a numbers of variables. The extraction procedure used for this study was Principal Component Analysis. The number of factors that were extracted was determined by the Eigen values. Eigen value is a measure of the amount of variability in the data explained by a given factor (Kothari, 2004; Acton *et al.*, 2009). Factors whose Eigen values were above 1 were selected because the values explain more variation in the data than an individual variable (Acton *et al.*, 2009).

### *3.4.3 Biodiversity Analysis*

To assess the contribution of AIVs to agro-biodiversity conservation, species level diversity was sought. Species level diversity takes into account species richness, relative abundance and community evenness (Magurran, 1998). Species richness is the total number of species present in a community. A high species richness indicates a complex community in which a high degree of species interactions is possible and by inference such communities have high levels of energy transfer in terms of food (Magurran, 1998).

Species richness was determined by denoting each type of species recorded. Evenness and richness which describe diversity was quantified using Shannon-Weaver Diversity expression;

$$H' = -\sum_{i=1}^{s} pi \ln pi$$

(Magurran, 1998; Molles, 1999)

Where *H'* is the value of the Shannon's diversity index, s is the number of species in the community, and *pi* is the proportion of individuals of each species belonging to the $i^{th}$ species of the total number of individuals. The proportions being given as:

$$pi = ni/N$$

The Shannon-Weaver Diversity Index (SDI) is commonly used in measuring germplasm collections and diversity in ecological communities (see for example Muriuki, 2008). The index is used to estimate evenness of species by combining richness and relative abundance. The basic idea of a diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities composed of discrete components in space or time (Carlo *et al.,* 1998). The values obtained were thus used to compare species diversity of sub-locations.

# CHAPTER FOUR: RESULTS AND DISCUSSION

## 4.1 Socioeconomic Profile of the Respondents

Data was obtained in an extensive field survey that covered 14 sub-locations of Mumias Sub-County. The sub-locations were sampled randomly from four sugarcane zones of MSC. The percentage number of respondents in the study per sub-location is shown in Table 4.1. Most of the respondents were from Isongo and Lubinu sub-locations which had a share of 12.0% each. Bungatsi had the lowest figure of 2.3%. Bungatsi as a sub-location for MSC is covered in more than one sub-county. The study sampled farmers whose farms lie in Mumias Sub-County. The percentage of respondents per sub-location varied depending on the number of farmers registered by MSC as explained in Chapter Three of this study.

**Table 4.1:** Percentage of farmers visited in each sub-location

| MSC 'Sub-location' | Percentage |
|---|---|
| Lubinu | 12.0 |
| Eluche | 5.9 |
| Ekero | 6.6 |
| Shikalame | 5.4 |
| Musanda | 4.8 |
| Khaunga | 10.5 |
| Isongo | 12.0 |
| Lureko | 8.7 |
| Imanga | 6.1 |
| Bungatsi | 2.3 |
| Mung'ang'a | 5.9 |
| Malaha | 6.9 |
| Bukaya | 5.1 |
| Buchifi | 7.9 |
| **Total** | **100.0** |

### *4.1.1 Gender of Respondents*

A total of 275 males and 117 females responded to the questionnaires. This gives a percentage of 70.16 and 29.84 respectively. Gender analysis reflects a high percentage of males in the sample compared to female indicating that males are more often the listed owners of sugarcane farms. This statistics confirm the observations made by Waswa *et al.,* (2011). According to the authors, in the Abaluhyia community which is patrilineal, land issues especially for commercial farming is the male gender's responsibility. The questionnaire was structured with items ranging from general information about the household to specific items on the cultivation of indigenous vegetables. It was observed that in cases where men were the household heads – and therefore the listed owners of the land – the household head would ask the spouse to respond to items requiring detailed information on vegetables. This observation is a pointer to a dichotomy between land ownership and land utilisation; although it is mostly the males who are the registered land owners, utilisation of the land for cultivation of crops, especially vegetables, is dominated mainly by the female gender. This observation further emerged during the FGD to which one discussant shared,

> '... in the local dialect a married woman is referred to as *'omuteeshi'* of so and so. The main staple food of the Abaluyia people here is *ugali* which is usually eaten accompanied with vegetables. As such, a woman should be more concerned and knowledgeable on issues of vegetables' (FGD: Ebwaliro Women Group; recorded on 14th April 2012).

### *4.1.2: Age of Respondents*

Table 4.2 indicates that the age of the respondents ranged between below age 18 years to over 65 years. Majority were farmers between age 41 and 50 years of age. This constituted 38.78%. The results show a high tendency for people in age group 41-50 years to engage in sugarcane farming. Such results were also observed by Waswa *et al.,* (2011). The second largest group was the 31 to 40 years which constituted 19.13%. Discussions with a category of key informants, MSC field assistants showed that any age level of 18 years and

above was eligible to be a contract holder as long as one had a national identification card and had land which should not be less than two acres. The Assistant Chief of the area would validate the information. Very few respondents (1.4%) were below 18 years. However, they were not contract holders but family members of contract holders. In the Sub-County Development Plan, it is observed that although people of 14-17 years age bracket were ideally supposed to be in school, half of this number dropped out of school, often occasioned by poverty (Republic of Kenya, 2009). To reduce this, strategies to gainfully engage this population are important.

**Table 4.2:** Age of respondents

| Age category | Frequency | Percentage |
|---|---|---|
| < 18 years | 5 | 1.28 |
| 19-30 years | 31 | 7.91 |
| 31-40 years | 75 | 19.13 |
| 41-50 years | 152 | 38.78 |
| 51-60 years | 70 | 17.86 |
| over 65 years | 59 | 15.05 |
| **Total** | **392** | **100.00** |

### *4.1.3: Household Size*

Grouped household size analysis shows that the model household size is in the category of 6-10, comprising 228 respondents and forming 58.16% (see Table 4.3). Households with more than 15 members formed 5.61%. The high number of some households is attributed to cases of the extended family which is still prevalent in the study area as reported by FGD.

**Table 4.3:** Size of households

| Members in household | Frequency | Percentage |
|---|---|---|
| 1-5 | 118 | 30.10 |
| 6-10 | 228 | 58.16 |
| 11-15 | 24 | 6.12 |
| Over 15 | 20 | 5.61 |
| **Total** | **392** | **100.0** |

### *4.1.4: Marital Status*

Trends of marital status of household's heads were also investigated. The results (Figure 4.1) show status 'married' being predominant with 85.1% of households. Cases of separation were almost non-existent, with only 0.6% occurrence. The widowed constituted 13.7%. This was inferred to be female-led households.

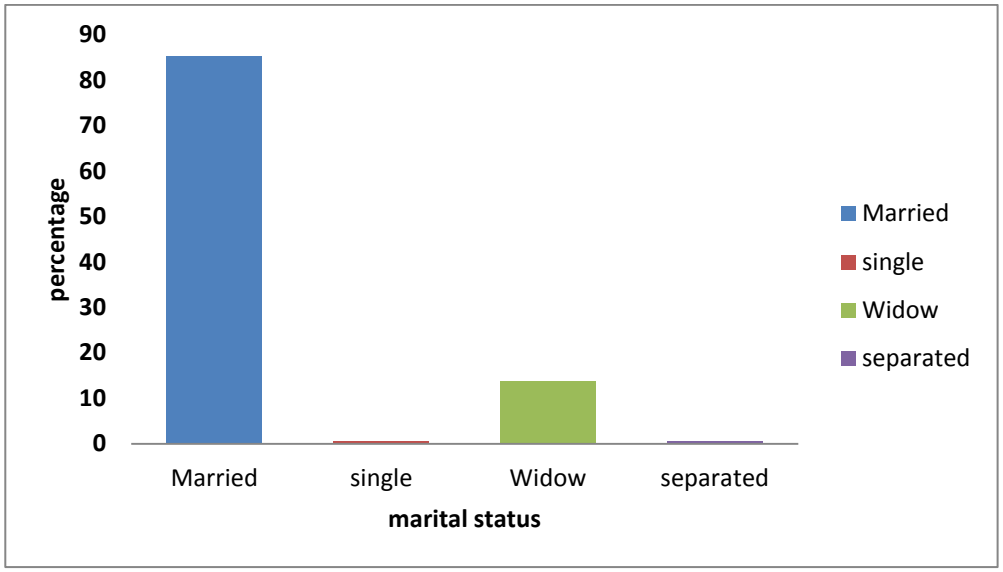


**Figure 4.1:** Marital status of respondents

### *4.1.5: Level of Education*

Respondents' level of education was one of the variables investigated during the study. Half of the respondents had primary school level education. Only a mere 23.1% indicated attaining secondary school level education. Of great

concern was the finding that a substantial number (19.7%) of respondents had not attended any formal education (Figure 4.2)

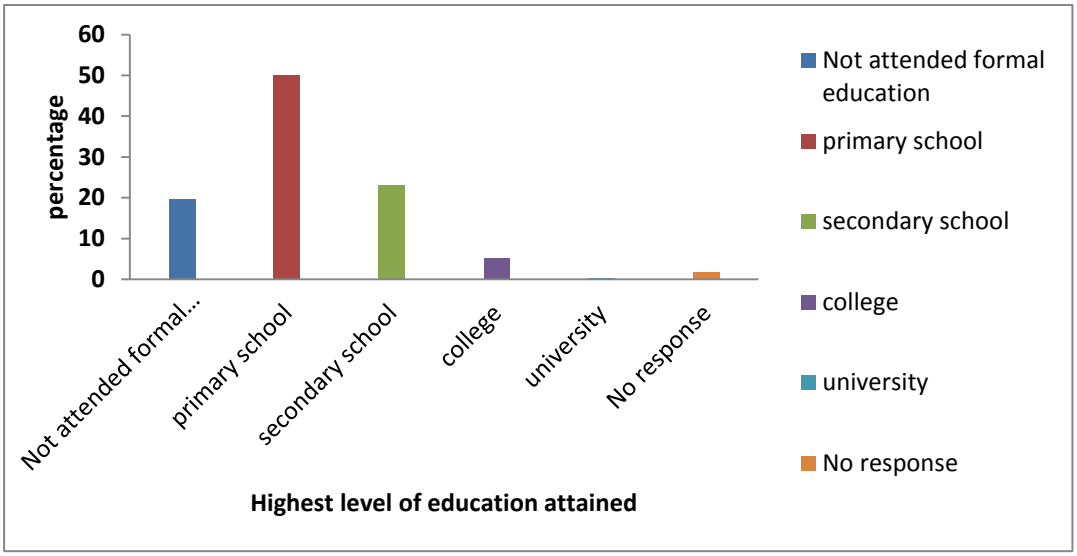


**Figure 4.2:** Level of education of respondents

### *4.1.6: Occupation of Household Head and Spouse*

To understand livelihood options that households' heads and their spouses have, respondents were asked to indicate livelihood activities they engaged in to earn a living. Options provided were agriculture and livestock, business, combinations of formal employment with agriculture, livestock keeping, informal employment and business. Those involved in agriculture and keeping of livestock formed the majority (55.1%) for household heads and 48% for spouses (Figure 4.3). Those in business formed 3.1% for household heads and 12.9% for spouses. The smallest proportion recorded was that of those in the category of agriculture, livestock keeping and formal employment with 1.7% and 4.4% for household heads and spouses respectively. A high percentage of respondents were involved in mixed farming, a practice where crops and livestock are grown and reared (see Figure 4.3).

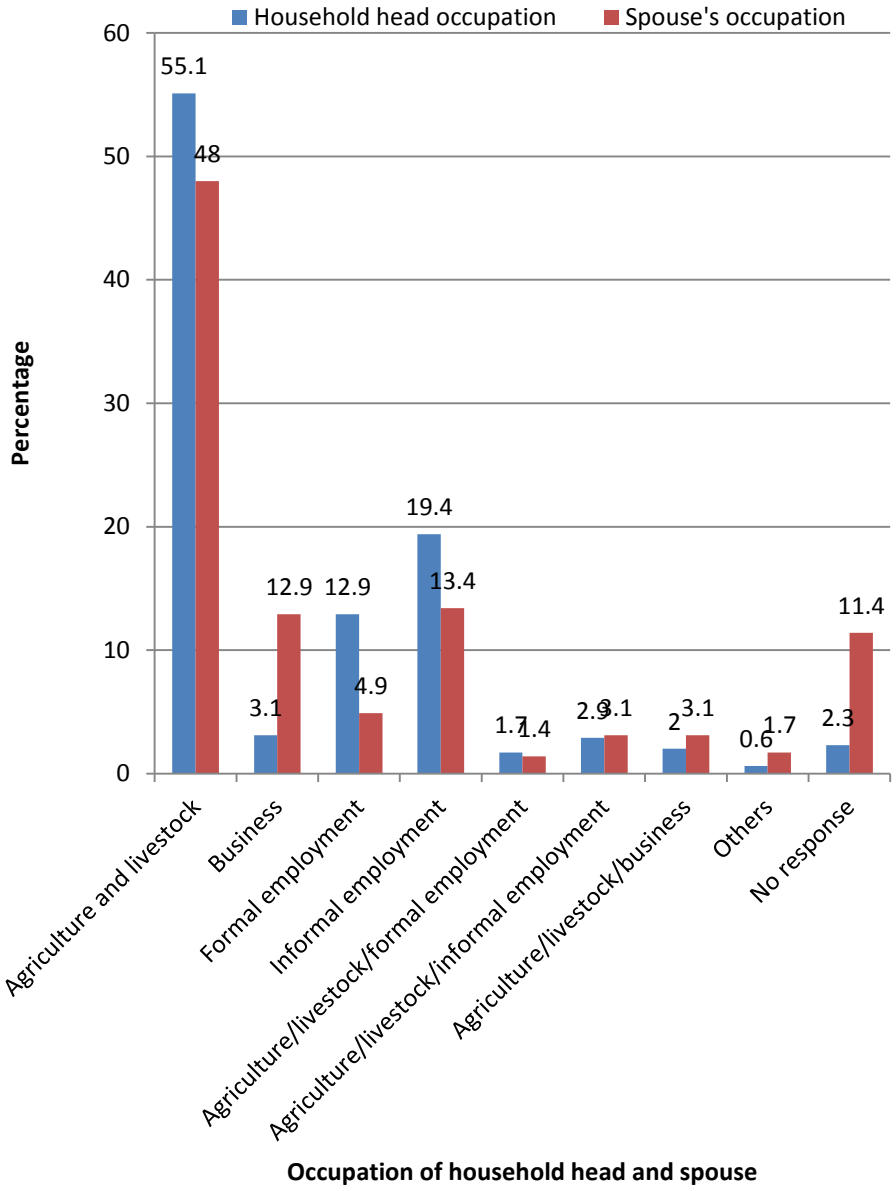


**Figure 4.3:** Occupation of household head and the spouse of respondent

Different types of crops cultivated the previous year were also investigated. Results show that majority of farmers (97.4%) cultivated beans. This was followed by maize (96.3%). Almost all respondents (96.9%) had cultivated AIVs the previous year (Figure 4.4). This shows that cultivation of AIVs was considered important socially. The cultivation of indigenous crops including millet, simsim and bambara nuts, was low. Those who had cultivated are represented by 34.9%, 36% and 36.3% respectively. This has an implication on

the community livelihood in terms of resilience as diversity of food crops on which the community depended in times of hunger is reduced. This finding concurs with other findings, for instance of Waswa, *et al* (2011) who observed that traditional crops were on the decline in this study area.

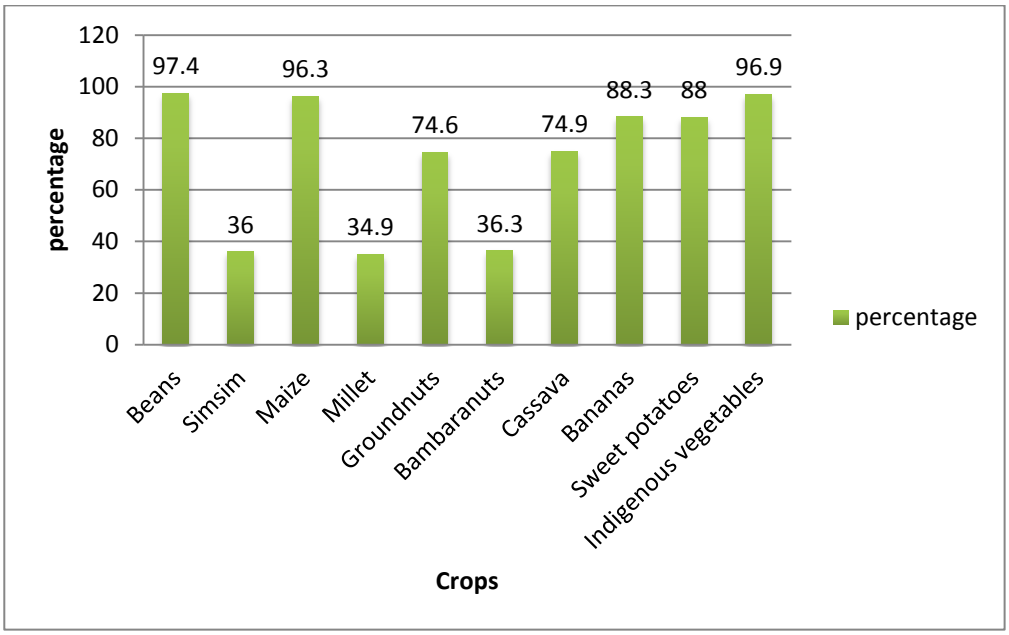


**Figure 4.4:** Crops grown in the previous year by the respondents

### *4.1.7: Type of Land Ownership*

The results show the most prevalent land ownership type being ancestral, constituting 90.2% where a father shares his piece of land to mainly his adult sons (from father to son). There were however, 8.3 % of respondents who had bought the land in which they cultivated sugarcane, those who rented constituted 1.4%. Leasing/renting is short term based on the number of times of harvesting the canes. One enters into an agreement with the owner of the farm on the number of times to harvest the canes. Karanja (1991) observed that ownership of land gives a Kenyan his or her true identity and that land is considered the single most important form of social security. There are social and economic implications of one leasing out his or her farm. One is that the owner of the farm does not now have access to the leased out farm and has to rely on whatever piece that has remained for cultivation of food crops, vegetables included. FGD results showed that some farmers leased land for

cultivation of vegetables. Such land was usually next to a water source to enable cultivation during dry season. A farmer makes arrangements to lease a farm as a way of increasing his or her sense of identity and in essence, increasing livelihood.

### *4.1.8 Socioeconomic Factors, AIVs, Agro-biodiversity Conservation and Community Livelihood*

Based on SLA, cultivation of indigenous vegetables and thus their conservation is hinged on five broad areas; assets, activities, vulnerability, context livelihood outcomes and policies, processes and institutions. The assets are considered to be human, land, financial and social; the humans, and in the context of this section the farmers, are a key asset and an entry point to conservation efforts. The socioeconomic characteristics of the farmer are therefore key in understanding the farmer and his or her potentials in cultivating AIVs and thus contributing to conservation.

The study has found out that there are more men than women listed as land owners and by extension contract holders of sugarcane farming. It has also found out that although the male gender own land, the access and utilisation of sections of land are gender determined. Abdelali *et al.,* (2008) noted that in most societies, men and women differ in activities they undertake in access to and control over resources and in participation in decision making. This is evidenced in the current research where the male-led households preferred that their spouses answer questions on vegetable cultivation. In the study area, subsistence vegetable cultivation is considered a domain for female gender. The strategies for on-farm conservation of the AIVs require awareness creation and empowerment of the custodians of land as a resource whose custodian is the male gender and the custodians of the vegetables who are the female gender. The study noted that based on SLA; land and humans who are the custodians of land resource and the vegetables produced are capital assets in the realisation of a sustained livelihood. Conservation of agro-biodiversity through AIVs cultivation will involve substantial changes in farming habits. It

will also involve empowerment of both genders that own and work on the land to produce cash crop (sugarcanes) and vegetables to make a living from it.

All respondents were contract farmers by the MSC. In contract farming, land portion is taken up by the MSC for sugarcane cultivation. Although the land is under the ownership of individuals, the farm owner has no play in farm policy for the land under sugarcane. Diversification on the sugarcane farm can only be negotiated through policy. This leaves the farmer with limited options to be applied on the land that is not contracted. Vegetable cultivation was observed to be on peasant levels characterised by a farmer making her decisions and plans for her farm. The decisions are made depending on the available resources which are generally meagre basing on land sizes. The land sizes will continue to diminish due to inheritance where individual holding declines with time as all members in a family have equal rights. Small pieces of land result in uneconomical use of resources.

Cultivation of sugarcane in the study area was observed to be across the age groups ranging from below 18 years to over 65 years. The mode was 41-50 years age group. The main staple food in the study area is *ugali* which is usually accompanied with vegetables. According to Keller *et al.*, (2004); Kimiywe *et al.*, (2007); Dweba and Mearns (2011), the choice of vegetable to use is determined by age among other factors. The younger generation have been found to prefer exotic vegetables because of lifestyle, stigma of AIVs as poverty food, time for preparation and inability to cook using traditional cooking methods. A large younger population is likely not to appreciate AIVs not unless intervention measures are put in place to actively campaign for their cultivation and consumption.

Education levels have been found to have potential in changing the behaviour of people towards biodiversity conservation (Abdelali *et al.,* 2008). The majority of the sugarcane farmers visited had basic education with half of the sample size attaining primary schooling as the optimal. For this majority, farming is their most probable livelihood. Options for formal employment are minimal. Extension services would make a meaningful contribution in

addressing skills like agricultural technology and production in their programmes to help boost vegetable production and achieve a sustained livelihood.

**4.2: Contribution of AIVs to Agro-biodiversity Conservation.**

This section answers the question, *"What is the contribution of AIVs to agro-biodiversity conservation?"* According to Subrahmanyam and Sambamurty (2006), conservation has three main objectives which are: to enable maintenance of ecological processes and the life support system, preservation of genetic variability within and between species, and ensuring sustainable utilisation of species and ecosystem. Cultivation of AIVs, the study envisages, preserves genetic diversity of the species cultivated. This in turn enables AIVs to contribute to agro-biodiversity conservation in terms of enabling variability and diversity within and between species. To exhaustively answer the question, the study investigated the common types of cultivated AIVs, and their diversity. Diversity consists of two components; variety or species richness and relative abundance of species. Shannon-Weaver diversity index was used to measure the diversity of AIVs in the study area. This index was used because it takes into account the two components; variety and relative abundance (Magurran, 1998).

***4.2.1: Common types of Cultivated Indigenous Vegetables***

Food and Agriculture Organisation (2003) classified vegetables as cultivated, semi-cultivated and gathered from the wild. The vegetables gathered from the wild are mainly from uncultivated land, while the semi-cultivated grow as weeds together with cultivated crops. These are used for vegetables and uprooted during weeding. The cultivated vegetables require agricultural practices such as land preparation, sowing, weeding, pruning and watering (Maundu *et al.*, 1999; Keller *et al.*, 2005) Farmers were asked to list the cultivated AIVs present on the farm, and those that were cultivated the previous year. This was to ascertain the common AIVs cultivated in the area. The individual farm(s) containing the AIVs listed to be present on the farm

were then visited to ascertain the species cultivated and management practices noted. Ten different AIVs were cultivated in the study area. Samples representing species observed in the study area were collected and identified in the East African Herbarium. Table 4.4 contains vernacular names together with the scientific names of the vegetables.

The average number of species that a farmer had cultivated the previous year was five different vegetables species while the mean number of species on the farm at the time of the investigation was found to be 2.93 species. This means that on the average, a farmer had cultivated close to 3 different species of vegetables on their farms. The practice of having more than one vegetable species was inferred to be a strategy for self-sufficiency, an efficient use of labour and diet diversity (Keller *et al*, 2005).

**Table 4.4:** Cultivated African Indigenous Vegetables

| **Common name of vegetable (English)** | **Abaluyia (Wanga dialect) name** | **Scientific name** |
|---|---|---|
| Jute mallow | "Omurere" | *Corchorus olitorius* (L.) *(*Family: Tiliaceae) |
| Cowpeas | "Likhubi" | *Vigna unguiculata* (L.) Walp subsp. *dekindtiana* (Harms) (Family: papilionaceae) |
| Spider plant | "Tsisaka" | *Gynadropsis gynandra* (L) Briq. Family: Capparaceae) |
| Pumpkin leaves | "Lisebebe" | *Curcubita maxima* (Family: Curcubitaceae) |
| Slender leaves (bitter variety) | "Emiro emilulu" | *Crotalaria brevidens (*Kotscy) Polhil var.*parviflora.(*Family papilionaceae) |
| Slender leaves | "Emiro emibobo" | *Crotalaria ochroleuca* (G.Don) (Family: papilionaceae) |
| African kales | "Kanzira" | *Brassica junceae* (L.) Czern.(Family: Cruciferae) |
| African Nightshade | "Isutsa" | *Solanum nigrum* (L.) (Family: Solanaceae) |
| Leaf Amaranthus | "Litoto lia nabanyolo" | *Amaranthus hybridus (*L*)* subsp. *cruentus (*L) Thell.(Family: Amaranthaceae) |
| Leaf Amaranthus | "Litoto lia namukasa" | *Amaranthus lividus* L. subsp. *lividus (*Family: Amaranthaceae) |

Plates 1-9 show the common AIVs cultivated in the study area.

**Plate 1:** *Vigna unguiculata* (L) Walp subsp. *dekindtiana* (Harms) Verd. Common name - Cowpeas

**Plate 2:** *Curcurbita maxima* - pumpkin leaves

**Plate3:** *Corchorus olitorius* - Common name - jute mallow

**Plate 4:** *Crotolaria ochroleuca* - Slender leaf

**Plate 5:** *Crotalaria brevidens* – Slender leaf-bitter type

**Plate 6:** *Brassica junceae* (L) Czern. Common name - African kales

**Plate7:** *Gynadropsis gynadra* (L) Briq - Common name - spider plant

**Plate 8:** *Amaranthus hybridus* (L) subsp. *cruentus* (L) Thell

**Plate 9:** *Amaranthus lividus* (L).subsp. *lividus*

The frequencies and percentages for the different vegetables are shown in Figure 4.4. The vegetable that was planted by most farmers during that period was cowpeas, representing 95.7% and 83.1% for the previous year and at present (time of field survey, 2012) respectively. All cases of the vegetables cultivated the previous year showed higher frequencies as compared to the present. This is explained by the fact that farmers cultivate vegetables every rainy season which is bimodal in the study area; the time of the survey was the first.

The trends in the frequencies of the vegetables are observed to be the same irrespective of the season (Figure 4.5). The vegetable cultivated by most farmers being cowpeas, was followed by pumpkin leaves and slender leaves for both seasons. These results are in line with the findings by Ekesa *et al.*, (2009), who noted that cowpeas was the most popular vegetable in the region. The findings of the study showed that there are vegetables whose availability was observed to have low frequencies in both seasons. These are slender leaf (the bitter variety), African kales and African nightshade. There are two varieties of the slender leaf species one of which is bitter in taste (*C. brevidens)* and the common variety which is not bitter (*C. ochroleuca*). The results showed decreased availability of the bitter variety with only 5.2% of farmers having

planted it in the previous one year and 4.3% at the time of the field investigation. This is an indication of reduced availability. Dweba and Mearns (2011) noted that availability and accessibility affected consumption of a vegetable.

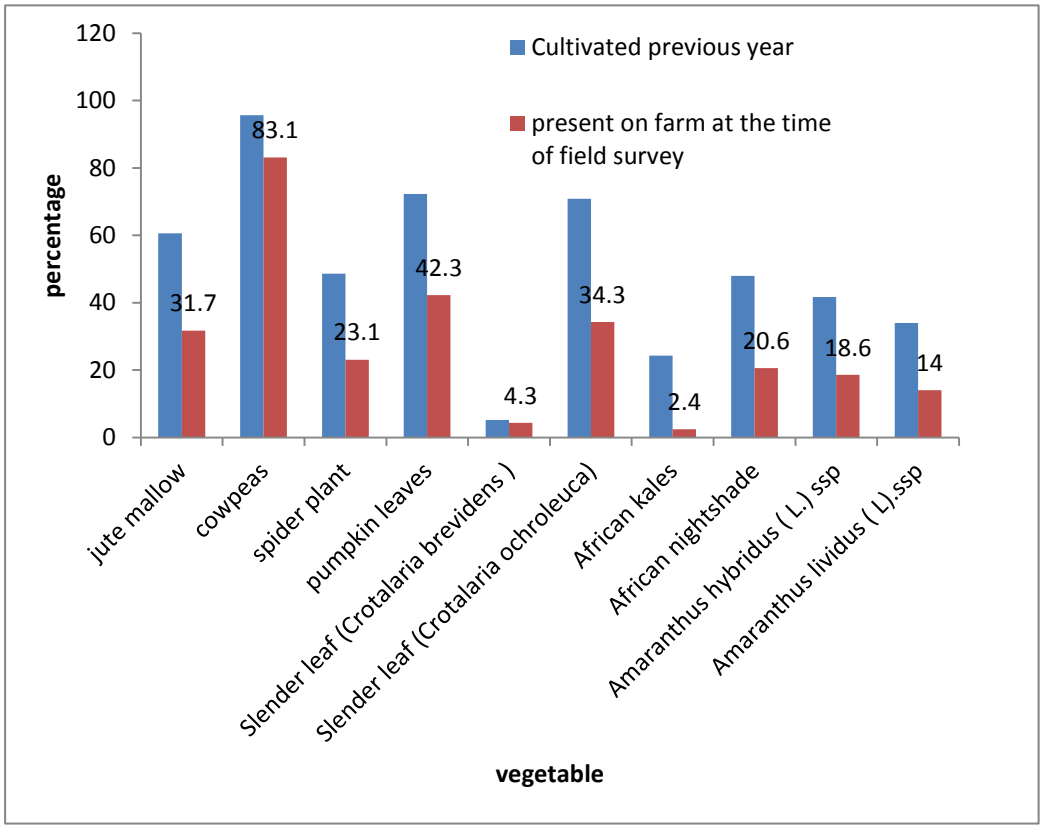


**Figure 4.5:** A Comparison of the types of vegetables on farm in 2011 and 2012

A variety of vegetables provided different nutrients than an individual needed (Weinberger and Msuya, 2004). Reduced availability would impact negatively on this need, conservation of agro-biodiversity and the general wellbeing of the community.

It is noted that although there are various AIVs in the study area, some of the vegetable species are declining in occurrence. Such vegetables include African kales and slender leaves (the bitter variety). Although African nightshade is reported to be cultivated, the variety cultivated in most farms is the 'improved' variety and not the indigenous variety as reported by discussants of FGDs. The

indigenous type used to grow wild especially in fertile places. Shackleton *et al.,* (2009) noted that although cultivation of improved varieties is essential in solving the challenge of taste preferences, the same impacts negatively on biological diversity in terms of species richness. The indigenous African nightshade, the bitter variety, is found thriving in sugarcane plantations probably because of presence of fertilisers and is declining in cultivated fields due to limited skills in its cultivation among the farmers and absence of fallow lands as observed by discussants in FGDs held.

### *4.2.2 Diversity of AIVs in the Study Area*

Using a checklist in the questionnaire, respondents were asked to tick AIVs on their farms at the time of the survey. The totals were then tallied to enable making conclusions as to the frequency of occurrence of the AIVs. Results show that the vegetable that occurred most frequently on farms was cowpeas, with 291 respondents having cultivated it in their farms at the time of the survey. Vegetable slender leaf (the bitter type) had been cultivated by only 15 respondents who were scattered in 8 out of 14 sub-locations surveyed. It was also observed that African kales were only in 26 farms (Table 4.5) out of 392 farms visited.

**Table 4.5:** Occurrence of AIVs in sub-locations

| | **Pumpkin leaves** | **Jute mallow** | **cowpeas** | **Spider plant** | **slender leaf (bitter type)** | **slender leaf (ordinary)** | **African kales** | **African nightshade** | ***Amaranthus hybridus*** | ***Amaranthus lividus*** | **Total cases** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lubinu*** | 32 | 21 | 38 | 6 | 1 | 25 | 4 | 15 | 11 | 7 | 160 |
| **Eluche** | 9 | 6 | 18 | 2 | 0 | 10 | 0 | 2 | 2 | 2 | 51 |
| **Ekero*** | 12 | 5 | 21 | 9 | 1 | 19 | 3 | 9 | 7 | 7 | 93 |
| **Shikalame** | 3 | 4 | 16 | 3 | 0 | 3 | 0 | 3 | 3 | 0 | 35 |
| **Musanda*** | 6 | 8 | 13 | 2 | 0 | 6 | 2 | 7 | 3 | 4 | 51 |
| **Khaunga** | 20 | 11 | 35 | 9 | 0 | 13 | 1 | 3 | 3 | 6 | 101 |
| **Isongo*** | 21 | 13 | 38 | 13 | 2 | 13 | 3 | 7 | 8 | 3 | 121 |
| **Lureko*** | 12 | 8 | 22 | 12 | 3 | 8 | 3 | 5 | 9 | 6 | 88 |
| **Imanga*** | 12 | 8 | 16 | 4 | 2 | 6 | 1 | 8 | 5 | 5 | 67 |
| **Bungatsi** | 1 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| **Mung'ang'a*** | 4 | 4 | 13 | 2 | 1 | 4 | 2 | 2 | 2 | 1 | 35 |
| **Malaha*** | 6 | 8 | 20 | 6 | 1 | 5 | 2 | 3 | 4 | 1 | 56 |
| **Bukaya** | 2 | 3 | 16 | 1 | 2 | 1 | 0 | 0 | 1 | 2 | 28 |
| **Buchifi*** | 8 | 12 | 21 | 11 | 2 | 7 | 5 | 8 | 7 | 5 | 86 |
| **Total** | 148 | 111 | 291 | 81 | 15 | 120 | 26 | 72 | 65 | 49 | 978 |

*Sub-locations with all the 10 AIVs in cultivation

To work out the diversity of vegetables Shannon-Weaver diversity index was used. The index is used to characterize species diversity in a community. It accounts for both abundance and evenness of the species present (Magurran, 1998). The proportion of species *i* relative to the total number of species ($p_i$) is calculated, and then multiplied by the natural logarithm of this proportion ($\ln p_i$). The resulting product is summed across species, and multiplied by -1:

$$H = -\sum_{i=1}^{s} pi\ In\ pi$$

(Magurran, 1998)

Where,

H = Shannon-Weaver diversity index

s = Total number of species in the community (richness)

Pi = proportion of s made up of the *i*th species

In the equation, H is the Shannon-Weaver diversity index, s represents the number of cultivated vegetables also representing the species richness; $p_i$ denotes the proportion of the abundance of a specific vegetable and $l_n$ is the natural logarithm. H in the equation equals zero when there is only one vegetable indicating no diversity. The value of H increases with the number of species reaching its maximum when the species are cultivated in equal shares, that is, when $p_i$ is equal to 1/S (Huhtala and Timo, 2012).

The mean number of species per $1m^2$ per farm per sub-location was calculated and results entered in excel matrices (appendix VII). The figures obtained were then used to work out the diversity indices. The diversity indices obtained are shown in Figure 4.6. The results show that Lubinu sub-location had the highest diversity index of 1.85 while Bukaya had the lowest with 0.69. An analysis of cultivated AIV species density shows that although there are 10 commonly cultivated AIVs in the sub-county, of the 20 farmers visited in Bukaya sub-location, none of them had cultivated spider plant, slender leaf (the bitter type), African kales and African nightshade. These affected the abundance and the species richness of the sub-location and hence the low diversity index. Non cultivation of a species as explained by FGD held during field survey is said to be driven by various factors that range from lack of land, lack of seeds and taste preferences among others. Non cultivation of a vegetable species will not only lead to reduced consumption but also impact negatively on indigenous knowledge transference from one generation to another.

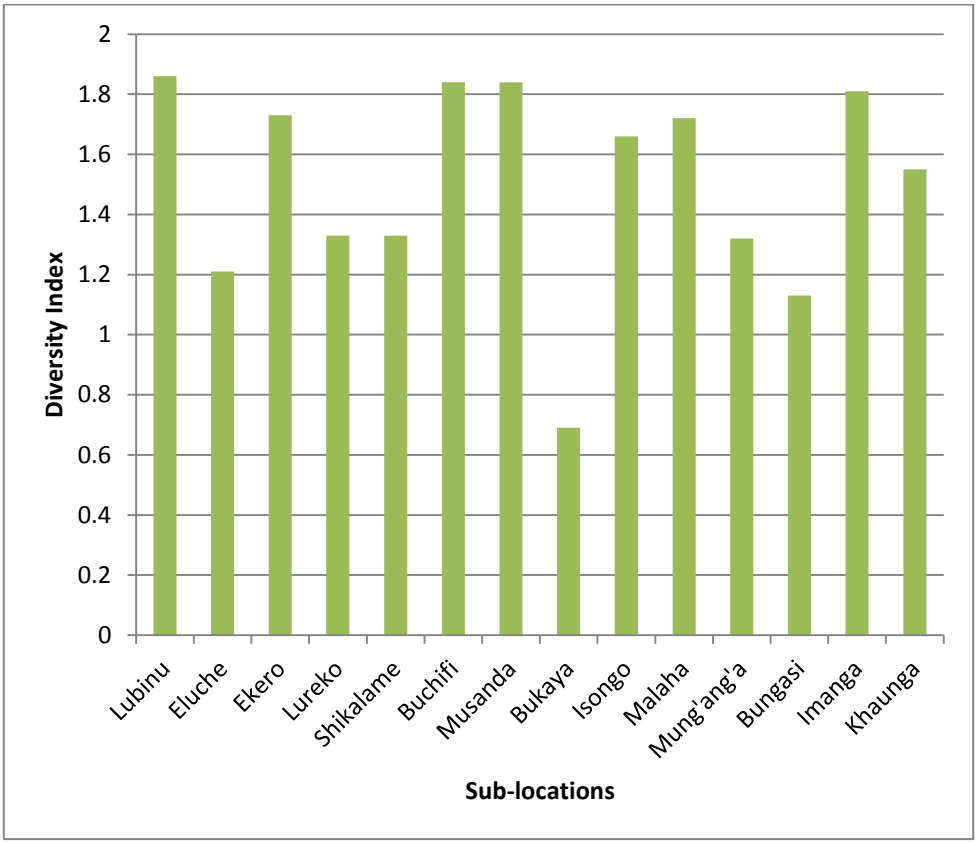


**Figure 4.6:** Shannon Diversity Index for AIVs in sub locations

This section revealed that 10 common AIVs are cultivated in the study area. The distribution of the vegetables in the sub-county is almost even. Three most abundant vegetables are cowpeas, pumpkin leaves and jute mallow. Slender leaf (the bitter type) is the scarcest followed by African kales, amaranthus and African nightshade.

### 4.3: Motivations for Cultivation and Consumption of AIVs

This section gives findings on the factors that promoted cultivation of AIVs in the study area. The explanation is based on the status as observed and then inferred. To explain the status, socioeconomic determinants of the practice were sought. To this end inferential statistics; regression, correlation and factor analysis were used. Inferences were made based on the results in relation to agro-biodiversity conservation and community livelihood.

### *4.3.1: Correlation and Regression Analyses*

Correlation and regression analyses were used to analyse and determine whether there were relationships between selected variables, direction of that relationship and the strength of the relationship. The correlation matrix obtained is shown in Appendix IX. The correlation outputs obtained show a positive, although weak, correlation between age and size of household farm ($r = 0.300$, $N = 383$, $p < 0.000$). This means that elderly sugarcane farmers had large parcels of land as compared to the younger farmers. This finding agrees with Muriuki (2008) who observed that larger pieces of land are owned by the elderly persons in the society. This trend is expected since the majority of respondents were in the age group of 41-50 years; these are people whose children have not yet attained the age when land can be subdivided to them. According to key informants; field assistants, to own a parcel of sugarcane farm requires one to have a national identification card and land. The latter is verified by the Assistant Chief. The farmers cultivated sugarcane on family land and the proceeds are shared amongst the family members.

Land is an important factor in any land-related production enterprise. The Sub-County Development Plan for 2008-2012 shows that for the sub-county, land use is generally below optimal level although land is extensively cropped (Republic of Kenya, 2009). Brookfield *et al.*, (2003) observed that changes in management systems enable more intensive and diversified land use for food crops but without compromising the larger portion devoted for commercial crops. In the study area, large pieces of land are devoted to sugarcane farming; a diversification of land use would enable diversification of AIVs intercropped with other crops.

Regression models were sought to help explain the determinants of presence of AIVs on farms of sugarcane farmers. For this study, the dependent variable was taken to be the total number of AIVs (the number of species on the farm was taken as a measure of diversity) while the independent variables selected was the number of indigenous vegetable species on the farm in the previous 12 months. Adjusted R square of 0.201 was obtained. This means that the model

accounts for 20.1% of variance in the number of AIVs a farmer maintains on the farm. The model indicates that there is a significant relationship between the number of types on the farm and the number and types cultivated the previous year ($F = 87.311$, $p < 0.0005$).

The analysis shows that the number of vegetables species a farmer cultivated the previous year is a predictor of the number of varieties of vegetables on the farm for the subsequent season. A regression model; $Y = 1.048 + 0.368X$ was obtained to explain the relationship. The number of types of vegetables cultivated is predicted by a constant 1.048 plus a slop of 0.368 multiplied by the number of types cultivated the previous year. Most farmers obtain their seeds from previous harvests hence what a farmer planted is a predictor of what a farmer would plant in subsequent seasons. The conservation of agro-biodiversity through cultivated AIVs will therefore depend on the ability of the farmer to select, harvest and store seeds for subsequent sowing. Cases where on-farm seed production is affected, the farmer will rely on external source or not cultivate the vegetable species. This leads to loss of genetic material of the species on the farm. The low variance explained by this model is a pointer to the fact that on-farm agro-biodiversity conservation through AIVs is not just a linear process, but rather a complex venture determined by many more biophysical factors, skills, values and knowledge as observed by Pascuel, *et al.*, (2011).

### *4.3.2: Factor Analysis*

The study used Factor Analysis to derive factors that explain what motivates cultivation of AIVs in the study area. Table 4.6 shows the output. Based on the output, 5 out of 10 factors had Eigen values above 1. The five factors accounted for 73.516% of the variance of the relationships between variables.

**Table 4.6:** Total variance explained by selected factors

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 2.45 | 24.54 | 24.542 | 2.45 | 24.54 | 24.54 | 1.94 | 19.34 | 19.36 |
| 2 | 1.43 | 14.26 | 38.817 | 1.43 | 14.28 | 38.81 | 1.48 | 14.84 | 34.20 |
| 3 | 1.26 | 12.63 | 51.451 | 1.26 | 12.63 | 51.45 | 1.48 | 14.79 | 48.99 |
| 4 | 1.17 | 11.66 | 63.107 | 1.17 | 11.66 | 63.11 | 1.26 | 12.61 | 61.60 |
| 5 | 1.04 | 10.41 | 73.516 | 1.04 | 10.41 | 73.52 | 1.19 | 11.92 | 73.52 |
| 6 | .74 | 7.42 | 80.937 | | | | | | |
| 7 | .58 | 5.84 | 86.775 | | | | | | |
| 8 | .52 | 5.19 | 91.968 | | | | | | |
| 9 | .47 | 4.67 | 96.637 | | | | | | |
| 10 | .34 | 3.36 | 100.000 | | | | | | |

The table shows Eigen values for each of the components extracted, percentage variance of each component and cumulative percentage. Based on the table, the components with highest loadings were components 1-5 which accounted for cumulative percentage of 73.516% of the total variance in the dependent variable. To select the factors, the loadings of each variable on the component in the component matrix shown in Table 4.7 were considered.

**Table 4.7:** Rotated Component Matrix (Extraction method: Principal Component Analysis) **(*** important variables for the factor)

| | Component | | | | |
|---|---|---|---|---|---|
| Variable | 1 | 2 | 3 | 4 | 5 |
| 1. Age | .075 | .100 | -.303 | .796* | -.128 |
| 2. Household population size | .022 | .013 | .054 | .058 | .910* |
| 3. Size of household farm | -.058 | -.134 | .296 | .762* | .153 |
| 4. Total number of species on farm the last 12 months | -.102 | .867* | .074 | -.033 | .004 |
| 5. Total number of species on farm at present | .232 | .822* | .077 | .008 | .014 |
| 6. Size of land under indigenous vegetables | .205 | .027 | .754* | .077 | -.045 |
| 7. amount of seeds | .074 | .135 | .794* | -.088 | .104 |
| 8. financial gain from indigenous vegetables(amount) | .872* | .047 | .081 | -.002 | .105 |
| 9. amount spent buying vegetables if to buy per month | .617* | .013 | -.007 | -.144 | .535* |
| 10. percentage contribution to household income by indigenous vegetables | .821* | .079 | .282 | .093 | -.118 |

Based on the nature of variable loadings on a factor, five factors were selected to explain factors that motivated cultivation of AIVs. Factor loadings by each variable on the factor are shown in Table 4.7. To label the factor, variable loadings were considered. A variable was selected to be important for the factor if it was above 0.4 (Comrey in Acton, 2009). Factor loadings marked * in Table 4.7 were considered important in explaining the factor.

To label the factors, variable loading on a factor was considered. The researcher informed by variable loadings labelled Factor One as financial contribution to household livelihood because of the high loadings by percentage contribution to household income, financial gains from vegetables and amount spent in buying vegetables. Factor Two was labelled diversification of AIVs for risk aversion because of the high loadings by the total number of vegetable species on the farm the previous 12 months and on the farm presently. Factor Three was labelled availability of land and seeds because of high loadings by size of vegetable farm and amount spent buying

seeds. Factor Four was labelled household land size and demographic characteristics because of high loadings by age of the farmer and size of household farm. The Fifth Factor was labelled household vegetable sufficiency because of high loadings by household population size and amount spent per month in buying vegetables (see Table 4.8).

**Table 4.8:** Factors and variables that motivate cultivation of AIVs

| Factor | Name | Variable | Variable loading |
|---|---|---|---|
| 1 | Financial contribution to household livelihood | Financial gains from AIVs | 0.872 |
| | | Amount of money spent on buying vegetables | 0.617 |
| | | Percentage contribution to household income | 0.821 |
| 2 | Diversification of AIVs for risk aversion | Number of AIVs on the farm previous year | 0.867 |
| | | Number of AIV species on farm at the time of survey | 0.822 |
| 3 | Availability of land and seeds. | Size of land under AIVs cultivation | 0.754 |
| | | Amount of money spent buying seeds for planting | 0.794 |
| 4 | Household land size and demographic characteristics | Age of household head | 0.796 |
| | | Size of household farm | 0.762 |
| 5 | Household vegetable sufficiency | Household population size | (0.910) |
| | | Amount spent buying vegetables per month | (0.535) |

Discussion of each of the factors is expressed in the following sections:

*4.3.2.1: Financial Contributions to Households*

According to the findings, financial contributions to household livelihood are a motivator in the cultivation of AIVs. This study noted that although the main reason for vegetable cultivation is subsistence, there are farmers who carry out market gardening, where cultivation transcends family tastes or needs. It resonates with market demands for financial gains. The results are in line with the findings of Adebooye and Opabote (2004); Vorster *et al.*, (2007); and

Pasquini *et al.*, 2009) who reported that indigenous leafy vegetables play a key role in income generation. This factor is in itself facilitated with availability of the market for the vegetables.

Respondents were asked whom they sold the vegetables to. Figure 4.7 shows that 50.8% of the respondents sold their produce to consumers. According to the discussants in the FGD, the consumers as a market segment were mainly neighbours who came to the farm to buy vegetables for home consumption. A total of 33% respondents sold their vegetables to retailers and 16.2% to wholesalers. It is noted that wholesalers collected AIVs from farmers to take to far-off centres, including places such as Mumias Town, Kakamega and even Nairobi. It was also noted that farmers did not specialise on the segment of the people to sell to. For example, a farmer could sell to all the three segments of the market. The selling is unstructured, especially for those whose vegetables are cultivated in small parcels of land, an equivalent to kitchen garden. Farmers who had specialised in the selling of vegetables were mainly those who belonged to self-help community based organisations (CBOs), for example, the groups the researcher held FGDs with. For most of the other farmers who did not belong to a group, selling remained volitional, seasonal and unstructured, depending on the availability of vegetables; otherwise the produce was for home consumption.

According to the Ebwaliro and Shallomat groups – noted during FGD – that the demand for vegetables was very high especially during dry seasons. However, the FGDs identified lack of market for the vegetables as a major challenge. This would be evident in times of overproduction when the rains were in plenty. It hampered transportation to the nearest large market, Mumias Town, where participants in FGD claimed prices were better. An FGD participant lamented:

> "...we sometimes leave a whole sack of unsold vegetables on the market for goats to eat during seasons of overproduction since carrying back home is a big frustration after having paid the daily market rates."

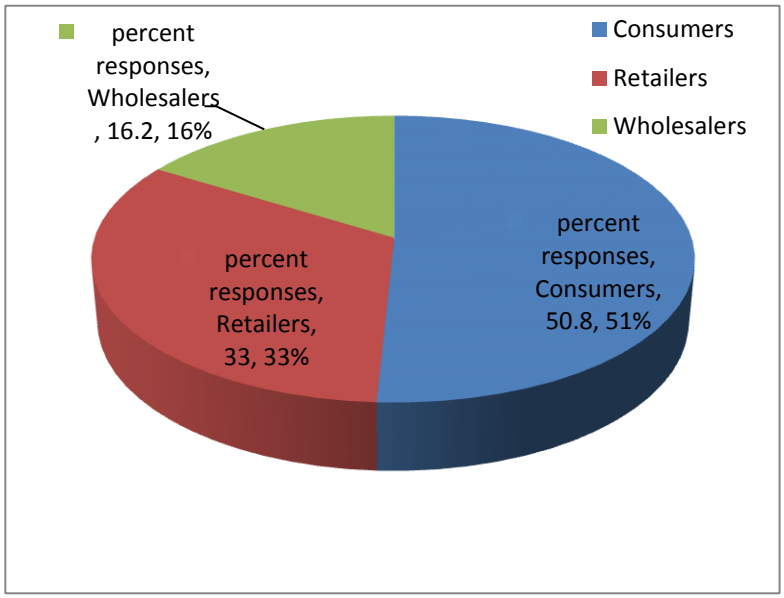


**Figure 4.7:** Group to whom vegetables are sold

The study observed that market gardening, a practice in place in the study area, could be developed to absorb a large youth population that was not in employment and was out of school. Market gardening would enhance diversification of income, reduction of malnutrition, enhancement of social capital and reduction of poverty levels of households. For this to be realised, infrastructure, markets, credit facilities, education, inputs, and capacity building need to be addressed for sustainable production. To increase production, there was need to strengthen groups to pool together in raising capital to improve production and scale up profit margins.

*4.3.2.2: Diversification for Vegetable Security*

Factor Two was labelled diversification for vegetable security**.** The number of vegetable species on the sampled farms at the time of the field survey, ranged between zero and eight (see Figure 4.8). The mean number was 2.94 which approximated to three species. The study findings showed that farmers cultivated a variety of AIVs on their farms. Variety does not only ensure sustainability and a diversification of vegetable diet but also cushions a

household against vulnerabilities such as pests, diseases and weather related shock such as hailstones and drought. The major concern however is that some of the species such as slender leaf (bitter type), African kales and the African nightshade were facing decline in terms of production. According to the key informants, especially the elderly women interviewed, many landraces familiar to them in the past were no longer available. Indeed, a vegetable, such as *B. alba* (African vine) had declined both in production and in consumption. This study posits that examining the vegetable security factor with a view to strengthening it would enhance vegetable production hence increased on-farm agro-biodiversity conservation.

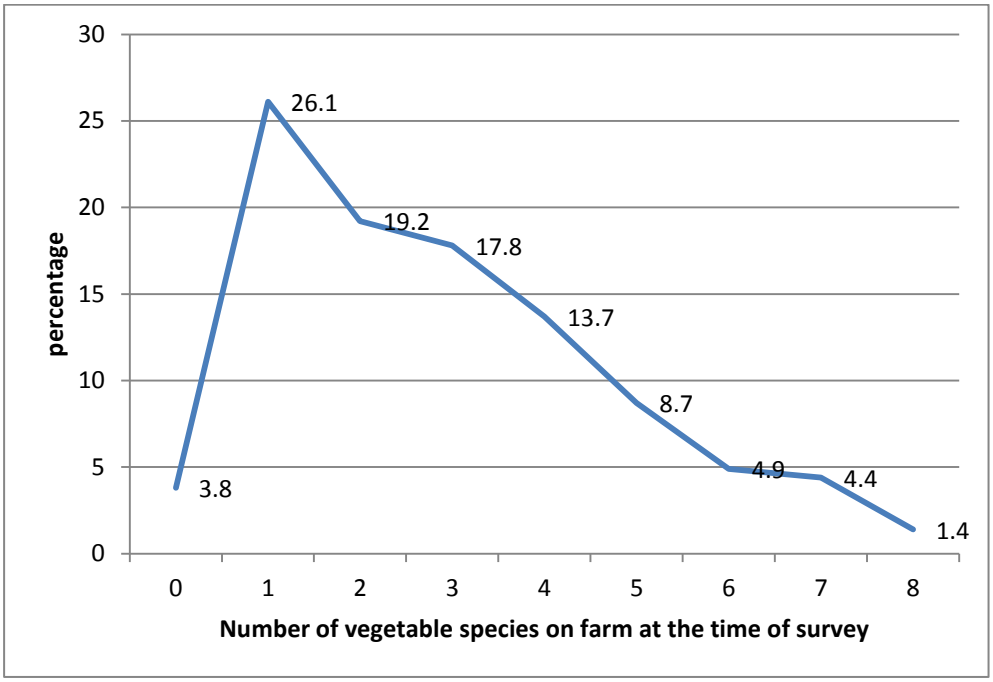


**Figure 4.8:** Number of AIVs on farm at the time of field survey

*4. 3.2.3: Availability of land and seeds*

Factor Three was labelled availability of land and seeds. This was because of high loadings by size of vegetable farm and amount of money spent on buying seeds. This sub-section discusses each of these variables.

**1. Size of Vegetable Farms**

Although almost an overwhelming majority (98.2%) of the farmers visited cultivated AIVs, most of them (80.3%) cultivated the AIVs in kitchen gardens on pieces of land that were less than ¼ of an acre. Those who cultivated their vegetables on more than ¾ of an acre constituted only 0.6% (Figure 4.9). The study findings show that the vegetables were cultivated mainly in small kitchen gardens or in home gardens. This form of food production has been found to use organic farming practices which are friendly to the environment. Researchers, as seen earlier, have found land to be scarce. Netondo *et al.*, (2010), for example, noted that a farmer would convert a larger portion of family land into sugarcane cultivation, leaving only a small percentage for food crops, including maize and others. Vegetables are then cultivated in small portions, next to the kitchen or in some instances, intercropped with maize for those that can be intercropped. Through FGDs, it became evident that to cope with land scarcity, some farmers would often hire from friends and relatives, land for cultivating vegetables. However, a few farmers were found to cultivate in large pieces of land of more than ¾ of an acre. Such farmers cultivated for subsistence and for sale. This shows the commercial potential AIVs have.

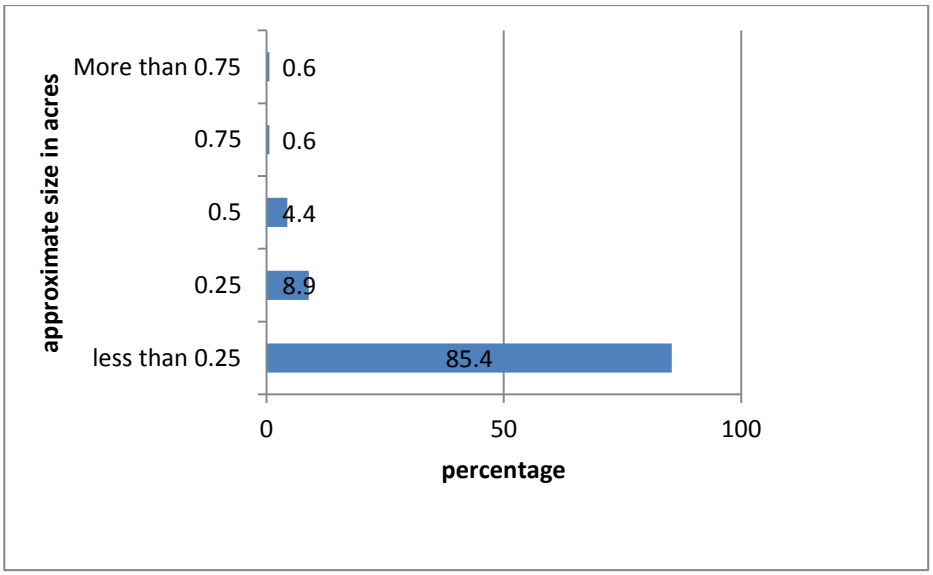


**Figure 4.9:** Approximate size of land under cultivation of AIVs

The type of vegetables was cross-tabulated with location where the same was grown. The results are shown in Table 4.9. The main cropping pattern was cultivation in kitchen gardens and intercropping of the vegetables with other crops grown on the farm. Findings show that intercropping of vegetables was due to scarcity of land, security of the vegetables and minimisation of labour requirements. The vegetable most intercropped was cowpeas, with 87 cases. The reasons given for intercropping included: diversification of vegetable species on the farm, spreading of risks and optimal utilisation of the land resource. This finding is in line with Gudhalanga and Makaudze (2012) who observed that intercropping enabled diversification and optimal utilisation of nutrients in the soil. Within crop groups, different varieties are planted to match stresses of the local environment.

The study observed that farmers planted a combination of varieties that ensured availability of different vegetables hence food and by extension nutrient security. It also ensured conservation of genetic material contained in the diversity of vegetables cultivated. Other studies show intercropping to have several advantages. These include having diversity of vegetables in a given season, optimal utilisation of resources like nutrients, water and light especially if the intercrops had different growth patterns (Abukutsa, 2007 and Brookfield *et al.*, 2003).

**Table 4.9:** Location where AIVs are cultivated

| Vegetable species | Towards fence | Intercrop | Kitchen garden | Hired farm |
|---|---|---|---|---|
| 1. Jute mallow | 13 | 41 | 57 | 0 |
| 2. Cowpeas | 32 | 87 | 170 | 2 |
| 3. Spider plant | 10 | 26 | 45 | 0 |
| 4. Pumpkin leaves | 20 | 49 | 80 | 0 |
| 5. *C. brevidens* | 1 | 5 | 9 | 0 |
| 6. *C. ochroleuca* | 9 | 40 | 71 | 0 |
| 7. African nightshade | 8 | 20 | 44 | 0 |
| 8. African kales | 2 | 9 | 15 | 0 |
| *9. A. hybridus* | 5 | 20 | 40 | 0 |
| *10. A. lividus* | 4 | 22 | 23 | 0 |

**2. Cost of Seeds**

The second variable that loaded high on the factor was amount of money spent on seeds. This implies the financial requirements for seed acquisition. The financial inputs determine the source of seeds, type and amount of seeds to be bought. Financial inputs also may determine the farm size to be cultivated for the vegetables and the type of cropping system whether intercropping or pure stand.

The cost of seeds varies from one vegetable species to the other. Majority of respondents (33.7%) considered spider plant seeds to be the most expensive seeds, followed by cowpeas (26.6%). Cowpeas seeds were considered to be expensive to some and yet not expensive to others. This reflects the popularity of the vegetable in the study area; it also reflects on the availability of the seeds. Those who produce on farm do not view the seeds as expensive. But those who regularly buy seeds view them as expensive. It is interesting to note that respondents did not view the seeds of a vegetable species such as African kales and slender leaf (the bitter variety) considered to be on decline, to be expensive. This shows that for these specific vegetables other reasons other than expense incurred in buying seeds are responsible for their decline.

Cowpeas seeds are the least expensive seeds on the open market followed by jute mallow seeds. Seeds for African kales and African nightshade were not mentioned in the category of the least expensive seeds. It is noted that availability of African kales is on the decline in the study area, yet farmers take no notice of the unavailability of seeds. African nightshade is semi-cultivated. According to the FGD, most farmers who cultivated the vegetable purchased the seeds from agro-shops, which were an ‘improved’ variety. It was, however, noted from key informants (the elderly women) that farmers who had the skills of preparing African nightshade seeds prepared their own seeds. Keller *et al.,* (2004) noted that when farmers chose to change from cultivating traditional food crops to high yielding hybrid seeds, indigenous varieties, carefully selected over generations for specific ecosystems disappear. Stone (2010) however; observed that introducing a new variety did not have to replace the

traditional variety. There is need to understand how to facilitate coexistence of new and old varieties in such dynamic systems for continued cultivation of the traditional variety of African nightshade.

Respondents were asked to state the amount of money that one spends on buying seeds. Results (Figure 4.10) show that 61.6% spent less than Ksh. 100 in buying seeds. It is observed that inputs in terms of amount of cash in buying seeds is quite minimal, with majority of the farmers spending less than Ksh.100 on seeds. A mere 3.9% spent more than Ksh 500. Seeds in the open markets were sold in different measures, beginning with quantities measured on a tea spoon to 2kg tin (for large seeds such as cowpeas). Based on the responses, it is clear that although most of the farmers bought their seeds, the amount spent was minimal. Vegetables are cultivated in small plots of less than ¼ of an acre. This coupled with the ability of some farmers to produce seeds from farms, explains the low amount of cash spent on buying seeds.

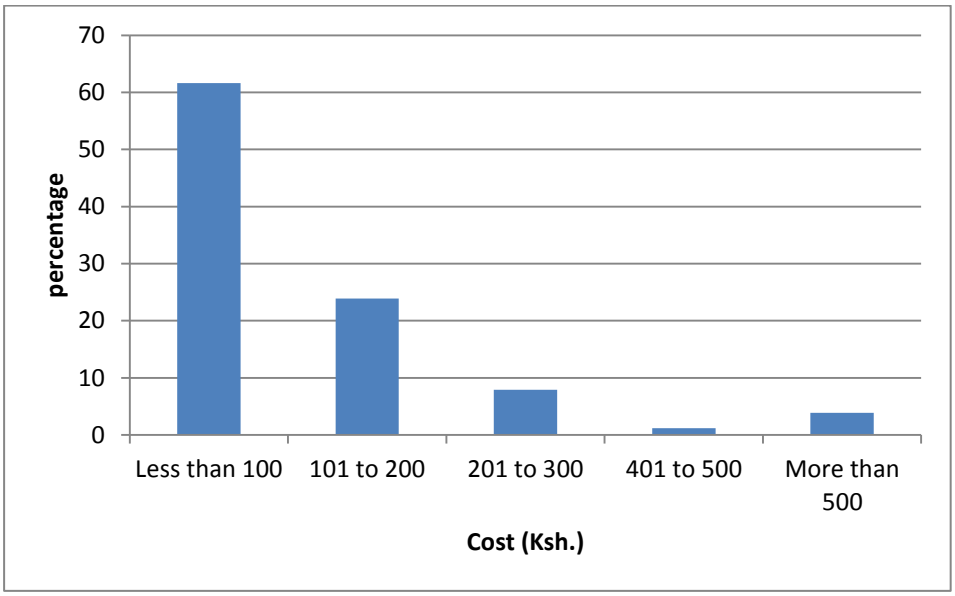


**Figure 4.10:** Cost of seeds

### 3. Quantity of Purchased Seeds

Farmers were asked to quantify the amount of seeds bought using an equivalent of a 250g measure. Responses obtained are shown in Table 4.10. Majority of farmers 67% bought less than 250g of seeds. A small cumulative 6.8% of the

respondents bought more than 1.5kg of seeds. This shows that the farmers cultivated the vegetables mainly for home consumption. For the majority, selling of vegetables was incidental. Seeds were bought from the informal market. The quality of seeds determines the rate of germination hence the ability to conserve genetic material contained in the seeds. The amount of seed bought coupled with the source of the seed impacts on the germination. The study noted that an initiative is required to have the farmers participate in seed production. Nevertheless, they need to be equipped with relevant knowledge in order to produce quality, viable and healthy seeds.

**Table 4.10:** Quantity of purchased seeds

| Frequency | Percent |
|---|---|
| less than 250g | 67 |
| 251g to 500g | 15.9 |
| 501g to 1kg | 4.1 |
| 1kg to 1.5kg | 2.9 |
| 1.5kg to 2kg | 3.5 |
| more than 2kg | 3.5 |
| Missing | 3.1 |
| Total | 100 |

The quantities of seeds bought were low. These tally well with the farm sizes under AIVs, majority of which are less than ¼ acre planted in the size of kitchen gardens. A correlation coefficient of ($r = 0.316$, $N = 354$, $P = 0.000$) was obtained when the land size under AIVs was correlated with amount of seeds bought. This shows a positive relationship between the amount of seeds bought and the land size under vegetables. Availability of seeds plays a crucial role in biodiversity conservation as observed by Keller *et al* (2005). Presence of viable healthy seeds planted suitably promoted species conservation in terms

of preservation of genetic material. For continued conservation through seeds, more land needed to be put under cultivation.

**4. Role of Gender in Seed Purchase**

Respondents were asked to state the role of gender in the buying of seeds. Figure 4.11 shows the responses. More than half of the responses (53%) indicated that males bought the seeds, 39% pointing at women (wives) and only 3% showing both gender being involved in the buying of the seeds. Buying could be interpreted to mean the physical buying from the market or the financing aspect in buying of seeds or both. From that perspective, although the physical buying of seeds is generally taken to be a woman's role (Abukutsa, 2007), this study observed that the male gender contributed in terms of finances. This in itself shows that on-farm conservation of genetic material meant to contribute to livelihood of a household was a corporate responsibility that involved both male and female gender.

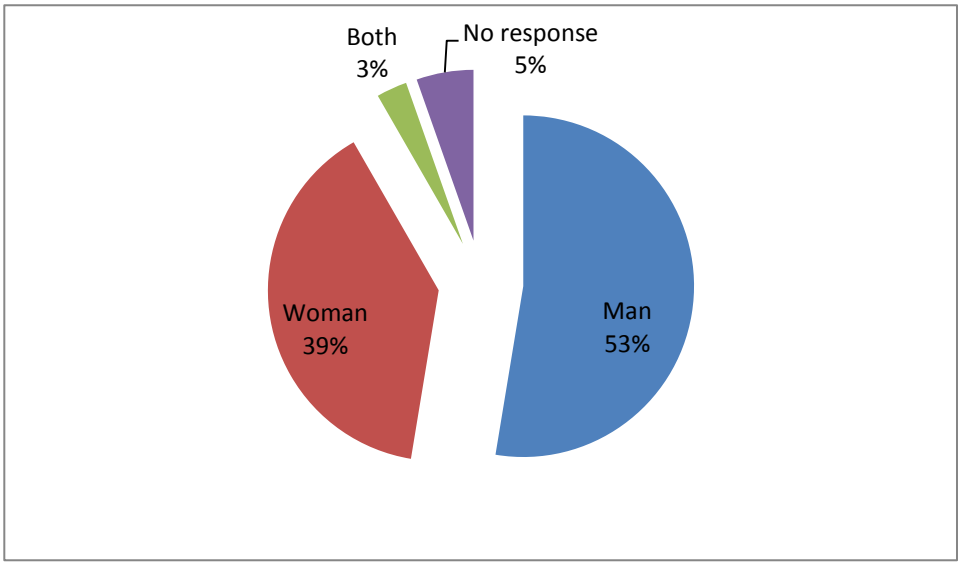


**Figure 4.11:** Role of gender in buying planting seeds

**5. Management of Indigenous Vegetable Farms**

For proper yields and conservation of species, the vegetable farms need to be managed. In addition to observation of the farms to ascertain answers given in the questionnaire, the respodents were asked to list ways through which they

manage their vegetable farms to enhance good growth. Table 4.11 shows the responses in percentage given. Results show that there were various management processes put in place to promote growth. A major management process is timely weeding required for all AIVs. It was also brought out that application of farm yard manure was an important process for the vegetables. Although control of pests and diseases is an important management process, farmers did not rate it as key. Prunning is done to remove apical dominance, enabling the vegetable to branch and stay longer on the farm before flowering. Some vegetables such as pumpkin leaves are, however, not prunned. Thinning, is a management process applied to various vegetables to space the stems and reduce competition. Although mulching is an important management process to help conserve soil moisture, control proliferation of weeds and also reduce soil erosion, the practice had limited application in the AIVs farms. It was applied in very few farms, ideally, an accumulated frequency of only 17.1% of farms had the practice applied.

**Table 4.11:** Processes involved in managing AIV farms

| Species | Inorganic fertilisers | manuring | Timely weeding | Controlling pests | fencing | prunning | Thinning | mulching | Providing support |
|---|---|---|---|---|---|---|---|---|---|
| Jute mallow | 6 | 3.4 | 40.6 | 1.1 | 0.3 | 1.4 | 2.0 | 6.6 | 0.3 |
| Cowpeas | 3.7 | 6.5 | 65.6 | 4.0 | 0.9 | 2.6 | 1.7 | 10.5 | 0.3 |
| Spider plant | 4.5 | 2.8 | 2.8 | 6.8 | 1.4 | 2.0 | 1.1 | - | 0.3 |
| Pumpkin leaves | 2.3 | 3.7 | 26.4 | 0.9 | - | 0.6 | 1.7 | - | 1.7 |
| Slender leaf (bitter type) | 0.6 | 1.4 | 8.5 | - | - | 0.3 | 0.6 | - | - |
| Slender leaf | 2.6 | 2.8 | 23.0 | 0.3 | - | 0.9 | 2.0 | - | - |
| African kales | 1.1 | 2.0 | 8.0 | 1.7 | - | 0.3 | 0.3 | - | - |
| African nightshade | 2.3 | 2.6 | 15.6 | 1.7 | - | - | 0.3 | - | - |
| *A.hybridus* | 1.4 | 1.7 | 11.9 | 0.6 | - | 0.3 | 1.7 | - | - |
| *A. lividus* | 1.4 | 1.7 | 9.9 | 0.6 | 0.3 | 0.3 | 0.9 | - | - |

*4.3.2.4: Household land and demographic characteristics*

Factor Four obtained from factor analysis, was labelled household land and demographic characteristics. This was due to high factor loading by the variables age of household head (0.796) and size of household farm (0.762).

**1. Age of Farmer and Conservation of Indigenous Vegetables**

Majority of the farmers (38.78%) were between 41 and 50 years old. This shows a high tendency for this age group to engage in sugarcane farming. The second largest group was that of 31 to 40 years (19.13%). According to the FGD (Shallomat SHG, 23/6/2012) 'the age of a person has a link on the type of vegetable grown'. The FGD revealed that younger generation tended to ignore AIVs as compared to older people who were in their fifties. This, as explained by participants in the FGD, was because the vegetables were considered cumbersome to prepare and required special traditional cooking skills which many of the younger generation were unfamiliar with. The results confirm findings by Keller *et al.*, 2005 that feeding habits changed with the young generation. The consequence of this is low consumption and cultivation of AIVs by the young generation as well as loss of IK. Millstone and Lang (2003) describe this change in preference as nutritional transition.

**2. Size of Household Farm**

Respondents were asked to choose a category that would represent the size of their farm. Results show that the majority (38.0%) of the respondents in the study area had between 2 and 4 acres of land (Figure 4.12). An overwhelming cumulative 83.4 % of the respondents had farm sizes that were 7 acres or below in size. This is a pointer to the fact that most of the farmers visited were small scale farmers who had to share the little land they had for cropping of cash crops and subsistence crops, including AIVs. A large piece of land would allow a farmer to set aside some section for food crops including vegetables. This meant that availing more land to the farmer is likely to enable putting aside a sizeable piece of land for cultivation of vegetables. If motivated by

intrinsic and extrinsic factors such as nutrition and income respectively, this would however, be possible with appropriate non-formal environmental education aimed at enhancing sustainable livelihood.

The study noted that a small percentage of respondents were cultivating on land that was still under family ownership. Access to such parcels of land is limited depending on the perception of the eldest in the family. The issues become more complex when the head of the family is polygamous, where according to the traditional Abaluyia community norms, the catchment of the study area, a farm is shared along the number of wives (Source: key informant). A household with many sons will then have to fragment the farm more to have each of the sons get a share. To achieve sustainable agriculture in such a backdrop requires adoption of practices and strategies that promote conservation of natural resources, land included.

The low acreage of land by most of the farmers was indicative of small scale sugarcane farming. A key informant (MSC field assistant) observed that according to the MSC guidelines, the lowest total acreage of land that a farmer required to cultivate canes was two acres, so that half an acre is for sugarcane, another half an acre for the home-stead and one acre for food crops. Based on the fact that the majority of farmers had two to four acres, a farmer needed to diversify on-farm income to supplement the proceeds from the canes for a sustained livelihood. This interpretation stems from the FGD, where in both cases, the participants affirmed that proceeds from canes were not enough. In view of the population growth, the acreage per household is expected to continue declining due to land fragmentation as household heads subdivide their land. Increased fragmentation affects the ability of a portion of land to sustain diversity of crops, vegetables included.

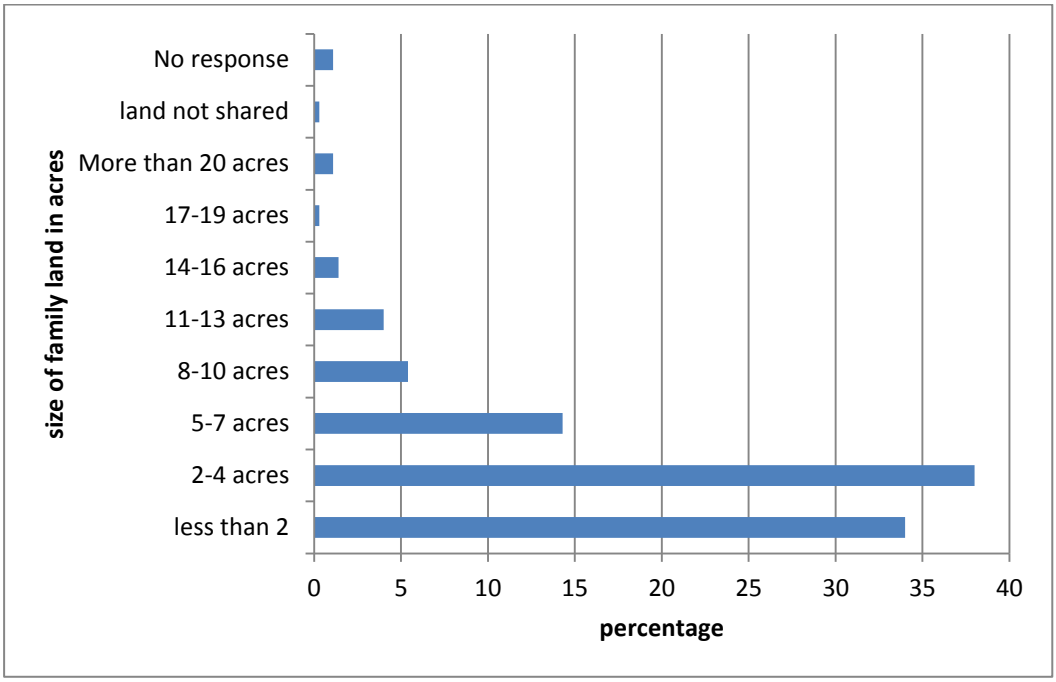


**Figure 4.12:** Size of family land

Joshi *et al.*, (2002) noted that the underutilised plant species of economic importance are the key to sustainable agriculture in most of the developing countries facing resource constraints as well as rapid depletion of natural resources due to ever-increasing population pressure. Studies show that competing factors in vegetable production include increased sugarcane production, land subdivision and the shift to exotic species that are not adapted to the ecological parameters prevalent in the study area (Abukutsa, 2007; Netondo *et al.*, 2010; Waswa *et al.*, 2011). This study, however, observed that production of vegetables can be increased on the existing land by incorporating different techniques of crop production to enhance livelihood and promote sustainable utilisation of the available land resource. The conservation and sustainable use of AIVs for food and agriculture play a critical role in the fight against hunger, by ensuring environmental sustainability while increasing food and agricultural production for households. Production of vegetables without compromising the natural capital land is imperative in agro-biodiversity conservation (IPGRI, 2006). A large reservoir of genetic and species diversity

will need to be maintained and sustainably used. The diversity would further help maintain and rehabilitate productive ecosystems to supply households.

*4.3.2.5 Household Vegetables Sufficiency*

Factor Five was labelled household vegetable sufficiency. The study observed that farmers maintained vegetable production to enhance household's vegetable sufficiency in terms of nutrition and self-reliance. The variables that loaded highly on the factor were household population size (0.910) and amount spent buying vegetables per months (0.535).

The study shows that 56% of households visited had a population size of 6-10 persons. A correlation between household population size and amount of cash spent on buying vegetables showed a positive significant relationship ($r = 0.115$, $N = 360$, $P<0.05$). This means that with more people to feed in a household, a family would spend more money on buying vegetables for household use. A family would, therefore, strive to cultivate vegetables to supplement household vegetable needs instead of buying the same on a regular basis. A regression analysis was further done to establish the causality between the two variables. The independent variable was taken to be the size of household while the dependant was the amount of money that would be spent if a household was to buy vegetables monthly. Results of the analysis are shown in Appendix VIII. The model summary showed the adjusted $r^2$ to be 9.8%. This shows that 9.8% of the variance in amount of money spent in buying vegetables can be explained by household population size. The F, value of 35.617 is very significant ($p<0.005$). The slope of the regression is 0.162 and the constant is 2.432. A *t* value of 5.968 and its confidence value significance <0.0005 (Appendix VIII) shows the predictor value is highly significant.

The resulting regression model is $y = 2.432 + 0.162 x$. This shows that the amount of money spent on buying vegetables is predicted to be a constant 2.432 plus a coefficient 0.162 times the number of persons in the household. Thus, every rise of one unit for the persons in the household predicts a rise on

the dependant variable amount of money spent on vegetables of 0.162. The findings showed that farmers, for purposes of being self-sufficient in vegetables and to avoid buying, would cultivate vegetables. The challenge, however, is that there is no guarantee that one would cultivate AIVs. Keller *et al., (*2004), Oniang'o and Shiundu (2005), Smith and Eyzaguirre (2007) and Abukutsa (2007), among others observed that AIVs contain a variety of nutrients that are necessary for proper growth. The vegetables are however underutilised because of various reasons, including ignorance and the changing lifestyles. This study posits that creation of awareness on the role of vegetables in provision of essential nutrients would improve the well-being, self-sufficiency and general community livelihood; it would also enhance conservation of genetic material contained in the diverse species of the AIVs.

Results in this section show five main factors motivating production of AIVs hence, explain the factors that motivate cultivation of AIVs in the wake of competing factors prevalent in the study area. To sustain cultivation amidst pressure to grow other food crops and produce sugarcane simultaneously, the farmer must be not only sensitised about the importance of AIVs in community livelihood, but also be capacitated in adaptive measures of coping with diminishing land sizes and population pressure. Such capacity building will include how to carry out mixed cropping which takes on different forms such as crop rotation, intensification and diversification. This study observed that production of AIVs is a necessary activity that households are already engaged in. Mechanisms ought to be put in place to build on the current motivations to enhance production for a sustained livelihood.

### 4.4: Contribution of AIVs to Household Livelihoods

Conceptually, "livelihoods" are means, by which people make a living. People put strategies in place to achieve livelihood. This study sought to find out the contribution of AIVs to livelihoods. As a concept, livelihood can be perceived in different ways. One of it is in the context of sustainable livelihood which perceives the outcomes of livelihoods in the domains of increased food security, increased well-being, reduced vulnerability and increased income

(Scoones, 1998). This study attempted to answer the research question, *"What is the contribution of indigenous vegetables to community livelihoods*?" The study had thus to consider livelihood in the five aforementioned outcomes of livelihood. Responses from the questionnaire (Appendix I), from the FGD (Appendix II) and from key informants were examined. A recorder was used to record the FGD and key informants. This data was carefully transcribed to make meaning of what was said. Let us briefly discuss the findings.

### *4.4.1: African Indigenous Vegetables as a Natural Capital*

African Indigenous Vegetables are battiological resources. Productivity of these resources has been used by some farmers to contribute positively to the livelihood of a household and by extension, the community. Respondents in the study area basically draw their livelihood options from sugarcane farming, besides cultivation of other crops such as AIVs and other food crops. Their livelihood also benefits from holding of livestock and other forms of non-agricultural wage employment off-farm. Those who cultivate AIVs were 99.2% of the respondents. Only 0.8% of those interviewed did not indicate having vegetables on their farms. They were asked to give the reasons why they cultivated vegetables. All farmers indicated that they cultivated vegetables basically for food and secondly, for income. Evidently, the farmers had adopted strategies for diversifying vegetables on the farm to spread risks and compensate for losses in case of shocks. Table 4.12 shows the various livelihood options of the household head and the spouse. Majority (55%) of the household heads obtained their livelihoods from agricultural and livestock produce. Those in formal employment constituted 12.9% for household heads and 4.9% for the spouse. This is a reflection of basically an agrarian community, basing their livelihoods on agricultural production.

A cross-tabulation on the distribution of household livelihood and vegetable species diversity on-farm shows that those whose livelihood is agricultural and livestock keeping also have a wider spread of the vegetables species on the farm with the majority having a spread of 5-6 species on the farm. In households where the heads depended on agriculture, livestock and formal

employment, vegetable diversity was low in spread with majority having one or two species on the farm (see Figure 4.13). People in formal employment due to time constraints are likely to cultivate less. Cultivation of indigenous vegetables, though requiring low inputs, is a labour intensive activity.

**Table 4.12:** Main occupation of head of the household and the spouse

| Household head | % | Spouse occupation | % |
|---|---|---|---|
| Agriculture and livestock | 55.1 | Agriculture and livestock | 48 |
| Business | 3.1 | Business | 12.9 |
| Formal employment | 12.9 | Formal employment | 4.9 |
| Informal employment | 19.4 | Informal employment | 13.4 |
| Agriculture/livestock/formal employment | 1.7 | Agriculture/formal employment | 1.4 |
| Agriculture/livestock/informal employment | 2.9 | Agriculture/informal employment | 3.1 |
| Agriculture/livestock/business | 2 | Agriculture/ livestock/business | 3.1 |
| Others | 0.6 | Others | 1.7 |
| No response | 2.1 | No response | 11.3 |
| | 100.0 | | 100.0 |

These results in away are in line with the findings of Jansen Van Rensberg *et al.,* (2007) who observed that low income communities tended to consume more AIVs than their wealthier counterparts. The results also are in line with Kimiywe *et al.,* (2007) who noted that the casual labourers and the unemployed consumed more AIVs than those in full employment due to time availability for buying, preparing and cooking. The fact that 98% of those visited had AIVs on their farms is a convincing indication that agro-biodiversity facilitates small scale subsistence farmers' livelihood and vegetable diversification strategies. The households made conscious efforts to cultivate AIVs to enable vegetable diversified diets.

African Indigenous Vegetables are described by Maundu (2007), Masayi and Netondo (2012) and Abukutsa-Onyango (2003), among others as easier to

grow, more resistant to pests, and culturally acceptable. The FGD showed that the vegetables could be upgraded to a cash crop. This could be done with a view to enhancing this natural resource to contribute and supplement more to livelihoods. Integrating AIVs in the backyard garden, in other production systems and intercropping with the major crop; sugarcane, before reaching 'knee high' in length would increase acreage and provide livelihood opportunities. This would increase the income of the resource-poor households thus, addressing the issue of poverty.

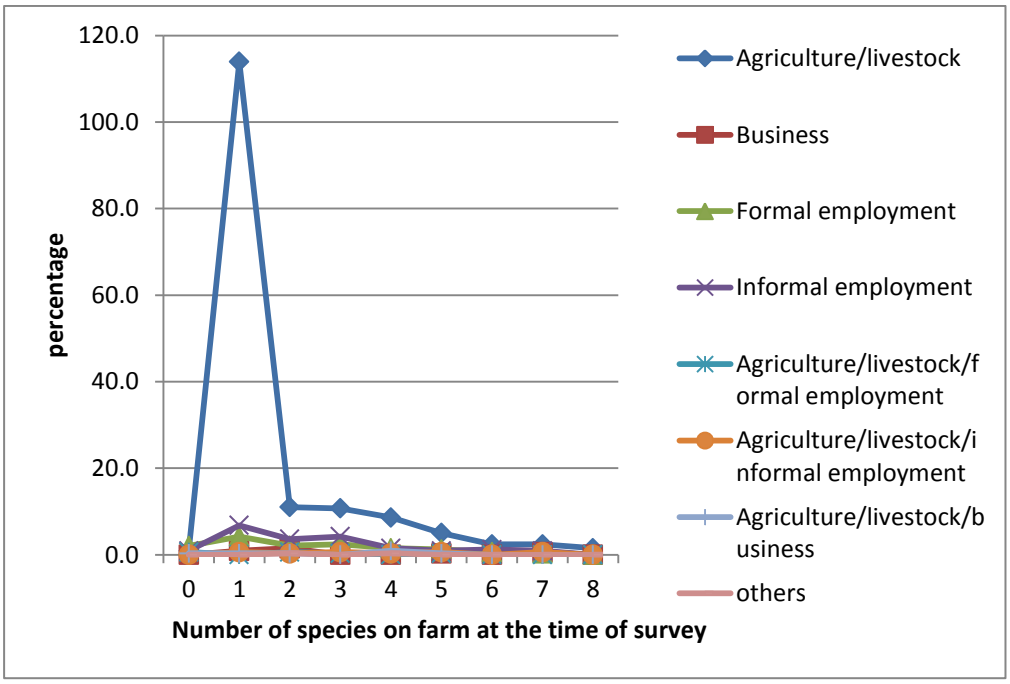


**Figure 4.13:** Variety of AIVs on farm and occupation of household head

### *4.4.2: Benefits from Indigenous Vegetables*

Respondents were to indicate benefits they obtained from AIVs. Food and income in terms of finances topped the list. Medicinal benefits were also cited (Figure 4.14). The study had already identified ten common vegetables served with *ugali*, the stable food in the region. The variety of vegetables cultivated, is significant in nutrition and diversification of vegetable diet. Consumption and utilisation of indigenous vegetables were highest when the vegetables were in season (Kimiywe *et al.*, 2007; Acipa *et al.*, 2013). The vegetables also served as income sources.

As noted earlier, production of the vegetables is in varied amounts, depending on the popularity of the species. Although different vegetables have different nutrients (Oniang'o *et al.*, 2005; Weinberger and Msuya, 2004; Schönfeldt and Pretorius 2011), consumption of vegetables such as *C. brevidens (*slender leaf – the bitter variety), African nightshade and African kales in the study area is limited due to availability and taste preferences among other factors. Some researchers, for example, Adebooye, 2003; Kimiywe *et al.,* 2007 have linked AIVs with therapeutic elements. However, these study findings demonstrate that only 2.3% of the respondents deliberately used them for therapeutic purposes. Majority saw the vegetables as primarily valuable for food and not necessarily medicine. A key informant remarked:

> "... Yes, we used to give freshly circumcised boys some special vegetables to eat so as to heal fast, and so were lactating mothers who would be given certain vegetables to enable production of breast milk, but currently the same are no longer in use, we now have other ways of treating circumcised boys and for inducing increased milk production in lactating mothers, people are no longer keen in using our traditional ways of going about those challenges..."

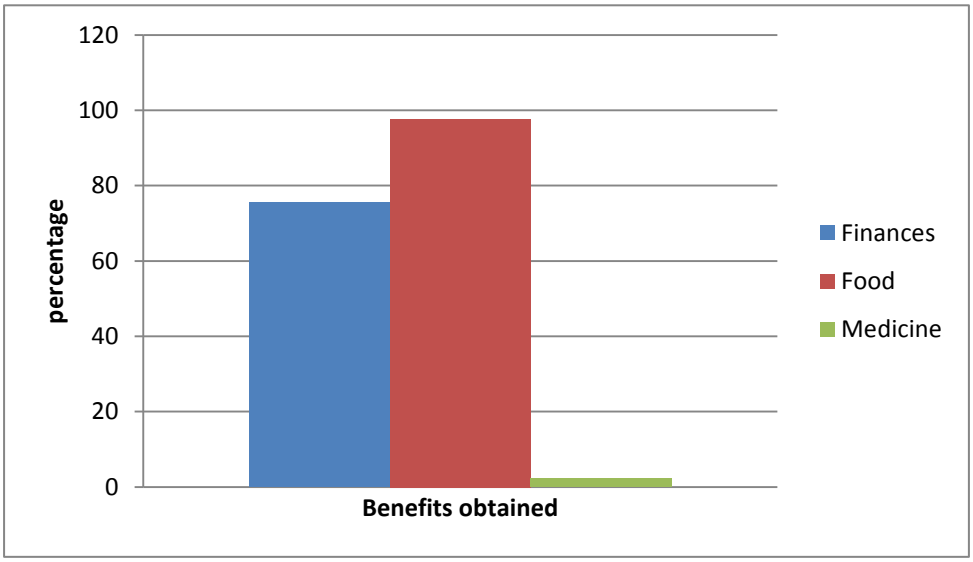


**Figure 4.14:** Benefits from vegetables

*4.4.2.1: Financial Gains*

Farmers were also asked to explain why they planted their vegetables. Results single out home consumption as the main reason. Indeed, of all the 99.2% farmers who cultivated vegetables, none did so solely for income. It is, however, appreciated that a high percentage of farmers (80%) viewed certain vegetables as having potential for income. In terms of consumption, cowpeas ranked top on the list of the vegetable produced for consumption. Figure 4.15 shows that all the vegetables cultivated except *C. brevidens* have potential to be cultivated for income. The realisation that these vegetables can be cultivated and would fetch income for the farmer is a positive view. It would help improve livelihoods for the community, encouraging members to diversify sources of income and at the same time, enhancing biological diversity. Vegetables are fast maturing and require little or no inputs except availability of seeds, land and water and production skills. This renders vegetable production suitable for all those with a piece of land, as is the case with the target population.

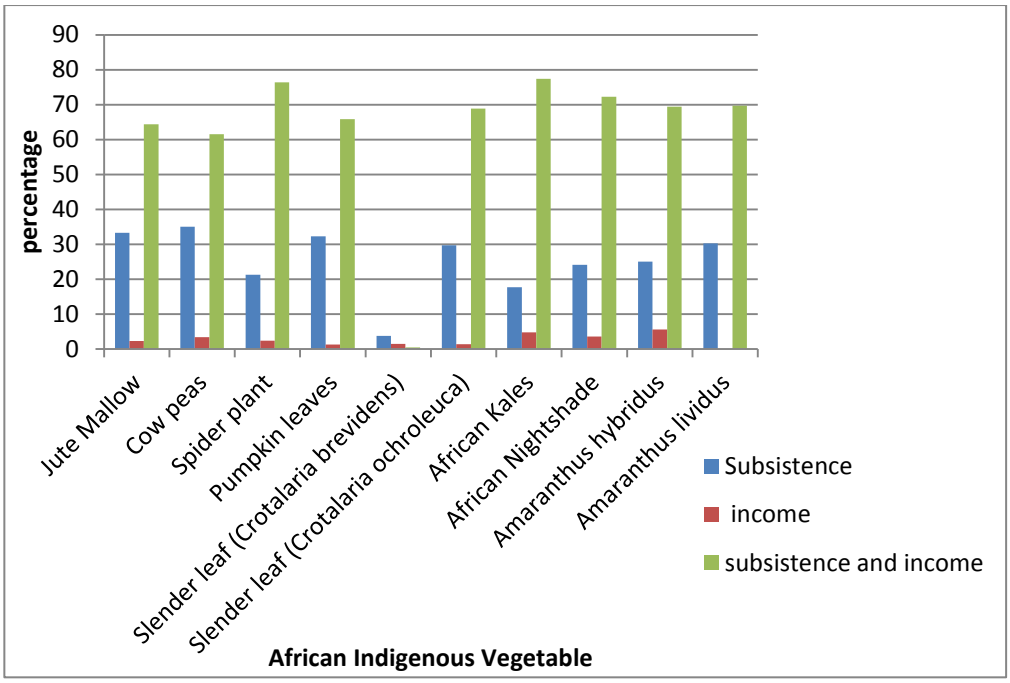


**Figure 4.15:** Reasons for cultivation of AIVs

Respondents shared about the financial gains from the vegetables, 25.4% of them indicating that they got more than Ksh. 5,000 in the previous year from the vegetables. Those who received less than Ksh. 1,000 were 16.6% (Figure 4.16). This result shows two categories of the farmers visited. Almost 25% of the farmers actively cultivated AIVs for income while the majority was engaged in selling vegetables on an informal basis, that is, when the vegetables could favourably be produced and sold. The results also show that there was potential in this sector to cultivate vegetables for income generation, job creation and poverty reduction, with an overall advantage of achieving agro-biodiversity conservation.

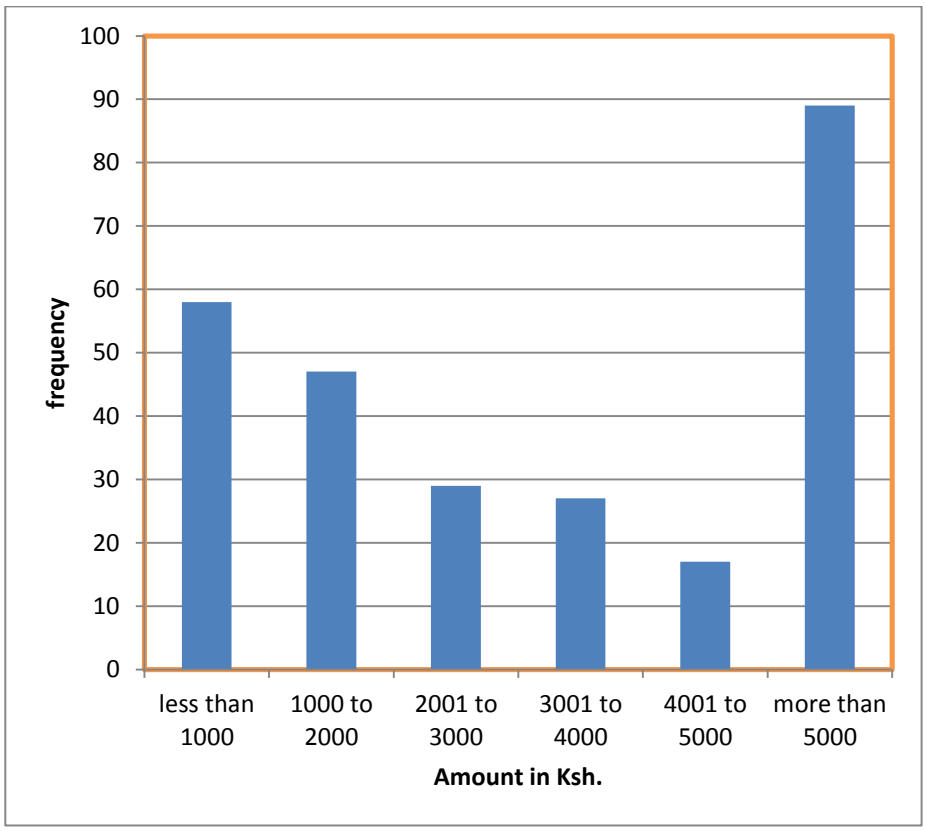


**Figure 4.16:** Financial gain from indigenous vegetables

*4.4.2.2: Vegetables and Household Needs*

Respondents quantified the amount of money their respective households would use monthly to buy the vegetables. The results showed that majority of households (37.4%) would spend more than Ksh. 2000 (see Table 4.13),

meaning that AIVs contributed to the livelihood for the households. A farmer would be required to spend more from other resources to feed the family. A bivariate correlation analysis showed a significant positive relationship between land size under AIVs and percentage contribution to household income by AIVs with $r = 0.286$; $N = 296$; $p = 0.000$. Land size under AIVs is a factor in the amounts gained from the vegetables if the farmer was to sell. The proceeds contributed to household income.

**Table 4.13:** Probable cost of vegetables

| Cost | **Percentage** |
|---|---|
| less than 500 | 10.0 |
| 500 to 1000 | 17.4 |
| 1001 to 1500 | 19.7 |
| 1501 to 2000 | 10 |
| more than 2000 | 37.4 |
| No response | 5.4 |
| **Total** | **100** |

Respondents were asked to state the percentage contribution of AIVs to household income. The responses (Table 4.14) show that all farmers appreciated the contribution that AIVs have on their livelihoods, with the majority (27.1%) showing that the vegetables contributed 51-70% of the household income. 23.4% of the respondents who gave no response were those that had not cultivated AIVs on their farms together with those who were non-committal on the amount percentage contribution of sale of vegetables to household income.

**Table 4.14:** Contribution to household income by AIVs (%)

| Indigenous vegetables contribution to household income (%) | **Responses (%)** |
|---|---|
| 1 to 20 | 16.9 |
| 21 to 50 | 16.0 |
| 51 to 70 | 27.1 |
| 71 to 90 | 11.4 |
| 91 to 100 | 5.1 |
| No response | 23.4 |
| **Total** | **100.0** |

*4.4.2.3: Needs Solved Through Sale of Vegetables*

Farmers were asked to state the needs they have been able to solve using the income from vegetables, the needs listed were analysed and categorised as shown in the Table 4.15.

**Table 4:15:** Needs solved by sale of indigenous vegetables

| Category label | % of Responses |
|---|---|
| farming related | 6.3 |
| Household needs | 76.1 |
| Socio related | 4.6 |
| school related issues | 8.4 |
| Health related | 1.7 |
| Buy livestock | 1.7 |
| Boost business | 1.3 |
| **Total responses** | **100.0** |

Results show that although vegetables are cultivated mainly for food, the surplus is sold and farmers are able to meet diverse needs, the major one being,

meeting household needs, which from the FGD and questionnaires included buying household commodities. The results further show that the sales were unstructured and incidental, done on small scale. Many of the farmers used the cash obtained as petty cash, to mainly solve household related needs. These results correlates with observations made by Shiundu and Oniang'o (2007) who noted that AIV production provide women a chance to earn income in a predominantly sugarcane growing zone. Sugarcane being a cash crop is dominated by the male gender. The farmer, however, is able to utilise the proceeds from sale of vegetables to meet basic needs that would otherwise be a bigger challenge.

### *4.4.3: Increased Well-being*

The study sought to find out if farmers had structured self help groups (SHGs) dealing with cultivation of indigenous vegetables. Membership in SHGs according to FGDs accorded one a sense of belonging and a strong bargaining power in accessing micro-finance, besides empowerment in terms of skills and management. Results (Figure 4.17) show that majority (51.7%) did not belong to a SHG, 24% indicated belonging to SHGs, and equally a similar number (24.3%) not responding to the item. The explanation for the latter could be that they either did not cultivate vegetables on their farms and/or that they did not therefore need to respond. It is also possible that some were indeed unaware of the existence of such SHGs in their locality. The study noted that farmers engaged in SHGs were able to cultivate vegetables throughout the year because of the financial motivation. They are able to go an extra mile to ensure availability of vegetables, especially during drought. This is the time when they got maximum profit from the sales.

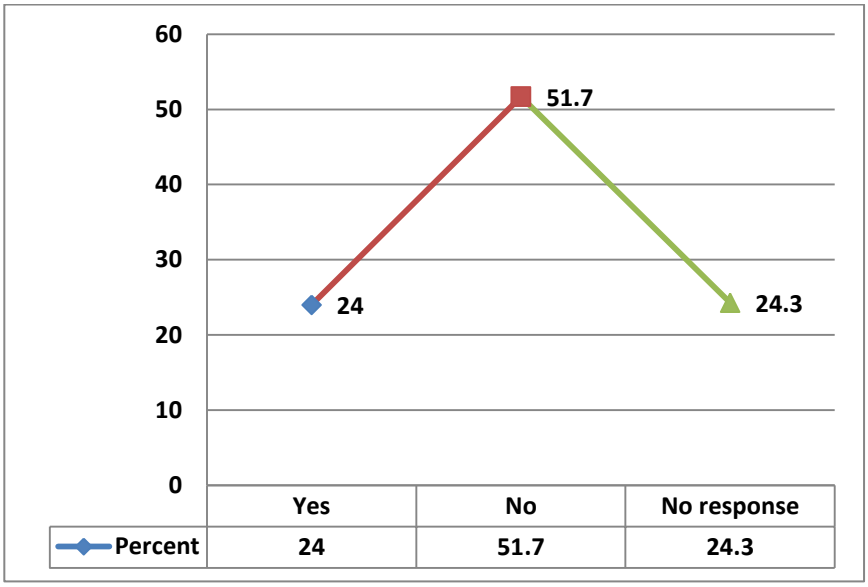


**Figure 4.17:** Membership in a SHG

The responses posted are an indication that there were several SHGs in the study area. Members had a common objective of producing, harvesting and marketing of AIVs to strive to improve their conditions which included income and well-being. Members met on monthly basis to contribute money to buy seeds and rent land for the cultivation, make turns to weed, harvest and sell and bring the income to a treasurer of the group who keeps their records. The profits are shared according to their respective constitutions. According to FGDs held, SHGs were quite valuable; members educated one another on the best practices of land preparation, seed preparation and management of the vegetables. They also formed a block for the purposes of selling the vegetables: membership in a SHG would give one a collective bargain. This provides more opportunities to gain representation, technical and economic services.

More than half the respondents (51%) did not belong to any SHG dealing with AIVs. This is an indication of a people who are producing the vegetables mainly for subsistence (home) consumption. Belonging to a group is an important social capital that contributes highly to the livelihood of the community. Members responded to a key question, *'How has membership in this self-help group helped you?'* According to discussants of the FGD,

membership in a SHG afforded a member a collective bargaining power. It also accessed services, and in that way, enables a member to value oneself and to gain societal esteem; a member being built capacity-wise and develops skills such as leadership, communication and conflict resolution. These are essential skills that contribute to one's livelihood in the community helping to fight poverty. This is in agreement with the observation made by Wennink, Nederlof and Heemskerk, (2007) in which they noted that empowering a people is important in fighting poverty

### *4.4.4: Reduced Vulnerability*

The results show that 99.2% of the farmers visited cultivated 10 different AIVs. Production of vegetables such as cowpeas was increasing because it can be cultivated throughout the year. Part of the reason for this was that the various varieties coped with different environmental conditions. AIVs could be produced by all farmers since one did not need sophisticated skills, or high inputs to establish. Studies (such as Maundu *et al.*, 1999; Abukutsa and Onyango 2005, Weinberger and Msuya, 2004) show that AIVs took 3 - 4 weeks after planting; harvesting could go on for almost 3 months. Guaranteed availability of water could scale up sustained production of these vegetables throughout the year, thus ensuring food security and reduced vulnerability.

According to the FGD (both Ebwaliro Women group and Shallomat SHG held on separate occasions), participants felt that the demand for AIVs was high, especially for those who could access the bigger markets such as Mumias Town. The infrastructure to link the consumer and the producer on a sustainable basis is however important. Shiundu and Oniang'o (2007) observed that the success of Rural Outreach Programme (ROP), an organisation involved in vegetable production and selling in Butere sub-county, was because of railway services which facilitated transport of the vegetables from the source of production to large markets. Results from the FGD indicated that the labour inputs were high in terms of land preparation, weeding and harvesting given that they were manually done. Nevertheless, production inputs were low. There

must, however, be a secure supply all year round and a good transport network for farmers to realise good proceeds.

### *4.4.5: Sustainable Natural Resource Use*

All households that were visited depended on land for sustained food and cash crop production. Cultivation of the vegetables is one dimension through which the community would be able to sustain the natural resource. Households in the study area depended on land, a natural resource for sustenance. Proper maintenance of the resource would enhance the productivity of the same, ensuring sustainable livelihood. The practices used in the cultivation of AIVs at the moment, though on small scale, reinforced sustainability of the natural resource. From what was observed and recorded, there were several processes in place that enhanced the natural resource, land and agro-biodiversity. Let us turn to some of these processes albeit briefly.

#### *4.4.5.1: Diversification of Vegetables*

Results show that at the time of the study which was during the rainy season, farmers had planted on their farms an average of 2.93 different species. This translates to an average of three per farm. This compares favourably with the number of different species that had been planted the previous 12 months, whose average was 5.10 species. Diversity of vegetable species is created from time to time as farmers make efforts to sustain their livelihoods economically and socially. According to FGD (Ebwaliro Women group on 14$^{th}$ April 2012 and Shallomat SHG on 23$^{th}$ June 2012) variety is enhanced through intercropping. Cultivation of vegetables is an ongoing activity as long as there is rain. This ensures that the soil is covered hence reducing soil loss which would otherwise compromise the sustainability of the natural resource base. Based on IK, farmers are able to select vegetable varieties that are well suited to the farm's soil and the environment in general.

#### *4.4.5.2: Seed Selection*

The selection of seeds is based mainly on colour of seeds. For all the vegetables, a different colour would signify a different variety of the same

species. This would also be an indicator of preference and taste. For instance, a key informant from Matawa in Lureko sub-location intimated that there were varieties of pumpkin leaves, and knowledge on the differences of their respective seeds was important. Ability to resist drought was another factor mainly used for selection of cowpeas seeds. Hence, vegetables, including cowpeas, could be in season all through the year. This was because farmers understood the different types. Market value, resistance to pests and taste preference were also important factors considered (see Table 4.16).

**Table 4.16:** Criteria for selecting seeds for planting

| | Colour of seed | Tolerant to drought | Market value of the vegetable | Ease of cooking | Resistance to pests | Taste |
|---|---|---|---|---|---|---|
| Jute mallow | 47.4 | 23.1 | 8.3 | 9 | 7.1 | 5.1 |
| Cow peas | 41.1 | 39.7 | 4.7 | 4.5 | 8.0 | 2.0 |
| Spider plant | 46.5 | 14.2 | 18.1 | 1.6 | 6.3 | 13.4 |
| Pumpkin leaves | 49.0 | 18.9 | 8.7 | 14.3 | 4.1 | 5.1 |
| Slender leaf (C. *brevidens*) | 53.8 | 9.6 | 13.5 | 0.0 | 0.0 | 23.1 |
| Slender leaf (*C. ochroleuca*) | 53.5 | 12.1 | 5.2 | 2.3 | 3.4 | 23.6 |
| African Kales | 52.5 | 10.2 | 18.6 | 5.1 | 1.7 | 11.9 |
| African Nightshade | 38.7 | 10.8 | 21.6 | 1.8 | 2.7 | 24.3 |
| *A. hybridus* | 53.7 | 11.9 | 11.9 | 13.4 | 4.5 | 4.5 |
| *A. lividus* | 45.7 | 8.6 | 20 | 2.9 | 8.6 | 14.3 |

*4.4.5.3: Methods to Improve Soil Fertility*

When asked about the methods they used to enhance soil fertility, 59.2% of the farmers indicated that they added farmyard manure to their farms (Table 4.17). Those who practised crop rotation constituted 3.8%. Those who added artificial fertilizers formed 11.2%. Probably they used the left-over fertilizers either

meant for sugarcane or as they intercropped the vegetables with the canes before the latter reached knee-high length. Artificial fertilizers ought to be used in an environment where appropriate soil analysis has been done and matched with the crop for use. Without such analysis, the utilisation of artificial fertilizers was open to abuse, leading to environmental degradation. The high percentage of farmers using this method was a point for consideration in creation of awareness on the proper utilization of artificial fertilizers to avoid abuse and the negative attendant effects. Nutrient cycles are enhanced to minimise loss of nutrients off the farm, realised by composting livestock manure or by rotating using legumes to fix nitrogen. Extension services are important in enabling farmers to use fertilizers in a sustainable manner. Mulching, an important method of increasing soil fertility, has not received considerable attention as would be expected with only 17.1% of cases having used it.

**Table 4.17:** Methods used to improve soil fertility

| **Methods** | **% of Responses** |
|---|---|
| Artificial fertilizer | 11.2 |
| Manure | 59.2 |
| Crop rotation | 3.8 |
| Mulching | 17.1 |
| Addition of house refuse | 7.4 |
| None | 1.3 |
| **Total** | **100.0** |

*4.4.5.4: Methods used to obtain water for vegetables during drought*

The fast growth of vegetables requires that a lot of water is availed to enhance the growth. There are times when the area experiences drought. According to the FGD (Ebwaliro Women group), this is the best season for them to ensure availability of the vegetables because of the heightened demand for the vegetables. Most farmers (70.4%) practised irrigation. On further enquiry, it

was evident that there were farmers whose farms extended to the river; a water source. Although the area did not have a situation when the rivers were dry, policies to discourage diversion of water from rivers were required. Mulching, a method that maintains moisture and protection, was practiced by only 17.1% of the farmers (Table 4.18). The study noted that creation of awareness and development of skills in this aspect would reinforce availability of vegetables in an enhanced environment.

**Table 4.18:** Methods used to cope with droughts

| **Method** | **N** | **% of Responses** |
|---|---|---|
| Mulching | 67 | 17.1 |
| Irrigation | 276 | 70.4 |
| None | 49 | 12.5 |
| **Total responses** | **392** | **100.0** |

The findings of this section revealed the contributions of AIVs to the livelihood of the households by highlighting the livelihood outcomes. These are in the domains of increased vegetable security. With policies and institutions in place, increased vegetable security could be a reality throughout the year. Availability of vegetables throughout the year would boost a farmer's income, thus enable him to purchase other livelihood needs. It would also guarantee a diversified source of income, a parameter in poverty alleviation. Vegetables on-farm enhance agro-biodiversity which indirectly leads to a sustained agro ecosystems. Vegetables provide different nutrients to the human body; their availability implies increased well-being in terms of nutrition, social inclusion and economic empowerment. The coming together of farmers in SHGs was definitely a social empowerment, enabling them to participate in decision-making, a prerequisite component to participatory approach for poverty reduction in rural areas.

### 4.5: Local Knowledge and Cultivation of AIVs

Local knowledge is a collection of facts and relates to the entire system of concepts, beliefs and perceptions that people hold about the world around them. It includes the processes whereby knowledge is generated, stored, applied and transmitted to others. Local knowledge is a human capital, a main asset that people invest in their endeavour to survive, to produce food and to achieve control of their own lives (www.fao.org/sd/links). Local knowledge is passed on from generation to generation; it is closely interwoven with a people's cultural values. For sustainable development, the ability of a people to understand and be able to use their local knowledge is imperative. Local knowledge encompasses the skills, experiences and insights of people, applied to maintain or improve livelihood.

The type of knowledge people have is related to their age, gender, occupation, labour division within the family, enterprise or community, socioeconomic status, their experience, environment and history (www.fao.org/sd/links). Based on this understanding, the key informants whose information contributed to this section were elderly women aged 50 years and above and who were known in the community as people involved in the cultivation and/or selling of AIVs. Results were also consolidated from FGD, and Section E of the structured questionnaire (Appendix I). Local knowledge assembled for this study is related to knowledge of names and utilisation of gathered, cultivated and semi-cultivated vegetables, land preparation, *in situ* conservation through seed selection and strategies for seed conservation, cropping patterns, planting times, harvesting and preparation of the vegetables.

#### *4.5.1: Names and Utilisation of Gathered Vegetables*

Respondents were asked to name plants that the community did not usually cultivate but were collected from the wild for use as vegetables. The findings show various vegetable species as gathered from the wild. Vine spinach (*B. alba*), *E. atroviriens*, *C. bengalensis* and pigweed are among the many wild species that were considered as gathered from the wild or semi-cultivated. The researcher noted that although vegetables such as jute mallow are cultivated,

there are still varieties which grew wild and people used them during drought, a time when cultivated vegetables were in low supply. Some of the vegetables mentioned are cultivated in some areas and not cultivated in others. According to key informants (the elderly women), *C. bengalensis* and *C. africana* and pigweed are among the many semi-cultivated vegetables that are uprooted during weeding. Species such as African nightshade when found in the garden are pruned for continued use.

It is interesting to note that some of the respondents were unable to name any vegetable they considered as wild. This is interpreted to mean lack of sufficient knowledge due to absence or rarity of the gathered vegetables in the study area. Indeed, according to key informants (the elderly women), certain vegetables that were used before are no longer used as vegetables, because they were rare, their habitats having been destroyed with the advent of sugarcane farming. Analysis of responses from key informants showed that the preparation and use of some of these gathered AIVs was part of cultural heritage and pride that played a significant role in customs and traditions. People found an identity by referring to certain vegetables as '*our vegetables*'. This identified the individual with the community. According to key informants, gathered species such as *B. alba*, are rarely used today because of their unavailability occasioned by habitat destruction. Indeed, they are rated to be among those on the verge of disappearing.

According to the key informants and the FGD, the vegetables in the category of gathered or wild vegetables were very useful, especially the time when the community would suffer droughts. Accordingly, they were a fall-back strategy to cope with drought. The vegetables are now threatened with loss due to habitat destruction, social factors including taste preference, access and utilisation dynamics that work together to exclude users. Discussion with key informants revealed that habitat destruction streaming from human activities and population pressure compelled people to cultivate places that would otherwise be left in the natural state for years having harboured wild vegetables such as vine spinach. Species of this kind are now endangered or threatened

with extinction from the community. The present findings are in line with other researchers who observed the same (Munzara, 2007; Maundu *et al.,* 1997; Abukutsa, 2007). A reduced usage of such vegetables for whatever reasons compromises the ability of a household to access a cheap source of livelihood during drought in terms of food and nutrient sufficiency. It also alters people's sense of cultural identity, leading to a breakdown in intergenerational transmission of knowledge, because IK is built up through generations of living in close proximity and contact with nature (Johnson, 1992).

When asked what the community was doing to save the endangered species, one key informant of Imanga sub-location remarked:

> "... some vegetables gathered from the wild are now becoming domesticated and now that they are rare, they are being sold on the market. To my surprise, I have seen vine spinach being sold; this was a vegetable we would go collecting from the riverine forest during dry seasons and use it. Now that the forests have been cleared, one can hardly find them."

This remark is a pointer to the fact that selected varieties of AIVs are being domesticated and that the domestication is driven by market economy. Although it is true – as observed by different studies – that the habitat of the wild vegetables continue to suffer deterioration, this study contented that continued availability of these vegetables will be supported by domestication and market economy.

### *4.5.2: Cultural Methods Used to Establish African Indigenous Vegetables*

Key informants who were elderly women aged fifty years and above were each asked to explain how the vegetables were being maintained on the farm. The information was recorded and later transcribed. The results showed that although the care of the AIVs is almost the same, there are species-to-species differences. It was noted that for most of the vegetables, suitable fertile land was necessary. There were those AIVs such as African nightshade, non-cultivated black-berried *S. nigrum* which volunteered. However, even these thrive in rich soils. The land for cultivating the vegetables should be prepared well by digging and reworking it to have smooth soil in which the seeds can be

planted. The seeds of most of the vegetables are tiny, except for the pumpkin and cowpeas. The cowpeas are planted by broadcasting or in farrows. For slender leaf vegetable species and all the other common AIVs that this study focused on, the seeds are mixed with dry smooth soil or ash before planting. This enables the seeds to spread out evenly and avoid congestion on germination. It was noted that for some vegetable species such as the jute mallow, notwithstanding all other conditions necessary for germination, including moisture, the seeds could stay in the soil for a very long period before germination. Appendix VI shows an account given by key informants on cultivation of AIVs.

When asked how one would ensure that the crop did well, the participants in the FGD (Ebwaliro Women group on 14th April 2012 and Shallomat SHG on 23rd June 2012) affirmed that it would entail proper land preparation; followed by planting of seeds. This was to be coupled with good supply of water and proper harvesting procedures. Pruning needed to be done on time, if the vegetables would be required on the farm for a longer period of time. If the crop was meant to be for seeds, minimal harvesting was to be done selectively, leaving stronger crops un-harvested. According to key informants, to increase quantity and quality of seeds produced, the vegetable would require pruning.

According to key informants, vital information on management of AIVs was often encoded during day-to-day cultivation activities. IK was transmitted vertically from mother to daughter as they tilled the land, pruned the vegetables and also horizontally, through oral communication, imitation and participation in communal activities. This was confirmed by the results obtained when respondents to the questionnaire were asked to state the means by which information on the need to cultivate vegetables was transmitted (see Table 4.19). An overwhelming 89.2% indicated learning about cultivation of AIVs informally, where learning resulted from daily life activities. They learned cultivation of vegetables as a common practice from childhood. Oral transmission constituted 5.2% of responses. Use of media for transmitting

messages about AIVs was rather remote with only 0.6% having been made aware through radio and newspapers.

**Table 4.19:** Awareness on Cultivation of Indigenous Vegetables

| **Information source** | **Code** | **% responses** |
|---|---|---|
| Common practice from childhood | 1 | 89.2 |
| Word of mouth by other farmers | 2 | 5.2 |
| Radio, newspapers | 3 | 0.6 |
| Extension Officer | 4 | 5.0 |
| **Total** | | **100.0** |

According to Rajul (2008) loss of IK leads to loss of biological diversity as well. Most respondents (89.2%) learned about the importance of indigenous vegetables informally, knowledge being passed on through work and common community practices that engaged people at different times and settings hence transmission of knowledge from one person to another and from generation to another. This study contented that continued cultivation would facilitate faster transmission of knowledge. To realise this, however, it is important that knowledge about AIVs and their cultivation be transmitted more effectively by being incorporated in formal and non-formal environmental education curricula. In this way, individuals would be given an opportunity to acquire knowledge, values, attitudes, commitment and skills needed to conserve genetic material contained in AIVs, thereby enhancing agro-biodiversity conservation.

### 4.5.3: *In Situ Conservation through Seed Preparation and Selection*

#### *4.5.3.1: Criteria for Seed Selection*

Respondents were asked to choose the factors they would consider when selecting seeds for planting. The results showed that a farmer would base the selection on various factors depending on the vegetable species to be planted. The FGD (Ebwaliro women group on the 14th April 2012) affirmed that even in the same species, there were varieties which a farmer needed to know besides

an understanding of the proper season for which the seeds are to be planted. For all the species under consideration, the colour of the seeds was a main criterion (see Figure 4.18).

AIVs are varied; even in the same species, there are peculiar varieties that a farmer needs to know about to make informed decisions before cultivation. The varieties are selected on the basis of colour of seeds, ability to withstand low rainfall amounts, market value of the species, ease and varieties in cooking of a vegetable, and flexibility in being mixed with other vegetables in making cuisine. There are species that cannot resist common pests. There are vegetables planted because of the taste; there are others planted due to other reasons such as their propensity to be intercropped with other crops. These show the rich culture of the people with regard to cultivation and using vegetables.

It was observed that the colour of seeds is an important factor considered and used to guide a farmer on the type and species variety of the vegetable to be planted. There is colour variability within and between species of a particular vegetable. There are vegetable species best suited for the long rains, short rains and even limited rainfall situations. A farmer needed to have this knowledge to cultivate the correct variety for the expected weather conditions to avoid poor or no yields.

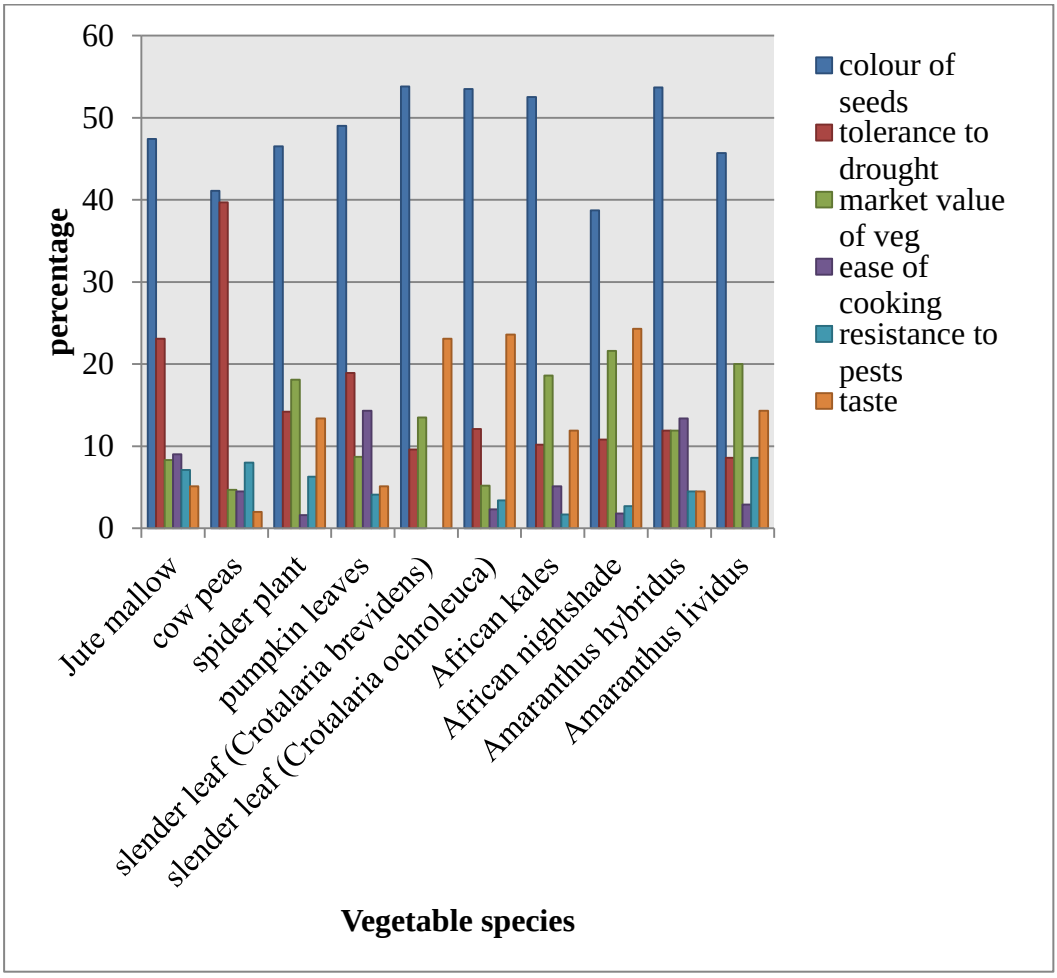


**Figure 4.18:** Criteria for selecting seeds for planting

According to key informants (the elderly women), cowpeas seeds come in various colours. The colour is important in knowing which variety is suited for which season. For instance, the black seeds known in the catchment language as '*nalulande'* were viewed to be best suited for all season. They could persist for a long time and could also be intercropped with crops such as maize. *'Matunguru'*, on the other hand, are brown in colour and were viewed to be mainly planted during low rainfall season. *'Namungulu'* are grey in colour and are short-lived. These were viewed to be suitable for planting during heavy rainfall season. It is important that a farmer has this kind of knowledge to facilitate planting the right seeds at the right time, to sustain the vegetable both for home consumption and for sale if necessary, and for agro-biodiversity conservation.

Cowpeas is considered a vegetable for '*all seasons and homes*' as was remarked by one of the participants in the FGD (Shallomat SHG on 23th June 2012). This is because it can be cultivated throughout the year as long as the farmer understands which colour of seed to plant during which season. Other critical information includes the vegetable being cooked in different ways, mixed with other vegetables. For example, jute mallow, slender leaf, amaranthus, African nightshade can be mixed with other vegetables or can be cooked without mixing it with any other vegetable. AIVs, as remarked by one key informant from Isongo sub-location, could also be cooked with or without oil, making them suitable for those on oil-free diets.

Spider plant was known in the study area to be of two varieties, the difference being the size of the seeds: according to a key informant, they are 'tsisaka tsia abamia' and 'tsisaka tsieshiwanga' (the naming was based on the origin of the variety). The former have long leaves with yellow stems while the latter have wide leaves with brown stems. According to key informants, slender leaf exists in two types: *C. brevidens* and *C. ochroleuca*. The former is bitter in taste. The colour of seeds and preference in taste is used to select the variety to be cultivated. Some vegetable seeds are selected based on the market value of the vegetable variety, with some not given much preference. A case in point is a variety of jute mallow known to grow wild. This was rated to have low preference in selection.

Focused Group Discussion revealed that various types of vegetables had different processes of seed harvesting and vegetable preparation. The farmer would require technical IK to be able to select the right seeds, for the right season or else plant growth and genetic diversity would be adversely affected.

As an overview the varieties were thus selected on the basis of:

1. Colour of seeds
2. Ability to withstand low rainfall amounts
3. Market value of the species

4. Ease and varieties in cooking/ability of a vegetable to be mixed with other vegetables in making cuisine.
5. Vulnerability to attack by common pests
6. Taste
7. Ability to be intercropped with other crops

### *4.5.4: Seed Acquisition*

Results from the questionnaire, FGD and key informants showed that seeds for the various AIVs were either purchased on the market, or produced by the farmer on-farm and in very few instances, obtained from agro-shops or from the community (see Table 4.20). Majority of the respondents (74%) indicated obtaining seeds from the open markets, a few (25.1%) relying on neighbours and friends while a mere 0.7 % relied on agro-shops.

**Table 4.20:** Sources of Seeds

| Source | N | % of Responses |
|---|---|---|
| Market | 316 | 74.0 |
| From previous harvest (prepared by self) | 107 | 25.1 |
| Community - neighbours, friends | 1 | 0.2 |
| Agro-shops | 2 | 0.7 |
| **Total responses** | **427** | **100.0** |

Evidently, a large percentage of farmers obtained seeds from the open market, with a few others obtaining from neighbours, friends and relatives. This shows that farmers actively exchanged seed material, moving crop genetic diversity across households. Respondents totalling 25.1% recorded sourcing seeds from their own previous harvests. According to key informants, seed selection from vegetables on-farm involved observing the vegetable crop as it matured, selecting and sparing crops that appeared healthy for light pruning. When the seeds were mature, they were harvested, dried and depending on the vegetable species; ash would be added to preserve them for planting. This IK and farmer

participation in selecting new genotypes, harvesting and preparing seeds were necessary for crop development. The act of plant material selection for production of seeds enhanced genetic diversity. Although the primary goal of the farmer was for use and not conservation, the practice promoted conservation. Accordingly, use and conservation were interdependent (Pentasso *et al.*, 2012). Conservation approached in this sense gave the local farmer a locus of control; it enabled the farmer to conduct his or her own analyses and define his or her own priorities. Success of such undertaking depends on the IK that the farmer has. The use of certified seeds from agro-shops is low, with only 0.7% of cases having had an opportunity to use this source. Seeds from agro-shops are certified and considered to be of higher quality. The low rate of use can be attributed to the cost and the fact that farmers are able to prepare their own seeds on the farms.

### *4.5.5: Qualities of Different Vegetable Species*

Respondents were asked to rank vegetables cultivated in order of preference and show reason for ranking. Table 4.21 is a summary on qualities attached to the various vegetables.

Based on these results, cowpeas were the most preferred vegetable followed by African nightshade and pumpkin leaves. The least in preference were African kales and slender leaf (the bitter variety). Cowpeas were preferred because the vegetable takes a short time to cook, it is in season all year, can be combined with other vegetables in food preparation and can be prepared in many ways. Slender leaf's preference was low because of its taste and it takes time in preparation before cooking. Table 4.21 shows that a vegetable has both good and poor qualities. These qualities are important in the selection or choice of a vegetable by the consumers

To triangulate the information, key informants (the elderly women) were asked the same question (to give reasons for liking a particular vegetable). Responses showed that people attach different values to different vegetables. Discussions revealed that vegetables perceived to be bitter – such as slender leaf (the bitter

variety) – and African nightshade are detested by the younger generation and yet liked by the older generation. An intervention is required to ensure continuity of the affected species. This study noted that the older generation cultivated AIVs as part of tradition and value attached. The younger generation would, however, be motivated to cultivate and consume if recognition of the affected species is deliberately planned for. Creation of awareness could be done through campaigns and use of special days such as the 'Abaluyia day'.

Vegetables that can be combined with others are liked, for example, cowpeas and pumpkin leaves. The knowledge that some vegetables are medicinal was with the elderly people, especially so the key informants. This observation was also made by Keller, *et al.,* (2004) who noted that names of many wild traditional vegetables and their uses were often only known by elderly women; yet, the knowledge was not with the young generation. Time taken to prepare the vegetable is an indicator of whether the vegetable will be preferred or not. According to an FGD, the younger generation preferred vegetables such as *sukuma wiki* (kales), which can be prepared and cooked fast. Many were abandoning cultivation of AIVs for *sukuma wiki* which also had a variety that is perennial unlike the common AIVs. This study noted that innovative practices such as preparing the vegetables into a ready-to-cook state at the selling point would enhance consumption by those who considered preparation to be time consuming. Hygienic and proper packaging would also appeal to consumers.

**Table 4.21:** Some qualities of Vegetables

| Vegetable species | Good qualities | Poor qualities |
|---|---|---|
| 1. Jute mallow | Takes a short time to cook<br>It is easy to cook<br>It can be combined with others in food preparation | Its mucilaginous appearance when cooked puts some people off. |
| 2. Cow peas | It is easy to cook<br>It takes a short time to cook<br>It is in season all through<br>It can be combined with other vegetables in food preparation<br>It can be prepared in many ways | Many types; one can easily plant wrong seeds that are not meant for the season. |
| 3. Spider plant | Medicinal.<br>It can be combined with others in food preparation | Some people react to the vegetables |
| 4. Pumpkin leaves | It is easy to cook<br>It is medicinal.<br>It can be combined with other vegetables in food preparation | |
| 5. Slender leaf(bitter) | Some people consider it to be medicinal | It is considered very bitter<br>It takes time to prepare before cooking |
| 6. Slender leaf | It is easy to cook<br>It can be combined with other vegetables in food preparation | It takes time to prepare before cooking |
| 7. African kales | It can be mixed with other vegetables in cooking | It takes time to cook<br>Many of the younger generation are not conversant on how to prepare |
| 8. African nightshade | It is considered nutritious | The younger generation detest the bitter taste |
| 9. Amaranthus | It is used on special occasions | |

## 4.6: Challenges and Opportunities Existing in Cultivation of AIVs

This section discusses opportunities and challenges in maintaining indigenous vegetables on the farm. The section answers the question, *"What opportunities and challenges exist in the cultivation of indigenous vegetables?"* The findings are generated from FGD, key informant interviews and Section F of the questionnaire (Appendix I).

### *4.6.1: Challenges Facing Production of AIVs*

According to the FGD, the general perception was that most of the AIVs were on the declining trend, with more people tending to prefer exotic vegetables,

especially *sukuma wiki*, which at the time of field survey was cultivated in almost every homestead visited. The only AIV whose cultivation seemed to be on the increase was cowpeas (see Figure 4.19).

*4.6.1.1: Reasons for the Declining Production*

When respondents were asked in the FGDs to describe challenges underlying the decline, they reckoned that seeds for some vegetables such as the African nightshade were not easily found. The AIV species grew as a wild vegetable in cultivated fertile land which according to focus group discussions were seldom found as such lands were occupied by sugarcane. Scarcity of land was seen as another factor accounting for the decline. Most of the land was occupied by sugarcane limiting cultivation of other food crops leave alone AIVs. Preference given or not given to the vegetable was observed to be a major reason as well. Changing seasons was also a factor the discussants felt contributed to decline in production. Lack of knowledge and appropriate skills for preparation and cooking of the vegetables was also given as a reason. These results are in line with other researchers such as Netondo *et al.*, (2010), Keller *et al.,* (2004) and Abukutsa, (2005 and 2007), among others who share the observations made.

According to the responses in the questionnaire, FGDs and key informants, explanatory factors for the decline in production and consumption of AIVs largely depended on food preferences of individual households. A vegetable that is liked by households and is on high demand on the market is likely to be cultivated more for reasons of income and food sufficiency. Change in preference is a factor that is socioeconomic in nature. Some people due to either lack of time (indigenous vegetables require more time for preparation) or lack of skill may shift towards vegetables that can easily be prepared in the shortest time available. This would cause many to shift towards vegetables such as *sukuma wiki* and cabbages. There are, however, vegetables such as the African nightshade, thought to be on decline yet people showed preference for it. This can be occasioned by lack of seeds, as a result of scarcity of fertile land and skills needed for selection and preparation of the seeds. Land scarcity leads to loss of natural habitat and soil fertility due to over cultivation. These, among

other factors, are responsible for the decline of AIVs. This is especially so for the semi-cultivated vegetables such as the African nightshade and vine spinach (*B. alba)* which would do well in fallow land and in the riverine forests respectively; they are seldom present due to pressure on land, weather-related factors such as hailstones and unpredictability of rains which was also mentioned. This is a pointer to vegetable farming orientation that is dependent on rain-fed agriculture and which is quite vulnerable to weather changes.

Respondents were asked to fill a matrix showing vegetable and challenges facing production of the same on a scale of 1-4 with 1 = very high importance; 2 = high importance; 3 = moderate importance and 4 = low importance or not a challenge. This was done to consolidate the challenges the farmer faces with a view to proposing measures that could ultimately scale up production and hence on-farm agro-biodiversity conservation. The results obtained are shown in Figure 4.19. Based on the responses, five main challenges facing cultivation of AIVs emerged: market for produce, drought, pests and diseases, capital for seeds and finally, land scarcity. Let us discuss these challenges further.

*4.6.1.1 Markets for AIVs*

In the study area, a primary challenge was that of the market for the produce, especially in the event of overproduction. This was most prevalent during the rainy season. Those unable to reach larger markets would suffer exploitation by 'middlepersons'. The main market for the vegetables is in Mumias Town or the neighbouring towns depending on the sub-locations, for example, Musanda to Butere Town. When the rains were heavy, vegetable production was quite high as every farmer would be cultivating. Semi-cultivated vegetables such as amaranthus were seen as weeds hence weeded out. January through March is low rainfall period. Vegetables are scarce in such times hence demand outstrips supply. There is reduced effectiveness in ensuring vegetable security all year round. Opportunities for innovation exist to reverse this situation. The county government could educate the general population and extension workers to scale up services, leading to improved production of various species, processing, marketing and storage methods. This would realize increased

consumption, thereby contributing to food security, livelihood and on-farm conservation.

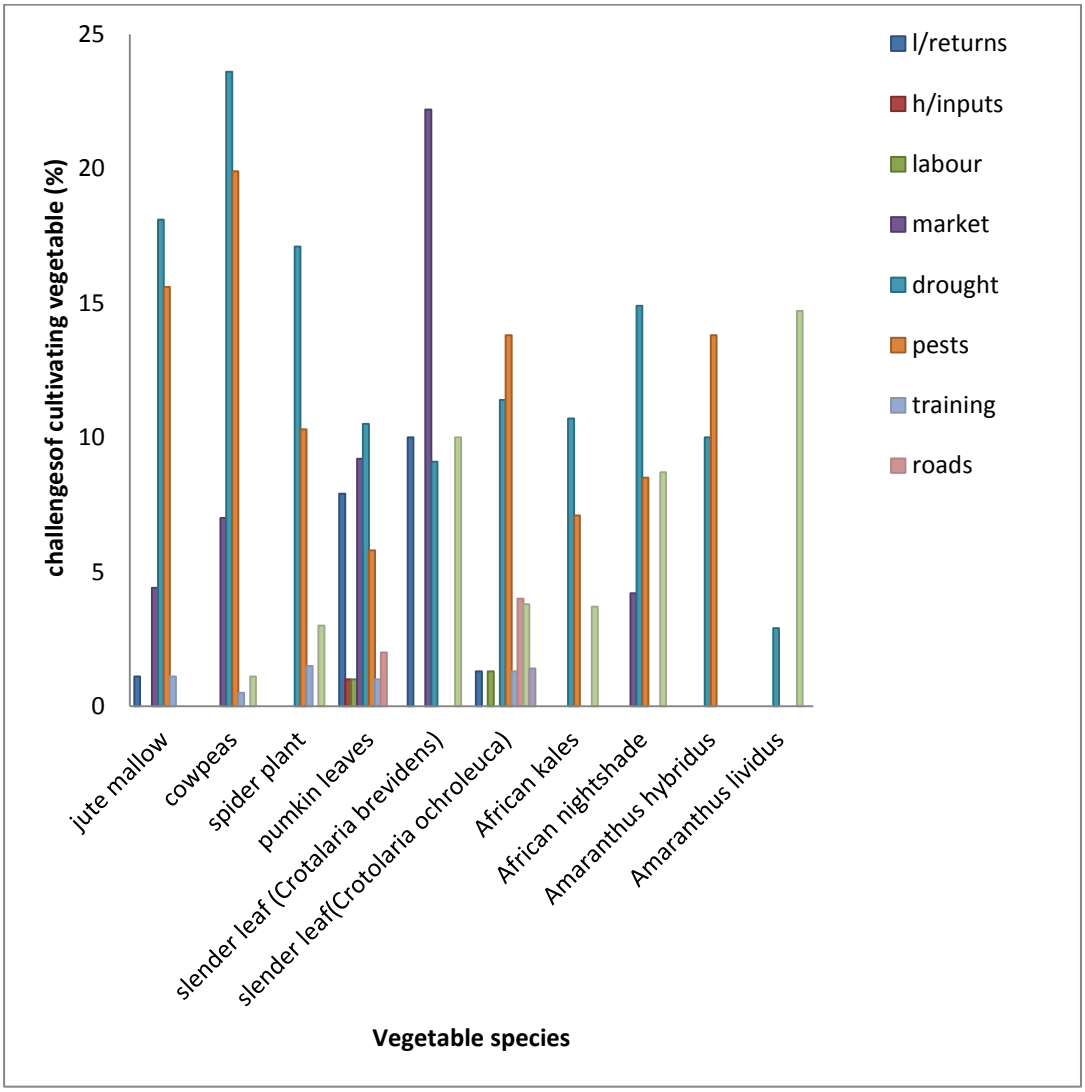


**Figure 4.19:** Challenges facing production of indigenous vegetables

*4.6.1.2: Drought*

The second challenge revolved around drought. Vegetables are fast growing crops; they require water to do so. In times when there is shortage of rain, vegetables easily wither rendering households vulnerable. The fast growth of vegetables requires that a lot of water is availed to enhance the growth. There are times when the study area experiences a season of low rainfall. According to the FGD, this is the best season for them because of the heightened demand

for the vegetables. Respondents gave their views about what they did when rainfall amounts were low. The majority (70.3%) practiced manual kind of irrigation. It is interesting to note that 12% of the respondents did nothing to enhance soil moisture. This explains why drought is perceived as a challenge because people in this category will be vulnerable during such times. As the main food for the people in this area, *ugali* is mainly accompanied with vegetables, beef, fish or chicken. Lack of vegetables would impoverish households even more because they would be required to buy them expensively from the open markets or from those producing using small scale irrigation. Indeed, there was a positive significant relationship between amount spent buying vegetables and size of households ($r = 0.318$, $n = 355$, $p = 0$). This means that if a farmer did not cultivate AIVs due to drought, the farmer would spend more money buying vegetables; the larger the size of household the more money will be required to buy the vegetables. This in itself adversely affects the livelihood of such a family.

Drought affects the amount and consumption patterns, with farmers preferring the cheaper and more available vegetable species. Opportunity exists for a mechanism that would avail water to the farms more cheaply to enable sustainable production. Conservation of rainwater and sustainable management of surface runoff that is a menace during rainy seasons are important practices that households can adopt assisted by CBOs and extension services.

*4.6.1.3 Pests and Diseases*

Pests and diseases came third as a challenge. Though indigenous and with adaptive capacity to environmental conditions of the area, the vegetables were reported to still be vulnerable to destructive attacks from some pests and diseases, thereby reducing their yields. Pests and diseases were reported to be a challenge to the community. Aphids were mentioned to be a problem to the vegetables, thereby affecting their health. According to farmers' experiences, sprinkling wood ash was the main method used to control the pests. None of the farmers reported using chemicals. Organic farming practices friendly to the environment were in use in the cultivation. Efforts by extension workers

would, however, further deepen an understanding of organic farming. This practice is critical in conserving diverse genetic material in the vegetables.

*4.6.1.4 Capital for Seeds*

Capital for seeds formed the fourth challenge. Though some farmers prepared their own seeds on the farm, some bought the seeds from open markets so as to plant. Although the average amounts bought were, however, quite minimal. The cost of seeds varies from one species to the other. Results showed that most farmers considered spider plant seeds to be the most expensive, followed by slender leaves and African nightshade in that order. The least expensive seeds were perceived to be jute mallow. Cowpeas seeds appeared to be expensive to some and yet not expensive to others. This reflected the popularity of the vegetable in the study area. It also indicated how available the seeds are in the study area. Those who carried out on-farm production did not view the seeds as expensive while those who regularly bought seeds viewed them as expensive. African kales and African nightshade seeds were not mentioned as least expensive. It was noted that although availability of African kales was on the decline in the study area, farmers did not take notice of the unavailability of seeds. African nightshade was supposed to be found in the wild. Very few farmers cultivated the indigenous type.

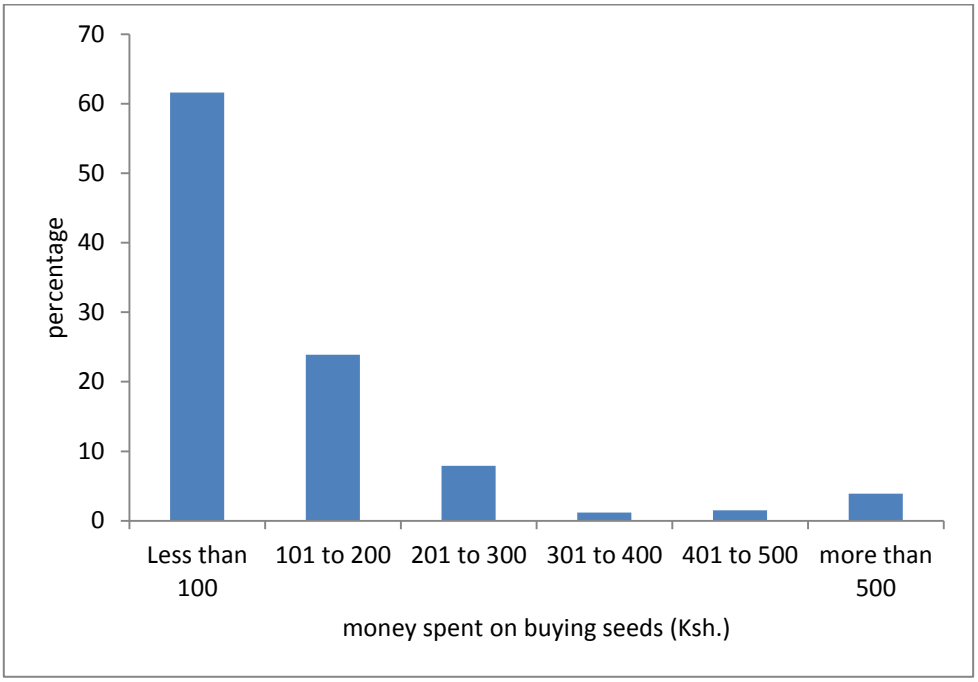


**Figure 4.20:** Cost of seeds

It is observed that inputs in terms of amount of cash in buying seeds was quite minimal, with many of the farmers spending less than KShs. 100 on seeds (see Figure 4.20). It was revealed that farmers produced their own seeds and would only buy the variety that a farmer did not produce and which he or she could have decided to cultivate. There was a positive significant relationship, though weak, between the amount of money spent on buying seeds and size of land under vegetables, ($r$ = 0.316, $N$ = 354, $p$ = 0.00). This shows that more land under vegetables called for increased cash input. A farmer supplementing buying of seeds would have to prepare his or her own seeds on the farm.

Farmers lost seed stocks through drought and other factors such as lack of knowledge on seed production technologies among other factors. ASARECA (2012) observed that seeds saved from previous crop or obtained from informal markets were often of poor quality; they were characterised with germination and purity level below 50%. Poor germination rate implied that farmers realised low yields per unit area. Low purity levels would compromise the quality in productivity of the vegetables. The amount of money spent on buying seeds was also found to have a positive relationship with financial gains

from the vegetables ($r$ = 0.324, $N$ = 301, $p$ = *0.00*). This means that the more the money a farmer spent on seeds the more the proceeds from the sale of vegetables. The square of the correlation coefficients ($r^2$) of the variables which gives an indication of the amount of variance linked to the variable was found to be low. As such, most of the variance is explained by other factors which in this case could include attitude towards the vegetable species. A seed stock produced by a SHG supported by a microcredit facility and technical knowhow from government agencies would help in conserving the different AIV species held by farmers. This would in turn assist in conservation of the genetic material ensuring as well availability.

*4.6.1.5: Scarcity of Land*

Finally, scarcity of land was mentioned as one of the challenges. Vegetables are cultivated in kitchen and home gardens. They were found to be intercropped with other crops. This was attributed to scarcity of land. Land for cultivation of food crops in the study area was said to be diminishing due to sugarcane cultivation and land fragmentation (Masayi and Netondo, 2012). The study established that the majority of the people had 2-4 acres of land. With the diminishing sizes, farmers would tend to produce vegetables that are preferred and relegate those with low preference. Education and concerted efforts to produce and consume AIVs would help reverse the situation. To maximise on this factor, the study observed that farmers needed to intensify production on the available land resource, enhance water availability and control pests.

*4.6.1.6: Causes of the Challenges Experienced*

When asked to state the causes of the challenges rated ‘of very high importance’ and ‘high importance’, respondents identified variability of seasons, poverty, overproduction and distance to markets as core causes of the challenges faced (Table 4.22). Farmers by use of experience and knowledge about the coming of rains would be prepared to plant vegetables at the start of the rains. Because of their fast growth, vegetables take three to four weeks on average to be ready for harvesting. With the variability in seasons, rains would

come when many farmers are unprepared for planting. This in essence is a challenge in the availability of the vegetables.

Adverse weather conditions, for example, floods experienced in the lowlands remained a challenge to the cultivation of AIVs. Observations of farms showed that some farmers planted vegetables in lowlands; these were prone to floods that damaged the crops, reducing yields and resulting to vegetable scarcity. In this way, adverse weather conditions undid the would-be gains from the vegetables, frustrating agro-biodiversity conservation and efforts to reduce poverty. Affected farms could neither produce seeds nor supply vegetables most needed at such a time. Indigenous knowledge about climate change adaptation need to be understood and be shared.

**Table4.22:** Causes of challenges

| **Causes** | **N** | **% of Responses** |
|---|---|---|
| Changing seasons | 254 | 56.7 |
| Pests and diseases | 94 | 21 |
| Poverty | 31 | 6.9 |
| Overproduction | 11 | 2.5 |
| Scarcity of seeds | 10 | 2.2 |
| Lack of market | 7 | 1.6 |
| Lack of land | 6 | 1.3 |
| Planting of canes and maize | 5 | 1.1 |
| Poor soils | 5 | 1.1 |
| Theft | 5 | 1.1 |
| Population increase | 4 | 0.9 |
| Ignorance | 4 | 0.9 |
| Short lasting | 3 | 0.6 |
| Preference and taste | 2 | 0.4 |
| Modern fertilizers | 2 | 0.4 |
| Poor roads | 1 | 0.2 |
| Takes time to grow | 1 | 0.2 |
| Inheritance | 1 | 0.2 |
| High prices for commodities | 1 | 0.2 |
| Weeding | 1 | 0.2 |
| **Total** | **448** | **100.0** |

Farmers also suggested ways of coping with the challenges. Responses showed that watering, spraying with chemicals and applying ashes on the affected plants would help address the problem of pests and diseases (Table 4.23). Extension education is, however, necessary to avoid misuse or abuse of farm chemicals which could have untold adverse environmental consequences that could downplay the conservation and livelihood efforts.

**Table 4.23:** Coping mechanisms

| **Strategy** | **N** | **% of Responses** |
|---|---|---|
| Watering | 136 | 35.7 |
| Spraying | 91 | 23.9 |
| Mulching | 65 | 17.1 |
| Reduce planting of cane and other crops | 14 | 3.7 |
| Look for money | 10 | 2.6 |
| Apply ashes | 19 | 5 |
| Wait for rains | 7 | 1.8 |
| Plant long term crops | 7 | 1.8 |
| Preserve seeds | 6 | 1.6 |
| Crop rotation | 5 | 1.3 |
| Create awareness | 5 | 1.3 |
| Work hard | 3 | 0.8 |
| Apply manure/fertilizer | 3 | 0.8 |
| Use available labour | 3 | 0.8 |
| Improve drainage | 2 | 0.5 |
| Put scare crows | 2 | 0.5 |
| Practice agro- forestry | 1 | 0.3 |
| Stop theft | 1 | 0.3 |
| Plant short term crops | 1 | 0.3 |
| **Total** | **381** | **100.0** |

### *4.6.2: Opportunities in Vegetable Production and Consumption*

To find out opportunities that exist in cultivation of AIVs, the study sought to establish qualities that predispose a preference for a specific AIV. Responses showed that a vegetable would be liked if it:

a) Was considered nutritious. African nightshade had the highest score of 63.5%.

b) Could easily be cooked. In this case, pumpkin leaves scored the highest with 37.6%.
c) Was considered medicinal. Leaf *amaranthus*, slender leaf and African nightshade had high percentage scores of 20.7%, 20.8% and 19.7% respectively.
d) Could be combined with many others in the same cooking pot. African kales, slender leaf and cowpeas had the highest scores of 22.1%, 17.7% and 16.7% respectively.
e) Took a short time to cook. Cowpeas had the highest score of 19.5%.s

These results showed that consumption of AIVs was influenced by predisposing factors that could be exploited to boost production. Awareness creation, equipping people with technical IK that would help to change attitude and create new patterns of consumption of AIV is important in reversing genetic erosion of agro-biodiversity. The role of extension education in this cannot be underestimated. This would contribute to increased consumption and increased cultivation. Keller *et al., (*2004) noted that knowledge determined not only which vegetables were cultivated but also how successful and for what purpose. In this case, knowledge about the usefulness of AIVs in terms of nutrition would stimulate vegetable cultivation and consumption.

There are certain AIVs that were used by lactating mothers. Such knowledge, however, was only with one of the key informants. This value of the particular vegetable, however, appears to have been lost with the advent of modern ways of increasing milk flow during lactation. Indeed, none of the respondents cited that as a reason for liking an AIV species. Information of this kind could, however, be taken up by researchers in developing food supplements using the vegetable. The medicinal attributes in some of the vegetables such as African nightshade, spider plant and slender leaf were opportunities that can be investigated further with a view to exploiting this potential in improving the health of the general population

The results of this section showed that AIV were once widely used basing on the many different species mentioned by the respondents to the questionnaire, key informants and discussants in the FGDs. The vegetables are becoming rare. The decline is, however, species specific occasioned by ecological, social agronomic, culinary and economic factors. Cultivation of cowpeas is on the increase because of the vegetable's popularity. The vegetable species exists in many varieties that are adaptable to diverse weather conditions. A farmer with the skills to identify the diverse types could be able to cultivate the species all year round. The popularity of cowpeas is also attributed to the fact that it could be cooked mixed with other vegetables; common mixtures being cowpeas, jute mallow and slender leaf. These results concur with those of Ekesa *et al*., (2007) who observed that cowpeas was the most preferred vegetable species in the neighbouring sub-county of Matungu. Vegetables such as African kales, African nightshade and spider plant were popular but their availability was however on decline.

The decline of specific vegetables such as the African nightshade, African kales and slender leaf (the bitter type) was attributed taste preferences, attitude, land pressure cost of seeds and lack of knowledge on cultivation and culinary aspects of the vegetables. It was reported that the younger generation perceive the said vegetables as bitter. The fact that these vegetables would be boiled and eaten without frying was interpreted to mean that the vegetables were for the poor. This stigmatised consumers of the vegetables to the extent of them shunning them, especially so with the younger generation. African nightshade was collected from uncultivated fallow lands or from around the cowsheds. With the advent of sugarcane cultivation and population increase, idle uncultivated land is not common anymore. This affected the availability of the vegetable (semi-cultivated), its consumption being limited to purchasing from the informal markets. The cost of buying the AIVs would be avoided by consuming what was available and in this case sukuma wiki; whose preparation and cooking time would take a shorter time. The bitter taste of

slender leaf (the bitter type) also contributed to its unavailability as many farmers chose to cultivate the variety that was less bitter.

The gathered species such as African vine had declined in availability. The reasons underlying the disappearance of the uncultivated species included habitat destruction, land pressure and attitude towards the vegetable due to changes in life-styles. Women would collect such vegetables as they collected firewood from the forests. The destruction of river bank forests was a challenge in the study area, cultivation having been done to the bank of rivers due to land pressure, consequently destroying the habitats of the gathered vegetables.

Securing the resource base for the AIVs is however crucial to maintaining the safety net diversification of food in terms of vegetables. Diversification of vegetables will enable sustainability and self-reliance of the households. Opportunities, therefore, abide in building the capacity of the farmers with the necessary skills and creation of awareness on the need for diversification for increased production, consumption and conservation of genetic resources.

# CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## 5.0: Summary

This chapter presents a summary, conclusions and recommendations made based on the study findings. Suggestions for areas for further research are provided towards the end of the chapter. Chapter One introduced the background of the study and set out the objectives and questions. It also presented the conceptual framework. Chapter Two reviewed literature and isolated gaps requiring further research. Chapter Three gave the background of the study area and the study design. It described the instruments and methods of data analysis and presentation. Chapter four reported the analysed data and discussion.

## 5.1: Conclusions

1. The study established that AIVs are cultivated in kitchen gardens which are less than 25% of an acre. Cultivation of AIVs have contributed to agro-biodiversity conservation by:
    a) Preserving genetic material in ten AIV species: *A. hybridus* (L). subsp. *cruentus*, *A. lividus* (L). subsp. *lividus*, *S. nigrum (*L). (African nightshade), *G. gynadra* (L) Briq (Spider plant), *B. junceae* (L) Czern (African kales), *C. maxima* (pumpkin leaves), *C. brevidens* (Kotscy) (Slender leaf, bitter type), *C. ochroleuca (*less bitter slender leaf*), V. unguiculata* (cowpeas), *C. olitorius* (L.) (jute mallow). The ten species belong to seven families; Amaranthaceae, Solanaceae, Capparaceae, Cruciferae, Curcubitaceae, Leguminosae and Tiliaceae. The occurrence of the vegetables at the time of field survey was variable. *V. unguiculata* (cowpeas) occurred most, cultivated by 83.1% of respondents. The two most infrequent cultivated AIVs were *C. brevidens* (Kotscy) (Slender leaf – the bitter type) cultivated by 4.3% of respondents and *B. junceae* (L) Czern (African kales) cultivated by 2.4% of respondents.

b) Preservation of genetic material in the various vegetable species. Lubinu sub-location had the highest Shannon-Weaver diversity index of 1.85 while Bukaya sub-location had the lowest diversity index of 0.69. The Shannon-Weaver diversity index across the sub-locations was low. Vegetable species such as African kales, slender leaf (the bitter variety), African nightshade and spider plant were absent in a number of sub-locations unlike cowpeas, pumpkin leaves and slender leaf, which were found cultivated in all the 14 sub-locations surveyed.

2. Five main factors promote cultivation of African Indigenous Vegetables in the study area.
   a) *Financial contributions to household livelihood by a vegetable species:* Farmers practice market gardening, though on small scale. Selling of the vegetables is volitional, informal and unstructured. The vegetables are sold mainly to consumers. The demand for AIVs is more pronounced during droughts, when vegetables are scarce in the market.
   b) *Diversification of AIVs for risk aversion:* A mean number of 3 species of AIV per farmer sampled was observed. Cultivation of variety is done to enhance variety and cushion a farmer against weather related vulnerabilities.
   c) *Availability of land and seeds*: The size of land on which AIVs were cultivated was determined by the land available for cultivation and the funds available for seed acquisition. AIVs were cultivated in small kitchen plots. The main cropping pattern was intercropping. The vegetable that was intercropped most with other crops or other AIVs was cowpeas. Spider plant seeds were considered the most expensive seeds, quantity of seeds bought was low. There was a positive relationship ($r = 0.314$, $N = 354$, $P = 0.000$) between the quantity of seeds bought and the land size under vegetables.
   d) *Household land size and demographic characteristics:* The mode acreage of land was between 2 and 4 acres of land. Large pieces of land allow for diversification. Increased land fragmentation is expected as a result of increasing population. Competing factors in AIVs production

was observed to be increased sugarcane production, land subdivision due to increasing household sizes and the shift to cultivation of more preferable exotic species such as kales. Smaller plots will result in reduced diversity of AIVs.

e) *Household vegetable sufficiency:* Fifty-six per cent of households had a household size of 6-10 persons. There was a positive, though weak, correlation between the household size and the amount of money spent on buying vegetables. A regression model y = 2.432 + 0.162x was obtained whereby for every rise of number of people in a household, there is a rise in expenditure on vegetables of 0.162 units. Farmers are expected to cultivate vegetables to be self-sufficient and to minimise expenditure on vegetables. The vegetable cultivated, however, will depend on many other factors including attitude that household members have towards a particular vegetable species.

3. African indigenous vegetables contribute to community livelihood through:

*a) Increase in food security through diversification:* The vegetables are consumed as an accompaniment to the staple food (*ugali*). The varieties of vegetables cultivated are necessary for diversification of vegetable diet. Production of the vegetables was in varied amounts, depending on the popularity of the species. People whose main occupation was agriculture and livestock keeping were found to have a variety of vegetables on their farms. Those in formal employment had fewer species on their farms. The latter have time constraints since cultivation of vegetables and preparation before cooking are time consuming activities. The most preferred vegetable for cultivation was cowpeas because of variety of sub species; each is adapted to different weather conditions. Consumption of vegetables such as *C. brevidens (*slender leaf – the bitter type), African nightshade and African kales in the study area was limited due to availability and taste preferences.

*b) Income to purchase other livelihood needs:* Cultivation of AIVs is not done solely for income. This study found out that farmers viewed all

vegetables except *C. brevidens* as having potential to earn income. A quarter of the farmers visited were actively engaged in cultivation of AIVs for income. The rest of the farmers sold their vegetables on an informal basis. Cultivation of AIVs provided farmers with diversification of income sources. There was a significant, though weak, positive relationship between land size under AIVs and percentage contribution to household income by AIVs (*r = 0.286, N = 296, P = 0.000).* Land size under AIV cultivation is one of the factors to consider if a farmer is to produce for the market.

4. *Provision of Sustainable natural resource base:* AIVs are a natural resource. Cultivation enhances the natural resource land; on which everyone depends for sustenance. Farmyard manure, diversification of vegetable species and provision of ground cover are processes that help in controlling soil loss which would otherwise compromise the sustainability of the natural resource base.

5. The Indigenous knowledge that has sustained the vegetables on farms was found to include the ability to:

   (a) Prepare land for vegetable cultivation.
   (b) Select and appropriately prepare the seeds. It entailed mixing seeds with ash or dry soil before broadcasting the seeds. This is done so that the seeds can spread out, avoiding congestion upon germination.
   (c) Use attributes of seeds such as their colour and size to distinguish vegetable species and even among cultivars of similar species.
   (d) Understand and practice appropriate cropping patterns.
   (e) Understand the appropriate time of thinning, pruning and weeding the vegetables for sustained growth.
   (f) Manage pests by using traditional methods.
   (g) Prepare the vegetables using traditional methods. Access to knowledge determines the type of vegetable consumed and by extension the vegetable cultivated.

(h) Utilise gathered vegetable species from the wild and cope with weather related changes as would be the case during droughts.

6. a) Constraints facing production of indigenous vegetables were found to be:

*i.* *Fluctuating market demand:* Production of vegetables in the study area is rain-depended. During the rainy season, production is high, with almost every farmer involved in cultivation. In such times, sales are low. During droughts, supply is very low; farmers who manage to cultivate are unable to adequately satisfy the market demand.

*ii.* *Drought:* Indigenous vegetables are fast-growing crops; they require water to do so. When there is shortage of rain, the vegetables dry out, jeopardizing the community's food security and livelihood.

*iii.* *Pests and diseases:* Although vegetables are indigenous and have adapted to the environmental conditions of the area, there are pests and diseases that attack and destroy the vegetables, especially cowpeas, thereby reducing yields.

*iv.* *Scarcity of land:* Indigenous vegetables are cultivated in kitchen gardens. Most of the land has been taken up by other food crops and sugarcane cultivation. To increase diversification for vegetable sufficiency and spread of risks, farmers have adopted intercropping and hiring of land from neighbours or relatives to cultivate.

*v.* *Vegetable preferences:* A vegetable is highly preferred if it is considered nutritious, can be cooked easily, is viewed to be medicinal, can be combined with many others and took a short time to cook. However, a vegetable attracts low preference if it is bitter in taste, has costly seeds or is difficult to prepare.

*vi.* *Inability to prepare indigenous vegetables using traditional methods:* There are vegetables that require special skills to prepare and cook. Those who feel unskilled are reluctant to either cook or consume them in their homes.

*vii.* *Distance between the farmer and towns such as Mumias where demand or market for indigenous vegetables is high:* Such distance is

conducive for manipulation by ‘middlemen’ who obtain vegetables from farmers at low prices, only to sell them at exorbitant prices.

(b) Opportunities that exist in indigenous vegetable production and consumption

This study established the motivating factors for consumption of AIVs to be the nutritional advantages of consuming the vegetable, ease with which a vegetable can be cooked, medicinal attributes of a vegetable and the likely combinations of culinary aspects attributed to a vegetable. The motivating factors form the basis for establishment of opportunities in improving production and consumption. The opportunities that exist are:

i. Education of masses to reveal the nutritional value of AIVs.
ii. Awareness creation on how best to cook the vegetables.
iii. Research to reveal the medicinal potency in vegetables such as spider plant and pumpkin leaves.
iv. Vegetable retailers to reduce the time required to prepare the vegetables by a consumer. This can be done by making preparation to begin at the selling point. This will encourage the consumers who due to time constraints are unable to buy the AIVs because of the intricacies and time involved in preparation.

## 5.2: Recommendations

To conserve indigenous vegetables is to contribute to conservation of agro-biodiversity which will go a long way in enhancing livelihood, sustaining the natural land resource, diversification of income and reduction of poverty. Indeed, this is in tandem with the theoretical framework that underpinned the study. Based on this premise the study recommends the following:

1. The study noted that there are AIV species that are on decline in production and consumption. This has affected diversity of the AIVs in the sub-county. To boost production and consumption and reverse loss of genetic material in the AIVs, awareness creation on the nutritional values, culinary aspects

of vegetables is necessary. This could be mainstreamed through formal and non-formal education. The Ministry of Education should mainstream concepts of AIV cultivation and conservation in the curricula.

2. The study noted that farmers are motivated by financial gains and household well-being in vegetable sufficiency to cultivate AIVs. Vegetables that are not favoured by these factors will be selected against and not cultivated, for example, vegetables that are bitter in taste are less preferred by the younger generation. Seed selection is an important process of maintenance of genetic varieties. Need arises for developing seed banks in the community and at the sub-county levels to avoid genetic erosion for the vegetable species that are on the decline due to changes in taste preference and change in lifestyles. This can be facilitated by community based organisations and NGOs initiating participatory and other improvement programmes to obtain the seeds.
3. There should be a socio-cultural motivation for the people to feel proud about their indigenous vegetables. People should be helped to rediscover the cultural value of cultivating and consuming AIVs by according special prestige to such traditions. This can be done using special community days like the Abaluyia day in which farmers are encouraged to show case variety of AIVs cultivation and culinary expertise.
4. There is need to develop the AIVs through government initiatives such as their use in school feeding programmes, or in the institutions such as hospitals and prisons to help promote consumption, provision of nutrients and conservation.
5. Vegetable production in the study area is rain-fed. This limits production only to periods when there is rainfall. Farmers can be educated on use of microfinance credit facilities to promote irrigation or rainwater harvesting technologies to conserve the water and use it when most needed during droughts. There is need to develop sustainable linkages and proper market infrastructure, credit facilities, education and capacity building to be addressed through extension education and line ministries at county level. This would enhance production, transportation and sale of the vegetables.

6. In demonstrating corporate social responsibility, the MSC, through the ODS section, should develop more roads in the sugarcane zones to enable farmers access markets. The company should also, through their education department, capacity build farmers on probable vegetables that can be intercropped with the canes and at what level of cultivation, to enable farmers intercrop compatible vegetables in sugarcane farms.
7. There is need to develop conservation policies that target subsistence farmers. Such policies should consider motivating farmers who will continue to cultivate vegetables that are not attractive to the market due to taste preferences.

**5.3: Suggestions for Further Research**

1. This study concentrated mainly on the cultivated indigenous vegetables. There is need to research and model the levels of gathered wild vegetables and their contributions to agro-biodiversity conservation.
2. Women play a special role in agro-biodiversity conservation. A study on their role in indigenous vegetable cultivation and agro-biodiversity conservation is essential.
3. There is need to investigate the effectiveness of different cropping patterns in agro-biodiversity conservation.
4. Research should be directed to the soil biota in AIV cultivation and agro-biodiversity conservation.

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# APPENDICES

## Appendix I: QUESTIONNAIRE

Questionnaire no._____

Name of Research Assistant_____

| Sugarcane Zone | Location | Sub location | Village |
|---|---|---|---|
| | | | |

**A: Respondent's Background Information**

1. Gender of household head/respondent: Please tick as appropriate
   - 1 Male ☐
   - 2 Female ☐
2. Age of household/responded (in years)
   - <18 ☐
   - 19-30 ☐
   - 31-40 ☐
   - 41-50 ☐
   - 51-60 ☐
   - Over 60 ☐
3. Household Population size
   - Male (number) ☐
   - Female (number) ☐
4. Respondent's marital status
   - Married ☐
   - Single ☐

Widow ☐

Separated ☐

5. Type of land ownership

1. Ancestral ☐
2. Bought ☐
3. Rented ☐
4. Others (please specify)

_____

6. Size of household farm (in acres)

< 2 ☐

2-4 ☐

5-7 ☐

8-10 ☐

11-13 ☐

14-16 ☐

17-19 ☐

>20 ☐

7. Highest level of formal education

Not attended formal education ☐

Primary school ☐

Secondary school ☐

College ☐

University ☐

8. Household head main occupation.

Agriculture and livestock ☐

Business ☐

Formal employment ☐

Informal employment ☐

Agriculture/Lives/Formal employment ☐

Agriculture/Lives/informal employment ☐

Agriculture/livestock/business ☐

Others (specify)

_____

9. Spouse's main_occupation. These two questions should go to bio-data section

Agriculture and livestock ☐

Business ☐

Formal employment ☐

Informal employment ☐

Agriculture/Formal employment ☐

Agriculture/informal employment ☐

Agriculture/livestock/business ☐

Other (specify) _____

8. Apart from sugarcane, what crops did you grow on your farm in the last 12 months? Tick the crops.

Beans ☐

Simsim ☐

Maize ☐

Millet ☐

Groundnuts ☐
Bambara nuts ☐
Cassava ☐
Bananas ☐
Sweet potatoes ☐
Indigenous vegetables ☐

**B: Indigenous Vegetables (Tick as appropriate)**

1. Do you plant indigenous vegetables on your farm?

   Yes ☐
   No ☐

   If "yes", go to number 2b of this section; If No, answer number 2a and then end.

2. (a) If you do not grow any of the indigenous vegetables on your farm, why is it so?

   Reasons for non-cultivation (please tick as appropriate)

   Size of land is small ☐
   Soil infertility ☐
   Changes in consumption tastes and preferences ☐
   Pests and diseases ☐
   Labour intensiveness ☐
   High cost of seeds ☐
   Theft ☐
   Hailstones ☐
   Water unavailability ☐
   Unfavourable weather ☐
   Lack of Awareness campaigns ☐
   Others (Please specify)

   _____

(b) Which of the following indigenous vegetables have you grown on your farm in the last 12 months?

| Vegetable | Grown on your farm in the last 12 months | Present on farm |
|---|---|---|
| Jute mallow (*omurere*) | | |
| Cowpeas (*likhubi*) | | |
| Spider plant (*tsisaka*) | | |
| Pumpkin leaves (*lisebebe*) | | |
| Slender leaf (*emiro emilulu*) | | |
| Slender leaf (*emiro emibobo*) | | |
| African kales (*kanzira*) | | |
| African nightshade (isutsa) | | |
| Leaf *amaranthus* (*litoto lia nabanyolo*) | | |
| Leaf *amaranthus* (*litoto lia namkasa*) | | |
| Others (please specify) | | |
| No of types on farm | | |

3. How is awareness of various indigenous vegetables created in this locality?

   Common practice from childhood ☐

   Word of mouth by other farmers ☐

   Radio, newspapers etc ☐

   Extension officer education ☐

4. What major aspect was emphasized in the awareness creation message?

   Nutrition benefits of indigenous vegetables ☐

   Having seeds for future ☐

   Medicinal value of the vegetables ☐

Income gained in selling the vegetables ☐

Saving money for buying from the market ☐

5. What is the size of your land under indigenous vegetables?

   Kitchen garden (less than 1/4acre)

   ¼ acre ( )

   ½ acre ( )

   ¾ acre ( )

   More than ¾ acre ( )

**C: Farming Systems**

1. Where on your farm do you plant your indigenous vegetables and why? Choose ratings shown below the table:

| Indigenous vegetable | Where grown on your farm | Reason |
|---|---|---|
| Jute mallow (*omurere*) | | |
| Cowpeas (*likhubi*) | | |
| Spider plant (*tsisaka*) | | |
| Pumpkin leaves (*lisebebe*) | | |
| Slender leaf (*emiro emilulu*) | | |
| Slender leaf (*emiro emibobo*) | | |
| African kales (*kanzira*) | | |
| African nightshade (*isutsa*) | | |
| Leaf *amaranthus* (*litoto lia nabanyolo*) | | |
| Leaf *amaranthus* (*litoto lia namkasa*) | | |

1= on the fence; 2 = intercropped with other crops; 3 = kitchen garden

2. Where do you get seeds for the indigenous vegetables?

   Market ☐

   From previous harvest (prepared by self) ☐

Community-neighbours, friends ☐

Agro shops ☐

Ministry of agriculture ☐

Others (Please specify)

_____

3. How much do you spend on seeds?

_____

4. Which seeds are:
   a) Most expensive:

      _____

   b) Least expensive:

      _____

   c) Who normally buys seeds?

      _____

   d) How much is bought in terms of grams? (Estimate using the 250gm measuring tins):

      _____

5. What criteria do you consider when selecting seeds for planting? Tick (√) as appropriate.

| Vegetable | colour of seed (1) | tolerant to drought (2) | market value (3) | ease of cooking (4) | Pest resistance (5) | taste (6) | Others (specify) (7) |
|---|---|---|---|---|---|---|---|
| Jute mallow (*omurere*) | | | | | | | |
| Cowpeas (*likhubi*) | | | | | | | |
| Spider plant (*tsisaka*) | | | | | | | |
| Pumpkin leaves (*lisebebe*) | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Slender leaf (*emiro emilulu*) | | | | | | | |
| Slender leaf (*emiro emibobo*) | | | | | | | |
| African kales (*kanzira*) | | | | | | | |
| African nightshade (*isutsa*) | | | | | | | |
| Leaf *amaranthus* (*litoto nabanyolo* | | | | | | | |
| Leaf *amaranthus* (*litoto lia namkasa*) | | | | | | | |

6. What methods do you use to improve soil fertility of the farm on which you grow the indigenous vegetables?

   Artificial fertilizers ☐
   Manure ☐
   Crop rotation ☐
   Application of crop residues ☐
   Addition of house refuse ☐
   Mulching ☐
   Others (specify)

   ____

7. What methods do you use when there is no rain for your indigenous vegetables?

   Mulching ☐
   Irrigation ☐

None ☐

Others (Please specify)

_____

**D: Contribution of Indigenous Vegetables to Community Livelihood**

1. Do you get any benefits from cultivating indigenous vegetables?

   Yes ( )

   No ( )

2. If Yes, mention the benefits.

   Finances ☐

   Food ☐

   Medicine ☐

   Not Applicable ☐

   Cultural (Please specify)

_____

3. If there are some financial gains, how much cash have you received from the vegetables in the last 12 months

   <1000 ☐
   1000-2000 ☐
   2001-3000 ☐
   3001-4000 ☐
   4001-5000 ☐
   >5000 ☐

4. If you were to buy vegetables for use in your household, how much do you think you will spend per month?

   <500 ☐
   501-1000 ☐

1001-1500 ☐
1501-2000 ☐
>2000 ☐

5. What percentage contribution to household income per months is from indigenous vegetables?

1-20 ☐

21-50 ☐

51-70 ☐

71-90 ☐

91-100 ☐

6. What needs have you been able to solve in your household using income from sale of indigenous vegetable

_____

7. Indicate the reason for which you plant the vegetables shown. Use the key shown below the table.

| Indigenous vegetable | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Jute mallow (*omurere*) | | | | | |
| Cowpeas (*likhubi*) | | | | | |
| Spider plant (*tsisaka*) | | | | | |
| Pumpkin leaves (*lisebebe*) | | | | | |
| Slender leaf (*emiro emilulu*) | | | | | |
| Slender leaf (*emiro emibobo*) | | | | | |
| African kales (*kanzira*) | | | | | |
| African nightshade (*isutsa*) | | | | | |
| Leaf *amaranthus* (*litoto lia* | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| *nabanyolo*) | | | | | |
| Leaf *amaranthus* (*litoto lia namkasa*) | | | | | |
| Others (please specify) | | | | | |

Use the ratings and tick (√) as appropriate:

1 = for home consumption; 2 = for income; 3 = both for home consumption and for income 4 = medicinal; 5 = it is cultural

**E: Status of Indigenous Knowledge in Cultivation and Consumption of Indigenous Vegetables**

1. Which indigenous vegetables were popular in this locality in the late 1980s and are at present not popular?

   ---------- ----------

   ---------- ----------

   What are the reasons for this?

   ----------

2. Which indigenous vegetables were collected from the wild (not cultivated)?

   ---------- ----------

   ---------- ----------

   Of these vegetables which ones are no longer used?

   _____

What are the reasons for this?

_____

3. What are the meanings of the names attached to the various indigenous vegetables of this locality?

   Jute mallow (*omurere*)

   _____

   Spider plant (*tsisaka*)

   _____

   Slender leaf (*Emiro*)

   _____

   African nightshade (*Isutsa*)

   _____

   Cowpeas (*likhubi*)

   _____

   Pumpkin leaves (*lisebebe*)

   _____

   African kales (*kanzira*)

   _____

   Leaf *amaranthus* (*litoto*)

   _____

4. Does your culture have any taboos regarding the consumption of indigenous vegetables?

   Yes ☐

   No ☐

5. If Yes, which taboos/regulations? Please explain.

   _____

6. Has this affected your participation in cultivation and consumption of indigenous vegetables?

   Yes ☐

   No ☐

7. If Yes, how? Briefly explain.

   _____

   If No, why?

   _____

8. Are there any self-help groups that deal with indigenous vegetables in this locality?

   Yes ☐

No ☐

If Yes what do they do?

_____

9. For the vegetables you have cultivated this year, list ways by which you manage them to enhance good growth. Use the key shown below the table

| Indigenous vegetable | Management processes | Reason |
|---|---|---|
| Jute mallow (*omurere*) | | |
| Cowpeas *(likhubi*) | | |
| Spider plant (*tsisaka*) | | |
| Pumpkin leaves (*lisebebe*) | | |
| Slender leaf (*emiro emilulu*) | | |
| Slender leaf (*emiro emibobo*) | | |
| African kales (*kanzira*) | | |
| African nightshade (*isutsa*) | | |
| Leaf *amaranthus* (*litoto lia nabanyolo*) | | |
| Leaf *amaranthus* (*litoto lia namkasa*) | | |
| Others (Please specify) | | |

1 = Application of inorganic fertilizer; 2 = Manuring; 3 = timely weeding; 4 = Controlling pests and diseases; 5 = Fencing; 6 = Pruning; 7 = Thinning; 8 = Mulching; providing support

10. Rank the vegetables listed in order of preference on a scale of 1-8 with 1 being the most preferred.

| Indigenous vegetable | Rank |
|---|---|
| Jute mallow (*omurere*) | |
| Cowpeas (*likhubi*) | |
| Spider plant (*tsisaka*) | |
| Pumpkin leaves (*lisebebe*) | |
| Slender leaf (*emiro emilulu*) | |
| Slender leaf *(emiro emibobo*) | |
| African kales (*kanzira*) | |
| African nightshade (*isutsa*) | |
| Leaf *amaranthus* (*litoto lia nabanyolo)* | |
| leaf *amaranthus (Litoto lia namkasao)* | |

11. Using the grid and the key provided below the table, tick as appropriate to show reason for the vegetable being liked in this community.

| Indigenous vegetable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Others (specify) |
|---|---|---|---|---|---|---|---|---|---|
| Jute mallow (*omurere*) | | | | | | | | | |
| Cowpeas (*likhubi*) | | | | | | | | | |
| Spider plant (*tsisaaka*) | | | | | | | | | |
| Pumpkin leaves (*lisebebe*) | | | | | | | | | |
| Slender leaf (*emiro emilulu*) | | | | | | | | | |
| Slender leaf (*emiro emibobo*) | | | | | | | | | |
| African kales (*kanzira*) | | | | | | | | | |
| African nightshade (*isutsa*) | | | | | | | | | |
| Leaf *amaranthus* (*litoto lilafu*) | | | | | | | | | |
| Leaf *amaranthus* (*litoto eliakhanyu*) | | | | | | | | | |

1 = Vegetable takes a short time to cook; 2 = Vegetable is easy to cook; 3 = Vegetable is medicinal; 4 = Vegetable used on special occasions; 5 = Vegetable is in season all through; 6 = Vegetable can be combined with others; 7 = Vegetable can be prepared in many ways; 8 = Vegetable is considered nutritious.

Briefly explain each of your choices

| Reason for liking vegetables | Examples (as appropriate) |
|---|---|
| Vegetable takes a short time to cook | |
| Easy to cook the vegetable | |
| Vegetable is medicinal | |
| Vegetable used on special occasions | |
| Vegetable is in season all through | |
| Vegetable can be combined with others | |
| Vegetable can be prepared in many ways | |
| Vegetable considered nutritious | |
| Others (specify) | |

**F: Opportunities and Challenges in Indigenous Vegetables Cultivation and Consumption**

1. Is the cultivation of specific indigenous vegetable increasing or decreasing? Use 1 = Yes; 2 = No: Give reason for your answer.

| Indigenous vegetable | Status (yes or No) | Reason |
|---|---|---|
| Jute mallow (*omurere*) | | |
| Cowpeas (*likhubi*) | | |
| Spider plant (*tsisaaka*) | | |
| Pumpkin leaves (*lisebebe*) | | |
| Slender leaf (*emiro emilulu*) | | |
| Slender leaf (*emiro emibobo*) | | |
| African kales (*kanzira*) | | |
| African nightshade (*isutsa*) | | |
| Leaf *amaranthus* (*litoto lilafu*) | | |
| Leaf *amaranthus* (*litoto eliakhanyu*) | | |

2. The following are challenges that could be facing cultivation and consumption of indigenous vegetables. Rate the challenges according to the type of vegetable. (The codes for vegetables are: 1=Jute mallow (*omurere*), 2= Cowpeas (*likhubi*), 3= Spider plant (*tsisaaka), 4=* Pumpkin leaves (*lisebebe*), 5= Slender leaf (*emiro emilulu*), 6= Slender leaf (*emiro emibobo*), 7= African kales (*kanzira*), 8=African nightshade (*isutsa*), 9=Leaf amaranthus (*litoto lilafu*), 10= Leaf *amaranthus* (litoto eliakhanyu).

| Vegetable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| l/returns | | | | | | | | | | |
| H/inputs | | | | | | | | | | |
| Labour | | | | | | | | | | |
| Market | | | | | | | | | | |
| drought | | | | | | | | | | |
| Pests/diseases | | | | | | | | | | |
| training in agro processing | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Poor roads to market | | | | | | | | | | |
| capital for seeds | | | | | | | | | | |
| Lack of skills | | | | | | | | | | |

Level of importance of the problem:

1 = Very high importance; 2 = High importance; 3 = Moderate importance; 4 = Low importance; Not a challenge

3. What is causing the problems you have rated 1 and 2?

   _____

4. What do you do to solve the problems?

   _____

5. What prospects exist in cultivation of indigenous vegetables in this community?

   _____

Thank you for your time and the information.

## Appendix II: FOCUSED GROUP DISCUSSION GUIDE

Introduction:

This is an academic research meant to find out the contribution of African Indigenous Vegetables on agro-biodiversity and community livelihood. The researcher values your opinions and your expertise in this area as people who are involved in the production and selling of the indigenous vegetables in this study area. The researcher acknowledges that we as the research team are here to learn from you.

**Introductory Questions**

What is your favourite vegetable?

When you think about cultivating indigenous vegetables what excites/worries you most? (To gauge concerns of farmers in cultivating indigenous vegetables and how this affects attitude towards cultivation).

**Key area 1: Types and Distribution of Indigenous Vegetables Maintained by the Farmers:**

Historical Resource Analysis/Matrix.

The group will be asked to draw the indigenous vegetable resource matrix on a flip chart after listing the vegetables e.g. jute mallow (*omurere*) and the parameter to be analysed e.g. vegetable production land size, threats etc.

The community will be asked from which period to start e.g. 1970 etc with a 10 year intervals.

The PRA team and community will draw a matrix; with dates going along the top, e.g. 10 years ago', '20 years ago' etc.

Topics of discussion will be written along the side – e.g. environmental changes and other key trends

Table 1: Historical Resource Analysis Table – Example

| Indigenous vegetable | | 1970s | 1980s | 1990s | 2000s | 2010 | Future – Vision |
|---|---|---|---|---|---|---|---|
| *Omurere* | | 5dots | 4dots | 3dots | | 2dots | 4dots |
| | Land size | | | | | | |
| | production | | | | | | |
| | Consumption | | | | | | |
| | Threats e.g. diseases | | | | | | |

**Key:** 5-High 3- Medium 1-Low

The teams will then illustrate the different occurrences e.g. an increased abundance was observed between 19xx and 20xx and then give reasons for the occurrence.

**Expected Output:** Trends in vegetable production and consumption use and possible reasons for observed changes.

**Key area 2: Find out the Processes used to Maintain Indigenous Vegetables on Farm.**

Seasonal Calendar: It identifies cycles of activity that occur within the life of a community on a regular basis, and helps determine whether there are common periods of excessive environmental problems (stress) or opportunities over the course of a normal year.

The tool will be applied as outlined below.

Process of carrying out the seasonal calendar exercise.

1. Twelve people purposively selected, will participate.

2. Topics to be covered will include;

-Rainfall seasons.
-Land preparation
-Harvesting
-pests and diseases

-Planting -Social functions
-Weeding.

3. The PRA team will bring a long a sample seasonal calendar to stimulate discussion.

4. The PRA team will draw a matrix on a flip chart indicating the period of the year (January to December) and a column of parameters.

5. The group members will be facilitated to discuss among themselves at what times of the year they carry out the different activities along the one year time period continuum.

6. The group with the guidance of the PRA team will discuss the trends on the seasonal calendar constructed and indicate the impacts of the occurrences.

7. Both the community and the PRA team will make a final seasonal calendar depicting important activities or events along the monthly continuum of activities.

- Expected Outputs: Information on environmental stress and other community problems.
- Information on community and household gender labor supply/demand dynamics.

Table 2: Seasonal Calendar Table–Example

| Parameter | Jan | Feb. | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall | | HR | HR | HR | | | | LR | LR | LR | |
| Land preparation | | MW | MW | | | | | | | | |
| Preparation and procuring seeds | | | | | | | | | | | |
| Planting | | MWC | MWC | | | | | | | | |
| Weeding | | | | W | WC | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C | | | | | | | |
| Thinning | | | | | | | | | | | |
| pruning | | | | | | | | | | | |
| Pest and diseases control | | | | | | | | WC | WC | | |
| Harvesting | | | | | | | | | | | |

Key: HR- Heavy Rains LR- Light Rains M – Men W – Women C - Children (Boys/Girls)

**Key are 3: Find out Factors that Influence Farmer Decisions on Maintaining Indigenous Vegetables.**

Resource Use and Control

This regards resource use and control at the household level. This tool examines who makes decisions and/or controls resource within the household set up.

Table 3: Resource Use and Control Table-example

| Resource | Boys | | Girls | | Male Adult | | Female Adult | |
|---|---|---|---|---|---|---|---|---|
| | Access | Control | Access | Control | Access | Control | Access | Control |
| Land | √ | X | √ | X | √ | √ | √ | √ |
| Indigenous vegetables | | | | | | | | |
| Income from indigenous vegetables | | | | | | | | |

**Key:** √Has access/Control X has no access/Control

**Key area 4: Find out the Farming Systems and their Effects on Maintenance of Indigenous Vegetables on Farm**

Decision making and Control of indigenous vegetables.

This regards resource use and control at the household level. This tool examines who makes decisions and/or controls resource within the household set up.

Table 4: Decision making and implementation Table - example

| Decision making and implementation of decisions on: | Boys | | Girls | | Man of the home | | Spouse | |
|---|---|---|---|---|---|---|---|---|
| | DM | IMP | DM | IMP | DM | IMP | DM | IMP |
| Land use- subsistence; commercial | | | | | | | | |
| Where to cultivate the vegetables | | | | | | | | |
| Which vegetable to cultivate | | | | | | | | |
| Securing of Seeds | | | | | | | | |
| Planting; timing | | | | | | | | |
| Weeding | | | | | | | | |
| Pruning/harvesting | | | | | | | | |
| Cooking-method | | | | | | | | |
| selling the vegetables for household income | | | | | | | | |
| Utilisation of income from the vegetables | | | | | | | | |

**Key:** √contributes in decision making X has no contribution in decision making

**Key area 5: Determine the indigenous knowledge among the local households on cultivation and consumption of indigenous vegetables**

Table 5: Activity /knowledge analysis table

| Activity/occurrence | Indigenous knowledge | Custodian of the knowledge | How knowledge is passed to the beneficiary |
|---|---|---|---|
| Coming of Rainfall (*ifula okhwakukha*) | | | |
| Land preparation (*okhukasia omukunda*) | | | |
| procuring and Preparation seeds (*okhunyoola nende okhukasia obufwa*) | | | |
| Planting (*okhuraaka*) | | | |
| Weeding (*okhwaaka*) | | | |
| Thinning (*okhwiyachira*) | | | |
| Pruning (*okhukhalira*) | | | |
| Pest and diseases control | | | |
| Harvesting (*okhwaya eliani*) | | | |
| Preparation of vegetables for cooking (*okhunyola eliani*) | | | |
| Cooking vegetables – method (*injira yokhuteeshilamwo eliani*) | | | |
| Preservation of vegetables for later use. | | | |

**Key area 6: Explore the Contribution of Indigenous Vegetables on Community Livelihood**

**Focus Interview**

**Purpose:** To assess opinion of change, assess contribution of indigenous vegetables and identify areas of improvement.

Process of carrying out Group Interview

12 participants will be involved (to be divided into 3 groups).

Six questions will be addressed including the following:

a) How have you participated in the group activities?
b) Which activities of the group are you implementing?
c) What benefits are you drawing from your participation in the group's project of production and selling of vegetables?
d) What factors determine your participation in the project? Social, cultural, political, environmental and economic?
e) What are the major constraints to participation of local communities in this project?
f) What is the major problem facing your group and how is it being addressed?

Discussion time will be 2-3hours

The PRA team will record and take notes of the proceedings.

Expected Outputs: Information on group participation in production and sell of indigenous vegetables.

Groups achievements in contributing to livelihood Social, cultural, economic, political and environmental factors determining community participation in production and consumption of indigenous vegetables

END

THANK YOU FOR YOUR PARTICIPATION

## Appendix III: INTERVIEW SCHEDULE FOR KEY INFORMANTS

I am Everlyn Wemali, a Ph D student at Kenyatta University. I am undertaking a field research to find out the contributions of African Indigenous Vegetables on agro-biodiversity conservation and community livelihood in Mumias Sugarbelt. The office of the District Agricultural Officer (DAO) is viewed as being key in development of indigenous vegetables. I therefore request for some time off your busy schedule for an interview with yourself as the DAO and/or with any other officer whom in your opinion will help me to access information concerning the cultivation and consumption of African indigenous vegetables in the Sub-County. Information obtained will be held with strict confidence and will only be used for the study.

1. Types and distribution of indigenous vegetables

Which indigenous vegetables are common in this area?[1]

_____

2. Farm systems and their effects on maintenance of indigenous vegetables on farm?

What could be the total acreage of these vegetables in the district?

_____

Where on the farm are indigenous vegetables grown and why?

_____

Where do the farmers get the seeds from? What criteria do you encourage farmers to consider when selecting seeds for planting?

_____

How often are the farmers reached for extension farmer education?

What methods do you use for carrying out extension education?

_____

What methods do the farmers use to improve soil fertility of the farm in which the indigenous vegetables are grown?

_____

What methods are used to improve availability of water for indigenous vegetables?

_____

How do the farmers control pests?

_____

What are the major factors (in order of importance) that affect the cultivation and consumption of indigenous vegetables?

_____

3. Contribution of indigenous vegetables to community livelihood:

Based on your records and projection how much do you think indigenous vegetables are contributing to income for the farmers yearly?

_____

Which strategies do you think would help improve this figure?

_____

Which vegetables are most popular in terms of market demand?

_____

4. Status of indigenous knowledge in cultivation and consumption of indigenous vegetables:

Which ways are used to manage the vegetables to enhance good growth?

_____

Which vegetable is most preferred in this area and why?

_____

Which cultural practices have helped to enhance production of indigenous vegetables?

_____

Opportunities and challenges of indigenous vegetables cultivation and consumption:

Would you say that the cultivation of indigenous vegetable is increasing or decreasing?

_____

If there is an increase what are the factors behind this?

_____

If a decrease what is causing this?

_____

Which problems face cultivation of indigenous vegetables?

_____

What is causing the problems?

_____

What is being done to solve the problems?

_____

What in your opinion would encourage an increase in cultivation of indigenous vegetables in this community?

_____

What do you think should be done to increase the consumption of indigenous vegetables in this area?

_____

Thank you for your time.

## Appendix IV: SURVEY SHEET FOR INDIGENOUS VEGETABLES

Survey sheet for indigenous vegetables

| Questionnaire no | Zone | Location | Sub location | Village |
|---|---|---|---|---|
| | | | | |

This instrument is meant to help determine the diversity of indigenous vegetables in the study area.

Instructions for research assistant:

Standing on the edge of the farm throw the 1m by 1m quadrat (Q) into the vegetable farm and count the number of individual plant species in the quadrate and record. Repeat this five times as you record each of the time.

| Vegetable Species | Q 1 | Q 2 | Q 3 | Q4 | Q 5 | Total |
|---|---|---|---|---|---|---|
| Jute mallow (*omurere*) | | | | | | |
| Cowpeas (*likhubi*) | | | | | | |
| Spider plant (*tsisaka* | | | | | | |
| Pumpkin leaves (*lisebebe*) | | | | | | |
| Slender leaf (*emiro emilulu*) | | | | | | |
| Slender leaf (*emiro emibobo*) | | | | | | |
| African kales (*kanzira*) | | | | | | |
| African nightshade (*isutsa*) | | | | | | |
| Leaf *amaranthus* (*litoto lilafu*) | | | | | | |
| Leaf *amaranthus* (*litoto eliakhanyu*) | | | | | | |
| Others (specify) | | | | | | |

Based on observation draw an outline of the vegetable farm showing features such as what borders the vegetable farm, e.g. fences, other crops

2. Observe and describe the parameters shown in the table below:

| Parameters | Description of observation |
|---|---|
| Estimate of farm size | |
| Estimated size of vegetable farm and location on the farm | |
| Fraction of vegetable farm to farm size | |
| Cropping patterns e.g. intercrops (name the intercrop), pure stand, broadcasted, cropped in lines. | |
| Evidence of vegetable maintenance strategies or lack of it e.g. weeding, thinning, pruning | |
| Presence and type of fences around the vegetable farm | |
| Source of water for the farm | |
| animals observed in the vegetable farm | |
| Domestic animals on farm | |
| Evidence of economic activities | |

## Appendix V: CHALLENGES FACING PRODUCTION OF AIVs

| Type of vegetable | | I/returns | H/ Inputs | Labour | Market | Drought | Pests/diseases | Training in agro- | Poor roads to | Capital of | Lack of skills |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jute Mallow | Very high importance | 1.1 | 0 | 0 | 4.4 | 18.1 | 15.6 | 1.1 | 0 | 0 | 0 |
| | High importance | 8 | 0 | 1.1 | 9.9 | 24.5 | 15.6 | 0 | 0 | 8.8 | 0 |
| | Moderate importance | 26.4 | 16.1 | 6.8 | 22 | 39.4 | 15.6 | 20.7 | 4.6 | 33 | 14.4 |
| | Low importance | 64.4 | 83.9 | 92 | 63.7 | 18.1 | 53.1 | 78.2 | 95.4 | 58.2 | 85.6 |
| Cow peas | Very high importance | 0 | 0 | 0 | 7 | 23.6 | 19.9 | 0.5 | 0 | 21.1 | 0 |
| | High importance | 11 | 0 | 0.5 | 22.2 | 36.6 | 34.2 | 0 | 0 | 5.3 | 0.5 |
| | Moderate importance | 24.7 | 7.7 | 6.6 | 23.2 | 31.4 | 34.2 | 10.9 | 9.8 | 26.7 | 8.7 |
| | Low importance | 64.3 | 92.3 | 92.9 | 47.6 | 48.4 | 11.7 | 88.5 | 90.2 | 66.8 | 90.8 |
| Spider plant | Very high importance | 0 | 0 | 0 | 0 | 17.1 | 10.3 | 1.5 | 0 | 3 | 0 |
| | High importance | 6.3 | 0 | 0 | 9.1 | 28.6 | 17.6 | 3 | 1.5 | 19.4 | 0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Moderate importance | 15.6 | 6.3 | 8.2 | 13.6 | 40 | 32.4 | 13.4 | 12.1 | 20.19 | 7.5 |
| | Low importance | 78.1 | 93.7 | 91.8 | 77.3 | 143.3 | 139.7 | 82.1 | 86.4 | 56.2 | 92.5 |
| Pumpkin leaves | Very high importance | 17.9 | 1 | 1 | 9.2 | 10.5 | 5.8 | 1 | 2 | 0 | 0 |
| | High importance | 6.9 | 1 | 0 | 10.2 | 23.8 | 12.5 | 1 | 0 | 1 | 0 |
| | Moderate importance | 8.9 | 9.1 | 8.2 | 16.3 | 30.5 | 9.6 | 9.2 | 4 | 14.9 | 8.2 |
| | Low importance | 76.2 | 88.9 | 90.7 | 64.3 | 35.2 | 72.1 | 88.8 | 93.9 | 84.2 | 91.8 |
| Slender leaf Crotolaria brevidens) | Very high importance | 10 | 0 | 0 | 22.2 | 29.1 | 0 | 0 | 0 | 10 | 0 |
| | High importance | 0 | 0 | 0 | 0 | 27.3 | 27.3 | 0 | 0 | 0 | 0 |
| | Moderate importance | 10 | 11.1 | 25 | 22.2 | 27.3 | 9.1 | 20 | 18.2 | 40 | 9.1 |
| | Low importance | 80 | 88.9 | 75 | 55.6 | 36.4 | 63.6 | 80 | 81.8 | 50 | 90.9 |
| Slender leaf (Crotolaria ochroleuc) | Very high importance | 1.3 | 0 | 1.3 | 0 | 11.4 | 13.8 | 1.3 | 4 | 3.8 | 1.4 |
| | High importance | 1.3 | 0 | 0 | 7.8 | 31.4 | 87.5 | 1.3 | 2.7 | 10. | 1.4 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Moderate importance | 20.8 | 11.8 | 15 | 23.4 | 63.8 | 13.8 | 21.3 | 5.3 | 33.3 | 14.9 |
| | Low importance | 76.6 | 88.2 | 83.8 | 68.8 | 19 | 65 | 76 | 88 | 52.6 | 82.4 |
| African Kales | Very high importance | 0 | 0 | 0 | 0 | 10.7 | 7.1 | 0 | 0 | 3.7 | 0 |
| | High importance | 0 | 0 | 0 | 7.1 | 28.6 | 10.7 | 0 | 0 | 14.8 | 0 |
| | Moderate importance | 11 | 11.1 | 14.3 | 14.3 | 50 | 46.4 | 19.2 | 3.7 | 33.7 | 3.7 |
| | Low importance | 88.9 | 88.9 | 85.7 | 78.6 | 10.7 | 35.7 | 80.8 | 96.3 | 44.4 | 96.3 |
| African Nightshade | Very high importance | 0 | 0 | 0 | 4.2 | 14.9 | 8.5 | 0 | 0 | 8.7 | 0 |
| | High importance | 0 | 0 | 0 | 2.1 | 34 | 21.3 | 0 | 0 | 17.4 | 0 |
| | Moderate importance | 19.1 | 6.4 | 16.7 | 14.6 | 27.7 | 44.7 | 21.7 | 6.5 | 28.3 | 18.6 |
| | Low importance | 80.9 | 93.6 | 83.3 | 79.2 | 23.4 | 25.5 | 78.3 | 93.5 | 45.7 | 81.4 |
| *Amaranthus hybridus* | Very high importance | 0 | 0 | 0 | 0 | 10 | 13.8 | 0 | 0 | 0 | 0 |
| | High importance | 0 | 0 | 0 | 0 | 30 | 86. | 0 | 0 | 30 | 0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Moderate importance | 20 | 10 | 20 | 23.3 | 36.7 | 917.2 | 17.2 | 6.9 | 30 | 13.3 |
| | Low importance | 80 | 90 | 80 | 76.7 | 23.3 | 62.10 | 82.8 | 93.10 | 40 | 86.7 |
| *Amaranthus* lividus | Very high importance | 0 | 0 | 0 | 0 | 32.9 | 0 | 0 | 0 | 14.7 | 0 |
| | High importance | 0 | 0 | 0 | 3 | 35.3 | 8.8 | 0 | 0 | 14.7 | 0 |
| | Moderate importance | 0 | 2.9 | 0 | 3 | 50 | 23.5 | 2.9 | 0 | 17.6 | 0 |
| | Low importance | 100 | 97.1 | 100 | 93.9 | 118.6 | 67.6 | 97.1 | 100 | 52.9 | 100 |

## Appendix VI: AN ACCOUNT OF KEY INFORMANTS ON CULTIVATION OF AIVS.

Cowpeas:

For the various cultivars of cowpeas, seeds are bought or prepared on-farm depending on the season (different types of seeds are planted in different seasons depending on the amount of rainfall available at the time of the planting season. The seeds are then either broadcast or planted in shallow farrows approximately the depth of the middle finger.

Slender leaf:

Farrows are made into which cow dung manure is added before planting. The seeds can also be planted by broadcasting, mixed with soil or ash to enable the small seeds to spread out evenly. After germination, the crop is left to sprout for one month after which thinning is made to avoid competition of the resources. Pruning is later done to make the crop spread out and stay longer before flowering.

African nightshade:

Mature fruits berries are collected and dried using sunlight; these are later pressed to release the white seeds inside. Land is prepared and re-ploughed to make it fine. The seeds are mixed with dry soil and broadcasted or spread out in prepared shallow farrows to which cow dung manure is added. A special hoe is used for weeding. Thinning is later done to avoid competition for resources hence healthy growth. Punning of the vegetables is done to make them spread out and also for the vegetables to stay on for a longer period before they flower.

Pumpkin leaves

Seeds are obtained from the fruit on maturity. The seeds are dried and then planted in a desirable place the vegetable has a weak stem which needs to be supported or else it runs on the ground and would then interfere with the growth of other crops. In this case, it is folded together in one spot or allowed to be supported on a fence.

Jute Mallow :

seeds when prepared on-farm: the crop is allowed to mature, flower and produce pods. These are collected and dried. When dry, they are pounded to release the seeds which are further dried to be used in the subsequent planting season. The seeds are broadcasted, mixed with dry soil or ash or planted in farrows. Like the other seeds of AIVs, the seeds are mixed with dry soil or ash to increase spreading out and avoid crowding.

## Appendix VII: AIV SPECIES IN SUB LOCATIONS

| Species | Lubinu | Eluche | Ekero | Lureko | Shikalame | Buchifi | Musanda | Bukaya | Isongo | Malaha | Mung'an'ga | Bungatsi | Imanga | Khaunga | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jute mallow | 602.0 | 126.0 | 200.0 | 24.8 | 77.0 | 399.4 | 216.6 | 19.0 | 149.2 | 74.8 | 40.4 | 13.2 | 85.4 | 128.4 | 2156.2 |
| Cowpeas | 731.4 | 533.2 | 714.2 | 341.2 | 176.6 | 410.8 | 225.4 | 208.0 | 1047.8 | 412.4 | 419.8 | 10.6 | 350.8 | 844.8 | 6427.0 |
| Spider plant | 66.2 | 1.8 | 49.6 | 109.2 | 10.6 | 199.4 | 32.8 | 0.0 | 404.8 | 11.6 | 18.8 | 15.0 | 87.8 | 72.8 | 1080.4 |
| Pumpkin leaves | 11.4 | 9.2 | 5.8 | 0.2 | 0.0 | 5.4 | 0.8 | 0.4 | 8.0 | 6.2 | 1.2 | 0.4 | 4.2 | 7.0 | 60.2 |
| Slender leaf (C. brevidens) | 41.8 | 0.0 | 13.6 | 0.0 | 7.4 | 110.8 | 0.0 | 0.0 | 0.0 | 11.8 | 51.8 | 0.0 | 22.4 | 55.2 | 314.8 |
| Slender leaf (*C. ochroleuca*) | 616.6 | 301.2 | 585.6 | 43.8 | 17.8 | 138.6 | 137.6 | 1.2 | 299.0 | 361.4 | 58.8 | 0.0 | 12.2 | 237.2 | 2811.0 |
| African kales | 106.2 | 0.0 | 78.4 | 0.0 | 25.8 | 1.2 | 116.6 | 0.0 | 34.2 | 100.6 | 26.2 | 0.0 | 79.0 | 28.2 | 596.4 |
| African nightshade | 140.8 | 1.6 | 106.8 | 24.2 | 0.0 | 90.0 | 27.6 | 0.0 | 146.2 | 9.2 | 2.8 | 0.0 | 297.0 | 6.0 | 852.2 |
| *A. hybridus* | 242.8 | 65.4 | 50.8 | 0.0 | 1.6 | 56.0 | 179.2 | 9.2 | 39.2 | 113.2 | 46.6 | 0.0 | 34.4 | 110.4 | 948.8 |
| *A. lividus* | 147.2 | 41.8 | 322.0 | 370.4 | 5.8 | 590.6 | 27.0 | 16.6 | 276.0 | 331.2 | 0.0 | 0.0 | 106.8 | 87.4 | 2322.8 |
| TOTAL | 2706.4 | 1080.2 | 2126.8 | 913.8 | 322.6 | 2002.2 | 963.6 | 254.4 | 2404.4 | 1432.4 | 664.4 | 39.2 | 1080.0 | 1577.4 | 17567.8 |

## Appendix VIII: REGRESSION ANALYSIS ON HOUSEHOLD SIZE AND COST OF VEGETABLES

### (a) ANOVA

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| | Regression | 65.017 | 1 | 65.017 | 35.617 | .000[a] |
| | Residual | 578.669 | 317 | 1.825 | | |
| | Total | 643.687 | 318 | | | |

a. Predictors: (Constant), Household population size

b. Dependent Variable: amount spent buying vegetables if to buy per month

### (b) Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 2.432 | .196 | | 12.377 | .000 |
| | Household population size | .162 | .027 | .318 | 5.968 | .000 |

a. Dependent Variable: amount spent buying vegetables if to buy per month

## Appendix IX: CORRELATION MATRIX OF SELECTED VARIABLES

| | Age | HPS | TLY | TPLY | SOFA | SLUIVEG | ASOS | FGIDEV | COIDEV | PCIDEV |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age** | | | | | | | | | | |
| r | 1 | -0.018 | 0.016 | 0.007 | .300** | -0.06 | -0.059 | 0.026 | -0.062 | 0.018 |
| sig,(2 tailed) | | 0.736 | 0.761 | 0.903 | 0 | 0.283 | 0.286 | 0.675 | 0.264 | 0.765 |
| N | 387 | 375 | 382 | 382 | 383 | 364 | 368 | 304 | 369 | 306 |
| **HPS** | | | | | | | | | | |
| r | -0.018 | 1 | 0.091 | 0.082 | .121* | 0.097 | .115* | 0.121 | .318** | 0.043 |
| sig,(2 tailed) | 0.736 | | 0.098 | 0.135 | 0.028 | 0.085 | 0.04 | 0.053 | 0 | 0.49 |
| N | 335 | 338 | 334 | 334 | 334 | 317 | 320 | 258 | 319 | 262 |
| **TLY** | | | | | | | | | | |
| r | 0.016 | 0.091 | 1 | .450** | -0.056 | 0.108 | .219** | -0.008 | 0.034 | -0.014 |
| sig,(2 tailed) | 0.761 | 0.098 | | 0 | 0.303 | 0.051 | 0 | 0.899 | 0.537 | 0.815 |
| N | 342 | 334 | 345 | 345 | 341 | 327 | 331 | 267 | 330 | 269 |
| **TPLY** | | | | | | | | | | |
| r | 0.007 | 0.082 | .450** | 1 | -0.044 | .114* | .321** | .184** | 0.108 | .231** |
| sig,(2 tailed) | 0.903 | 0.135 | 0 | | 0.421 | 0.039 | 0 | 0.003 | 0.05 | 0 |
| N | 342 | 334 | 345 | 345 | 341 | 327 | 331 | 267 | 330 | 269 |
| **SOFA** | | | | | | | | | | |
| r | .300** | .121* | -0.056 | -0.044 | 1 | 0.07 | -0.002 | 0.044 | -0.009 | 0.074 |
| sig,(2 tailed) | 0 | 0.028 | 0.303 | 0.421 | | 0.21 | 0.975 | 0.475 | 0.875 | 0.229 |
| N | 383 | 374 | 381 | 381 | 386 | 363 | 367 | 304 | 368 | 308 |
| **SLUIVEG** | | | | | | | | | | |
| r | -0.06 | 0.097 | 0.108 | .114* | 0.07 | 1 | .361** | .195** | 0.11 | .286** |
| sig,(2 tailed) | 0.283 | 0.085 | 0.051 | 0.039 | 0.21 | | 0 | 0.002 | 0.051 | 0 |
| N | 364 | 357 | 367 | 367 | 363 | 367 | 354 | 296 | 355 | 296 |
| **ASOS** | | | | | | | | | | |
| r | -0.059 | .115* | .219** | .321** | -0.002 | .361** | 1 | .324** | .150** | .371** |
| sig,(2 tailed) | 0.286 | 0.04 | 0 | 0 | 0.975 | 0 | | 0 | 0.007 | 0 |
| N | 368 | 360 | 371 | 371 | 367 | 354 | 371 | 301 | 358 | 303 |
| **FGIDEV** | | | | | | | | | | |
| r | 0.026 | 0.121 | -0.008 | .184** | 0.044 | .195** | .324** | 1 | .502** | .607** |
| sig,(2 tailed) | 0.675 | 0.053 | 0.899 | 0.003 | 0.475 | 0.002 | 0 | | 0 | 0 |
| N | 304 | 298 | 307 | 307 | 304 | 296 | 301 | 307 | 301 | 293 |
| **COIDEV** | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| r | -0.062 | .318** | 0.034 | 0.108 | -0.009 | 0.11 | .150** | .502** | 1 | .308** |
| sig,(2 tailed) | 0.264 | 0 | 0.537 | 0.05 | 0.875 | 0.051 | 0.007 | 0 | | 0 |
| N | 369 | 359 | 370 | 370 | 368 | 355 | 358 | 301 | 371 | 304 |
| **PCIDEV** | | | | | | | | | | |
| r | 0.018 | 0.043 | -0.014 | .231** | 0.074 | .286** | .371** | .607** | .308** | 1 |
| sig,(2 tailed) | 0.765 | 0.49 | 0.815 | 0 | 0.229 | 0 | 0 | 0 | 0 | |
| N | 306 | 302 | 309 | 309 | 308 | 296 | 303 | 293 | 304 | 309 |
| | | | | | | | | | | |

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