DETERMINANTS OF ADOPTION OF IMPROVED AMARANTH AMONG SMALL SCALE FARMERS IN BUURI SUB-COUNTY, MERU COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been submitted for any academic award in any other University.

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Recommendation

This thesis has been submitted for examination with our approval as supervisors.

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DEDICATION

This work is dedicated to my wife, Eunice Mueni Muasya, my son, Timothy Kyambo Muasya and my brother, Josphat Mutuku Kyambo for their patience, support and understanding during my study. I also dedicate it to my father, Kanyele Kyambo and my mother, Ndilu Kanyele, for their prayers and encouragement. I would also like to thank Dr. Amos Mutua for proof reading this thesis.

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ABSTRACT

There is paucity of information on *Amaranth* as a valuable source of food, medicine and income. In the recent past, the cultivation of *Amaranth* by small scale farmers in Kenya has been promoted by public extension services, Non-Governmental Organizations (NGOs), research organizations and universities. The extent of relationship between the selected factors such as access to extension services, availability of markets for *Amaranth* products, availability of certified seeds and consumption of *Amaranth* products on the adoption of *Amaranth* in Buuri Sub-County has not been adequately studied. The purpose of this study therefore, is to determine and document how the availability of certified seeds, access to extension advice, and availability of markets and consumption of *Amaranth* products has relationship on the adoption of the *Amaranth* crop in Buuri Sub-County of Meru County. An *expost-facto* survey design was employed in this study and targeted common interest groups growing *Amaranth* among Buuri Sub-County stakeholders. The population sampled comprised of 360 members of all common interest groups in Ruiri and Nchoroiboro locations. A total sample of 110 respondents from the population of 360 small scale farmers was selected from these two locations within Buuri Sub-County using a random sampling approach. Questionnaires were administered to the sampled small scale farmers. Data analysis was carried out using descriptive and inferential statistics. Pearson's product moment correlation coefficient analysis was appropriately used to determine the relationship between independent variable and dependent variables for the rejection or acceptance of hypotheses at alpha significant level of 0.05. This study found that availability of certified seeds, availability of market and consumption had positive significant relationship with the adoption of improved *Amaranth* in the study area. However, access to extension services was found to have no significant relationship to the adoption of improved *Amaranth*. This study recommends that stakeholders should have access to adequate certified seeds available during planting. Efforts should also be made to provide a competitive market for current farmers for continued *Amaranth* cultivation. Extension service providers should ensure that they also educate farmers on how to prepare *Amaranth* to enhance on-farm nutritional diversity. Efforts to make known the various uses of the products should be given priority. This should be geared towards increasing the consumption of *Amaranth* since it has relationship on the adoption of improved *Amaranth.*

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LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ASAL	Arid and Semi-Arid Lands
ASL	Above Sea Level
CIG	Common Interest Groups
CBO	Community Based Organization
CGIAR	Consultative Group on International Agricultural Research
FAO	Food and Agriculture Organization of the United Nations
FCI	Farm Concern International
GOK	Government of Kenya
HIV	Human Immune Virus
KARI	Kenya Agricultural Research Institute
KAPP	Kenya Agricultural Productivity Project
KAPAP	Kenya Agricultural Productivity and Agri-business Project
KEPHIS	Kenya Plant Health Inspectorate Services
KSU	KARI Seed Unit
NGO	Non-Governmental Organization
NMK	National Museums of Kenya
PEC	Poverty Eradication Commission
USA	United States of America
SRA	Strategy for Revitalization of Agriculture
SPSS	Statistical Package for Social Sciences
TB	Tuberculosis
WHO	World Health Organization

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Majority of the approximately 60 species of *Amaranthus* (collectively known as *Amaranth*) occurs in the wild and are regarded commonly as weeds (Brenan, 1981). Throughout the world, however, a limited number of species are cultivated and their grain and leaves are utilized for animal and human consumption (Gerson, 1989). With an increasing human population in Africa and against the background of drought, mismanagement of natural resources and food shortages, *Amaranth* has become a valuable source of human food.

Amaranth is among the orphan crops in Kenya (Ray & Roy, 2009). However, there is a lot of potential in the cultivation of this species as well as other orphaned crops. There is therefore the need to create awareness on the potential of these crops. The genus *Amaranthus* in the family *Amaranthaceae* is represented by commonly used leafy vegetables in Kenya (Table 1). With the exception of some species such as *Amaranthus graecizans* L., *Amaranthus thunbergii* Moq. and *Amaranthus sparganiocephalus* Thell. most of the species were introduced from other parts of the world especially from Asia and Central America (Brenan, 1981). In Kenya, *Amaranth* is harvested from the wild for domestic use and only a few species are cultivated in kitchen gardens (Maundu, Ngugi, & Kabuye, 1999). Most communities in Kenya harvest the leaves from *Amaranth* for cooking either alone or combined with other indigenous vegetables such as Cowpeas, Spider plant and Black nightshade (Mbugua & Gitonga, 2006). The leaves are a rich source of calcium, iron and vitamins A, B and C.

Several *Amaranth* species are widely distributed throughout the world especially in the tropical regions. In Africa, *Amaranthus dubius* Thell., *Amaranthus hybridus* L., *Amaranthus cruentus* L. and *Amaranthus blitum* L. are the most commonly cultivated species. Several hybrid varieties of these species also exist. *Amaranthus dubius* Thell., is believed to be of American origin. It is short compared to other species, has simple ridged leaves, ovate lamina and conspicuous veins underneath the leaves. This species is fast growing, taking approximately three weeks before the leaves are harvested. (Irungu, Mburu, & Maundu, 2006).In Kenya *A. dubius* is usually found in most sub-humid parts of Kenya below 2,000 m above sea level.

Amaranthus hybridus L. originated from tropical America but now has a wide distribution throughout the world. As a fast growing species, it is also resistant to moisture stress making it suitable for arid and semi-arid areas that has erratic rainfall distribution. The stems are green or tinted red and ridged. It produces a good yield of grain with *Sorghum* like heads. It is wide spread in tropical and subtropical regions of the world and widely distributed in humid to sub-humid areas in Kenya. It is common in the middle altitudes and highlands (1400 – 2400 m) (Irungu et al., 2006).

Amaranthus cruentus L. has long stems and bears large inflorescence. It is mainly grown in Africa and other warmer regions of the world as a source of grain. The grains are small in size with the colour ranging from cream to gold. It is fast growing and takes about 55 days to reach maturity. It is believed to has originated in America and introduced in Africa (Irungu et al., 2006). Under optimum conditions it grows to above one meter in height with a stem diameter of about 5cm. Young leaves of the species are also harvested as a source of green vegetable. This species is often treated as a subspecies of *A. hybridus* (Maundu et al., 1999)

Amaranthus tricolor L. is a species native to India and the pacific islands. It is mainly grown as a source of vegetable and referred to as spinach *Amaranth*. The plants are very succulent, low growing and compact. *Amaranthus blitum* L. is native to the Mediterranean region and naturalized in other parts of the world where it is used as a leaf vegetable.

Amaranthus spinosus L. is commonly known as the spiny *Amaranth*, prickly *Amaranth* or thorny *Amaranth*. It is native to the tropical America, but it is present on most continents as an introduced species and sometimes a noxious weed. It can be a serious weed in rice production in Asia (Grubben, & Denton, 2004).

Table 1: Distribution of Selected *Amaranthus* Species in Kenya

Genus	Species	Distribution in Kenya
Amaranthus	*A. spinosus* L.	Mombasa, Jilore, Malindi, Tana River, Kora National Park, Garissa, Tsavo East, Kaloleni, Sabaki, Kiboko, Kitui, Turkana, Baringo among others
Amaranthus	*A.viridis* L.	Kwale, Diani
Amaranthus	*A.dubius* Thell.	Mwingi, Nairobi, Sigor, Kisumu, Kilgoris, Taveta, Nguruman, Tana river, Diani
Amaranthus	*A.graecizans* L.	Nyeri, Matuga, Maralal,Tsavo, Malindi, Kilifi, Shimba hills, Garissa, Voi, Tana River, Loitoktok, Amboseli, Narok, Baringo among others
Amaranthus	*A.hybridus* L.	Taita taveta, Narok, Kajiado, Kericho, Mt Elgon, Kitale, Nairobi, Tigoni, Thika Machakos, Muguga, among others
Amaranthus	*A.sparganiocephalus* Thell.	Kora, Amboseli, Garissa, Kajiado, Meru, Koobi Fora, Marsabit, Kalacha, Lake Nakuru
Amaranthus	*A.lividus* L.	Embu, Kericho, Kitale, Naivasha, Thika, Nairobi
Amaranthus	*A.caudatus* L.	Nairobi, Ngara area.
Amaranthus	*A.deflexus* L.	Nakuru, Chania river.
Amaranthus	*A.thunbergii* Moq.	Nairobi, Kiambu, Kwale

Source: Lost Crops of Africa: Volume II: Vegetables (2006).

According to the Food and Agriculture Organization (FAO, 1988), traditional vegetables are all categories of plants whose leaves are accepted for use as vegetables. Cooked leaves are served as food particularly during famines and natural disasters. Generally *Amaranth* species grow as weeds in the wild or as cultivated crops or semi-cultivated crops. *Amaranth* is grown as crop for grain and leaf vegetable which is nutritious and has vitamins A and C. The vegetables also contain valuable minerals such as calcium and potassium and are said to be tasty. In addition, *Amaranth* seeds are unusually has relatively larger amount of protein for a non-legume, containing around 14 to 16% protein. The protein is well balanced in amino acids, and has lysine, an amino acid for which most grains are deficient (FAO, 1988).

In the recent past, indigenous vegetables especially *Amaranth* has received a lot of recognition and funding from research organizations, like the Kenya Agricultural Research Institute (KARI) and the Kenya Agricultural Productivity project (KAPP). KAPP is a strategic project that promotes cultivation of indigenous vegetables and specifically aims at increasing the sector-wide productivity to enhance competitiveness among service providers, improvement in the linkages between research, extension systems and service. The first KAPP phase (KAPP, 2007) supported continuation of ongoing reform in agricultural research initiation of a participatory process of change in extension services, farmer empowerment and pilot testing of innovative extension methods and delivery systems. The objective was to build on achievements made under the National Agricultural Extension Policy Framework to establish a new system of national agricultural extension (KAPP, 2007).

The Poverty Eradication Commission (PEC) began promoting the grain and vegetable *Amaranth* farming in Kenya in 2005 and within a year, small holder farmer's country wide were involved in the production of the vegetable and grain. The grain *Amaranth* crop is classified as "pseudo-cereal" and is highly nutritious with high protein content for a non-legume. In the United States of America (USA), it is popularly known as super or wonder grain since it is rich in dietary fiber, calcium and other minerals such as iron, magnesium, phosphorus, copper and manganese. It is a good source of essential amino acids, especially lysine which is very high in these grain (Ouma, 2004). The grains can be cooked as a whole grain, mixed with other cereals such as rice or can be milled into flour which is used to prepare meals.

Several constraints hinder the commercial cultivation of indigenous vegetables and these include, pest and disease infestation (Palada & Chang, 2003). In most surveys undertaken across the African continent, the need for research on pest complexes of indigenous vegetables has been a priority. The plants damaged by insect pests become more vulnerable to diseases. The correct identification of insect pests occurring in a particular area and their damage symptoms is a first step towards the development of integrated pest management strategies (Cock, 1986).

In recent years, there has been an increase in the consumption of *Amaranth*, which has raised demand in the markets. However, the supply of *Amaranth* in the market has not been exploited due to lack of knowledge on marketing of *Amaranth*. According Cock (1986) there

is a risk of losing *Amaranth* in Tanzania, Zambia, Botswana and Kenya due to farmers replacing them with improved vegetable varieties, citing the problem as lack of certified seeds and information about their performance, input requirements and marketing.

Available seed material for *Amaranth* consists of selected lines that vary in grain characteristics. The procedures for seed production and processing and the standards for seed certification developed slowly with the realization of the importance of quality seed in agriculture. Most likely, seed certification began in Sweden during the last quarter of the nineteen century. Seed has to meet certain rigid requirements before it is certified for distribution and ultimate use by farmers. The first and foremost requirement is that the seed must be of an improved variety and certified by the Kenya Plant Health Inspectorate Services (KEPHIS). The other requirements are genetic purity, freedom from weeds, diseases and pests, uniform germination, freedom of seed from inert material, defective seed and optimum moisture content (Singh, 1983).

Poor seed selection and seed management after harvesting can also lead to decline in agricultural production and low economic growth (Rosengrant, Paisner, Meijer, & Witcover, 2001). Seeds are planted shallowly (1-2.5cm deep depending on soil moisture) in finely prepared soil to ensure good seed-to-soil contact. Deep planting may delay and decrease emergence. Seed germinates quickly when soil temperatures are between 15°C to 18°C. Due to the shallow planting depth, drying out of the soil should be prevented until plants are established. Grain *Amaranth*s grow slowly during the first several weeks when weed control is critical. Once the plant is about a meter tall, it begins to grow rapidly and is competitive among weeds (O'Brien & Price, 1983).

Therefore, knowledge on how farmers can be involved into the production and value chain addition is of paramount importance. This is more so in Meru where cultivation of *Amaranth* has been done on a small scale, despite the high demand of *Amaranth* in Kenyan markets (Carter, 1993).

The specific factors to be investigated in this study include, access to certified seed for planting, access to extension services, marketing and utilization of the *Amaranth* products and consumption of *Amaranth* products. Strategies and tools for improving local access to high quality agricultural knowledge are a pre-requisite for improving livelihoods and

reducing vulnerability to poverty. In addition, a resource poor farmer is not only unable to capitalize on the benefits of improved technology, but also placed at a further competitive disadvantage by those who can. The possibility that the "rich get richer and poor get poorer" as result of technological change in agriculture is an extraordinarily broad question (Hasns & Flinn, 1975).

1.2 Statement of the Problem

Although the Ministry of Agriculture and other stakeholders has been sensitizing and training small-scale farmers on the benefits of *Amaranth* products in human diet and production techniques, production has remained low even in Buuri Sub-County. This is evident in that the farmers are depending on exotic vegetables despite the awareness to date.

The aspect of marketing is likely to be a significant factor on adoption of grain and vegetable *Amaranth*. The first operational principle is that if there isn't a market for a particular crop or product, then farmers should not be encouraged to produce it. In addition, as more and more farmers see the economic advantage of producing a particular new crop/product, it won't be long until some markets are inundated and prices will fall. In these situations, all producers will be left with crops/products that cannot be sold. The consequence will likely be a reduction in production the following year, erratic production cycles or abandonment of these crops or products altogether.

Most farmers use retained seed which may be pre-infected by pests and hence act as inoculums to infect the new crop in subsequent planting seasons. This can lead to low adoption. The extent of relationship between selected factors such as access to certified seeds for planting, availability of market for their produce, access to extension services and consumption of *Amaranth* products on the adoption of *Amaranth* in Buuri Sub-County has not been adequately studied and documented (Personal observation). These constraints in the production of *Amaranth* in Buuri Sub-County, Meru County form the basis for this investigation.

1.3 Purpose of the Study

The objective of the study was to identify and objectively evaluate the extent to which selected factors relate to the adoption of Amaranth production.

1.4 Objectives of the Study

The objectives of the study were to determine:

i) The relationship between availability of certified seeds and the adoption of improved *Amaranth* in Buuri Sub-County.

ii) The relationship between access to extension services and the adoption of improved *Amaranth* in Buuri Sub-County.

iii) The relationship between availability of market for improved *Amaranth* products and the adoption of improved *Amaranth* in Buuri Sub-County.

iv) The relationship between consumption of *Amaranth* products and the adoption of the improved *Amaranth* by farmers in Buuri Sub-County.

1.5 Hypotheses

The following hypotheses guided the study.

Ho_1 There is no significant relationship between availability of certified seeds and the adoption of improved *Amaranth* among small scale farmers in Buuri Sub-County.

Ho_2 There is no significant relationship between access to extension services and the adoption of improved *Amaranth* among the small scale farmers in Buuri Sub-County.

Ho_3 There is no significant relationship between availability of market for *Amaranth* products and the adoption of Improved *Amaranth* among small scale farmers in Buuri Sub-County.

Ho_4 There is no significant relationship between consumption of *Amaranth* products and the adoption of improved *Amaranth* Among small scale farmers in Buuri Sub-County.

1.6 Significance of the Study

The study hopes to make recommendations on how to formulate policies suitable for improved *Amaranth* production as well as help in enhancing transfer of *Amaranth* production concepts and practices to rural farmers. The study will also be useful to farmers in Buuri Sub -County in addressing the issues of marketing of their *Amaranth* product. In addition, the study may also help policy makers in planning strategies for leveraging agricultural development in the area. This could also provide a useful input for the development of training materials for the extension staff that is critical in the transfer of *Amaranth* technologies.

1.7 Scope of the Study

The study was done in Buuri Sub-County, Meru County. The subjects of the study were small scale farmers in Ruiri and Nchoroiboro locations who has 2.0234 hectares and below. The study mainly focused the relationship between selected factors and the adoption of improved *amaranth* production. The selected factors studied include Availability of certified seeds for planting, consumption of *Amaranth* products, access to farm based extension services, market and marketing information on *Amaranth* products.

1.8 Assumptions of the Study

i) The study assume that although most responses are based on recall rather than written records, the information obtained was generally accurate.
ii) The study also assumed minimum variation in climatic conditions in the Sub-County.
iii) Current Kenya Government policy economic environment and culture in the study area offered synergy on the small scale farmer's adoption of *Amaranth* varieties.
iv) The study also assumes that introduction of *Amaranth* and exposure of the farmers to the technologies related to *Amaranth* was uniformly done in the target Sub-County by the relevant stakeholders.

1.9 Limitations of the Study

The poor road infrastructure was a challenge to collection of data and visits to the Common Interest Group (CIG) by the researcher. These challenges were circumvented by using private and convenient means of insured motor cycles during the period of the study.

1.10 Definitions of Terms

Access to Agricultural extension - Agricultural extension is an applied behavioral science, which is applied to bring about desirable changes in the behavioral complex of farming community, usually through various strategies and programs of change, by applying latest scientific and technological innovation. Extension teaching is the process through which the extension workers stimulate interest in learning more by using various teaching methods, tools and techniques to improve the situation. This knowledge and skill should be so applied by the extension worker so as to arouse in them the interest to adopt the advanced scientific technology in their day-to-day practice (Wilson, and Gallup, 1985). In this study access to extension will imply that the farmers can get extension information three times in a month.

***Amaranth* -** The word *Amaranth* means "everlasting" in Greek. Indeed, *Amaranth* seed has endured the ages, as an important food source for ancient civilizations in South America and Mexico, to its current resurgence as a highly nutritious gluten-free grain. In this study *Amaranth* meant the traditional vegetable grown for its grain and leafy vegetable.

Availability of Markets - The management process through which goods and services move from concept to the customer. As a practice, it consists in coordination of elements such as identification, selection, and development of a product, determination of its price, selection of a distribution channel to reach the customer's place, and development and implementation of a promotional strategy (Bahilgwa, 2006). In this study availability of local market means shaping the market and the customers' understanding of the product.

Adoption - It is the mental process through which an individual passes from first learning a new idea to its final use (Rogers & Bsan, 1963). In this study, adoption means sustained growing of Improved *Amaranth* and use of the recommended *Amaranth* production practices.

Improved *Amaranth*- This refers to *Amaranth* that has been bred for high yield, pest and disease management, drought resistant and size of the grain. In this study improved *Amaranth* was that derived from certified seeds.

Consumption - Is defined as the variability in ratings attributable to changes in the sensory properties of ingested items which are intrinsic to the items being tested. The understanding of the word "consumption" is explained within a research context consisting of four

components: an ingestor, an ingestant, a response measure, and an observer. In this study the consumption of *Amaranth* mean agreeable or pleasant especially to the sense of taste.

Value addition - Is to economically add value to a product and form characteristics more preferred in the market place. The enhancement added to a product or service by a company before the product is offered to customers. Refers to the additional value of a commodity over the cost of commodities used to produce it from the previous stage of production. In this study value addition meant drying of *Amaranth* vegetable for longer storage and milling of grain *Amaranth*.

Household -A person or a group of people living in the same compound (fenced or unfenced), answerable to the same household head and sharing a common source of food and/or income. Domestic servants and other workers residing with the family members were included as household members (https://www.opendata.go.ke).

Small scale farmers - Smallholders are identified by the size of their farms. In this study a small scale farmers was farmers who owns less than 2.0234 hectares.

Selected factors - The act or an instance of selecting or the state of being selected. In this study selected factors meant some of the factors affecting the uptake of *Amaranth* production in the study area.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature important for this study. It will cover literature review focused on the selected factors that could be relating to the adoption of improved *Amaranth*, in Buuri Sub-County of Meru County. As well constraints and challenges to improved *Amaranth* production, dissemination of agricultural technologies, diffusion and adoption of technologies, theoretical and conceptual frame work is also elaborated.

The genus *Amaranthus* is widely distributed in Africa and other parts of the world. Many species from the genus are grown for the leafy vegetable and grain even in Kenya. The edible species provide calcium, iron, vitamin A and C and proteins. The crop is well adapted to a wide range of agro ecological zones. It is easy to establish in fertile soil with adequate moisture, the crop has high yields. It is more nutritious compared to other exotic vegetables such as cabbage, cucumber and tomatoes. Most of *Amaranthus* cultivars has only single stem and the roots system does not spread thus closer spacing can be utilized. In the western region of Kenya, there are currently two lines. These are the green and brown stalked plants and have short inflorescences which are sometimes not noticeable. Their leaves has the best flavor while the type with long peduncles is best for grain production but is not popular for fresh utilization as a vegetable (Ngugi, Gitau, & Nyoro, 2007). The crop is propagated by direct drilling in rows 30cm apart and later thinned to 15 cm between plants.

The growing of *Amaranth* in Buuri Sub-County was started by KAPP project. Most of the farmers viewed the crop as a very new one which was accompanied by uncertainties about production technologies, marketing, utilization, consumption and competition with the existing enterprises on the farm. KAPP encouraged the formation of common interest groups which started early 2001. The number of members registered in the eight zones averaged 45 members per CIG making a total of 360. Later the group grew up to 3500 farmers. (Muthee Personal Communication, March 22, 2012). Table 2 outlines information from the Ministry of Agriculture in Buuri Sub-County. .

Table 2: Crop Production Situation in Buuri Sub-County

Crop	Current Production		Potential Production	
	Ha	**Yield 90kg/Ha**	**Ha**	**Yield/Ha**
Maize	6120	14.4 Bags	7190	65 bags
Wheat	14460	17.8 bags	13975	55 bags
Barley	1350	20 bags	4000	55 bags
Sorghum	800	12 bags	700	25 bags
Field beans	2130	8 bags	11170	20 bags
Dolicos lablab	615	10 bags	850	22 bags
Pigeon peas	12	20 bags	100	20 bags
Cowpeas	20	22 bags	120	18 bags
Amaranth	32	24 bags	150	34 bags
Sweet potatoes	22	10 tons	24	25 tons
Irish potatoes	4900	7.1 tons	10600	25 tons
Coffee	20	1.24 tons	30	20 tons
Cotton	300	1 tons	840	2.5 tons
Snow peas	2500	4 tons	6000	5 tons
Runner beans	120	100 tons	400	100 tons
Cutflower(roses)	175	1.2stems/ha/year	3000	2.0m stems/ha/year

Source: Ministry of Agriculture (Buuri Sub-County Profile 2011).

Prior to 2000, indigenous vegetables never, featured in various market chains in Kenya, probably due to the notion that indigenous vegetables are grown by subsistence farmers only as 'hunger foods' that people consume in times of need and drought (Humphry & Clegg, 1993). Post 2000, trade in indigenous vegetables has increased significantly in volume and number of species on offer due to a combination of consumer promotion initiatives, stimulation of production, linking of small scale producers with supermarkets and strengthening of producer groups (Ngugi et al., 2007).

Amaranthus species belong to the plant family *Amaranthaceae*. *Amaranth* is derived from a Greek word "Amereino" meaning immortal, living forever or not withering. The importance of *Amaranth* as drought tolerant and valuable sources of food, medicine and income has been documented (Irungu et al., 2006). In Kenya, *Amaranth* is used by many communities and is

known by various local names. Some examples are: Kiswahili as Mchicha; Kamba as W'oa; Kikuyu as Terere; Kipsigis as Kelichot; Luhya as Lidodo; Kisii as Emboga; Luo as Ododo; Pokot as Sikukuu or Chepkuratian; Turkana as Lookwa or Epespes; Taita as Kichanya and Teso as Ekwala.

Amaranth leaves and grains has medicinal value, which can reduce or combat common diseases such as diabetes, hypertension, liver disease, hemorrhage, wound healing, kwashiorkor, marasmus, skin disease among others (Martirosyan, 2007). *Amaranth* seeds and biomass are rich in soluble and insoluble diet fibers important in prevention of coronary heart diseases of the colon. The compounds in *Amaranth* can enhance human growth and development, improve general health, and strengthen immune responses to combat diseases (Ouma, 2004). With high levels of essential micronutrients like carotene, vitamin C, iron and calcium, *Amaranth* has a high nutritional value. It is also rich in lysine, and essential amino acid that is lacking in diets based on cereals and tubers. *Amaranth* seed contains more protein than other grains such as Wheat, Maize, Rice or Sorghum (Pospisil, Pospisil, Varga, & Svecnjak, 2006). It also contains high levels of minerals especially Iron, Phosphorous and Magnesium more than what is found in animal products like milk and meat. It also has high levels of vitamin A, B, and E. The fat content in *Amaranth* seed is high (7 – 8%) and double that of other cereals. Grain *Amaranth* is highly recommended for infants because of its protein digestibility, absorption and retention by the baby's body system (Abele & Twine, 2007).

2.2 Relationship between Selected Factors and the Adoptions of Amaranth.

There are many factors affecting *Amaranth* production such as pests and diseases, certified seed, production technologies, marketing of *Amaranth* products, consumption of *Amaranth* products, extension services but this study will address some of these factors. Wekesa (2010) found in his studies that in Kenya, until recently, *Amaranth* leaves were more commonly consumed than the grains. Production and consumption of grain *Amaranth* varieties is a more recent phenomenon and is still limited to a few areas such as Homabay, Bondo, Kisumu West and Meru Sub Counties. A survey was conducted in 2010 by Wekesa to document current knowledge, attitudes and practices regarding grain *Amaranth* production and utilization in Kisumu West Sub-County, Kenya. The study was undertaken to identify potential points for intervention in the development of strategy to increase production and utilization appropriate to the needs and circumstances of low-income, small-scale farmers. Information was obtained

from secondary sources and further investigated using focused group discussions and key informant interviews. Semi-structured questionnaires were administered to 84 farmers selected using stratified random sampling techniques to collect data on grain *Amaranth* production, utilization and economic viability. Farmers' knowledge was relatively low regarding processing, utilization and medicinal value of grain *Amaranth*. Farmers identified and ranked seven constraints to grain *Amaranth* production as; unreliable rainfall, lack of awareness, lack of seed, lack of market, competition with other cereals, inadequate capital and pests and diseases. The study concluded that concerted efforts by all stakeholders are required to address production, processing, value addition and marketing challenges in a holistic manner to ensure sustainable production of grain *Amaranth* in the region (Wekesa, 2010).

2.2.1 Sources of Certified Seed

An Act of Parliament to confer power to regulate transactions in seeds, including provision for the testing and certification of seeds; for the establishment of an index of names of plant varieties; to empower the imposition of restriction on the introduction of new varieties; to control the importation of seeds; to authorize measures to prevent injurious cross-pollination; to provide for the grant of proprietary rights to persons breeding or discovering new varieties; to establish a Tribunal to hear appeals and other proceedings; and for connected purposes (Plant and Variety act chapter 326).

However much a farmer puts to use other productive inputs (land, fertilizer, labor), availability of quality seeds remains an important factor for crop production. The Government of Kenya has been pursuing strategies aimed at increasing agricultural productivity through the provision of quality seeds as the basis for accelerating economic growth and improving the wellbeing of both rural and urban people in Kenya. Seed has been recognized as a core component to realizing this strategy. Compared to other agricultural inputs, seed has been shown to has the greatest potential to increase on-farm productivity and enhance food security (Muyanga & Ayieko, 2005). Availability improved seed thus plays pivotal role in increasing agricultural productivity and reduces production costs inherent in our crop production systems.

Two seed systems exist in Kenya, the formal and informal seed systems. While the formal seed system is an important source of high quality certified seed, it is expensive and often is

not able to meet the farmers' demand. Majority of farmers therefore rely on the informal seed systems for seed and planting material for most agricultural crops. Consequently, there is frequent recycling of seeds that has not been exhausted each season and probably generations for cultivation. The result has been persistently low yields. The challenge in the Kenyan agriculture today is to develop seed production and delivery systems that encourage wider use of quality seed throughout the marketing chain. Indeed, one of the six fast-track activities for Kenya's Strategy for Revitalization of Agriculture (SRA) is to improve access to quality inputs and financial services (Republic of Kenya, 2004).

A well-functioning seed system is one that uses the appropriate combination of formal, informal, market and non-market channels to efficiently meet farmers' demands for quality seeds. While the seed industry in Kenya is better developed compared to other countries within the region, the high cost of seeds relative to other purchased inputs, coupled with the inability of the formal seed systems to meet the demand by farmers was cited as bottlenecks industry (Ngugi et al., 2007). Moreover, local and international seed companies find it unprofitable to make the investment required to provide the quantity, quality and variety of seed needed to support an expanding agricultural base. In addition, poor legislative and regulatory framework in the seed industry has adversely affected access to improved seed and planting materials by farmers.

Since the liberalization of the seed industry in 1996, private sector participation has increased, with a number of private seed companies being registered to produce seed, thus reducing the monopoly that these Kenya Seed Company has enjoyed for a long time. While it was widely expected that this would lead to improved accessibility to quality seed and hence increased efficiency, agricultural productivity has generally been low and shown declining trends. In addition, mechanisms to protect farmers from malpractices by the seed producers and traders was not been adequately put in place. Farmers, therefore has no fallback position when faced with challenges linked to low quality seeds. Poor accessibility to information regarding demand, supply and general performance in the seed market, are among other constraints identified in Kenya (Kamau, 2002).

The Kenya Plant Health Inspectorate Services (KEPHIS), which is charged with the regulation of the seed industry, has also been viewed by key stakeholders to slow the release of improved varieties from breeding programs to seed producers and eventually to farmers.

The seed production has been done by KARI among others. The goal of the KARI Seed Unit (KSU) is to meet farmers demand for sustainable and reliable supply of high quality seeds and vegetative propagated and open pollinated planting materials. The unit maintains all pre-released and released varieties, inbred lines and population as well as producing breeder, pre-basic and basic seeds. The formal seed sector purchases breeders seeds and informal sector purchases basic seed for further multiplication. Seed companies using breeders or basic seed purchased from KSU produce certified seed/stocks/seedlings. KSU also multiplies quality seed and planting material for sale directly to the farmers through selected seed growers/nursery operators.

2.2.2 Access to Extension Services

Farmers who has frequent contact with extension agents usually has higher adoption rate for farming practices than those farmers with less contact with extension staff. Thus the extent to which the farmers make contact with members of the extension staff determines the adoption of recommended practices (Wilson, & Gallup, 1985). Crop production extension services are important for the adoption of crop production technologies. Farmers require technical advice on measures suitable for their farms. Wilson & Gallup (1985) found out that the level of expertise manifested by farmers with intensive extension contact was consistently higher than that of other farmers. However, this is in contrast with the findings of Wasula, (2000), who found that the frequency of extension contacts with the farmers was not significant to the adoption of agro-forestry technologies.

In a study by Chitere (1980) to establish the extent to which farmers adopt recommended practices, it was found that nearly all the farmers in an area previously occupied by European settlers' were knowledgeable about improved farming practices. He also observed that farmers adopt improved farming practices largely because of early exposure to intensive extension teaching. Several studies indicated that a positive relationship between contact with agricultural information sources and adoption (Wasula, 2000). Farmers who have been exposed to an intensive extension education adopted many agricultural innovations in contrast to neighbours who are not exposed to extension campaigns.

2.2.3 Availability of Markets

If the market demand for *Amaranth* were larger, there would be thousands of farmers growing it at its current price. The species from the genus *Amaranth* are used for a wide

variety of purposes. Although the crop is used exclusively for seed production in the USA in other regions of the world there are many other uses. In Africa and the Caribbean, *Amaranth* is commonly eaten as a pot herb, with individual leaves picked off the plants periodically. Farmers in China are reportedly growing over 40,485.83 hectares *Amaranth* as forage for hogs. Many *Amaranth* species has therefore become popular ornamental plants (Jefferson, 2014). The primary Agricultural focus of rural, resource limited household in Kenya is food security. There is a range of markets running from markets, which may be held as frequently as every day to global and import markets. This range implies different quantities of products, ranging from individually countable numbers of products in the village setting to bulk shipment at the international level. Encompassed within this discussion of economies of scale is the notable distinction between rural and urban markets within Kenya. Whereas rural markets mostly likely offer commodities fresh from the field (shamba), urban markets require high quality products. Rural resource limited household may not be able to benefits from those urban markets due to their lack of training and organization to meet those standards demanded by supermarkets and urban consumers (Bahilgwa, 2006). Markets tend to be solely in the female domain, consisting of subsistence produce brought from the household home garden (Aspaas, 1998).

This relationship between marketing and the adoption of grain and vegetable *amaranth* is likely to be a significant factor affecting its production, especially in cases where households aim to cultivate *Amaranth* for commercial rather than for domestic consumption. Prices of grain *Amaranth* and other agricultural commodities are likely to vary seasonally as well as annually in response to demand and supply constraints. The issue of marketing of *Amaranth* products will be carefully considered in this study, to assess whether grain *Amaranth* has a future as a food crop, cash crop or both (Bahilgwa, 2006).

2.2.4 Consumption of *Amaranth* Products

Amaranth products are used for nutrition security and as one of the strategies for reducing poverty. They are eaten along with staple foods to complement their nutrient density, improve the taste and to promote health. Products include porridge, grains roasted to create traditional beer or milled into flour and mixed with maize and wheat flour to make Ugali, Chapati (flat bread) and Mandazi (doughnuts). It is also used in multigrain products like breads, noodles, pancakes, cookies and breakfast cereals (Hackman & Myers, 2003). It can be popped and mixed with sugar solution to make confections. The grain is also used in

fortifying food where the staple food is low in certain elements. Grain *Amaranth* has been found to have medicinal values. It has been used in the management of diabetes, migraines, hypertension, liver disease, haemorrhage, TB, HIV/AIDS, wounds, kwashiorkor, marasmus, stunting, diarrhoea and skin diseases. It also contains dietary fibers important in prevention of coronary heart disease and cancer of the colon. Consumption of the grain has been known to enhance human growth and development, improve general health and strengthen body immunity (Legacy, 2003).

Amaranth seed flour has been evaluated as an additive to wheat flour by food specialists. To determine consumption, different levels of *Amaranth* grain flour were mixed with the wheat flour and baking ingredients (1% salt, 2.5% fat, 1.5% yeast, 10% sugar and 52–74% water), fermented, molded, pan-proved and baked. The baked products were evaluated for loaf volume, moisture content, color, odor, taste and texture. The *Amaranth* containing products were then compared with bread made from 100% wheat flour. The loaf volume decreased by 40% and the moisture content increased from 22 to 42% with increase in *Amaranth* grain flour. The study found that the sensory scores of the taste, odor color and texture decreased with increasing amounts of *Amaranth*. Generally, above 15% *Amaranth* grain flour, there were significant differences in the evaluated sensory qualities and the high *Amaranth*-containing product was found to be of unacceptable consumption to the population sample that evaluated the baked products (Sauders & Becker, 1984).

2.3 Theoretical Framework

This study is based on the diffusion and adoption theory propounded by (Rogers & Bsan, 1963) and also the previous research work carried out by various researchers on the relationship between the farmer's characteristics, government policies and technological characteristics and the adoption. Rogers (2010) stated that the process of adoption consists of a series of action and choices over time through which an individual evaluates a new innovation or idea and then decides whether to adopt or reject the practice. Rate of adoption is the relative speed with which an innovation is adopted by members of a system. It is measured by the length of the time required for certain percentage of members of a system to adopt an innovation. The normal rate of progress might require from six to ten years between the introduction of the innovation and its adoption generally throughout the community (Supe, 1983). In this study adoption theory will apply since the farmers were taught by

stakeholders, some are going through decision innovation process. Figure 1, illustrates the adoption theory of innovations.

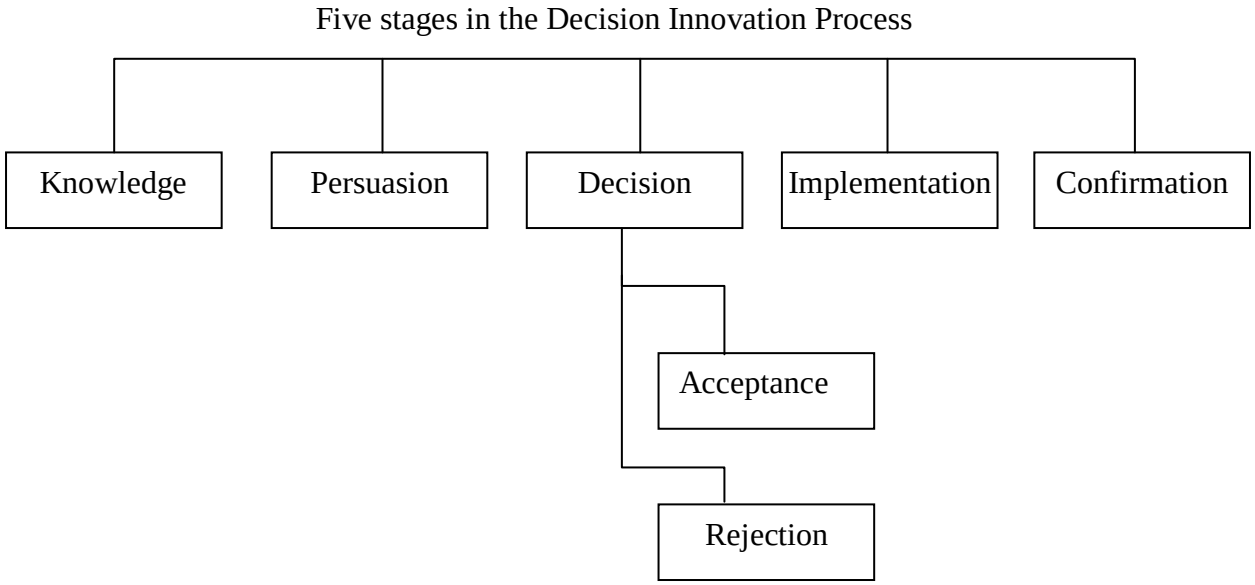

Figure 1: Five Stages in the Decision Innovation Process
(Source: Rogers, 1983)

Knowledge - In this stage the individual is first exposed to an innovation but lacks information about the innovation. During this stage of the process the individual has not been inspired to find more information about the innovation.

Persuasion - In this stage the individual is interested in the innovation and actively seeks information and details about it.

Decision - In this stage the individual takes the concept of the innovation and weighs the advantages of using the innovation and decides whether to adopt or reject the innovation. Due to the individual nature of this stage Rogers notes that it is the most difficult stage to acquire empirical evidence (Rogers, 2010).

Implementation - In this stage the individual employs the innovation at a varying degree depending on the situation. During this stage the individual determines the usefulness of the innovation and may search for further information about it.

Confirmation - Although the name at this stage may be misleading, in this stage the individual finalizes his or her decision to continue using the innovation and use the innovation to its fullest potential.

2.4 Conceptual Framework

The conceptual framework outlines the approach that has been used to study the selected factors that affect adoption of improved *Amaranth* by small scale farmers in the study area. The independent variables included in the study are marketing of *Amaranth* products, availability of seeds for planting, consumption and extension service provision while the dependent variable would be adoption of improved *Amaranth*. The dependent variable would be measured as proportion of the farmers growing *Amaranth*. Intervening variables has been built into the design of the proposed study to understand their effects on the dependent variable. These include income levels, farm size and level of exposure of the farmers to other agricultural enterprises on-farm. During hypothesis testing, the effects of household income, farm size, level of exposure of the farmers and other enterprises on the farm will be isolated by testing any relation they has with the adoption of *Amaranth*. Study has been conceptualized as outlined in the figure 2 below.

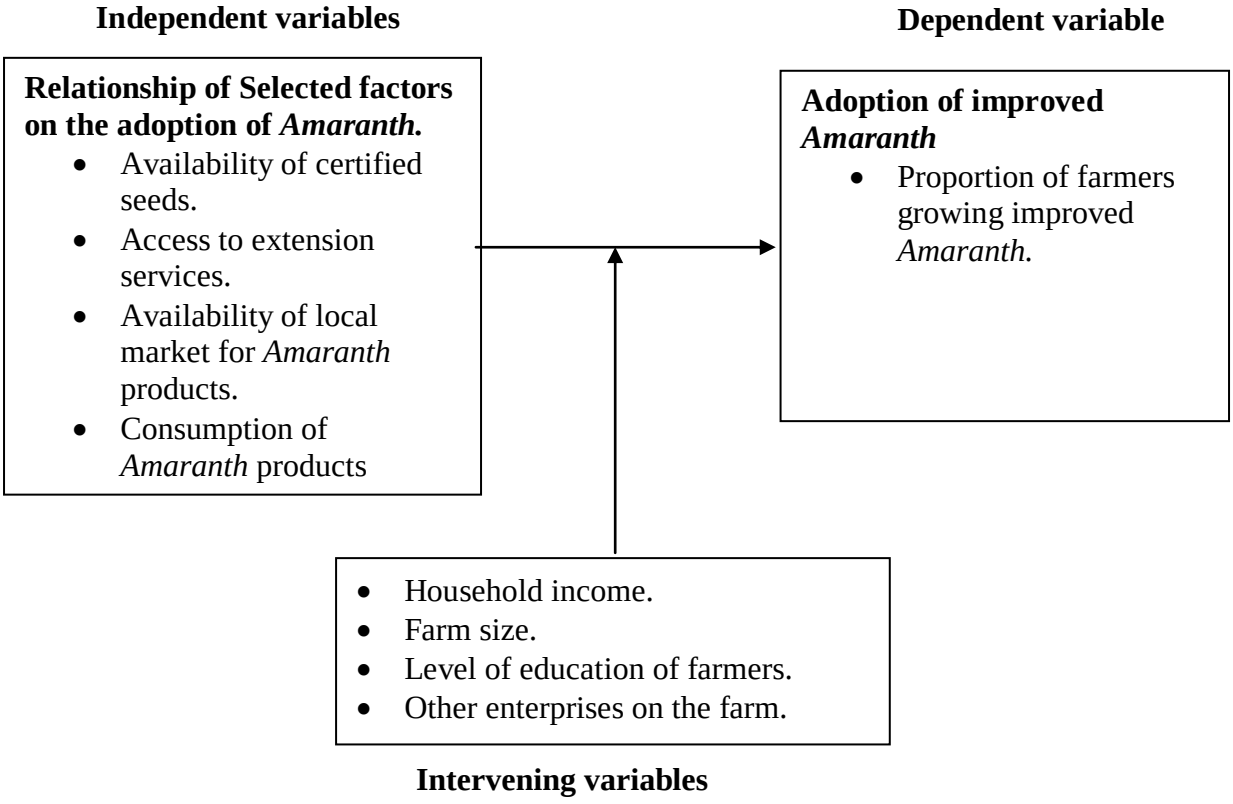

Figure 2: Own Conceptual Framework Showing the Interaction of Selected Factors on the Adoption of Improved Amaranth.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a description of how the research was carried out. It covers the research design, population, sampling techniques, instrumentation, data collection, data organization and data analysis procedures.

3.2 Research Design

The study used an *ex post facto* descriptive survey design. This design was appropriate for the study because it enabled the description and exploration of the selected factors on the adoption of improved *Amaranth* by farmers in the selected study area. This type of design involves data collection after a naturally occurring event. It involves collection of information from a sample that has been drawn from a population that has received a natural treatment not designed by researcher (Fraenkel, Wallen, & Hyun, 1993). The study attempts to describe the factors that affect the uptake of *Amaranth* production in relation to the adoption of *Amaranth* in retrospect. This design is appropriate for the study since it facilitates the collection of information from a sample of a population in order to describe their characteristics as they relate to the facts (Kerlinger, 1979). In this study, the characteristics of the sampled *Amaranth* farmers were described and their relationship on the adoption of *Amaranth* clearly described. In addition, the design provides accurate descriptive analysis of characteristics of a sample which can be used to make inferences on the population.

3.3 Location of the Study

The study was carried out in Buuri Sub-County of Meru County (Appendix B). The Meru population is about 1.5 million people with a population density ranging from 100 persons per square kilometer in lowland areas to over 400 persons per square kilometer in highland areas. Meru is a composition of Tigania, Igembe, Imenti, Miutuni, Igoji, Mwimbi, Muthambi, Chuka and Tharaka sub-tribes, which generally speak *Kimîîru* dialects, a Bantu language in the Niger-Congo family. The southern dialects of the Ameru are very close to Bantu-speaking Kikuyu people while those of the Northern part show some Cushitic tendencies. Although the Chuka and Tharaka sub-tribes has a slightly different oral histories and mythology, the Imenti sub-tribe dialect dominates in the entire Meru region. The differences in the culture, taboos and language phonetics amongst the sub-tribes of Ameru reflect the varied Bantu origins and influences from the neighbouring Cushite and Nilotic

people, as well as different Bantu-speaking neighbours such as the Kikuyu and Embu tribes. Nevertheless, the Meru people exhibit a much older Bantu characteristic phenomenon in grammar and phonetic forms than any other languages of the Bantu-speaking neighbours . Buuri is a *Kimîîru* word from which the district got its name, which means "dry land". According to Ameru much of the Buuri Sub- County is very dry due to the fact that it lies on the leeward side of Mount Kenya and thus receives very little rainfall. The actual population in Buuri Sub- County is not precisely known but the Meru Central District Development Plan (2002–2008) projected the population in 2008 to be roughly 276,000 people. Much of Buuri Sub- County is dominated by scattered trees, stretches of dry grass and shrubs as the main vegetation types with a number of forests in the neighbourhood, the largest being Mount Kenya forest. The topography of the district was largely influenced by the volcanic activity of Mount Kenya. The dominant soil type is the deep red loam soils, which are well drained and fairly fertile.

The study site was selected based on a fellowship project from the National Museums of Kenya which also involved investigation of *Amaranth* insect pest and integrated pest management. The location of the study also houses farmers who had previously been trained by stakeholders on *Amaranth* production.

3.4 Population of Study.

The population under study comprised of farmers in Buuri Sub-County who were selected by KAPAP conglomerated stakeholders.The accessible population was farmers in Buuri Sub-County who had received training from Farm Concern International (FCI), Kenya Agricultural Productivity Project and relevant stakeholders promoting the cultivation in the target area. Over all, there were 360 farmers who were trained on *Amaranth* production and who here by form the accessible population for the study sampling procedure and sample size.

The identified population comprised of 360 members who had received previous training on *Amaranth* production. A sample of 110 respondents from the population of 360 small scale farmers was selected from Ruiri and Nchoroiboro locations within Buuri Sub -County using a random sampling approach. Fifty farmers from Ruiri and fifty in Nchoroiboro respectively were randomly selected for the study. According (Kathuri & Pals, 1993), a minimum of 100 farmers are recommended for a standard survey research. This sample size of 100 farmers

provides a reasonable sample for subsequent sound data analysis. An extra number of 10 farmers were necessary to cater for natural attrition. This gives a reasonable number from each location of the study.

3.5 Instrumentation

A questionnaire (Appendix A) was designed and used as the main instrument of data collection for the small scale farmers growing *Amaranth* in Buuri Sub-County. The questionnaire used for the farmers is captured in (Appendix A). The questionnaire was chosen because of the ease of administration and scoring of the instrument besides the results being readily analyzed. It is also useful in that the type of response to items facilitates consistency across the respondents (Casley, Kumar, & Mundial, 1988). The items of the questionnaire were developed on the basis of the objectives of the study. The instrument was self-administered to the farmers and researcher was available to assist in case of difficulty in filling questionnaires especially where the farmers had a problem of low education. The researcher used the questionnaire to interview the respondents who could not read and write. The questionnaire consisted of structured and closed ended questions.

3.5.1 Validity

Validity of a questionnaire refers to the extent to which it measures what it claims to measure. Face validity deals with format of the instrument and includes aspects like clarity of printing, font size and type, adequacy of workspace, and appropriateness of language. Construct validity determines the nature of psychological construct or characteristics being measured by the instrument(Mugenda, 2012). Peers at South Eastern University and Experts at Egerton University were asked to review the instrument to address aspects of validity including content, construct and face validity. The validation of the instrument was aimed at ensuring the instrument measured what it was intended to measure (Kathuri & Pals, 1993).

3.5.2 Reliability

According to Frankel and (Fraenkel et al., 1993), reliability refers to the consistency of the scores obtained as well as how consistent they are from one administration of an instrument to another and from one set of items to another. The instrument was pre-tested for its reliability with a sample of 20 small scale farmers of *Amaranth* and two extension workers from Machakos and Kangundo. These two areas have similar characteristics to the study area. Twenty farmers was chosen for pre-test because according to (Kathuri & Pals, 1993), it is the

smallest number that can yield meaningful results on data analysis in a survey research. Consistency of reliability alpha coefficient of 0.70 or more was acceptable. According to (Fraenkel et al., 1993), reliability alpha coefficient should be at least 0.70 for research purposes in social sciences. If reliability alpha coefficient was less than 0.70, revision of the instrument was done accordingly. A high alpha coefficient of 0.70 and above implies that the items correlate highly among themselves and there is consistency among the items in measuring the concept of interest.

3.6 Data Collection Procedures

Upon receiving authority letter from Graduate School of Egerton University and a research permit from the National Council of Science and Technology (Appendix C), field work was initiated to collect relevant data for this study. A schedule for the visits to meet the respondents was then prepared with the assistance of divisional agricultural extension coordinator's, frontline extension workers and the village headsmen. The questionnaire was then administered to the farmers with prior training on how to fill them. The study focused mainly on household heads for uniformity of data collection. In case the household head was absent, then the most responsible member of the household was given the questionnaire to fill. This member was the one who at one time was entrusted with the responsibility of overseeing the households' activities for a period spanning five years or more.

3.7 Data Analysis

The data collected was organized considering independent and variables, dependent variables together with the respective hypotheses (Table 3). These variables were coded and entered into a computer for analysis using SPSS. Responses to each category of the instrument was coded and scored for the purpose of data entry. Each score was assigned a specific weighting for meaningful interpretation as required by each of the hypothesis. Descriptive analysis was used to determine the frequency and distribution of the demographic and socio-economic characteristics of the respondents. Inferential statistics using correlation coefficient was used. The Pearson product moment correlation coefficient was used to determine the of independent variables on the dependent variable for the hypotheses one, two and three and four which was analyzed at alpha coefficient confidence level of 0.05. The advantage with correlation coefficient is that it shows the strength and direction of the relationship. Data analysis was done using the Statistical Package for Social Sciences (SPSS) version 12.

Table 3: Summary of Data Analysis.

Hypothesis	**Independent Variables**	**Dependent variables**	**Method of analysis**
Ho_1 There is no significant relationship between availability of certified seeds and the adoption of improved *Amaranth* among small scale farmers in Buuri Sub-County	Availability of certified seed	Adoption of *Amaranth* (proportion of the farmers growing *Amaranth*)	Descriptive statistics and Pearson's correlation coefficient
Ho_2 There is no significant relationship between access to extension services and the adoption of improved *Amaranth* among the small scale farmers in Buuri Sub-County.	Access to extension services	Adoption of *Amaranth* (proportion of the farmers growing *Amaranth*)	Descriptive statistics and Pearson's correlation coefficient
Ho_3 There is no significant relationship between availability of market for *Amaranth* products and the adoption of Improved *Amaranth* among small scale farmers in Buuri Sub-County.	The availability of local market.	Adoption of *Amaranth* (proportion of the farmers growing *Amaranth*)	Descriptive statistics and Pearson's correlation coefficient
$H0_4$. There is no significant relationship between consumption of *Amaranth* products and the adoption of improved *Amaranth* Among small scale farmers in Buuri Sub-County	Consumption of *Amaranth* products.	Adoption of *Amaranth* (proportion of the farmers growing *Amaranth*)	Descriptive statistics and Pearson's correlation coefficient

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter is presented in five sections; section 4.1 provides the introduction, sections 4.2 outlines demographic and socio-economic characteristics of the respondents, section 4.3 elaborates the results and discussion of objective one, section 4.4 highlights the results and discussion of the objective two, section 4.5 provides the results and discussion of objectives three and section 4.6 outlines the results and discussion of objective four.

4.2 Demographic and Socio-economic Characteristics of the Respondents

The demographic and socio-economic characteristics of the respondents were identified in order to establish the kind of farmers who participate in *Amaranth* farming in Buuri Sub - County Meru County. The demographic characters included gender of the respondents, age of the respondents and level of education of the respondents while farm size and income of the respondents were the socio-economic parameters. These characteristics are believed to be crucial in understanding the nature and the role of farming in the area.

4.2.1 Age of the Respondents

Age is said to be a primary latent characteristic in the adoption decision. In Burkina Faso, age was found to positively affect the adoption of Sorghum (Adesina & Baidu-Forson, 1995). It is also believed that the age of household head is crucial for his or her decision making in determining what to farm on a given piece of land and season. In this study, 34% of the respondents were aged 40 years and below while 66 % were 41 years and above (Table 4). It is argued that adoption rates of improved *Amaranth* depend on age of farmers. Since most of the respondents in this study were forty one (41) years and above, the adoption rate could be low.

Table 4: Age of Respondents

Age bracket (Years)	Frequency	Percentage
21-30	8	8.0
31-40	26	26.0
41-50	28	28.0
Above 51	38	38.0
Total	**100**	**100.0**

4.2.2 Level of Education of the Respondents

(Hassan, Kiarie, Mugo, & Robin, 1998) has shown that the level of education and the use new technology are directly correlated. Findings of this study indicate that out of 100 farmers involved, only 15% were illiterate while 85% had acquired or qualified at least primary education and above (Table 5). This shows that adoption of *Amaranth* could be high in Buuri since 85% of the respondents have primary education and above. Therefore, based on the above findings, the level of education may not negatively adoption of *Amaranth*.

Table 5: Education Background of the Respondents

Level of education	Frequency	Percent
Not gone to school	15	15.0
Lower primary	22	22.0
Secondary	40	40.0
College	20	20.0
University level	3	3.0
Total	**100**	**100.0**

4.2.3 Gender of the Respondents

Gender is an important factor in the household decision making process. Previous studies has indicated that male farmers tend to focus on income generating enterprises, while female farmers focus more on food crops (Kidula, 2005). Survey responses in this study indicated that 38% of the farmers engaged in the study were males while 62 % were females (Table 6). This evidently shows that more female farmers were concentrating on the *Amaranth* as a food crop compared to their male counterparts.

Table 6: Gender of the Respondents

Gender	Frequency	Percent
Male	38	38.0
Female	62	62.0
Total	**100**	**100.0**

4.2.4 Income of the Respondents

Income may enable farmers to procure investments required before they can adopt new crop**.** Any new crop is likely to be expensive in the initial adoption stages and therefore there is a need for reasonable income for farmers who may adopt. The responses of the study showed that 76% of the farmers earn Ksh 3,000 and below while 24% earn Ksh 3001 and above (Table 7). This means that the rate of adoption of *Amaranth* production may be negatively affected by the income of the respondents.

Table 7: Total Monthly income

Income of respondents (Ksh)	Frequency	Percentage
Less than 1000	23	23.0
1001-3000	53	53.0
3001-10000	19	19.0
Above 10000	5	5.0
Total	**100**	**100.0**

4.2.5 Size of the Farm of Respondents

Land as a major factor of Agricultural production has been used in several studies. It is of immense importance since it is the original source of all material wealth. The economic prosperity of a country is closely linked with the richness of her natural resources. The quality and quantity of agricultural wealth of a country depends on the nature of soil, climate and rainfall (Douglas and Roy 1976).

Farmers with large farms adopt more advanced farm practices than small scale farmers (Amudavi, 1993). The results of this study indicate that 83% of the respondents had 2.9hactares of land and below while 17% had 3 of land above (Table 8). This is likely to have contributed to low adoption rate of *Amaranth* since most famers had small pieces of land and are not likely risk on new technology adoption.

Table 8: Size of Farm

Farm Size	Frequency	Percentage
Less than one hectare	21	21.0
1 - 1.9	38	38.0
2 - 2.9	24	24.0
3 - 3.9	7	7.0
4 - 4.9	6	6.0
Above 5	4	4.0
Total	**100**	**100.0**

4.3 Relationship between Availability of Certified Seeds and the Adoption of Improved *Amaranth* in Buuri Sub-County

This section covers the results and discussion on the relationship between Availability of certified seeds and the Adoption of Improved *Amaranth* in Buuri Sub-County.

This study sought to determine the different availability of seeds used by the respondents and consequently, the types of seeds used as well as the actual buying points for the certified *Amaranth* seeds. Figure 3 shows respondent's source of seeds for planting on-farm.

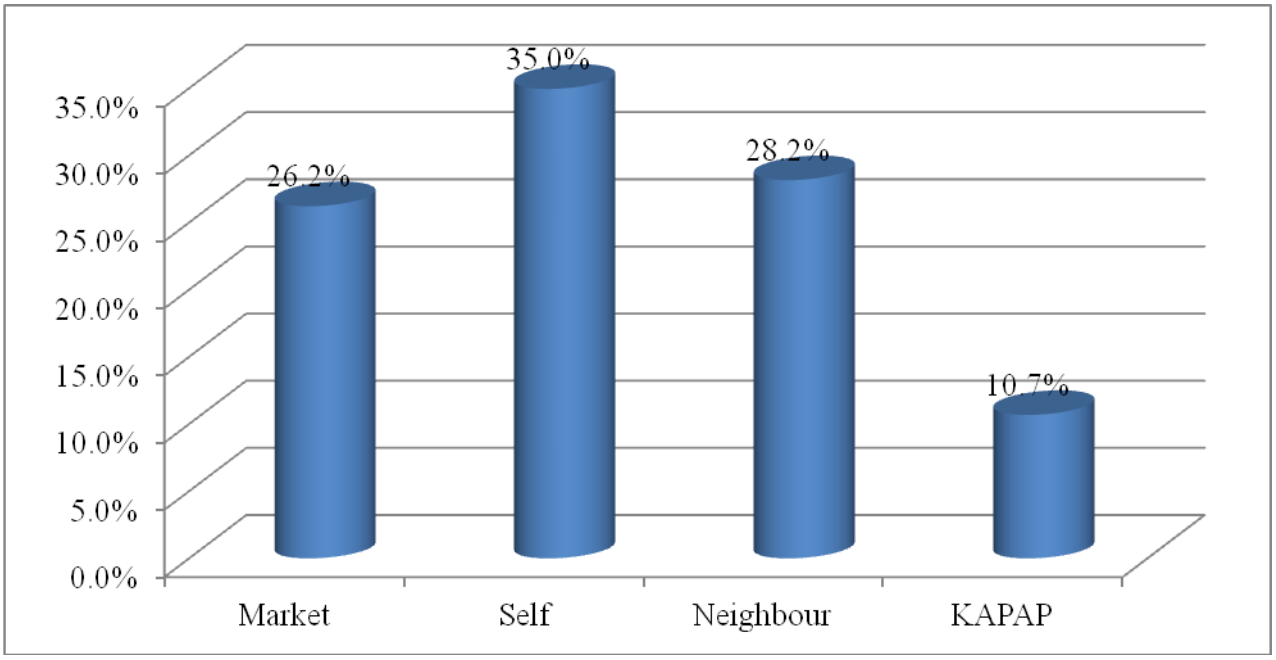

Figure 3: Availability of seeds for Planting

Most of the respondents sourced their seed planting stock from previous season's crop contributing 35.0% of the total respondents. Further, the results indicate that 28.2% of respondent's seed sources were from neighbours. This implies that 63.2% of the farmers had their seeds sourced from self and neighbours. Evidently from these results, only 26.2% of the sampled farmers sourced certified seeds for planting from the market while 10.6% of the seeds were obtained from KAPAP sources. This implies that farmers who accessed certified seeds for planting comprised a total of 36.8% (From market and KAPAP; Figure 4).

This study also investigated the outlets of certified seeds for planting by farmers. The results indicated that 63% of respondents were not aware of the places to buy certified seeds.

Table 9: Availability of certified seeds for Planting

Availability of certified seeds	**Frequency**	**Percent**
Agro-Vet shops	8	8.0
Simlaw company	29	29.0
Not Aware	63	63.0
Total	**100**	**100.0**

From the results above, it implies that 37% of respondents got their certified seeds from Agro veterinary shops and Simlaw Company. Wekesa (2010), found in his studies that availability of certified seed and adoption of *Amaranth* has a direct correlation and it appears this study agrees with his findings.

Further, this study also investigated the prevalence of farmers using seeds from previous crop or purchasing hybrid from the regulated market. Figure 5 shows that most of the farmers were using seeds from previous crop (81.0%) while 19.0% of the farmers tried hybrid seeds.

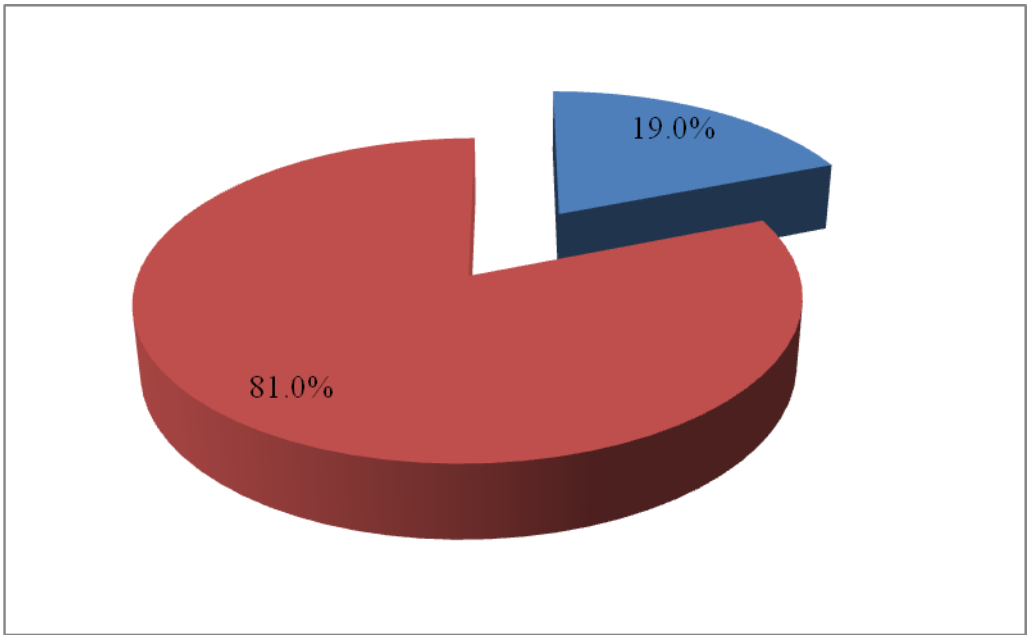

Figure 4: Types of seeds planted

Re cycling of the previous crop seeds could lead to a decline in yield and carryover of pests and diseases. A decline in crop yield therefore can negatively influence the adoption of the improved *Amaranth.* This can be explained by lack of improved varieties, high cost of seeds, lack of local seed dealers and inadequate knowledge on crop husbandry occasioned by limited technical support. Singh (1983) noted in his study that certified seeds are in many aspects superior to recycled seeds since they are free from pests, diseases and culminate to high crop yields.

Test of Hypothesis H_{O1}

Objective one was translated into the following hypothesis:

Ho_1: There is no significant relationship between availability of certified seeds and the adoption of improved *Amaranth* among small scale farmers in Buuri Sub -County.

Hypothesis was tested using Pearson's product moment correlation coefficient. An analysis of sources of *Amaranth* seeds as variable against growing of improved *Amaranth* was significant (Table 10). This suggests that the availability of seeds had a relationship on the adoption of improved *Amaranth*.

Table 10: Relationship between Source of Certified Seeds and the Adoption of Improved *Amaranth*

		Sources of *Amaranth* seeds	Do you grow improved *Amaranth* in your farm
Sources of *Amaranth* seeds	Pearson correlation	1	0.726 (*)
	Sig. (2-tailed)	.	0.035
	N	100	100
Adoption of Improved *Amaranth*	Pearson correlation	0.726(*)	1
	Sig. (2-tailed)	0.035	.
	N	100	100

* Correlation is significant at the $P \leq 0.05$ level (2-tailed).

On testing the relationship of the sources of the seeds for planting on the adoption of *Amaranth*, a P-value of 0.035 and r = 0.73 was obtained. Since a level of $P \leq 0.05$ significance level was adopted, the results of the study indicate that the availability of seeds for planting has a relation on the adoption of *Amaranth* and r = 0.73 indicate a strong relationship, hence the null hypothesis was rejected. Thus the source of seeds for planting has a statistically significant relationship on the adoption of improved *Amaranth* among small scale farmers in Buuri Sub-County. Simply stated, farmers who sourced their seeds from the market (Agro vet shops, Simlaw Company and KAPAP) had greater adoption of improved *Amaranth* compared to their counterparts who used recycled seeds. This agrees with studies by (Nyoro, 2004; Wekesa, 2010) who concluded that availability of certified seeds plays a major role in process of enhancing adoption rate of farmers to new farming or on-farm technologies.

4.4 Relationship between Access to Extension Services and the Adoption of Improved *Amaranth* in Buuri Sub -County

This section highlights the results and discussion of objective two. Figure 7 shows extension service providers to Buuri farmers and their frequencies.

The key stake holders who provide extension service within Buuri Sub-County were ministry of Agriculture (39%), Farm concern Africa (6%), Kenya Agricultural Productivity and Agri-business Project (47%), Simlaw Seed Company (3%) and Meru University College (5%).

From the data derived in this study, KAPAP and Ministry of Agriculture are the main extension providers in Buuri Sub-County. However, there are other stakeholders in the provision of extension services providers.

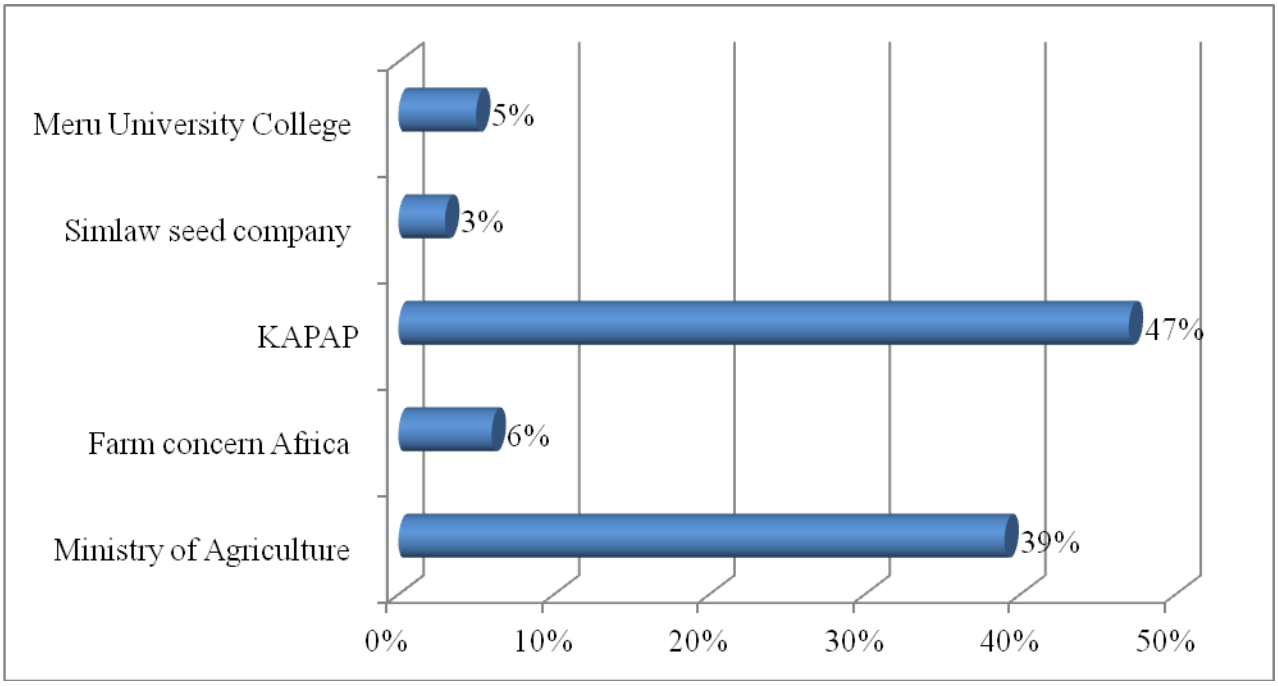

Figure 5: Extension Services Providers

During the study, identification of farmers who had access to extension services and those who did not has been done. In addition, the different *Amaranth* extension services providers were also identified. Figure 7 shows the proportion of sampled farmers who had access to extension services compared to those who had no access.

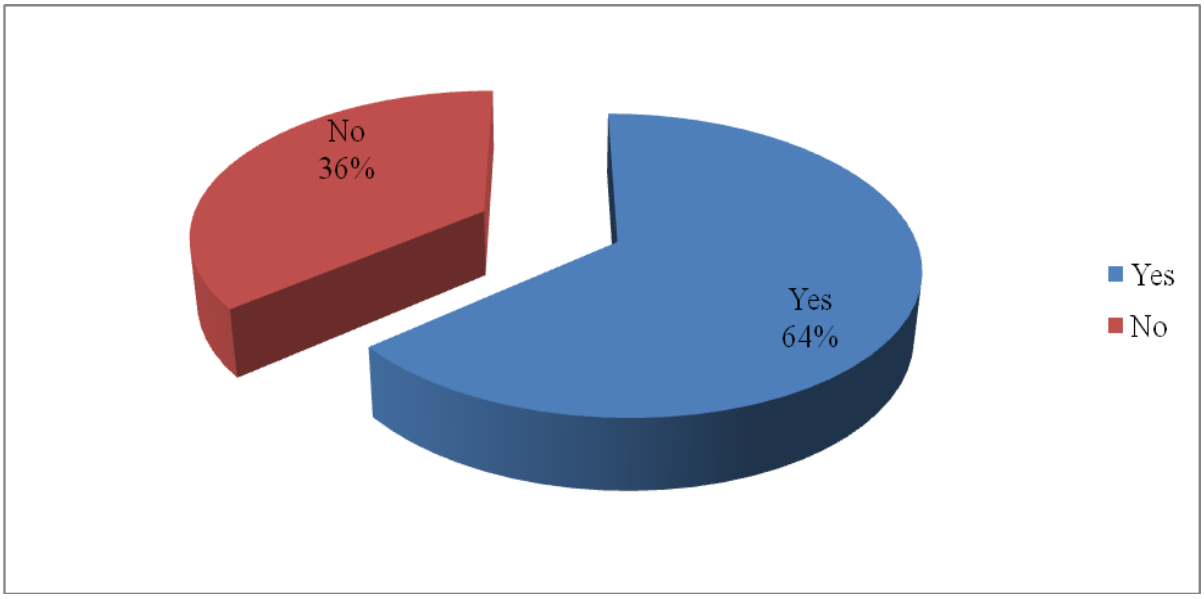

Figure 6: Percentage of the respondents who receive extension services.

It is evident that in Buuri Sub-County, most of the farmers (64%) received extension services on the various ways of improving the production of *Amaranth*. There are few farmers 36% who indicated that they had never received extension services.

Test of Hypothesis H_{O2}

Objective two was translated into the following hypothesis:

Ho_2: There is no significant relationship between access to extension services and the adoption of improved *Amaranth* among the small scale farmers in Buuri Sub-County.

The hypothesis was tested using Pearson correction coefficient. Table11 shows how extension service correlated with the adoption of improved *Amaranth***.**

Table 11: Relationship between Access to Extension Services and the Adoption of Improved *Amaranth*

		Do you grow improved *Amaranth* in your farm	Access to extension service
Do you grow	Pearson correlation	1	0.034
improved *Amaranth*	Sig. (2-tailed)	.	0.212
in your farm	N	100	100
Do you get extension	Pearson correlation	0.034	1
service of *Amaranth*	Sig. (2-tailed)	0.212	.
production	N	100	100

* Correlation is significant at the $P \leq 0.05$ levels (2-tailed).

On testing the relationship of access to extension services on the adoption of *Amaranth*, a P-value of 0.212 and r = -0.34 was obtained. Access to extension services alone has no significant relationship on the adoption of improved *Amaranth* among small scale farmers in Buuri Sub-County.

This study agrees with Wasula (2000) who found that the frequency of extension contacts with the farmers was not significantly correlated to the adoption of agro-forestry technologies.

4.5 Relationship between Availability of Market for Improved *Amaranth* Products and the Adoption of Improved *Amaranth* in Buuri Sub -County.

This section covers the results and discussions of objective three which was to determine the relationship between availability of markets and the adoption of improved *Amaranth* in Buuri Sub-County.

The study sought to determine the problems faced by farmers when marketing their *Amaranth* products as well as the available outlets where the respondents sell their *Amaranth* produce.

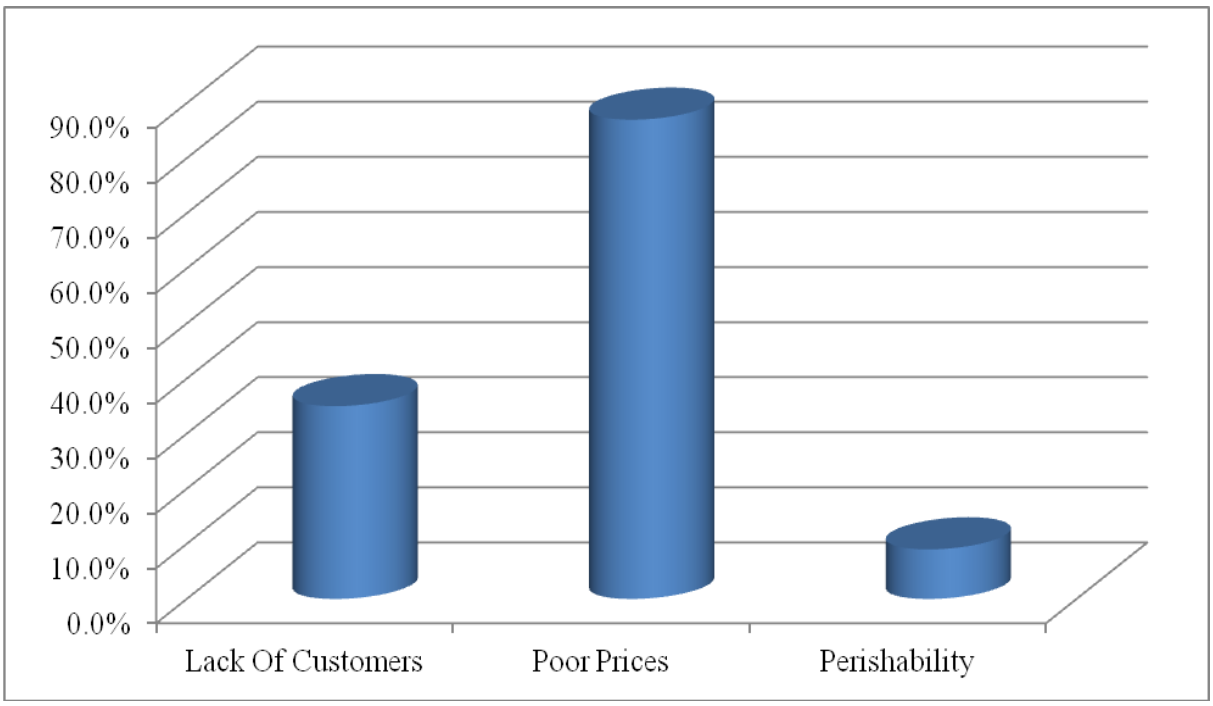

Figure7: Problems Faced when Marketing *Amaranth*

Most of the respondents indicated that the problems encountered during marketing included poor prices comprising about 76.0%. This was closely followed by farmers who cited that lack of customers was their main problem accounting for 22.0% of the total respondents. About 2.0% of the respondents indicated that perishability was a challenge prior to accessing markets. The existence of challenges on the marketing of *Amaranth* may be one of the reasons why some farmers have not adopted improved *Amaranth* production techniques. The lack of good market for *Amaranth* and the challenges involved in marketing are known to discourage farmers to produce more leading to decline in adoption of *Amaranth*.

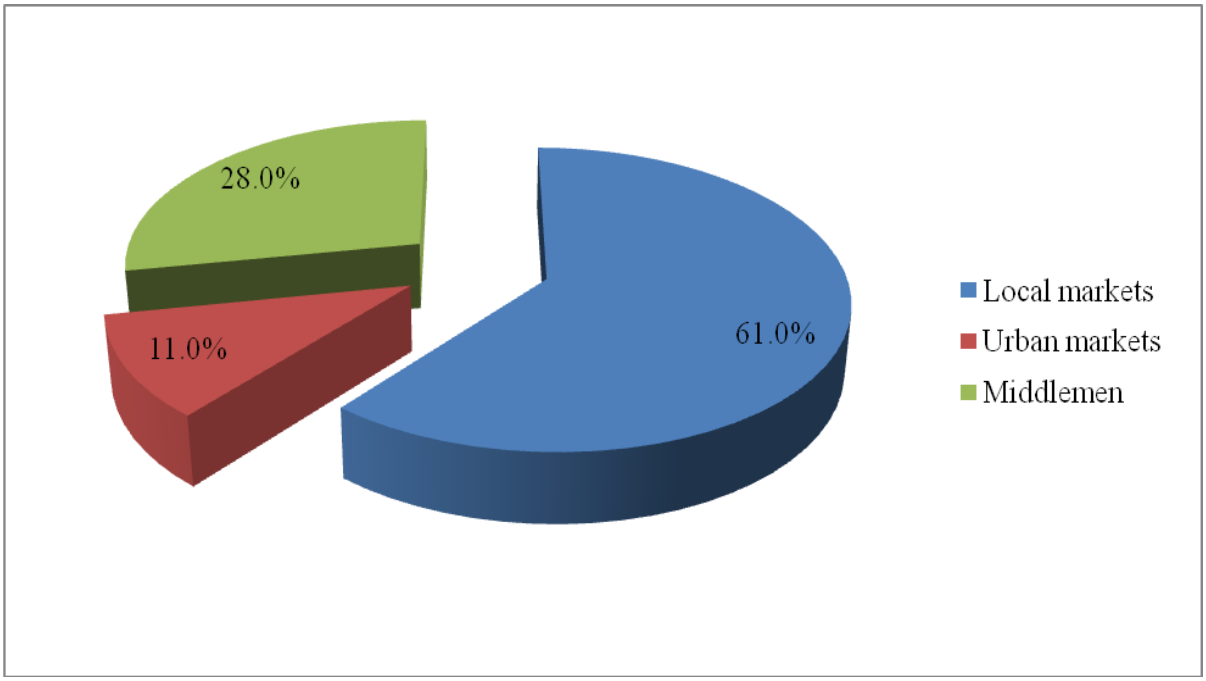

Figure 8: Outlets where the respondents sell their *Amaranth* produce.

Figure 8 above shows the outlets through which *Amaranth* products are marketed in the study area. Majority of farmers 61.0% sold their produce at the markets while 28.0% sold their *Amaranth* products through middle men. Urban markets particularly at Meru town were exploited by very few farmers representing 11.0% of the respondents.

The great popularity of *Amaranth* products at the markets could be attributed to the farmers need to lower the marketing transaction costs as this is known to lower their profits. This implies that most farmers ensure that they do not travel long distances to dispose their products as there were markets which could reduce marketing and other transactions costs and in return offer attractive profits.

Test of Hypothesis H_{O3}

Objective three was translated into the following hypothesis:

Ho_3: There is no significant relationship between availability of market for *Amaranth* products and the adoption of Improved *Amaranth* among small scale farmers in Buuri Sub-County.

The hypothesis was tested using Pearson correlation coefficient. Table 12 shows the relationship between availability of markets and the adoption of improved *Amaranth* in Buuri Sub-County.

Table 12: Relationship between Availability Market and the Adoption of Improved *Amaranth*

		Do you grow improved *Amaranth* in your farm	Where do you sell the *Amaranth* products
Do you grow improved *Amaranth* in your farm	Pearson correlation	1	0.921(*)
	Sig. (2-tailed)	.	0.010
	N	100	100
Where do you sell the *Amaranth* products	Pearson correlation	0.921(*)	1
	Sig. (2-tailed)	0.010	.
	N	100	100

* Correlation is significant at the $P \leq 0.05$ level (2-tailed).

Table 12 above shows that availability of markets has a direct correlation to the adoption of improved *Amaranth* (P = 0.01, r = 0.9). Since correlation is significant at the $P \leq 0.05$, p =0.01 was obtained and r value of 0.9 which indicate a strong relationship. Hence the null hypothesis was rejected. Thus availability of market has statistically significant relationship on the adoption of improved *Amaranth* among small scale farmers in Buuri Sub-County.

4.6 Relationship between Consumption and the Adoption of the Improved *Amaranth* by Farmers in Buuri Sub-County.

This section covers the results and discussion of objective four in this study. This objective determined the relationship of consumption of *Amaranth* products on the Adoption of the Improved *Amaranth* by Farmers in Buuri Sub-County.

The study further investigated the relationship between frequency of *Amaranth* consumption, perceived tastes of *Amaranth* products and the adoption of *Amaranth*. Table 13 shows the distribution of farmer's responses on whether consumption s the adoption of *Amaranth*. Majority (94.0%) of the farmers agreed that consumption of *Amaranth* products in particular the taste and frequency of consumption affect their adoption of *Amaranth*. It was only 6.0% of the farmers who had a different opinion that consumption does not affect the adoption of *Amaranth*.

Table 13: Farmers Response on Whether Consumption of *Amaranth* affects Adoption

Response	Frequency	Percent
Agree	94	94.0
Disagree	6	6.0
Total	**100**	**100.0**

Amaranth is perceived to have different tastes and this study further sought to investigate whether taste of *Amaranth* products affects its production. Of the total respondents sampled, majority of the farmers (43.0%) felt that the taste of *Amaranth* products was very good. This was closely followed by farmers who perceived the taste of *Amaranth* products as good (31.0%) (Table 14). In addition, other farmers indicated that the taste of *Amaranth* was average (14.0%), poor (8.0%) and very poor (4.0%).

Table 14: Respondents Opinion on the taste of *Amaranth* products

Response	Frequency	Percent
Very good	43	43.0
Good	31	31.0
Average	14	14.0
Poor	8	8.0
Very poor	4	4.0
Total	**100**	**100.0%**

Table 15 shows the frequency of consumption of *Amaranth* products. Most of the respondents who were noted to consume *Amaranth* frequently, implying that they liked the commodity's product. Generally, farmers who indicated that the taste of *Amaranth* was negative are expected to has their consumption of *Amaranth* to being rare compared to those who considered taste as good. Specifically, a cumulative of 72.0% of the total respondents indicated to has consumed *Amaranth* products for a period not exceeding one month. Majority (49.0%) of the farmers indicated to has consumed *Amaranth* product week before interview. This was closely followed by farmers who indicated that they consumed *Amaranth* products month before interview (17.0%). Some (11.0%) respondents reported to has consumed the products just one day before while other (12.0%) had actually consumed the product the very day of the interview.

Table 15: When the Farmers Last Consumed *Amaranth* Products

	Frequency	Percent	Cumulative percent
Today	12	12.0	12.0
Yesterday	11	11.0	23.0
Last week	49	49.0	72.0
Last month	17	17.0	89.0
Last year	11	11.0	100.0
Total	**100**	**100.0**	

The researcher noted that *Amaranth* was utilized in a number of ways (Table 16). Majority (79.0%) of the respondents indicated that they used *Amaranth* for preparing porridge and was closely followed by those who used *Amaranth* as a vegetable (57.0%). Some respondents used *Amaranth* for preparing Ugali (26.0%), Chapati (5.0%) and Cakes (3.0%).

Table 16: Different uses of *Amaranth*

How *Amaranth* is used	Frequency	Percent
Vegetable	57	17.0
Porridge	79	42.0
Ugali	26	3.0
Cake	3	2.0
Chapati	5	2.0
Total	**100**	**100.0**

The use of *Amaranth* products as an ingredient in many local food products implies a possibility of increased consumption, demand of the crop hence transforming to increased production.

Test of Hypothesis H_{O4}

Objective four was translated into the following hypothesis:

$Ho_{4:}$ There is no significant relationship between consumption of *Amaranth* products and the adoption of improved *Amaranth* Among small scale farmers in Buuri Sub-County.

The hypothesis was tested using Pearson product moment correlation coefficient.

Table 17 shows how consumption of *Amaranth* products affects the adoption of improved *Amaranth*.

Table 17: Relationship between Consumption and the Adoption of Improved *Amaranth*

		Do you grow improved *Amaranth* in your farm	How is the taste of *Amaranth* product
Do you grow improved *Amaranth* in your farm	Pearson Correlation	1	0.210(*)
	Sig. (2-tailed)	.	0.036
	N	100	100
How is the taste of *Amaranth* product	Pearson Correlation	0.210(*)	1
	Sig. (2-tailed)	0.036	.
	N	100	100

* Correlation is significant at the $P \leq 0.05$ level (2-tailed).

On testing the relationship of consumption on the adoption of *Amaranth*, a P-value of 0.036 and r = 0.21 was obtained. At a test of $P \leq 0.05$ significance level, the results of the study indicate that consumption has relationship on the adoption of *Amaranth* hence the hypothesis was rejected. It has r value of 0.21. Thus consumption has a significant relationship on the adoption of improved *Amaranth* among small scale farmers in Buuri Sub-County. This relationship is however weak since a correlation coefficient of 0.21 was obtained.

These results agrees with Abele, Twine, Ntawuruhunga, Baguma, Kanobe, & Bua, (2008) who noted that consumption increases the pleasure of individuals experiences in eating of Cassava in Uganda. The taste, smell, texture and appearance of food products all impact on the consumption of food. The higher the palatability of food, the higher the consumption, both from the farmer and the market at large which trigger more production. The increase in consumption of *Amaranth* as a result of its consumption enhances its adoption in return.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of this study was to determine the relationship between selected factors such as availability to certified *Amaranth* seeds, access to extension advice, marketing of *Amaranth*, and consumption of *Amaranth* products and the adoption of improved *Amaranth* in Buuri Sub -County in Meru County. The summary of findings, conclusions and recommendations are presented in this chapter. Suggestions for further studies are also presented.

5.2 Summary of Findings

Based on the analysis of the results obtained from the study, the following are the summary of key findings.

i) Demographic and socio-economic characteristics

On the demographic characteristics and socio-economic characteristics of the respondents, majority were aged above 51 years, this may have a negative impact on the adoption of improved *Amaranth* since age is said to be a primary latent characteristic in the adoption decision. Most of the respondents had secondary school education and above, and this could have a positive impact on the adoption of *Amaranth*. Most of the farmers engaged in the study were female. Economic characteristics of the respondents, majority had a monthly income of between Kshs. 1000 and 3000 and since any new crop is likely to be expensive in the initial adoption stages, therefore there is a need for farmers to have at least more than ten thousand shillings and above which may make them to adopt it.

ii) Availability of certified seeds for planting

Most of respondents had their seed sourced from previous crop. Only a few had certified seeds for planting sourced from the market or other sources such as KAPAP. Majority of respondents indicated that they didn't know the source of certified seed. Cycling of the previous crop could lead to a decline in yield and carry-over of pest and disease which can affect the adoption of the improved *Amaranth*. There was a significant relationship between size of land and adoption of improved *Amaranth*. It is evident that majority of the farmers who owned more than five acres were the ones using certified seeds as compared to those farmers with small tracts of land.

iii) Access to extension service

Most of the farmers indicated that they received extension service on production of *Amaranth* with a few farmers indicating that they had never received extension services. The stakeholders who provided extension services to farmers were: Ministry of Agriculture Farm concern Africa Kenya Agricultural Productivity and Agri-business Project, Simlaw Seed Company and Meru University College.

This study accepted the null hypothesis that extension service has no relationship on the adoption of improved *Amaranth* among the small scale farmers in Buuri Sub-County. Therefore the extension service may not be a factor affecting the adoption of improved *Amaranth* in Buuri Sub-County.

v) Availability of markets

Most of the respondents indicated that the marketing problems that they face were poor prices. This was closely followed by farmers who cited that lack of customers was their main problem when it comes to the marketing of *Amaranth*. Few of the farmers indicated that perishability was the main marketing problem that they faced. Majority of farmers sold their produce at local market. Some sold to the middle men while a few sold in the nearby urban markets located in Meru town.

There was enough evidence to conclude that availability of market for *Amaranths* products significantly relationship on the adoption of improved *Amaranth* in Buuri Sub -County in Meru County. Majority of the farmers with access to local and urban markets for the produce had better adoption of improved *Amaranth* as compared to farmers who sold their *Amaranth* mainly through the middlemen.

v) Consumption of Amaranth products

Majority of the farmers agreed that consumption of *Amaranth* products affect their adoption of *Amaranth*. Most of the farmers considered the taste of *Amaranth* products as very good. Likewise, most of the respondents indicated that they consumed *Amaranth* frequently, implying that they liked the commodity's product. Majority of the respondents indicated to consume *Amaranth* as porridge, vegetables Ugali, Chapati and Cake. This study concludes that, there is a significant relationship between consumption and adoption of *Amaranth*.

Farmers whose *Amaranth* consumption was negative had low adoption while farmers whose consumption was positive had high adoption.

5.3 Conclusions

Based on the study findings, the following conclusions were made:

i) There is a significant relationship between the Availability of certified seeds and the adoption of *Amaranth*. The test shows that Availability of certified seeds has relation on the adoption of improved *Amaranth*.

ii) The size of land has a positive relationship on the adoption of improved *Amaranth*. Farmers who own bigger land were more likely to use certified seeds as compared to those farmers with small tracts of land.

iii) Provision of extension service alone has no positive relationship on the adoption of improved *Amaranth* among the small scale farmers in the study area mainly due to the weaknesses in the mode of delivery of the research results to the farmers.

iv) Availability of markets for *Amaranth* products has significant relationship on the adoption of improved *Amaranth* with majority of the farmers with access to local and urban markets for their produce having better adoption of improved *Amaranth* as compared to farmers who sold their *Amaranth* mainly through the middlemen.

v) Consumption of amaranth products has a positive significant relationship on the adoption of improved *Amaranth* among small scale farmers in Buuri Sub-County. Since majority of the farmers agreed that consumption of *Amaranth* products affect their adoption of *Amaranth*.

5.4 Recommendations

i) Adoption of grain *Amaranth* will be enhanced if efforts are made to develop good systems of accessing certified seeds for planting. Stakeholders should have adequate certified seeds available during planting time. This will ensure that farmers do not plant previous seeds which might be infected with pests.

ii) For sustainable *Amaranth* production in the region, provision of extension services should be strengthened through provision of support services alongside other advisory services to farmers. The extension service should also be combined with provision of farm inputs to farmers.

iii) Efforts should also be made to educate the farmers on the availability of market opportunities for continued *Amaranth* cultivation.

iv) Extension service providers should ensure that they also educate farmers on how to prepa*re Amaranth* to enhance on-farm nutritional diversity. Efforts to make to educate farmers on various uses of the products should be given priority. This should be geared towards increasing the consumption *of Amaranth* since it has relationship on its adoption.

5.5 Suggestions for Further Research

This study has shown the effects of selected factors on the uptake of improved *Amaranth* Buuri Sub-County in Meru County. However, more research needs to be done on the following areas:

i) A comparative study of the effects of government and private firm's extension services to the adoption of improved grain and vegetable *Amaranth* in Buuri Sub-County in Meru County is required.
ii) A study on the socio-economic implications for introducing grain and vegetable Amaranth in Buuri Sub -County in Meru County is needed.

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APPENDICES

APPENDIX A: A Sample of Questionnaire for Farmers

You have been selected among other farmers to assist in providing information on the factors influencing adoption of improved *Amaranth* in Buuri Sub-County Meru County. The information you provide will be used for study purposes in Egerton University. Successful study may promote the future of *Amaranth* production in this region and other parts of Kenya. Please give information as correct as possible for it to be useful in the research and will be kept highly confidential.

SECTION A: PROFILE OF THE RESPONDENTS.

Instructions: Tick and/or fill where appropriate

Date----------

1. Location----------
2. Division----------
3. What is your educational level?
   - Has not gone school ☐
   - Lower primary ☐
   - Primary level ☐
   - Secondary level ☐
   - College ☐
   - University level ☐
4. Gender
   - Male ☐
   - Female ☐
5. What is your monthly income?
   - Less than 1000/= ☐
   - 1001-3000/= ☐
   - 3001-10,000/= ☐
   - Above 10,000. ☐

6. What is your age?

   Less than 20 years ☐
   21-30 years ☐
   31-40 years ☐
   41-50 years ☐
   Above 51 years ☐

7. What is the size of your farm in hectares?

   Less than 1 ☐
   1 - 1.9 ☐
   2 - 2.9 ☐
   3 - 3.9 ☐
   4 - 4.9 ☐
   More than 5 ☐

8. Do you belong to a farming group?

   Yes ☐
   No ☐

9. What problems does your group face in carrying out the activities?

   Financial constraints ☐
   Management challenges ☐
   Lack of skills ☐
   Others specify----------

10. What is you occupation?

    Crop farmer ☐
    Livestock keeping ☐
    House wife ☐
    Business ☐
    Employed ☐
    Casual labor ☐
    Others----------

11. What crops do you grow normally in your farm?

Maize ☐

Beans ☐

` Bananas ☐

*Amaranth*s ☐

Pigeon peas ☐

Others specify----------

12. Do you grow improved *Amaranth* in your farm?

Yes ☐

No ☐

13. What portion of your farm is under *Amaranth* in hectares?

0.25 ☐

0.5 ☐

0.75 ☐

1.0 ☐

1.25 ☐

1.50 ☐

More than 1.55 ☐

SECTION B (AVAILABILITY OF CERTIFIED SEEDS)

14. What are your seed sources for planting?

- Market ☐
- Self ☐
- Neighbors ☐
- Others specify----------

15. What type of seed do you use during planting of *Amaranth*?

- Previous crop seeds ☐
- Hybrid seed ☐

16. If hybrid, which variety of *Amaranth* do you grow?

- A. cruentus ☐
- A. hybridus ☐
- A. caudatus. ☐
- A. hypochondriacus ☐
- A. dubius ☐
- Others specify----------

17. Where do you get certified *Amaranth* seeds for planting?

- Agro-Vet shops ☐
- Simlaw Company ☐
- Others specify ---------

18. If you use previous crop seed, how long do you store them before planting?

- Less than 1 year ☐
- 2-3 years ☐
- More than 3 years ☐

19. How do you store your grain *Amaranth*?

- Gunny bags ☐
- Plastic bags ☐
- Cotton bags ☐
- Gourds ☐
- Others specify ----------

20. How do you carry out multiplication of your seed?

Small plots ☐

Large plots ☐

Others specify----------

21. How do you dry your seed?

Under shade ☐

In sun ☐

In the fire place ☐

Others specify----------

22. When do you harvest your *Amaranth*?

Shattering time ☐

When the seeds change color ☐

Prior to harvest time ☐

23. What are the reasons for not growing certified *Amaranth* seed?

Not available ☐

Very costly ☐

Others specify----------

24. How do you preserve your seed after harvesting?

Drying ☐

Pesticide application ☐

Drying and pesticide application ☐

Others specify----------

SECTION C (ACCESS TO AGRICULTURAL EXTENSION SERVICES)

25. Do you get extension service of *Amaranth* production?

Yes ☐

No ☐

26. If yes who provides extension service?

Ministry of Agriculture ☐

Farm Concern International ☐

KAPAP ☐

Simlaw Seed Company ☐

Meru University ☐

Others specify……..

27. If no how do you get information on *Amaranth* production?

From friends ☐

Radios ☐

Others specify----------

28. How many times has been trained on *Amaranth* production?

Once ☐

Twice ☐

Thrice ☐

More than three times ☐

Not at all ☐

29. Do you think Extension services have helped on adoption of *Amaranth* production?

Yes ☐

No ☐

SECTION D (MARKETING OF *AMARANTH* PRODUCTS)

30. Which products do you get from *Amaranth* plant?

Vegetable ☐

Grain ☐

Others specify----------

31. Where do you sell the *Amaranth* products?

Local market ☐

Urban market ☐

Middle men ☐

Others specify ----------

32. What problems do you face when marketing your *Amaranth* products?

Lack customers ☐

Poor prices ☐

Perishability ☐

Others specify----------

33. If there are marketing problems how do you think that they can be solved?

Awareness of importance of *Amaranth* products ☐

Forming marketing co-operative's ☐

Harvesting when there is need ☐

Others specify----------

34. How much money do you get from *Amaranth* products per season?

Less than KSh 1000 ☐

KSh 1001-2000 ☐

KSh 2001-3000 ☐

KSh 3001-4000 ☐

More than KSh 4001 ☐

35. How do you spend the money you get from *Amaranth*?

Buy other food ☐

Pay school fees ☐

Buy cloths ☐

Others specify……

SECTION E (CONSUMPTION OF *AMARANTH* PRODUCTS)

36. How is the taste of *Amaranth* products?

Very Good ☐
Good ☐
Poor ☐
Very poor ☐

37. Among the vegetables given, which is the most palatable?

☐
Cabbage ☐
Kales ☐
Black nightshade ☐
Cow peas ☐

38. How often do you consume *Amaranth* products?

Today ☐
Yesterday ☐
Last week ☐
Last month ☐
Last year ☐
Never ☐

39. How do you use *Amaranth* products?

As a vegetable ☐
Mixed with flour ☐
Porridge ☐
Cake ☐
Chapati ☐
Others specify----------

40. Do you think the consumption of *Amaranth* can affect its adoption?

Yes ☐
No ☐

41. How do you add value to *Amaranth* products?

Drying ☐
Milling ☐
Drying and Milling ☐

APPENDIX B: Map of Kenya Showing Buuri Sub-County and the neighboring Sub-Counties

APPENDIX C: National Council for Science, Technology and Innovation Authorization

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349, 254-020-2673550
Mobile: 0713 788 787 , 0735 404 245
Fax: 254-020-2213215
When replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RCD/10/013/45**

Date: **29th July 2013**

Onesmus Muasya Kyambo
Egerton University
P.O Box 536-20115
Egerton.

RE: RESEARCH AUTHORIZATION

Following your application dated **25th July, 2013** for authority to carry out research on ***"The Influence of Selected factors on the adoption of improved Amaranth among small scale farmers in Buuri District, Meru County, Kenya."*** I am pleased to inform you that you have been authorized to undertake research in **Buuri District** for a period ending **30th September, 2013.**

You are advised to report to **the District Commissioner, District Education Officer and District Agricultural Officer, Buuri District** before embarking on the research project.

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

DR. M. K. RUGUTT, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:

The District Commissioner
The District Education Officer
The District Agricultural Officer
Buuri District.

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THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Onesmus Muasya Kyambo
of (Address) Egerton University
P.O Box 536-20115, Egerton.
has been permitted to conduct research in

Buuri Location
Meru District
County

on the topic: The Influence of Selected factors on the adoption of improved Amaranth among small scale farmers in Buuri District, Meru County, Kenya.

for a period ending: 30th September, 2013.

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Research Permit No. *NCST/RCD/10/013/45*
Date of issue *29th July, 2013*
Fee received *KSH. 1000*

Applicant's Signature

For Secretary
National Council for
Science &Technology

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed with-out prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

HARAMBEE

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

GPK6055t3mt10/2011

(CONDITIONS—see back page)