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ROLE OF BIOFORTIFIED CROPS IN MITIGATING FOOD SECURITY IN THE RURAL HOUSEHOLDS IN MURANG'A COUNTY: A CASE OF WOMEN FARMERS OF DRY LAND ARROWROOTS

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DECLARATION

This Research Project is my original work and has not been presented for a Degree in any other University or institution of higher learning.

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DEDICATION

This Master's Thesis is dedicated to my family and my husband for their tireless support during the long study period, and the travels. It is also dedicated to the women of Kenya particularly in the sub counties Muranga County for their support.

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ABSTRACT

The purpose of this inquiry is to investigate the role of biofortified dry land arrowroots in mitigating food security among rural women farmers' households in Muranga County. The study on biofortified dry land arrowroots as a strategic biofortified crop to fight hunger. Muranga County is considered a hardship county because of the vast pockets of dry arid and lands that experience rain shortage and prolonged drought. The unreliable rainfall implies that farmers experience unstable crop production. The study seeks to establish biofortified dry arrowroots nutrition value, the economic value of dry land arrowroots and challenges experienced by women farmers in Muranga County. The Study is founded on the theory of innovation and feminist theory that best explains change and transformation in society. The study methodology included the use of semi-structured questionnaires, Focus group discussions and interviewing key informants. The study sampled 120 respondents. The qualitative and quantitative data was analyzed and a report prepared. The study achieved 83% response rate. The Study findings indicate that biofortified dry land arrowroots crops are beneficial in assisting rural households gain food security because the crop is fast maturing and uses little rainfall. The women farmers benefited from selling surplus crops. Lastly women farmers experience myriad challenges in growing dry land arrowroots from difficulty in obtaining seedlings and accessing finances to support the crop production. Conclusion of the study is that dry land arrowroots have significant effect on food security among women farmers in Muranga County. The findings however cannot be generalized in Kenya. The study recommends that the government needs to adopt biofortified dry land arrowroots farming production to address food insecurity in arid and semi-arid lands. The study further recommends studies in other Counties on dry land arrowroots to allow generalization.

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DEFINITION OF TERMS

Biofortification: described as a scientific process of enhancing concentration and density of vitamins and minerals in a food crops through plant breeding, transgenic techniques, or agronomic practices using science and technology according to Brooks (2011). During the research, the women farmers understood biofortification as adding nutrients to foodstuffs to improve nutrition among foods consumed in the community.

Food Security: According to Barrett (2010) food security is described as the availability, access and use of food products to provide energy and nutritional needs. Food security in the community of study means is ability to get food daily for sustenance and not going hungry.

Elements: Refers to the micronutrients derived from consumed foodstuffs of which absence leads to health challenges. During the study the farmer understood elements as substances whose absence causes Kwashiorkor and malnutrition.

Policy: Is defined as an aspect of governance with political, economic and administrative effects on management, mechanisms, processes and institutional operations, Hyden (1999). In the study Policy refers to government directives that guide farmers in the community. The women farmers understood policy as government directive that has to be followed.

Nutrition Security: According to Food and Agriculture Authority nutrition security is achieved when one individuals experience health and happy life through the consumption of adequate food with guaranteed quality, safety and acceptability, (2012). In the study Nutrition security refers to the ability of households to get enough nutrition from local food

stuffs. The women farmers understood Nutritional security as having good food for good health.

Human rights: defined as universal freedoms and entitlements that all humanity is guaranteed, Shestack (1998). Human rights are the right to get food. The women farmers understood human rights as fairness to everyone and being treated fairly.

Climate Change: According to the Regional Climate Change, change is described as the change or variation in air temperature, water precipitation, quality of air and weather variability. Climate change locally refers to changing rainfall patterns.

Biotechnology: The women farmers' considered biotechnology as improvement of crops.

Micronutrients: The farmers understood micronutrients as things that make food useful to the body.

Dry land arrowroots: The farmers' regarded dry land arrowroots as a new form of arrowroots that matures faster, uses less water.

LIST OF ABBREVIATION AND ACRONYMS

ASAL	Arid and Semi-Arid Lands
AWSC	African Women Study Centre
COK	Constitution of Kenya
FAO	Food and Agriculture Organization
FGD	Focused Group Discussion
GOK	Government of Kenya/Republic of Kenya
KNBS `	Kenya National Bureau of Statistics
KPHC	Kenya Population and Housing Census
UN	United Nations
UNDP	United Nations Development Programs
UNICEF	United Nations Children's Fund
UON	University of Nairobi
WHO	World Health Organization
COK	Constitution of Kenya

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The United Nations (UN)estimates the Global population to be at 7 billion with a forecasted increase of an additional 2 billion by the year 2050 (United Nations, 2012). There are challenges in meeting food requirements of the growing population because of growing water scarcity and continued soil degradation (Garcias-Casal & Pena-Rosas, 2017). Women are perceived to significantly contribute to food production especially among the populations in the lower economic stratum. According to Valenca, Bake, Brouwer and Giller (2017) asserts that Biofortication provides a suitable intervention to address hunger and more specifically hidden hunger defined as deficiency in essential elements in food consumed. The use of biofortified foods show promise in feeding an estimated 2 billion people with perennial hunger problem (WHO, 2015).

The last 50 years has shown marked agricultural research in developing countries through bilateral collaborations in food production Valenca *et al*. (2017). Extensive research on staple foods like maize, rice, bananas and arrowroots in countries like Malawi, Mozambique and Zimbabwe have increased production and productivity per acres of land under cultivation to help mitigate food insecurity (Krush *et al*., 2012).

Saltzman *et al*. (2015) laments on little research in biofortification of vegetables, pulses and animal products that essential for food security. In connect the continued rise in prices of non-staple food have made it difficult for the poor to afford adequate dietary supplies for energy needs and necessary nutritional needs leading to hidden hunger according to Bouis *et al*. (2011).

There are strategies that can alleviate hunger and promote nutritional security. The production of fortified crops rich in micronutrient is a long-term strategy in combating micronutrient deficiencies is one strategy (Garcias-Casal & Pena-Rosas, 2017). However, short term interventions make use of food supplements to address micro-nutrient deficiencies (Valencia *et al*., 2017).

Biofortification is a complex process realized through the use of genetically improved seeds, and the use of fertilizer application. Improved seeds are disease resistant and do well with minimal rainfall, Hounkonon (2011). Biotechnology and biofortification have been identified as promising strategies in the production of healthy foods crops. Biofortification of staple foods provide an economical means of targeting rural communities in the production and consumption of staple foods that addresses hunger and nutrition needs. Nutrition can help reduce cases of severe malnutrition that require medical treatment. According to Saltzman *et al*. (2015) propose that consistent use and consumption of biofortified staple crops has a significant influence on health supported by fortified crops. China is a large expansive country with a massive population of 1.4 billion people. China has managed to provide food consistently to the huge population through extensive investment in research and development in biofortified rice production, Gu *et al*. (2016).

According to Covic, Low and Mackenzie (2017) China is assisting African countries with advanced food production techniques for the most commonly consumed starchy staple foods like arrowroots. In order to enrich food crops, Krush, Lee, Cho and Jeon (2012) suggest that biofortification of crops will mitigate the scarcity of essential mineral and vitamins among foods consumed among communities in Africa. Several Countries like, Malawi, Zimbabwe, Mozambique, Ethiopia, Rwanda and Zambia have benefitted through

bilateral collaboration with China in research and development in food production and biofortification aimed at food security.

According to UNICEF (2017), malnutrition kills over one million children annually in Africa. Malnutrition has been singled out to significantly contribute to 35% of children mortality in Africa. Malnutrition is a problem, possibly combated through use of biofortified crops mainly tubers like cassava, arrowroots and sweet potatoes that are considered drought resistant crops. Furthermore, according to the UN Organization reports on children aged less than five years, mortality is severe in Africa and Asia. Out of 15 worst hit countries with child mortality 10 are in Africa Chao *et al.* (2018). According to United Nations (UN, 2017), Africa has the highest prevalence of children born with low birth weight and many children are underweight during growth phase with estimated at 25% globally, which is a huge health challenge. Wesseler and Zilberman (2014) assert that children suffering malnutrition are associated with ill health and sickness vulnerability. In addition, Children with low birth weight and malnutrition increase possibility of irreversible mental and physical impairment.

Conversely, Haas, Luna, Lung'aho *et al*. (2017) posit that biofortification has salient benefits in serving underserved rural communities more effectively when compared to nutritional supplements with regard to cost in the long run. The upfront investments in biotechnology and micro-nutrients fixation in seeds help farmers produce biofortified crops at no extra costs. This position contradicts (Valencia *et al*., (2017).

Saltzman, Birol and Bouis (2013) observed in a study that significant rural populations have challenges in having diet diversification to meet nutritional needs of children, mothers and families. The study proposes that biofortification empowers farmers in providing crop outputs rich in micro-nutrients. Therefore, biofortification is a suitable strategy in enhancing food and nutrition security.

According to Bouis *et al.* (2013), biofortification is a useful strategy that involves the transfer of genetic traits favoring elevated micronutrients and higher crop yields to boast production of selected crops. Biofortification contrasts nutrition supplementation popular among urban affluent. The micro-nutrients supplementation is an expensive undertaking. Bouis*et al.* asserts that biofortified staple foods are able to deliver adequate levels of micro-nutrients per day compared to industrial supplements and fortified foods. Food crops fortification used routinely has the capacity to enhance micro-nutrient adequacy (Bouis *et al*., 2011).

Dry land arrowroots are hardy tuber crops grown in places with scare rainfall and long periods of hot climatic conditions. In 2018, Kenya experienced severe food crisis resulting to maize importation to help lower prices caused by rise in demand, Gitau *et al*. (2019). Hidden hunger represented by nutritional diseases like malnutrition. Hidden hunger is associated with dearth of essential minerals and vitamins in the diet. Essential micro-nutrients are; iodine, iron, zinc and vitamin A. According to Hickey *et al.*, (2012) malnutrition is a threat to the livelihood of millions in Arid and Semi-Arid Lands, ASAL (Hickery *et al*., 2012).

There are factors that threaten food security like flooding and prolonged drought; presumed as evidence of climatic change, are deemed to be responsible for food crisis resulting in humanitarian crisis according to Bryan *et al*., (2013). Climate change has influenced farmers' decisions with regard to changing rainfall patterns, use of irrigation to overcome rain insufficiency in a bid to raise food production according to Kimiywe (2015).

The long-term impact of insufficient nutrition is scarcely known in the short term. Boius and Saltzman (2017) propose the growing of climate resistant and with high nutrients potential to curb malnutrition. Investment in research and development of biofortified crops with resilience to changing climatic conditions while retaining nutritional capabilities remains a viable strategy towards food and nutrition security. Boius and Saltzman (2017) recommend the use of biofortified tubers like sweet potatoes, cassavas, arrowroots and grass like starchy sources like as the key to food security. The nutrition experts and food policy analysts posit that crop productions of biofortified crops are more economical than processed foods.

Food security and nutrition are considered pillars to healthy societies. There is significant food insecurity among majority of the population in Kenya. This is because 84% of Kenya land mass is considered arid and semi-arid which make it unsuitable for rain fed agriculture, Hickery *et al*. (2012). Kimiywe (2015) reported that10 million Kenyans are considered foods insecure in addition 2-4 million suffering poor nutrition. Biofortification is regarded as a strategy towards achieving food security.

In Muranga County a densely populated County is vastly considered a semi-arid region because of the pockets of dry land areas. Muranga County constitutes Maragwa, Kagema, Mathioya and Gatanga sub-counties. The Land tenure system is based on traditional

practices that favour male heirs. Women suffer discrimination in land ownership as far a succession is concerned in spite of the majority of women being engaged in farming in Muranga County.

The continued farming of staple foods has left vast soils experiencing degradation. Gitau *et al*. (2016) in a study reported increasing cases of anemia and malnutrition among school going children in Kandara. The study revealed cases of hidden hunger among school going children associated with lack of diet diversification.

Kamoni *et al*. (2013) argued that food security can be enhanced using fortified crops that give better yields per unit of farm cultivated using modern farming methods. Kamoni *et al*. observed that modern farming methods which include, use of improved seed varieties, use of soil fertility enhancers and advanced farming methods that conserve soils and the environment. According to World Health Organization (WHO) in Codex Alimentations (2015) micronutrients have a significant contribution to cognitive functions among school going children. In addition, nutrition adequacy is vital in maintaining health and fighting off diseases. In the Kenyan constitution, it is a constitutional right (article 43;1c) everyone has a protected right; right to food and freedom from hunger. The freedom guarantees all Kenyans the right have adequate good quality food, Constitution of Kenya, COK (2010).

1.2 Statement of the Problem

Food insecurity in Muranga over the years has made many households to experience hunger especially the arid and semi-arid parts in Muranga County. Hunger and malnutrition has affected school children growth and education. Farmers in Muranga have embraced biofortified crops according to Covic *et al.* (2017). Despite biofortification efforts

adoption, there is scarcity of research in Muranga on women farmers and the possible implications of biofortified dry land arrowroots.

The Kenya National Bureau of Statistics, (KNBS, 2019) estimate Murang'a County population as 1,056,640. There are 523, 940 Male and 532,669 Female according to the Kenya Population and Households Census (KPHC, 2019). The region is considered to be a dryland and consists of the following sub-counties; Maragwa, Kagema, Mathioya and Gatanga. Farmers in Muranga have been growing crops that are not biofortified consistently leading low food productivity due to insufficient rainfall exposing households to hunger. Bouis and Saltzman (2017) postulate that fortified starchy tubers like sweet potatoes and arrowroots are believed to hold the key to food security.

The depth of information about biofortified food crops grown in Muranga, the attitudes towards dry land arrowroots, economic value of dryland arrowroots and the role of women in dryland arrowroots need to be established. This inquiry sought to fill this knowledge gap concerning dry land arrowroots farming among women farmers' in Muranga County.

1.3 Objective of the Study

1.3.1 General Objective

The general objective of this study was to examine the role of f biofortified crops in Mitigating Food Security in the rural households in Murang'a County; A case of women farmers of dry land arrowroots.

1.3.2 Specific Objectives

i. To determine the nutrition value of dry land arrowroots in Muranga County.
ii. To establish the economic value of dry land arrowroots in Muranga County.
iii. To examine the role of women farmers in dry land arrowroots farming in Murang'a County.

1.4 Research Question

i. What is the nutrition value contribution of dry land arrowroots in Murang'a County?
ii. What are the economic benefits of dry land arrowroots in Muranga County?
iii. What is the role of women farmers in dry land arrowroots farming in Murang'a County?

1.5 Justification of the Study

In Murang'a County, even though it is around Mt. Kenya region, the County has over the last few decades experienced shortages in rain leading to food insecurity in parts of the County according to Kimiywe (2015). There is scarcity of information on the production of dryland arrowroots by women farmers in Muranga County. The study would provide information on the nutrition value and economic value of dry land arrowroots which would inform policy in the County. One of the key crops that have been widely accepted in the region is dry land arrowroot as it can be planted and grown in areas with little water. The study will generate new knowledge on the role of bio-fortified crops on household food and nutritional security in Murang'a.

1.6 Significance of the Study

The study findings will be used to show importance of biofortified arrowroots in mitigating food insecurity, and provide information of nutrition value of dry land arrowroots and further provide insights on the use of modern farming methods that are easily adaptable to women farmers. The study results will inform agricultural policy at the county level in supporting biofortified crops production.

The research in biofortification, women farmers and economic impacts of dryland arrowroots farming is vital in households' food security. The Inquiry was beneficial to policy makers in the ministry of agriculture nationally and county departments at the local levels as it helped in the formulation and implementation of innovative strategies that focuses on combating challenges related with food insecurity in the County.

1.7 Scope of the Study

The study was carried out geographically in Muranga County part of Central Kenya. The study was carried out among dry land arrowroot women farmers residing in four sub-counties Kangema, Mathioya, Gatanga and Maragwa within Murang'a County. The reason why the study was carried out in the four sub-counties was because of pockets of semi-arid lands that suffer food insecurity and pressure from growing population. The study sought to determine if dry land arrowroots farming improved household food and nutrition security.

1.8 Limitations of the Study

The researcher encountered some hesitancy among the respondents in freely sharing information. The researcher engaged and explained to the respondents the nature of the exercise and through involvement of local leaders managed to reassure respondents that there was no risk in participating and giving requested information. The respondents were convinced with evidence of letters of authority from the University. There were some difficulty with some farmers communicating in English and Kiswahili; efforts were made to translate the questionnaires and explain the questions in the local Kikuyu language to help collect valid responses, because of intermarriages in the region there were some who would not understand the local language too. This was also factored in and a Kiswahili peaking person would interpret for them. The challenge with respondents' schedules which dictated that consensus was built around use of focus groups discussions to collect the data.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter discusses theories that describe the inquiry, reviews relevant literature to the study, critiques past studies relevant to the study thematic areas. Issues regarding climate change, biofortified crops, land tenure, women farmers and food security are reviewed.

2.1 Theoretical Framework

The inquiry was guided by two theories namely; the theory of innovation and Feminism Theory. The two proposed theories provide theoretical foundations to the inquiry. The biofortified crops are considered a strategic intervention in providing food security to households and meeting nutritional adequacy needs.

2.1.1 The Theory of Innovation

The theory of innovation was proposed by Joseph Schumpeter in 1942 as a process of creative destruction. The theory describes creative disruption as a means to development and improvement. According to Schumpeter (1999), innovation is finding new ways, creating new products or improving processes. The theory best describes the transition from traditional arrowroots to dry land arrowroots believed to be a variety native to Eritrea. The importation of the specie to Kenya is an innovation because it comes to a new market. The dry land arrowroots are characterized as fast maturing and requires less rainfall compared to common arrowroot species in Kenya.

Innovation is a strategy that is used to promote change and solve problems in society. The food insecurity and hidden hunger are serious challenges globally with reducing arable lands and increasing world population. The intervention using biofortified arrowroots to provide food and nutrition is a viable innovation. Biofortification involves adding micronutrients to crops enabling them to be vehicles for food security and nutrition security. Biofortification thus involves addition of Iron, Iodine, or Zinc to crops to address dietary deficiencies (Kimiywe, 2015).

The dry land arrowroots also called *Tacca Involurrata* is popularly grown in Eritrea and has been introduced in Muranga to solve the food insecurity. The theory sufficiently attempts to describe the motivation in switching to biofortified dry land arrowroots farming. The dry land arrowroots provide dietary needs and surplus for sale. The surplus is achieved through fast maturing species, and shortens the path to the market. Fast maturity and improved nutrition support Joseph Schumpeter's description of innovation. The theory of innovation can be used to explain change from traditional arrowroots to fortified dry land arrowroots.

Women farmers are vital players in innovation adaptation. Women farmers using their networks can bring about significant change in the community with regard to food security. Women farmers in Kenya can benefit from growing fortified arrowroots and experience food and nutrition security in addition to economic empowerment as demonstrated in Mwanga District, Tanzania (Muthoni & Wangui, 2013). The inquiry sought to confirm if dry land arrowroots influences to household food and nutrition security in Muranga County.

The theory of innovation describes the transition to dry arrowroots farming and the benefits of innovation. The benefits of innovation are access to new products, markets and better products in this case improved crop, dry land arrowroots.

2.1.2 Feminist Theory

Feminist theory is described as a movement a philosophy guided by ideology of gender equality, and equal opportunities for women. Feminist Theory help shade light on forces that deliberately oppress, violate and practice inequality against female gender. The Feminist philosophy is multi-disciplinary from anthropology, sociology, economic and political thought in discourse. The theory presupposes that freedom is a necessity in the space where there is gendered labour distribution that reserves certain roles based on gender. Arendt thus suggests that freedom empowers women economically and politically both in public and private spaces. Hannah Arendt (1973) observed that feminist organizations have power in solidarity which is achieved in unity of purpose away from identity and race issues (Arendt, 1968). The feminism movements suffered in the past from the clash of ideologies and identity towards women empowerment. Feminist theory forms a significant basis of women to gain justice, freedom and social equality away from discrimination and abuse that women have experienced in society according to Dill and Kohlman (2012).

According to Ellen Dubois (1999) women have suffered untold injustice and rights violations by society mirrored on duties and resources allocations as dictated by society. Women remain strong economic contributors towards food production, caring for families and providing necessary labour for economic development**.**

According to Liam and Belinda (2015) in a study on gender and food security in Malawi there was glaring differences in the definition of gender. Gender according to the study is reviewed in regard to roles played by men and women at work and at home. This shows that gender differences and complexities is global and agrees with Arendt that gender in a way is describes division of labour.

The Feminist theory helps explain the gender contribution to food security and describe cultural roles in households. The feminist theory explains the role of women as a pillar towards food justice and food security. Therefore, women farmers in Muranga County roles are catalytic to households' economic empowerment towards food justice. The dryland arrowroots give hope to sustainable crop that meet farmers economic and sustenance needs.

2.2 Empirical Studies

2.2.1 Women in Agriculture

According to Resurreccion (2013) Women are key players' in sustainable development which includes agriculture and environmental protection. Women provide labour and also produce food in majority of households directly contributing to food security and nutrition. Women have many roles in society as care givers, managers of local household resources and also economic players at the local level, where they grow crops and nurture their families (Muthoni & Wangui, 2013).

Women suffer ill health and are vulnerable to hunger and malnutrition as mothers and expectant mothers due to increased dietary needs in addition to demands for labor and food production in the households. The increased dietary needs include lactation and caring for

unborn babies when faced with under nutrition and iron deficiency according to Kimiywe and Chege (2015).

Food and Nutrition Security is linked to human development issues. Sustainable development can be achieved through gender representation, poverty reduction and mitigating risks occasioned by climatic changes (Resurreccion, 2013).

In many studies there are reports of women being the significant food producers despite few owning lands. Land tenure systems tend to discriminate against women. Kieren *et al*. (2015) noted that less than 10% of women in Nepal, India and Thailand own land. Land is a necessary input in food production. The motivation to provide for family and households through provision of labour in producing food to cater for family needs is significant.

The economic contribution of women farmers in food production is scarcely noticed. The customary traditions have maintained land ownership in the hands of men, while women work the land. Empowering women to own land, access inputs, markets information and modern farming methods can greatly influence food security, nutritional security and economic empowerment of households (Muthoni & Wangui, 2013).

Access to education and technology has empowered women to access economic opportunities. Women experience challenges to improve their nutritional status as well as their children's nutritional status. Radhakrishnan and Solari (2015) pointed out the challenges experienced by women as inadequate employment opportunities and gender discrimination in wage payments. In addition, it was noted that women are disadvantaged in accessing information and lack of involvement in decision making. Women have less access to education and tend to drop outs earlier because of early marriages, culture or

adolescent pregnancies (Radhakrishnan & Solari, 2015). Generally, women suffer poor health and nutrition. The maternal demands contribute to increased mortality due to poor access to health care. The gender inequalities can be reversed through access to education and technology from evidence adduced by Radhakrishnan exploring South Asian women who immigrated to the United States overtaking their male counterparts from the same lower social strata.

Female workers have been the backbone of agriculture and food production in many third world countries due to economic migration of men in search of work. Women are taking up more and more responsibilities including farming and food production. The effects of Men economic migration are seen in Nepal where most households are led by women (Adikari *et al*., 2015). FAO proposes that Women can contribute to higher crop yields by 20-30% thereby reducing global hunger by 17% through improved production (2012). FAO proposes increased engagement of women on agricultural production from policy to implementation for better food production. Women empowerment has a significant effect on food production and household food security from a study in South Africa according to Shauranga, Mudhara and Bogale (2016).

Low food productivity puts a strain on women to seek financial resources to buy food to cover deficit from food production. The drive to seek employment results in lower wage jobs further marginalizing women economically. Women are innovative and learn through social networks that serve as a means of economic empowerment (Ogutu, 2015). The social networks counteract gender inequality, lack of access to household income and opens up economic opportunities like trading. In some communities' women work while their wages are given to their spouses as per cultural norms. Men and women have different spending

habits. Men led households differ from women led households. Men prefer purchasing non-food items leading to gender domination in budgets allocation. Women empowerment through budget resources tend to increase spending in nutrition and health often ignored by men (Radhakrisnan & Solari, 2015). It was further noted that women are better savers as a cushion for possible disasters like illnesses, drought or poor harvest.

The role of women in agriculture is not sufficiently documented. The rise of women led households provides an opportunity to understand the contribution of women in economic development and more specifically in food production. Women involvement in agriculture plays a pivotal role in enhancing food security and nutrition adequacy in the community. Generally, women take care of households' nutrition needs. The inquiry on dry land arrowroots in Muranga County provides an opportunity to evaluate its role in nutrition.

2.2.2 Gender, Climate Change and Food Security

Gender and climate change adaptations from Uganda insights from Lakai, gendered perception of climate shocks and change affecting women and households Patti, Christafen and Elizabeth Bizion. A review on farm modeling which is a focus of climate change adaptations and mitigations demonstrate evidence of the effects of climate change on households coping with evolving scenarios.

Food security has evolved over time and remains a challenge globally. There are factors that have direct impact on food security; namely, technological advances, increased population and soil exhaustion have provided enormous challenges to food production. Furthermore, food security implies access and intake of adequate minerals and vitamins through consumption of foodstuffs. Food security is measured in regard to supply and demand of food crops; historically data on supply shortfalls threaten food security.

Moreover, the aspect of hidden hunger broadened food security to include insufficient food intake and insufficient micronutrients intake in consumed food crops and incorporated application to community, local, household or at the individual level (Foster, 1992). Broadly, large populations in Asia and Africa are unable to derive nutritional micronutrients from diet due to insufficient content and lack of dietary variety leading to hidden hunger often manifested as anemia, malnutrition and general ill health (Kimiywe, 2015).

Food security is affected by production, distribution and demand patterns. In addition, a part from food supply it also includes nutritional adequacy which implies that it is not enough to have adequate food without deriving sufficient micronutrients from the consumed diet. The World Bank (1986) proposed definition of food security; summarized by Maxwell and Frankenberg (1992:8) as, access to health foods always. According to Food and Agriculture Organization, FAO (2000), Food Security can be sustained when all people receive foods that are nutritious, accessible and provide all dietary requirements commensurate with good health. Food is described as solids or liquids that people eat or drink for sustenance. Clean water forms part of vital daily food requirements

In brief, dryland arrowroots are tubers that are fast maturing, need little water and are more nutritious compared to traditional arrowroots making them a suitable choice in combating food insecurity and hidden hunger. Therefore, dry land arrowroots growing and production can contribute significantly is addressing hidden hunger.

Furthermore, in Tanzania, Muthoni and Wangui (2013) reported in a study that women in Mwanga region in Tanzania that despite limited access to land ownership and financial resources through their social networks and labour were able to contribute significantly to economic empowerment of households through farming arrowroots and other tubers.

In another study Kimiywe and Chege (2015) conducted an inquiry in Kitui to determine the influence of complementary feeding among children 6 months to 23 months. The study reported that diet variety which includes proteins, vegetables and tubers like cassava and arrowroots have significant effect on children growth, providing nutritional adequacy and meeting energy needs. Mwangi and Mundia (2015) in a study examining improving land use and productivity pointed out that cassava, arrowroots and sweet potatoes growing have great potential in sustainable food security in rain scare regions of Machakos in Eastern Kenya.

According to FAO, Nutrition Security requires adequate food, where adequacy is measured in terms of quantity, quality, safety, socio-cultural acceptability; the food needs to be available and accessible to individuals for consumption and utilization in the body to live a healthy and happy life at all times FAO (2012). Arema (2014) summarizes Nutritional security as adequate availability of nutritional components that make up a balanced food intake with regard to nutritional adequacy

According to Kamoni *et al*. (2016) revealed in a study that food intake alone does not constitute health. The researcher argued that lack of essential minerals and vitamins constitute hidden hunger that impedes health. The study explored the quality of nutrition among food products consumed among school going children as part of baseline survey study. The cases of malnutrition and anemia were recorded. An intervention study was

conducted where respondents received fortified foods over the study period. The cases of malnutrition and anemia decreased from the study findings. The study findings demonstrated the significant role of nutrition on health achieved through diversified foods.

Gitau *et al*. (2013) asserts that food security can be achieved through the use of improved seed varieties, modern farming technologies, soil fertilization and bio-fortification. The interventions suggested have viable impact in increasing productivity per area cultivated. Arrowroots grown in fertile soils increase micro-nutrients embedded in fortified crops enriching consumers in their consumption. Soil fertility enhanced done through fertilizer application. Kimiywe (2015) reported that in Kenya in hidden hunger is estimated to affect between 2-4 million people. Hidden hunger can be addressed through biofortification motivated in increasing quantities of essential minerals and vitamins in food crops according to Saltzman *et al*. (2015).

Adequate nutrition is a basic human need. Human rights are defined as universal freedoms and entitlements that all humanity is guaranteed (Shestack, 1998). All people need to satisfy their regular nutritional demands; through consumption of food crops with nutritional adequacy, FAO (2012). Wessler and Zilberman (2014) posit that hunger and insufficient micro nutrients and severe health effects especially among children because of potential impact to cognitive development as well as physical health. Sustainable food and nutrition security are essential for long term health of citizens. Healthy citizens play a significant role in the economic prosperity of a nation.

Food security is a basic human right, which implies that Food insecurity and malnutrition are violations of human rights. There are several international conventions that support human rights. According to the International Covenant on Economic, Social and Cultural

Rights as part of the United Nations General Assembly in 1966 defined and formalized the right to food as a basic human right, which earlier had been mentioned in the Universal Declaration of Human Rights of the United Nations in 1948, and further re-affirmed in 1974.

Majority of the global population especially poor households suffer micronutrient deficiencies according to FAO (2012Studies show that food supplementation and biofortification as efficient strategies against hidden hunger. The World Bank report (2015) shows the results of food supplementation using salt iodization in Tunisia and Algeria demonstrate significant impact in reducing thyroid functions insufficiency in the population. Population health coverage with iodine salt supplementation estimated at100 percent (Tunisia) and 60 percent (Algeria). In Morocco, only 21 percent of households had access to iodized salt. The iodine deficiency remains a challenge in the Middle East and North Africa populations because of the essential role it (iodine) plays in thyroid functions (Doggui *et al*., 2017).

In the Middle East and Northern Africa (MENA) anemia is a common health problem. Studies show that anemia is independent of household income levels. Reports indicate that about 30 percent for non-pregnant women are anemic. The World Bank reports low treatment associated with lack of awareness (2006). The use of fortified crops especially the tubers like arrowroots, cassava and sweet potatoes have shown significant effect on reducing micronutrient deficiency in large populations without changing their lifestyles (Hounkonon, 2011).

The effect of climate change remains a grave concern globally due to its effects on the environment experience either through prolonged drought and increased flooding impact food production, (Nelson *et al*., 2014). Climate Change is described by the Regional Climate Change Index (RCCI) as the change or variation in air temperature, water precipitation, air quality and weather unpredictability. The rainfall patterns have become unpredictable significantly affecting farming. Climatic changes have been occasioned by deforestation due to demand for timber, farm lands, firewood and growing energy needs. Increasing carbon dioxide pollution is known to significantly increase global temperatures creating global warming according to Mwangi and Mundia (2015) cited in UNDP report (2015). Confalonieri *et al*. (2007) argues that Climate change is indirectly associated with increased cases of diarrhea and infectious diseases due to hygiene and sanitation effects occasioned by flooding and poor sanitation.

The concern for the environment and challenges of meeting immediate needs provides a dilemma to most vulnerable groups among small holder farmers. The need for their immediate survival and livelihoods creates a dilemma with rising energy needs, land demand and protecting the environment for sustainability, (Muthoni & Wangui, 2013). Deforestation defined as cutting down trees and forests to create room for farmland provide timber supply and meet growing energy needs. The demand for energy has negative consequences for the environment. Human activities for short-term sustenance contribute to forest destruction through burning of forests, charcoal and collecting firewood.

Thompson presupposes that efforts to stop deforestation may fail if attempts are not made to address the survival and livelihood needs of small-scale holder farmers (Thompson, 2006). Governments and international organizations need to create sustainable programs

to address hunger and malnutrition through addressing structural constraints driving food insecurity such as land tenure, extension workers, access to quality seeds and agricultural support services. The marginalization of female farmers, population growth and climate change all contribute to food insecurity.

The environment which includes forests, water sources and land are affected by varying weather patterns occasioned by global warming. The increased incidences of flooding due to rising global temperatures and prolonged drought have a negative effect on food production (Covic *et al*., 2017). McMichael *et al*. (2004) projected an increased burden of diarrheal diseases by 2-5% by 2020 due to climate change. The diarrhea diseases will affect the populations at the lowest economic status already burdened by diseases.

Food security demands predictable and sustainable sources of food crops which arrowroots and other biofortified crops offer because of low water demand, faster maturity and improved nutritional value, Hickey *et al*. (2012). Women are known to forage forests for firewood, food producers who are affected by continued climate change that influence agricultural process in food production. Women are recognized as agents of change in protecting the environment and ensuring sustainable exploitation of the environment for food production and energy needs (Resurreccion, 2013).

There are many studies on the role of women in climate change and food security. However, there is no consensus on whether women affect the environment or promote conservation with regard to climate change drivers and mitigations. There are arguments that support women activities in food production, and agricultural activities. Despite the obvious role of women in agriculture there are limited studies on the role of women in dry land arrowroots farming.

2.2.3 Land Tenure System and Food Security in Kenya

The land ownership system as currently constituted is a threat to food security in Kenya. Private land ownership with vast idle tracks of land and no economic or productive activity puts pressure land resources. Majority of small-scale farmers are men who hold titles while women till the land.

Moreover, the growing population is putting pressure on land causing scarcity and changes in land use thereby threatening food production (Ogechi & Hunja, 2014). According to Manji (2012), women are historically disadvantaged significantly with the land tenure system that reduces their ability to acquire credit to support farming activities. Land succession discriminated against the female gender contributing significantly to access to farm land for agricultural activities. In another study comparing land tenure system in Suba and Laikipia, Owoo and Boakye-Yiadou (2014) found no significant difference between women who own land titles and men with regard to food production. This implies that irrespective to land ownership food production output remains unchanged whether the land is owned by a woman or man. This contradicts previous believe that if women owned land, they would produce more agricultural produce. Therefore, a key determinant of economic progress and food security remains productive land use irrespective of ownership.

According to FAO/IFPRI (2008), an estimated one billion people live under extreme poverty; unable to achieve the required calorific measure of 2100 calories per day. Poverty contributes significantly to malnutrition due to insufficient consumption of dietary needs. The food deficiency measured in terms of quality and quantity occasioned by lack of financial resources to produce adequate food to meet food demand. Lack of resources to

produce food like arable land, farm inputs and water are contributory factors leading to food insecurity (Ogechi & Hunja, 2014).

Poor households suffer malnutrition, stunted growth, and anemia, all associated with dietary deficiencies and food insecurity (Kimiywe, 2015). Incidences of diarrhea contribute to health challenges due to reduced absorption of food and nutrients. Malnutrition and dietary diseases negatively affect household incomes. The poor tend to suffer malnutrition and poor health due to inability to access preventive health services, access to nutritious foods and lack of access to health information leaving them food insecure. Furthermore, HIV provides a health challenge where nutrition is concerned. Diseases like HIV, increases nutritional demand. HIV is associated with bouts of diarrhea caused by impaired nutrients absorption. Climatic changes pose a greater threat to food security because of the effects of drought and flooding have a direct effect on food production (Arema *et al*., 2014). The disruption of agricultural activities reduces food production leading to food insecurity.

Rapid Population growth threatens global food security. High population asserts pressure on local food production and imports to meet growing demand. The United Nations Population Division (2009b) noted a rapid rise in population in five decades from 1950-2009 in the world. The population increased from 2 billion to over 6 billion in 2009 people. The global population is forecasted to grow to 9 billion by the year 2050. Population growth is projected to increase rapidly in Asia and Africa.

According to the United Nations (2012) Africa's population currently estimated at 1.3 billion people will increase to 2 billion people by 2050. Moreover, the Asia population expected to increase to 5 billion people from 4 Billion this will increase global food demand. The population growth increases food demand and causes wide gaps between

production supply and food availably. The food production gaps are experienced more in sub-Sahara Africa. In sub-Saharan Africa, there is low food production per acre and food production. FAO laments low yields per acre in sub-Sahara Africa despite increase in land under cultivation (2009).

Fortified Arrowroots are a strategic crop that offers adequate nutrition and food security to households. Experiences in Tanzania, Mwanga region show that women who invested in growing arrowroots contributed significantly to food security, improved economic status and general households' health according to Muthoni and Wangui (2013). Adapting starchy fortified crops especially tubers have a great potential in improving food security and nutrition in sub-Sahara Africa based on the study findings in Mwanza, Tanzania.

In summary, poverty, deforestation, and climatic changes increase food insecurity. Poverty contributes significantly to deforestation to increase agricultural land and as a source of energy; tackling poverty can contribute to environmental protection and food security (De Soto, 2003).

2.3 Women in Agriculture

Women farmers face various challenges economically, socially, politically and culturally. UNDP (2016) recognized women as the backbone of world economies through their economic productivity. Women are marginalized in earnings and productive labour. It is estimated that women constitute a significant contribution in the production of food in the world, according to Doss, Meinzen-dick, Quisumbing and Thesis (2018). The UNDP (2016) asserts that in food production women face challenges with the land tenure system that is traditionally exclusively men dominated. Women lacking title deeds in the past excluded them from accessing finances to acquire assets and therefore limiting their

personal growth according to Njiraini, Ngigi, and Barake (2018). Lack of information on markets and opportunities has forced women to form self-help groups for self-improvement.

2.3.1 Crops Grown in Muranga County

Muranga is a vast County with varying micro-climates due to large pockets of dry land areas. There is significant agricultural activity in Muranga from tea farming, coffee farming, maize, beans, bananas, horticulture as well as dairy farming in the more fertile land areas. The drier parts of the County suffer from inadequate rainfall, changing climatic patterns and unreliable rainfall according to the County Government of Muranga (2019). Literature shows that certain crops have been biofortified with micronutrients to make them nutritionally beneficial to consumers are adapted by women farmers. Among the crops that are fortified are arrowroots, Maize, Beans, Cassava and sweet potatoes. The study sets out to determine which fortified crops are grown by women farmers in Muranga County.

There exist many myths associated with gender commonly leaning towards women (Doss *et al*., 2018), this contributed to the perception that gender implies women. Countries like Tanzania, Uganda and Ethiopia most land is either owned by the man or jointly owned thereby offering women an opportunity to exploit land for agricultural purposes. Gender according to the people of Muranga represents the female gender. This corresponds with evidence from Malawi were any mention of gender automatically refers to women issues according to Dill and Kohman (2012).

According to Mageto and Gathiaka (2018) reported in a study of sweet potato farming and commercialization that poverty restricts farming when farmers operate individually. Successful farmers from a survey of 108 farmers in Mosocho Kisii belonged to a self-help group similar to merry-go round among women groups that acted as sources of information and peer support in agricultural production.

Biofortified crops like Dryland arrowroots according to evidence from Mwanga District Tanzania demonstrate that women who grew Fortified Arrowroots as a food crop were able to achieve significant food security and nutrition adequacy in addition to changing the economic status in the surveyed villages (Muthoni & Wangui, 2013).

Manji (2012) argues that women need equal access to land ownership and succession as a means to gain access to capital. The land ownership has significant effect to household food security when women are sole owners. Kamoni *et al*. (2013) posit that women involved in food production could benefit from supportive land tenure system that support women land ownership would have significant effects on food production.

2.3.2 Government Policy

Government is an enabler and facilitator in society. Government policies have significant influence on citizens. Government policies are governance instruments that create order and guide administration. Munguti *et al.* (2014) recognized the role of government policy in motivating economic development. The ministry of health for a long time concentrated on treatment of diseases as a means of maintaining health instead of promotion of diseases prevention. Recent advances in science and technology has favored prevention medicine that promotes nutrition. Government policy therefore has become cognizant of the need to promote healthy foods production and consumption.

2.4 Research Gap

There is a gap in knowledge with regard to fortified tubers especially dry land arrowroots in Muranga County as an intervention for food security and nutrition. There is a gap on government policy on food security and nutrition. Security. Gap on biofortification. Dry land arrowroots farming provides farmers with fast maturing crop, an opportunity to enhanced productivity per acre cultivated and reliable crop for sustenance. Dry land Arrowroots provide farmers with a crop that can be commercialized for economic use.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter enumerates the roadmap the researcher took to realize the research objectives. It includes discussing the study design, research procedure, data collection, discourse analysis and reporting.

3.2 The Study Area

The study targeted women farmers in Muranga County. According to Muranga County (2019) the total land area is 2558 kilometers squared. The area geographically described 00 34’ South, 107’ South and longitudes 360 East and 370 27’ East. Muranga County is surrounded by Nyeri County to the North, Embu County to the North East, Kirinyaga County to the West, Kiambu County to the South, And Machakos County to the East.

The study was done in four sub-counties in Muranga County which are considered to be semi-dry though farming still takes place there. These sub-counties are Kagema (population of 80,447), Mathioya (population, of 82,914), Gatanga (population of 187,989) and Maragwa renamed Muranga East (population of 110,311). The women population reported in the Population and household census Kagema (40,862), Mathioya (47,359), Gatanga (93,548) and Maragwa (Muranga East)-50,645 (KPHC, 2019). The majority of residents are engaged in small scale farming, Muranga County consists of pockets of dry regions making it a suitable choice as an area of study.

3.3 The Research Design

This study approach adopted a descriptive survey study design. A study design generally needs to provide a roadmap to the process that involves observation, collection and analysis of data to allow drawing conclusions from study findings. The study design deployed qualitative and quantitative techniques in data collection. Qualitative techniques are described as non-numeric data collection that helps measure feelings, behavior and attitudes (Cooper & Schindler, 2014).

According to Schindler and Pamela (2014) qualitative and quantitative approaches allows collection of relevant data for analysis. The qualitative data help gain depth and getting deeper insights on the subject of study. The qualitative data described in prose using thematic areas. The use of qualitative data collection method gives the researcher latitude to ask questions for clarity and gather more relevant vital information data for analysis.

Qualitative methods allowed the researcher to measure attitudes, experiences and expectations on dry land arrowroots farming among the study population. The data reflected the feelings of the women farmers, the county government officials and women groups engaged in dryland arrowroots farming. The feelings of the people with regards to acceptance and the transformation experienced with the introduction of biofortified dryland arrowroots farming in Muranga County among women farmers.

3.4 The Study Population

A study population constitutes elements united under a common characteristic of interest to a researcher according to Cooper and Schindler (2014). The study surveyed women farmers in Muranga County with purposive targeted sampling towards areas with many dryland arrowroot farmers from four sub-counties (Kangema, Mathioya, Gatanga and

Maragwa) within Murang'a County. The research study was carried out covering the women farmers engaging in dry land arrowroot farming in order to determine food adequacy and nutritional needs contributed by dry arrowroots farming.

3.5 Sample and Sampling Procedure

The study deployed purposive sampling to collect data as objectively as possible from the target population of women farmers. The study selected sub-counties in Muranga that are considered ASAL areas. Women groups, sub-county agricultural officers were part of the sample population. For the purpose of this study, the researcher utilized stratified sampling technique to select 120 dry land arrowroot farmers from across the four targeted sub-counties.

According to Kenya Population Households Census, the number of Households in Muranga County is 318,105 and are widely dispersed covering the whole county considered a densely populated (2019). Hence, the entire target population was divided into different subgroups or strata represented by Kangema, Mathioya, Gatanga and Maragwa Sub –Counties where representative samples from women farmers, government officials and key informants were purposively determined and respondents randomly selected the final sample of 120 dry land arrowroot farmers from the four sub-counties.

3.6 Research Instruments

The researcher used semi-structured questionnaires, a camera and notes taking and meeting minutes to collect data for analysis. Discussions with key informants this included County government officers in the ministry of agriculture, agriculture extension officers, land officers, and local administration and women leaders to provide relevant data for analysis.

3.6.1 Questionnaire

The questionnaires had semi-structured questions to guide data collection; were used to collect qualitative data among women farmers representing households in the target population. The researcher used secondary data sources to collect secondary data from reports, journals and magazines that provided background information from government records.

3.6.2 Key Informants

In this study Key informants were Ministry of Agriculture Official, County government officers and women leaders. During the study, the women farmers refer to people with knowledge and who come to educate and improve their farming knowledge and practice. The study used key informants as sources of reliable data necessary for the study. The key informants were the County government agricultural officers at the County level and sub-county level in the selected study area. The land officials at the county offices also formed part of the key informants. The women group leaders formed another significant key informant group providing information about dryland arrowroots farming in the Muranga County. The key informants among the selected women groups were represented according to age groups 18-35 years (youths), 36-50 years (middle aged) and over 60 years (considered retired) this was informed from the characteristics of the women groups some have been in existence much longer than the other. The more aged women groups belong to elderly women. The researcher interviewed a land officer, the local chiefs, and agricultural officers in the selected sub-counties.

3.6.3 Focused Group Discussions (FGD)

Described as a unit consisting of 6-10 people facilitated by a moderator, over a short period of time usually not exceeding two hours; the purpose is to exchange ideas, observe feelings expressions and collect data for analysis according to Cooper and Schindler (2014). In the study Focus groups refer to women farmers engaged in dry land arrowroots farming and self-help groups.

The researcher used women groups with organized structures among the women farmers' self-help groups comprising between 6-12 women for focused group discussions to collect qualitative data for analysis. The women leaders in selected sub-counties were requested to reach out to their members and share their experiences with dryland arrowroots farming before and after describing experience with dry land arrowroots farming.

Focused groups discussion helped collect data for analysis. The focus groups picked for the study were women groups. The discussions used the focused group discussions guide outline to aid data collection. A Camera was used as a data collection tool from activities of the respondents observed from the field. The pictures were processed, coded and labeled.

3.7 Data Collection Procedure

Once the study sample was determined questionnaires were issued to the targeted respondents as identified by the researcher assisted by local leaders. The researcher explained the purpose of the research and requested respondents to give required information and ask questions when in need for clarity.

The focused group discussions were organized small groups of 6-12 members, where guided discussions were conducted by the researcher to collect information from women farmers, county officials and government officers. Twelve focused group discussions were conducted with women leaders, sub-county agricultural offices and local administration representing the four chosen sub-counties.

The researcher took notes, pictures for records and analysis. The minutes formed part of the data collected. The notes and minutes were collected and stored in research enveloped labeled in a way that helped the researcher to collate the data for analysis. The labeled envelops were kept for analysis. The labeling was to assist the researcher recall the study group and location.

3.7.1 Data Collection Methods

The data collection methods refer to the techniques used to gather qualitative and quantitative data. The Data collection methods used included focused group discussions, use of key informants' interviews, use of questionnaires, and a camera. According to Mugenda and Mugenda (2003) describes sampling technique as a procedure that entails selecting a specimen of a group of items to represent the population as part of the study.

3.7.2 Qualitative Data Collection

The Qualitative Data Collection involved asking respondents questions that allowed them to describe in detail their experiences, allowing the researcher to measure attitudes, how women farmers felt about Arrowroots farming, views on nutrition value and role of women farmers.

3.7.3 Quantitative Data Collection

The qualitative data collection involved asking individual and groups' questions and pictures were also taken. The data collected was numerical/ mathematical in nature. The data could be presented in graphs, tables to allow analysis. Examples of quantitative data collected were ages of respondents and number of years in dry land arrowroots farming.

3.8 Data Analysis

According to Pearman (2014), data analysis describes the procedure that includes the act of organizing collected information, in an orderly manner, cleaning and organizing and analyzing to deduce information from main components in a way that the findings can be easily and effectively communicated.

Upon completion of data collection from 120 respondents, the researcher reviewed all the questionnaires for completeness and readiness for analysis. The collected quantitative data on demographics, age classified from 18-35 years, 36-50 years and above 51 years. The information on age was to find out the distribution of women farmers in Muranga County. The background information on education, and farming activity helped describe the data collected from the questionnaire. The data was coded and entered into the computer for computation of descriptive statistics. The Statistical Package for the Social Sciences (SPSS Version 23.0) software was used to run descriptive statistics such as percentages, mean and standard deviation that help describe the data statistically. The information was important because it would allow forecasts and possible generalization. The Likert scale was used to measure trends, agreements and disagreements with Statements to collect respondents' views. The analysed data was then presented in the form of frequency tables, figures and in terms of mean and standard deviations.

On the other hand, qualitative data aimed at understanding attitudes towards dry land arrowroots farming, role of women farmers in cultivating arrowroots, their views on nutritional values and their perspectives on arrowroots. The views regarding time before dry land arrowroots were introduced and the situation during the study. The collected qualitative data was analysed thematically where responses with similarity collated together into similar categories

3.9 Ethical Considerations

The researcher obtained an approval letter from the University of Nairobi with permission to conduct research. The researcher ensured that the study was carried out according to the highest dictates of ethical conduct in research which includes confidentiality and professionalism. The researcher, guided by the best practise in research undertook the following measures: respondent consent was sought before administering the questionnaires, whereby the researcher engaged the respondents and explained the reason why the study was being undertaken.

The researcher assuring respondents the research was useful to the community and findings can help policy directions that are important to society but for now it serves academic purpose the researcher assured respondents highest confidentiality and all information collected remained anonymous. While administering the questionnaires, the respondents were received warmly and purpose of the inquiry explained. The researcher maintained a professional engagement throughout the data collection processes. The researcher emphasised the voluntary nature of their participation. The participants were assured of confidentiality and anonymity during the study and afterwards.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter presents data analysis, presentation and interpretation of the study findings on the role of biofortified crops in mitigating food security in rural households in Muranga County with focus on dry land arrowroots farming.

This chapter presents the study findings followed by detailed discussion to derive meaning from study results. The findings were intended on answering the study's research questions. The study used quantitative data where Likert scale questions were adopted. Qualitative data obtained was grouped together and analysed in prose form.

4.2 Study Response Rate

The study targeted 120 dry land arrowroot women farmers. There are significant participation in food production by women farmers; from across the four targeted sub-counties (Kagema, Mathioya, Gatanga and Maragwa) within Murang'a County. In addition, the researcher targeted 12 focus groups three each from each sub-county in Murang'a County which were visited at different times.

However, out of the 120 respondents who were targeted for data collection among women farmers; the Researcher was only able to administer and collect a total of 100 fully filled questionnaires cumulatively which represents a response rate of 83.3 %. The researcher was able to gather information from all the twelve focus groups. The response rate was perceived reliable for the purpose of data analysis as Mugenda and Mugenda (2003) pointed that for generalization a response rate of 50% is adequate for analysis and

reporting. A response rate of 60% is good, while and a response rate of 70% and over as excellent. The response rate of 83.3% returned filled questionnaires and 16.7% non-response.

4.3 Demographic Information of the Respondents

This section describes study respondents; it provides vital information on demographics, age, and gender. The information helps the researcher generate meaning from the general information of those who participated in this study in the form of their gender, age, educational level and the number of years they had been cultivating dry land arrowroots.

4.3.1 Respondents Age

Researcher requested respondents to reveal their age by giving a range that is representative to the age groups of interest namely; youth (18-35 years), 36-60 and above 60 years. The results are as presented in Table 4.2 below.

Table 4.1: Respondents Age

Age	Frequency	Cumulative Frequency	% Percentage
18 to 35 years	19	19	19
36 to 60 years	59	78	59
Above 60 years	22	100	22
Total	**100**		**100**

According to the study findings presented in Table 4.1, it was established that majority (59%) engaging in dry land arrowroots in Muranga County are aged between 36 to 60 years, 22% are aged above 60 years, 19% are aged between 18 to 35 years, 13% are aged between 21 to 35 years while 6% are aged below 20 years. From the study results, it is

clear that majority of those engaging in arrowroots farming in Muranga County are past their youthful age above 35 years. This can be attributed to the fact that most of the youth in the area are focused more on seeking formal employment as opposed to engaging in arrowroots farming which many youths in the area terms as tasks for older people, this corresponds with Ntale, Litondo and Mphandes (2014) study findings on agriculture agribusiness is a popular activity among rural households. The elderly with previous work experience with land assets are able to exploit opportunities in their environment.

4.3.2 Highest Educational Level

Respondents were further asked to reveal the highest education level they had attained. This information would help the researcher if there is any relationship between education and arrowroots farming.

Results are presented in **Figure 4.1**.

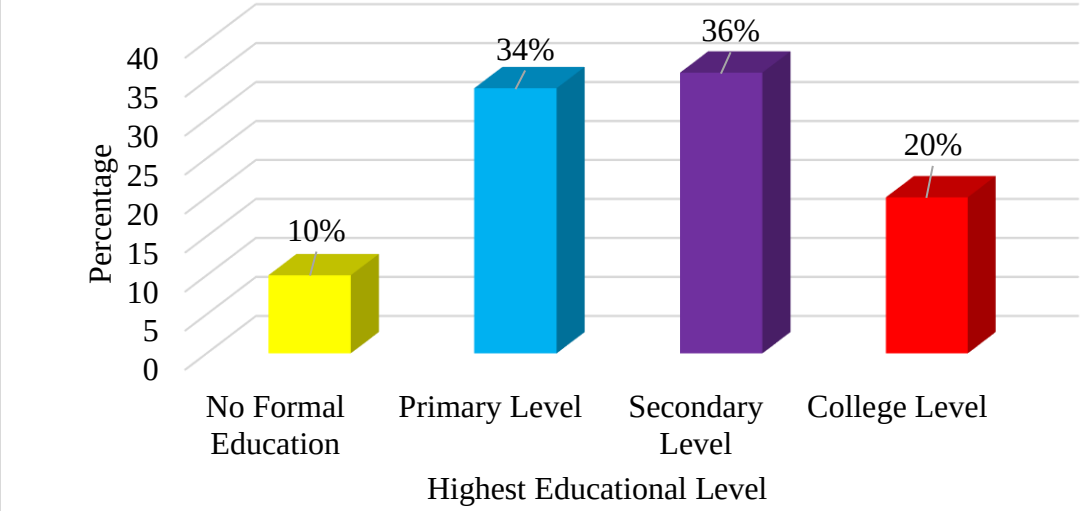

Figure 4. 1: Highest Educational Level

Based on the study results obtained, the data show that 36% of respondents had attained secondary school as the highest educational level, 34% had primary school education as their level of education, and 20% had college education as their highest level of education while 10% of respondents indicated that they did not have any form of formal education. The study results indicate that majority of those engaging in dry land arrowroots farming in Muranga County are literate as shown by the high percentage of those participants who have formal education.

4.3.3 Number of Years Cultivating Dry Land Arrowroots

The study also requested respondents to declare the number of years they had been cultivating dry land arrowroots. The results are presented in Figure 4.2.

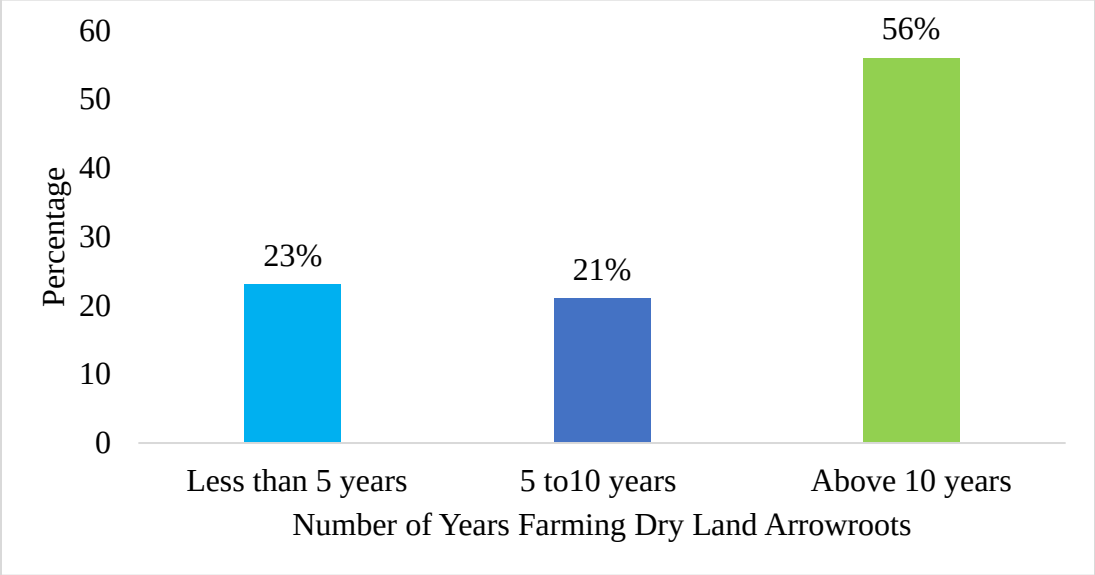

Figure 4. 2: Number of Years Cultivating Dry Land Arrowroots

According to the study results in Figure 4.2, it was found out that majority, 56% of those who participated in the study had been cultivating dry land arrowroots for above 10 years, 23% had less than five years since starting to cultivate dry land arrowroots while 21% had

been cultivating dry land arrowroots for between 5 to 10 years. This indicates that farming of dry land arrowroots as a strategy to achieve food security the area is not a new undertaking given the high number of respondents who have been cultivating it for more than 10 years. Arrowroots are predominantly a food crop in Central Kenya historically and adoption shows from the high frequency of many years of cultivation. The study findings are in concurrence with Bouis, Eozenon and Rahman (2011) that demonstrated in a study the correlation relationship between food prices and income relationships in a population. The dry land arrowroots are a source of food, nutrition and income in Muranga County as expressed by respondents. Arrowroots have developed a niche market in towns for breakfast competing with wheat products. The growing market of arrowroots can explain the increase sustained production over the years.

4.4 Type of Food Crops Grown

Respondents were requested to indicate the type of food crops that they usually grow in Muranga County. Based on the study results, majority of respondents indicated that there are a number of food crops grown within Muranga County which include maize, beans, cassava, yams, millet, among others. A woman narrated how life was difficult in Muranga; more than 10 years ago when they received visitors from Nairobi paid them a visit. "*The traditional arrowroots took a long time to mature. I was in women's group meeting when we received visitors who educated us on dry land arrowroots farming. At first, I was hesitant but I decided to try because I was tired on sleeping hungry. Today am stronger and can work better.*" However, respondents indicated that given the unpredictable rainy season in their area, significant populations of people have shifted to cultivation of fast maturing fodder crops especially dry land arrowroots. Another respondent reported, "*I have*

enough to feed my family and have surplus to sell at the market. The dryland arrowroots have changed my life. The money I get I pay school fees for my grandchildren. The children are also healthy and stronger" The study results agree with Haas *et al*. (2017) who did a study in Rwanda on the contribution of fortified crops improved health and nutrition using fortified arrowroots

4.4.1 Hunger Situation Now and Before Dry Land Arrowroots

The researcher also sought respondent's perception on hunger situation in the region now and before they started growing dry land arrowroots. The respondents indicated that they grew many crops namely maize, beans, and Irish potatoes in addition to arrowroots. One respondent indicated that "*dry land arrowroots have reduced the occurrences of my family members sleeping hungry. I am happy because the new arrowroots mature quickly and are bountiful."* Majority of respondents indicated that with dry land arrowroots, they are assured of their food security since the crop matures faster than the normal arrowroots and also requires less water to grow. In addition, respondents indicated that dry land arrowroots are tastier and filling and their large yield size gives ample food for the family. The study results correspond with Gitau *et al*., (2016) who argues that scarcity of minerals and vitamins associated with hidden hunger has significant problems to health and wellness. The respondents' commented that dry land arrowroots, tastes better and motivates production and consumption.

4.5 Contribution of Dry Land Arrowroots on Household Food Security

Respondents were asked to show their extent of agreement or disagreement to the below statements relating to contribution of dry land arrowroots on household food security. Results presented in **Table 4.2**.

Table 4. 2: Contribution of Dry Land Arrowroots on Household Food Security

Statement	N	Mean	Std. Dev
Food security; people never go without food. They have access to food that meets their needs. Do you agree with the statement?	100	3.96	0.95
In your family do you have adequate food in terms of quality and quantity essential for good health? Do you agree?	100	3.86	0.83
Nutritional security: The good food that keeps people health. Fewer cases of anemia and malnutrition	100	3.89	0.76
In your family does your daily diet intake constitute nutritional security in terms of food quality and quantity necessary for health? Do you agree with the statement?	100	3.93	0.88
From your perspective are there cases of reduced school performances.	100	3.52	0.13

The study results in Table 4.2indicatethat, respondents strongly agreed that food security is achieved when people don't miss food or never go hungry/food health? Throughout the year, mean score of 3.96. This implies the respondents moderately agree with the statements on food security.

In addition, the study established that respondents strongly agreed that a healthy life is achieved with fewer cases of nutrition related diseases in the community like anemia and malnutrition by the mean score of 3.93. Further, the study established that respondents agreed that nutritional security is when people gain good food that provides for good health. The good food entails balanced dietary needs with sufficient amounts of energy, micro-nutrients and vitamins necessary for health. Nutrition security is achieved through consumption of good healthy foods according to respondents as shown by the mean scores of 3.89 and 3.86 respectively. Lastly, it was established that respondents moderately agreed

that prolonged hunger leads to physical and cognitive deficits in the long term affecting economic and human development as illustrated by the mean score of 3.52. Fortified Arrowroots farming contributes significantly to food security and nutritional needs of the respondents studied.

4.6 Challenges Faced by Women Farmers in Accessing Dry Land Arrowroots

Respondents were requested to indicate the extent of agreement to the below statements relating to challenges faced by women farmers in accessing seedlings for dry land arrowroots for planting in Muranga County. Results are presented in Table 4.3.

Table 4.3: Challenges Faced by Women Farmers in Accessing Dry Land Arrowroots

Statements	N	Mean	Std. Dev
Do you own the land that you farm?	100	3.79	0.49
It is easy to get dry-land arrowroots seedlings.	100	4.05	1.18
Seedling propagation is accessible to most farmers, with more seedlings I can increase my acreage	100	3.92	1.026
The county government and agricultural officers assist in the arrowroots farming	100	3.91	1.23
Acquiring seedling require a big budget	100	3.95	1.07

The study results in Table 4.3, it was established that, respondents strongly agreed that lack of titles reduces women's ability to get credit to access farm inputs like fertilizer, seedlings and farming equipment's. Lack of credit affects capacity of women economic development. The women experience a challenge in accessing dry land arrowroots seedlings, which prevent them from achieving food security as shown by the mean score of 4.05. The study found out that respondents strongly agreed that women in Muranga with access to seedlings are able to cultivate large farms with arrowroots. Women have limited

access to government advisory services. The women farmers lamented that they are rarely visited in their farms except during large farmers meetings do they find agricultural extension officers. The women farmers reported that getting dryland seedlings require a large sum of money because a seedling costs five shillings. The study confirmed that have limited access to financial support to access seedlings and

4.6.1 Role of Women in Household Food Security through Arrowroots farming

Respondents were asked to declare the extent of agreement to the below statements relating to the role of women in household food security. Results are presented in Table 4.4.

Table 4.4: Role of Women in Household Food Security-through arrowroots farming

Statements	N	Mean	Std. Dev
Women are leading food producers; they grow food consumed by their families and majority of the households	100	3.65	1.15
Women are active players in food production, meeting energy needs and conservation needs.	100	3.79	1.49
Women grow food to feed their families and sell excess produce. Women suffer access to farm inputs that directly affect food production.	100	3.75	1.12
Women farmers are savers of income through women groups/self/help groups, and that play an active role in managing household risks during disasters.	100	3.93	1.83

According to the study results depicted in Table 4.4, the study established that respondents strongly agreed that women are better at saving incomes generated compared to men, and tend to manage household food needs during droughts and other natural disasters as

indicated by the mean score of 3.93. In addition, the study found out that respondents agreed that women are the main managers in food production, and energy utilization.

Further, it was established that respondents moderately agreed that women are active food producers as farmers and laborer's playing a role in feeding their households as indicated by the mean score of 3.65. The study results conform to Ogutu (2015) who argues that women groups accord women social capital. The women groups provide social networks for learning and social insurance against life challenges. The respondents intimated that the women groups helped popularize dry land arrowroots farming. Women organize themselves to offer labour by pooling collective capital that they control. This shows that women control capital in terms of labour capacity and availability of its mobilization. Women groups in the past rarely received farm visits for knowledge exchange. The Self-help provides women with a platform to gain through trainings and capital from members' contributions.

In addition, respondents indicated that women lack farm inputs, technical support, and access to quality seedlings and markets for their dry land arrowroots crop. One respondent lamented that "*arrowroots that are long maturing take too much land resources where land is scare, hence, we prefer to grow faster maturing crops that assures them income and food"*.

4.7 Discussion of Study Findings

On the question on food crops grown in Muranga County, the study established that there are a number of food crops grown within Muranga County which include maize, beans, cassava, yams, millet, among others. It was also established that given the unpredictable rainy season in their area, a significant number of people have shifted to cultivation of fast

maturing fonder crops especially dry land arrowroots which matures fast, are tasty and produce bumper harvest. The dry land arrowroots can meet communities mineral and vitamin needs from crop biofortification. One respondent indicated that "*ever since I started growing dry land arrowroots my family never sleeps hungry because we have enough food"*. The study results agree with Haas et al, (2017) who did a study in Rwanda which demonstrated improved food security has a positive impact on health. The consumption of biofortified bean crops improved food access and nutrition security.

On the hunger situation now and before dry land arrowroots, the study established that with dry land arrowroots residents of Muranga County assured of their food security since the crop matures faster than the normal arrowroots and also requires less water to grow. The fast maturity enables farmers to have several crops in a year. The shorter maturity period allows food surplus generation. In addition, fast maturing food crops are essential for food security and fighting hidden hunger. This agrees with Gitau *et al*., (2016) who argues that hidden hunger is a significant problem where people consume food to fight hunger at the expense of nutritional value. Children consuming biofortified crops experienced fewer cases of anemia's among school going children from pre intervention and post intervention with fortified food crops demonstrate better health and nutritional security.

On the contribution of dry land arrowroots on household food security in Muranga County, it was found out that respondents strongly agreed with a mean score of 3.96 food security can be guaranteed when all people receive sufficient, safe and nutritious food which meets their daily dietary needs. In addition, the study established with a mean score of 3.93 that respondents strongly agreed that only if people can satisfy their food requirements using balance food diversity to achieve health. Moreover, the study results reported mean scores

of 3.89 and 3.86 that respondents agreed that nutritional security is ability to get good food for good health.

On the challenges faced by women farmers in accessing dry land arrowroots seedlings in Muranga County, the study established that respondents strongly agreed with a mean score of 4.05. On the issue of land tenure relationship with food security is inconclusive Owoo and Boakye-Yiadow (2014) in a Study demonstrated that land owners and food production are not collerrated. However, the poor benefit from access to land for food production (Ogechi &Hunja, 2014). Lack of titles as a sign of land ownership limits the capacity of women to access financial support from financial institutions.

The study found out that respondents strongly agreed with mean scores of 3.95, 3.92 and 3.91 that many women in developing countries lack control over the household income and budgets because they work in own farms and produce is consumed within the family with very little surplus. The lack of income possibilities tends to limit women's as well as income generation opportunities. Women naturally are more vulnerable and are affected by hunger and malnutrition especially by iron deficiency and undernourishment during pregnancy and lactation. Women experience challenges in accessing financial and also face inequities in accessing farm inputs such as seeds and fertilizers, technology, market information, knowledge, skills and advisory services. The study findings agree with Manji, (2012) who posit that land for many years has been passed on to male heirs disregarding daughters leaving women powerless in making decisions regarding food security and long-term investments.

On the role of women in household food security in Muranga County, the study established that respondents strongly agreed with a mean score of 3.93 that women Save part of their incomes as security for emergencies and potential difficulties. Women participate in self-help groups in this case women farmers groups for information, education, savings and self-growth. Women support each other against risks thus improving the household's food security in times of natural disasters, such as drought as indicated by the mean score of 3.93. In addition, the study found out that respondents agreed with a mean score of 3.79 and 3.75 that women are the main managers of natural resources and also that women are responsible to their families and societies well-being. It is evident women play a significant in motivating household food security.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary, conclusion and gives recommendations made on the role of fortified crops on household food and nutritional security in Murang'a County. The chapter is therefore structured into summary, conclusion, recommendations and suggestions for further areas of study.

5.2 Summary Study Findings

On the objective of the type of food grown in Muranga County, The study found out that there are a number of food crops grown within Muranga County which include maize, beans, cassava, yams, and millet, among others. It was also established that given the unpredictable rainy season in their area, many people have shifted to cultivation of fast maturing fodder crops especially dry land arrowroots.

On the objective of contribution of dry land arrowroots on household food security in Muranga County, the study established that food security can be achieved when all women farmers have access to good quality seedlings of dry land arrowroots that can ensure adequate food production and nutritional adequacy throughout the year. The farmers can also benefit from support of agricultural extension officers for better farming methods.

On the objective of challenges faced by women farmers in accessing dry land arrowroots in Muranga County, the study established that lack of land ownership based on historical land tenure discriminates and excludes women towards access to financial loans to finance farming activities like buying inputs, and dry land arrowroots seedlings. The women

farmers can benefit from land ownership and financial support against titles as collateral to support farming activities financing.

5.3 Conclusion

On the first objective, the study concluded that despite the parts of Muranga in which this study was undertaken being considered as semi-dry area, It was also concluded that, the reason why many farmers in the area have shifted to cultivation of dry land arrowroots is a promising food crop in terms of food security.

On the second objective, it was concluded that food security can be achieved in the consumption of biofortified crops like dry land arrowroots.

On the third objective, the study concludes that women farmers can support food production and ensure food security through access to farm inputs and access affordable credit necessary for financing farming operations.

5.4 Recommendations

Based on the study findings, the study recommended the following:

- Women farmers need to be encouraged to adopt dry land arrowroots farming needs to be considered as a potential intervention in mitigating food insecurity.
- Women farmers need to be supported to acquire dry land arrowroots seedlings to enhance dry land arrowroots production as a source of food as well as income generation at the local level in the community.
- Women need support in seedling propagation and training on modern farming methods to enhance food production and food security in the community.

- Biofortified food crops are essential in mitigating food insecurity therefore efforts need to be made to support biofortified food crops like dry land arrowroots.
- Government policy need to adopt biofortified crops like dry land arrowroots farming as a strategy to achieve food security in Kenya among Arid and semi-arid lands.

5.5 Implications for Policy, Theory and Practice

The success in dry lands arrowroots farming in Muranga and its contribution in transforming the lives of women farmers by providing economic empowerment, food security and food justice demonstrate the suitability of the fortified crops in transforming lives in the community. The findings are suitable in guiding government policy in arid and semi-arid agriculture.

5.6 Areas of Further Research

The main aim of this study was to examine the role of fortified crops on household food and nutritional security in Murang'a County. Therefore, the results that were obtained cannot be generalized in all counties in Kenya. Thus, the study recommends that further study in other counties to allow generalization of study results.

Studies ought to be undertaken examining how adoption of drought resistant biofortified food crops helps in alleviating food insecurity among communities living in arid and semi-arid areas in Kenya.

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APPENDICES

Appendix I: Questionnaire

This questionnaire aims at collecting information and data for academic use by the researcher. Your kind participation will help in providing useful information necessary to complete this research. Please answer the questions precisely and objectively; the information will be treated with utmost confidentially.

Section A: Background Information

1. **Kindly indicate your gender**

   Male [ ] Female [ ]

2. **Kindly Indicate your Age**

   18 to 35 years [ ]
   36 to 60 years [ ]
   Above 60 years [ ]

3. **Kindly indicate your Highest level of education**

   No Formal Education [ ]
   Primary Level [ ]
   Secondary Level [ ]
   College Level [ ]

4. **How did you know about dry land arrowroots?**

5. **Kindy indicate the number of years you have been cultivating dry land arrowroots**

   Less than 5 years [ ]
   5 to10 years [ ]
   Above 10 years [ ]

Section B: Type of Food Crops Grown

6. Kindly indicate the main type food crops cultivated in your farm?

……

……

……

……

7. Kindly indicate hunger situation now and before dry land arrowroots?

……

……

……

……..

Section C: Contribution of Dry Land Arrowroots on Household Food and Nutritional Security

Kindly indicate your level of agreement to the statements below relating to contribution of dry land arrowroots on Household food and nutritional security in Murang'a County. Please tick using scale of 1–5, where 5–Strongly Agree, 4–Agree, 3 Moderately Agree, 2–Neutral, 1–Strongly Disagree.

Statement	**Likert scale**				
	1	**2**	**3**	**4**	**5**
Food security; people never go without food. They have access to food that meets their needs. Do you agree with the statement?					
In your family do you have adequate food in terms of quality and quantity essential for good health? Do you agree?					
Nutritional security: The good food that keeps people health. Fewer cases of anemia and malnutrition					
In your family does your daily diet intake constitute nutritional security in terms of food quality and quantity necessary for health? Do you agree with the statement?					
From your perspective are there cases of reduced school performances and what do you attribute the same to?					

Section D: Challenges Faced by Women Farmers in Accessing Dry Land Arrowroots

Kindly indicate your level of agreement to the statements below relating to challenges faced by women farmers in accessing dry land arrowroots in Murang'a County. Please tick using scale of 1–5, where 5–Strongly Agree, 4–Agree, 3 Moderately Agree, 2–Neutral, 1–Strongly Disagree.

Statement	**Likert scale**				
	1	**2**	**3**	**4**	**5**
Do you own the land that you farm?					
It is easy to get dry-land arrowroots seedlings.					
Seedling propagation is accessible to most farmers, with more seedlings I can increase my acreage					
The county government and agricultural officers assist in the arrowroots farming					
Acquiring seedling require a big budget					

Section E: Role of Women in Household Food Security

Kindly indicate your level of agreement to the statements below relating to role of women in household food and nutritional security. Please tick using scale of 1–5, where 5–Strongly Agree, 4–Agree, 3 Moderately Agree, 2–Neutral, 1–Strongly Disagree.

Statement	**Likert scale**				
	1	**2**	**3**	**4**	**5**
Women are leading food producers; they grow food consumed by their families and majority of the households					
Women are active players in food production, meeting energy needs and conservation needs.					
Women grow food to feed their families and sell excess produce. Women suffer access to farm inputs that directly affect food production.					
Women farmers are savers of income through women groups/self/help groups, and that play an active role in managing household risks during disasters.					

Appendix II: Key Informants Guide

The study protocol under use of key- informants selected individuals with knowledge of the community being studied as key opinion leaders based on knowledge and specialized skills.

Key knowledge Area

a. Land issues
b. Agricultural issues
c. Women leader
d. Government policy

A key informant was selected in each of the studied sub-counties Mathioya, Gatanga, Kangema and Muranga East.

Key informants' information was triangulated with focus groups to verify their validity.

The purpose is to collect reliable information from potential information sources

Wealth Indicators

1. Rainfall pattern
2. Energy used
3. Economic activities and sources of income

Appendix III: Focus Group Discussion Guide

1. Name of Group

2. Main activity

3. What are the main crops grown by most farmers

4. How did you learn about dryland arrowroots farming?

5. Describe life before and after dryland arrowroots farming with regards to hunger, produce and income

The group member are then briefed on the questionnaire and additional data collected for analysis.

Focus Group 1: Young Women (18-35 years)

Interviewing youth group members on their knowledge of dryland arrowroots planting and uses: The purpose was to establish level of knowledge and motivation behind dryland arrowroots farming.

Focus Group 2: Experienced Farmer-Trainer

Field Trainer on Dry Arrowroots Farming in Kangema

A field tour to observe the different stages of arrowroots growth and uses from an experienced farmer- A key informant that distributes dryland arrowroots seedlings to the women farmers. The key informant is aged between 30-40 years, and attained secondary school level of education.

Focus Group 3: Planting Arrowroots Women Group

Women group in Maragwa

The women groups are social capital centres, where information is shared and peer influence enhances cohesion and drives change. Peer learning, counseling and influence.

Focus Group 4: Discussions

Women Group Meeting: Gatanga

Women group sharing experiences about challenges in farming, food security and nutrition. The women groups are sources of learning and economic empowerment. [11] eleven women present.

Focus Group 5: Women Group

Focused group discussion on dryland arrow farming in Gatanga on food security, nutrition and farmers challenges, and [12] twelve women attended. The women group has a significant number of youths in attendance

Focus Group 6: Women Group –Social Capital and Demonstrations Networks

Observing shared labour, group learning and peer influence from women group in Mathioya

Focus Group 7: Mature Arrowroots

Mature arrowroots used as source of carbohydrates, making floor and source of breakfast accompaniment. Most women farmers confirmed it is a food crop that can be used at all times for any meal of the day.

Appendix IV: Introduction Letter

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Website: http://awsc.uonbi.ac.ke
Nairobi, Kenya

Date: November 8th, 2019 **Ref:** UON/CHSS/AWSC/8/3

From: Director,
African Women Studies Centre
University of Nairobi

TO WHOM IT MAY CONCERN

SUBJECT: **INTRODUCTION LETTER FOR MS. JULIAH CHEGE**

This is to confirm that **Ms. Juliah Chege (M10/9958/2018)** is a registered Master of Arts student at the African Women Studies Centre, University of Nairobi. She is currently working on her research project entitled, **"Role of Biofortified Crops in Household Food Security and Nutrition Security among Dry land Arrowroot Farmers in Muranga' County".**

Any assistance accorded to her during her research period is highly appreciated.

Prof. Wanjiku Mukabi Kabira
Director, African Women Studies Centre
University of Nairobi

Appendix V: NACOSTI Cover Letter

UNIVERSITY OF NAIROBI
AFRICAN WOMEN STUDIES CENTRE
P.O Box 30197-00100
Tel: (+254-20) 3318262/28075; 725 740 025
Email: awsckenya@uonbi.ac.ke

Date: November 8th, 2019 **Ref:** UON/CHSS/AWSC/8/3

To: Director General,
National Commission for Science, Technology and Innovation
Off Waiyaki Way, Upper Kabete,
P. O. Box 30623, 00100,
Nairobi, Kenya.

SUBJECT: INTRODUCTION LETTER FOR MS. JULIAH CHEGE

This is to confirm that **Ms. Juliah Chege (M10/9958/2018)** is a registered Master of Arts student at the African Women Studies Centre, University of Nairobi. She is currently working on her research project entitled, "**Role of Biofortified Crops in Household Food Security and Nutrition Security among Dry land Arrowroot Farmers in Muranga' County**"

Any assistance accorded to her during her research period is highly appreciated.

Prof. Wanjiku Mukabi Kabira
Director, African Women Studies Centre
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