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ABSTRACT

The main purpose of this study was to investigate the role of biofortified dry land arrowroots in mitigating food security among rural women farmers' households in Muranga County. The specific objective was to determine the nutrition value of biofortified dry land arrowroots in Muranga County. 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 was founded on the theory of innovation 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 indicated 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. Conclusion of the study was 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 recommended 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 recommended studies in other Counties on dry land arrowroots to allow generalization.

Key Words: Biofortified Dry Land Arrowroots, Nutrition Value

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INTRODUCTION

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.

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 that 10 million Kenyans are considered food insecure in addition 2-4 million suffering poor nutrition. Biofortification is regarded as a strategy towards achieving food security.

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) estimated 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 was considered to be a dryland and consists of the following sub-counties; Maragwa, Kagemu, 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 and the attitudes towards dry land arrowroots nutrition value need to be established. This study sought to fill this knowledge by determining the nutrition value of bio-fortified dry land arrowroots in Muranga County.

Objective of the Study

The general objective of this study was to examine the 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. The specific objective was to determine

the nutrition value of dry land arrowroots in Muranga County.

The study was guided by the question, what is the nutrition value contribution of dry land arrowroots in Murang'a County?

LITERATURE REVIEW

The inquiry was guided by the theory of innovation. The biofortified crops are considered in providing food security to households and meeting nutritional adequacy needs.

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 (Kimiye, 2015).

The dry land arrowroots also called *Tacca Involurata* 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.

Empirical Studies

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).

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.

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.

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.

Poor households suffer malnutrition, stunted growth, and anemia, all associated with dietary deficiencies and food insecurity (Kimiye, 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.

Biofortified crops like Dryland arrowroots according to evidence from Mwangi 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).

METHODOLOGY

This study approach adopted a descriptive survey study design. The study design deployed qualitative and quantitative techniques in data collection. 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 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. The study deployed purposive sampling to collect data as objectively as possible from the target population of women farmers. The researcher utilized stratified sampling technique to select 120 dry land arrowroot farmers from across the four targeted sub-counties. The researcher used semi-structured questionnaires, a camera and notes taking and meeting minutes to collect data for analysis. The key informants were Ministry of Agriculture Official, County government officers and women leaders.

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 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.

FINDINGS

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 represented a response rate of 83.3 %. The results established that majority (59%) engaging in dry land arrowroots in Muranga County were aged between 36 to 60 years, 22% are aged above 60 years, 19% were aged between 18 to 35 years, 13% were aged between 21 to 35 years while 6% were aged below 20 years. From the study results, it was

clear that majority of those engaging in arrowroots farming in Muranga County were past their youthful age above 35 years. The study established 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 indicated that majority of those engaging in dry land arrowroots farming in Muranga County were literate.

This study found out that farming of dry land arrowroots as a strategy to achieve food security in the area was not a new undertaking given the high number of respondents who had been cultivating it for more than 10 years.

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 were a number of food crops grown within Muranga County which included 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 agreed with Haas *et al.* (2017) who did a study in Rwanda on the

contribution of fortified crops improved health and nutrition using fortified 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 were 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.

DISCUSSION

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 fodder 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 agreed 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 enabled farmers to have several crops in a year. The shorter maturity period allowed food surplus generation. In addition, fast maturing food crops are essential for food security and fighting hidden hunger. This agreed 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.

CONCLUSION AND RECOMMENDATIONS

On the type of food grown in Muranga County, the study found out that there were a number of food crops grown within Murang'a County which included 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.

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.

Based on the study findings, the study recommended biofortified food crops are essential in mitigating food insecurity therefore efforts need to be made to support biofortified food crops like dry land arrowroots.

Areas of Further Research

The main aim of this study was to examine the nutritional value 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 recommended 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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