

**ASSESSING THE EFFECT OF BAMBARA NUTS PRODUCTION ON FOOD
SECURITY IN BUIKWE DISTRICT:
A CASE STUDY OF NYENGA SUB COUNTY**

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DEDICATION

I dedicate this book to my beloved late father Mr. Wandera Simon and my mother Mrs. Wandera Jennifer who always supported and encouraged me with their wisdom, to my dear brother Kiiza Nicholus, to my lovely sisters Atogonza Florine and Akugizibwe Moreen plus all my dear friends.

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ABBREVIATIONS AND ACRONYMS

SSA	Sub-Saharan Africa
FAO	Food and Agriculture Organization
MAAIF	Ministry of Agriculture, Animal Industry and fisheries
CVI	Content Validity Index
UBOS	Uganda Bureau of Statistics
NAADs	National Agricultural Advisory Services
NARO	National Agricultural Research Organization
ALC	Agriculture and Livestock Census

ABSTRACT

The general objective of the study was to examine the effect of Bambara nuts production on food security in Buikwe district using a case study of Nyenga Sub County. The study was guided by the following specific objectives: to evaluate the effect of Bambara nuts production on smallholder farmer's incomes in Nyenga Sub County; to determine the effect of Bambara nuts production on food availability at household level in Nyenga Sub County and to examine the effect of Bambara nuts on food accessibility at household level in Nyenga Sub County. A survey research design was used while employing both qualitative and quantitative methods. The study population consisted of 98 participants. A sample size of 72 respondents was selected using simple random and purposive sampling techniques. Quantitative data analysis mainly consisted of descriptive statistics (means and standard deviations) and inferential statistics (Pearson correlation and regression). Findings revealed that Bambara nuts production has no significant effect on farmer's incomes in Nyenga sub-county and this is because most of the farmers grow it on small scale and the crop has low market potential. Further, Bambara nuts production has a significant and a positive effect on food availability in Nyenga sub-county. This thus means that without other foods, Bambaranuts can be available for home consumption, and lastly it was established that that Bambara nuts production has a significant and a positive effect on food accessibility in Nyenga sub-county. This thus means that most people have a possibility of getting food since Bambara nuts makes food cheaper and accessible to any person in the area. it was therefore recommended that there is need to initiate development of programs and deliberate policies that can enhance farmer's adoption of production of Bambara nuts.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This study was carried out as an evaluation of farmers' perceptions on adoption Of Bambara nuts Production as a Food Security Crop in Buikwe District using Nyenga Sub County as a case study. The chapter presents the background to the study, statement of the problem, research objectives, research questions, conceptual framework, and significance of the study as well as the scope of the study, definition of key terms and justification.

1.1 Background to the study

Bambara nuts (*Vigna subterranea* (L.) Verdc) originated from West Africa but has become widely distributed throughout the Sub-Saharan part of Africa (SSA). Sharing a high nutritive value with other widely consumed legumes, Bambara nuts has an appealing flavor which is reflected in demand from small local and niche markets. The crop is a low input leguminous crop that is rich in nutrients, drought tolerant, short production period and high yielding even in less fertile soils besides being a nitrogen fixer. When cooked, the crop is a complete food, as contains sufficient quantities of protein, carbohydrate and fat (Baudoin *et al.*, 2001). Despite its high and balanced protein content, Bambara nuts remain under-utilized because it takes a long time to cook, contains anti-nutritional factors such as tannins and trypsin inhibitors and it has poor milling characteristics, as it does not dehull easily (Barole, 2005). The long cooking time consumes more fuel and water than might be required for cowpea or phaseolus bean. Boiling from fresh may take 45-60 minutes, while dried beans may take as much as 3-4 hours. Bambara nuts yield well under conditions which are too arid for groundnut (*Arachis hypogea*), maize (*Zea mays* L.) and even sorghum (*Sorghum bicolor*). Its drought tolerance makes Bambara nuts are

useful legume to include in climate change adaptation strategies. A number of projects on Bambara nuts, involving several countries in Sub-Saharan Africa since the 1980s, have failed to stimulate a sustainable increase in the production of the crop. The absence of functioning value chains has been a factor in this failure, as accessible market outlets might provide the required incentive for smallholder households to obtain improved seed and invest more of their land and labor in the crop (Igodan and Jabar, 1993).

Globally, Bambara nuts (*Vigna subterranea* (L.) Verdc.) is known as an African specie, the cultivation of which predates that of groundnut. Although occasionally grown in Asia and elsewhere, its cultivation is rare outside the African continent. In Africa, it is very much grown in Nigeria, Niger, Ghana, Zimbabwe, Botswana, South Africa, Swaziland and Cote d'voire (Goli *et al.*, 1991). It is in West Africa that most of the world's Bambara nuts are grown and where the crop is most prominent in the traditions of rural communities (Yao *et al.* (2005). Bambara nuts are now widely distributed in the semi-arid zone of sub-Saharan Africa (SSA) and particularly in Uganda (FAO, 2007).

Bambara nuts are important for smallholders and their households because the beans are an important source of food security, being nutritious and high in protein. Although, in common with other legumes, Bambara nuts are deficient in sulphur-containing amino acids (Azam-Ali *et al.*, 2001), through some genotypes contain higher amounts of methionine and lysine than is found in other legumes (NRC, 2006). As a nitrogen-fixing legume, Bambara nuts also contributes to the maintenance of soil fertility. Although normally grown in areas where cowpeas and groundnuts are grown, Bambara nuts are considered to have an advantage over those crops in their adaptation to poor soils and tolerance to drought. Bambara nuts yields well under

conditions which are too arid for ground nuts, maize and even sorghum (Thottappilly and Rossel, 1997).

In Uganda, Bambara nuts emerged in 1960s especially in Eastern part of Uganda and later were spread all over the country (FAO, 2006). Since then, a number of projects like NAADs and Plan for Agriculture Development projects put up a lot of efforts to see that this crop is adopted by farmers in Uganda, however, the rate of adoption appears to still be below expected. Production of Bambara nut in Kenya has been on the decrease for the past few decades. Knowledge on factors that are perceived to influence farmer decisions in adoption Bambara nuts production will play a greater role in ensuring nutritional and food security in the region (KARI, 2009; Korir, *et al* 2011; Onyango, 2010). According to MAAIF (2008), Bambara nuts have had an effect on food security (Onyango, 2010; Andika *et al*, 2010). Although initiatives to develop and commercialize the crop have been largely unsuccessful, primarily due to barriers to the establishment of functional value chains, the significance of the crop still remains (Berchie, 2009).

According to FAO (2004), food security consists of farmer's incomes, food use, food availability, food accessibility and access. Mwanga et al (2005) indicates that tremendous research efforts have been taken by the National Agricultural Research Organisation in Uganda (NARO) on Bambara nuts production and its effect on food security. Efforts have been made to see that this nut is supplied and released to farming communities in Uganda including Buikwe District, Nyenga Sub-County. However, ever since the introduction of Bambara nuts in this area, the question on food security still remains. Therefore, this study was conducted to assess the effects of Bambara nuts production on food security in Nyenga Sub-County

1.2 Problem Statement

Bambara nuts production is regarded as a major food crop in improving food access, availability, and farmer's income to rural poor households in Ugandan communities (FAO, 2001). Given the fragile balance between population, food production and economic growth, government policy seeks to ensure Uganda's continued ability to sustain food self sufficiency. Increases in Agricultural productivity and agro- enterprise development are key elements in the government's strategy to increase the incomes of rural households and to facilitate expansion of the overall economy. As such researchers and many development partners have become increasingly interested in the role of Bambara nuts in Ugandan food system and its potential to enhance food security and increase rural incomes. In this case, the government of Uganda supplied free and better Bambara nut seeds to see that food security in terms of food access, food availability and famer's incomes improves. However, food insecurity is still prevalent in Nyenga Sub-county. For instance, according to UBOS (2013), smallholder farmer's incomes in Buikwe district is still poor, food access and availability is also not promising. It is against this background that the researcher developed interest to undertake this study to assess the effects of Bambara nuts production on food security in Nyenga Sub-county.

1.3 General objective

The study aimed at assessing the effect of Bambara nuts production on Food Security in Buikwe District using a case study of Nyenga Sub County.

1.4. Specific Objectives

- i) To evaluate the contribution of Bambara nuts production on smallholder farmer's incomes in Nyenga Sub County.

- ii) To determine the relationship between Bambara nuts production on food availability at household level in Nyenga Sub County.
- iii) To examine the effect of Bambara nuts on food accessibility at household level in Nyenga Sub County.

1.5. Research Hypotheses

- i) There is a significant effect of Bambara nuts production on smallholder farmer's incomes
- ii) There is a significant effect of Bambara nuts production on food availability at household level
- iii) There is a significant effect of Bambara nuts on food accessibility at household level

1.6. Scope of the study

This focused on the geographical scope, content scope and time scope as indicated below;

1.7 Geographical scope

The study was conducted in Nyenga Sub County, in Buikwe district, in central Uganda. This island has over 1000 households. It is approximately 18kilometers (11 mi), by road, northeast of Buikwe. The sub-county is also located approximately 7.5kilometres (4.7 mi), by road, southwest of Njeru town council the largest metropolitan area in the district (Map of Uganda, 2015). The coordinates of Nyenga are: 0°22'48.0"N; 33°09'00.0"E (Latitude: 0.3800; Longitude: 33.1500). According to UBOS survey (2014) Nyenga Sub County has over 207,089 people. The major activities done in the sub-country include; trading, tourism activities, sugarcane growing and agriculture. And that is why this area was found to be the best place for the study.

1.8 Content scope

The study focused on the effects of Bambara nuts production on food security. Bambara nuts production was measured using crop commercialisation, crop utilisation, market potential,

consumption, vine distribution and cultivated area, whilst food security was measured using farmer's incomes, food access and availability at household level.

1.9 Time scope

The study was limited in assessing the effect of Bambara Nuts on food security. This research was carried out between the period of 2009 and 2014. This period is chosen because this was when NAADs introduced the giving of Bambara nuts to farmers in Nyenga Sub-county (NAADs, 2009).

1.10 Significance of the study

According to Oso et al (2008) argues that the significance of the study is the relevance of the study in terms of academic contribution and the practical use that might be made out of conclusions. In other words the study was focused on the following

To guide the agro-ecologists in pointing out the household adoption of Bambara nuts in Uganda.

The study will also serve as a tool in discovering major factors/perceptions behind less adoption of Bambara nuts from household point of view.

The study will guide policy makers in designing and implementing appropriate strategies required to improve on adoption of Bambara nuts.

The study will equally help the academicians to carry out research in future while using these study findings as the basis for investigation.

1.11 Justification of the study

Prior studies had been done on the effect of Bambara Nuts on food security. However, no study has been done on the aforementioned topic in Buikwe district and Nyenga Sub-county in particular considering the same dimensions of Bambara nuts production. Thus, the rationale behind the choice of this study is to empirically establish the effect of Bambara Nuts on food

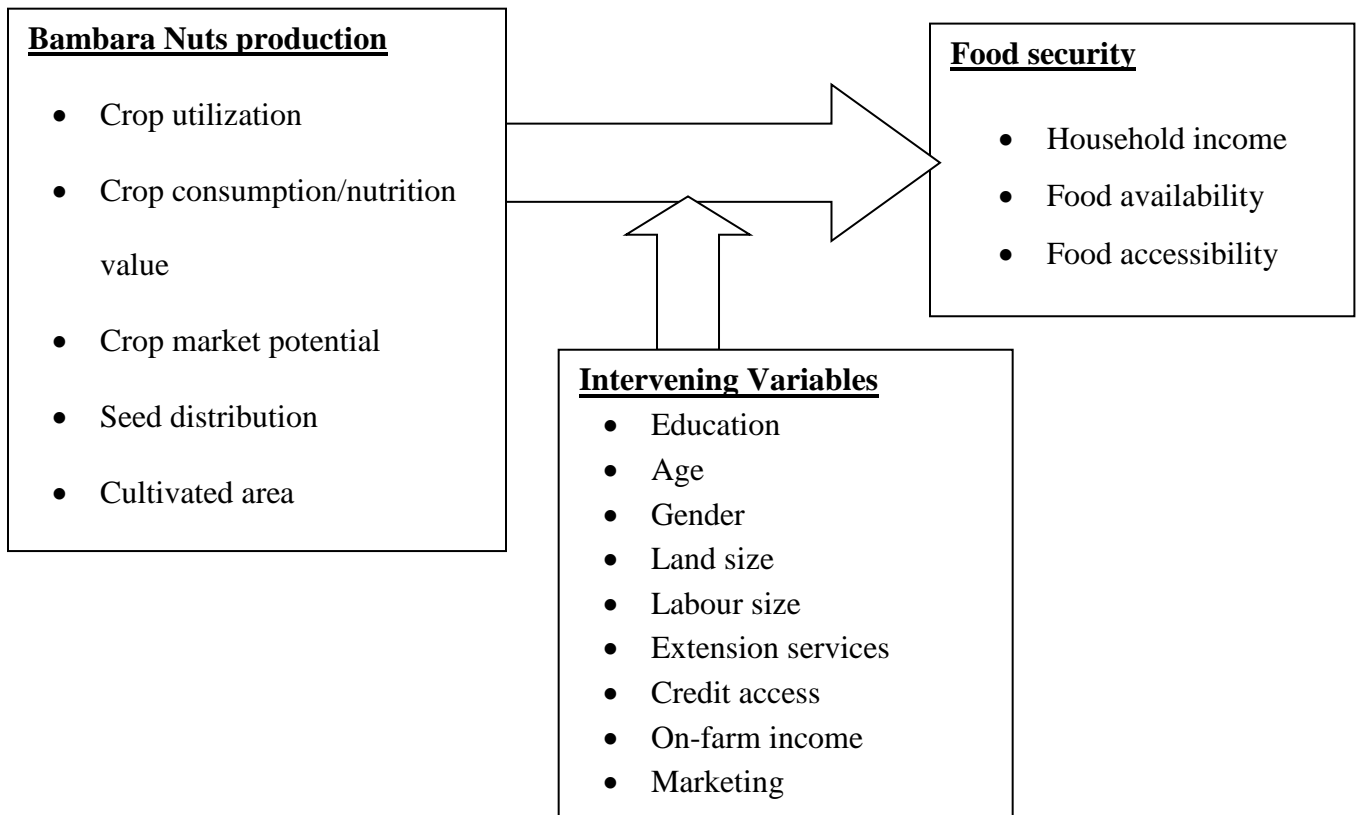
security. The researcher therefore felt the need to carry out as research in order to understand the linkage between the aforementioned dimensions of topic.

1.12 Conceptual Framework

The conceptual framework below was based on two main variables that is: Bambara nut production and food security as independent and dependent variables respectively. Bambara nuts production was entirely conceptualized to mean crop utilization, crop consumption/nutrition value, crop market potential and seed distribution. Food security on the other hand was conceptualized to mean household income, food availability and food accessibility. Among the intervening variables for the study included; education, age, gender, land size, labour size, extension services, credit access, on-farm income and marketing

INDEPENDENT VARIABLES

DEPENDENT VARIABLES



Source: adopted and modified from FAO, WFP, and IFAD (2012).

In the conceptual framework above, it was hypothesized that the production of Bambara nuts that is in terms of crop utilization, crop consumption/nutrition value, crop market potential, Seed distribution and cultivated area may have an effect on food security in terms of household incomes, food availability and access. However, this relationship may be affected by education, age, gender, land size and labour size and cost

1.13 Definition of Key Terms

Crop Utilization: this referred to the extent to which Bambara nut was being consumed by farmers (Barimalaa and Anoghalu, 1997). The long cooking time consumes more fuel and water than might be required for cowpea or phaseolus bean. Boiling from fresh may take 45-60 minutes, while dried beans may take as much as 3-4 hours.

Crop Consumption/Nutrition Value: this referred to the nutritional value possessed by Bambara nuts that would induce farmers to plant them

Crop Market Potential: this meant the extent to which Bambara nut was being sold on local market in the area. Despite having nutritional advantages over competing legume crops, such as higher content of methionine, BG has not developed as a traded commodity (Azam-Ali *et al.*, 2001).

Seed Distribution: this referred to the extent to which the seeds or seedling of Bambara nuts could be accessed by local farmers

Cultivated Area: this referred to the size of land offered to planting of Bambara nuts by local farmers

Food security; this refers to the availability of food and one's access to it (Amos, 2012). This means that, the food must be available and people must have access to it. To have access to food means that it must be affordable.

Bambara nuts (*Voandzeia subterranean* (L) Verdc.); this is an indigenous African legume that constitutes the third most important pulse crop in the continent after groundnut and cowpea.

Farmer's incomes: this refer to the amount of money and assets achieved by farmers as a result of growing Bambara nuts.

Food accessibility: this refers to ability of people to access all forms of food required for survival.

Food availability; this refer to the presence of food in households of farmers.

A household; is defined to comprise all usual residents, where they live together and eating from the same kitchen, share common facilities and mutual reciprocal responsibility.

1.14 Conclusion of the Chapter

This chapter introduced the concepts of Bambara nuts production and food security. Bambara nuts production in this case was represented the independent variable and food production as the dependent variable. Bambara nuts production has been depicted as meaning e crop utilization, crop consumption/nutrition value, crop market potential, Seed distribution and cultivated area. Food security was measured to mean household incomes, food availability and access. These formed the objectives of the study. Therefore, this study aimed at findings out the contribution of Bambara nuts production on smallholder farmer's incomes in Nyenga Sub County; determining the relationship between Bambara nuts production on food availability at household level in Nyenga Sub County and examining the effect of Bambara nuts on food accessibility at household level in Nyenga Sub County. This chapter thus provided the introductory part of the study. It

comprises of the background of the study, statement of the problem, objectives of the study, research hypothesis, conceptual framework, significance, justification of the study, scope of the study and operational definitions.

CHAPTER TWO

LITERATURE REVIEW

Introduction

In this chapter, the researcher critically analyzes works of other people related to variables under study. A review of Bambara nuts production and its relationship with smallholder farmer's incomes, food access and availability is presented.

2.1 Bambara nuts production

Bambara nut seeds contain 63% carbohydrate, 19% protein and 6.5% oil (Lineman 1987). The gross energy value of Bambara nut seeds is greater than that of other common pulses such as cowpea, lentil (*Lens esculenta*) and pigeonpea (*Cajanus cajan*) (FAO, 1982). De Kock et al (2011) provides the following nutritional breakdown: carbohydrates: 54.5 - 69.3%, protein 17 - 24.6% and fat 5.3 - 7.8%. Bambara nuts are good source of fiber, calcium, iron and potassium. The red seeds could be useful in areas where iron deficiency is a problem, as they contain almost twice as much iron as the cream seeds (de Koch, 2012).

Often, it is the cream or white seeded Bambara nuts which have more price command up to a 10% premium in Ghana (Quaye and Kanda, 2004). Red seeds are more popular than the cream seeds in Zimbabwe, where they command a higher price with the Grain Marketing Board. Bambara nuts have the potential to provide a balanced diet in areas where animal protein is scarce and/or expensive and where the cultivation of other legumes is risky due to low rainfall. Bambara nuts compares favorably in nutritional status, with other well known and highly commercialized beans

Bambara nut grows close to the ground and the nuts are produced underground. It is therefore, a difficult crop to harvest mechanically which discourages large-scale commercialization, but it is an ideal crop for smallholder households. The crop yields reasonably well on poor soils in areas of low rainfall (500 – 800 kg ha⁻¹) and can be grown without fertilizers and chemicals which are costly and often difficult to access in more remote areas. It grows well on acidic lateritic soils which are common in Africa, but less well on calcareous soils (Mkandawire, 2007).

2.2 Bambara nuts production and smallholder's farmer incomes

Mose et al (2003) indicated that farmers in the North Rift Valley region of Kenya only grew a narrow range of crops, notably maize, beans, wheat, potatoes, and exotic vegetables such as cabbages and kales. The major source of farm income was maize and milk. Since market liberalization, the farmers started facing fluctuating farm incomes from sale of maize and milk until they introduced Bambara nuts. Over-dependence on maize for both food production and income generation made farm households insecure during periods of drought and glut production. Inadequate crop diversification for food and cash make farmer's food and income insecure whenever there are external shocks to their farming system. For instance, during periods of glut production, maize prices drop drastically as supply exceeds demand and crop losses are high because only a few farmers will have invested in storage facilities (Wasula et al, 2012). The result was low farm income, which translated into subsequent decline in the use of purchasable inputs such as fertilizers and seed. The narrow range of crops grown also contributed to inadequate food supply in case of poor weather. Using the Farmer Participatory Approach (FPA), Bambara nuts were introduced to the farmers in De Cote d Ivoire (Yao et al, 2005). Over time, the farmers who adopted Bambara nuts new varieties, their farm incomes and food supply

in the region had improved. Stable farm incomes are necessary for farmers to meet their domestic needs such as health and payment of school fees, besides re-investing in the farm.

According to a recent Agriculture and Livestock Census (ALS) conducted from January 2014 to March 2015. The numbers of smallholder farms, medium-scale farms, estimated at 623,998; 5,238; and 148, respectively. Buikwe accounted for approximately 7% of the country's smallholders, 25% of its medium-scale farms, and 19% of its commercial holdings. During the same cropping season, smallholders in Uganda cultivated 99% of total farms, accounted for 11% of the total area in basic food crops, and 9% of the total cultivated Bambara nuts (INE, 2002).

In terms of area cultivated in the 2014/15 rainy season, coffee was the major cash crop grown by small-scale farmers, followed by sunflower, cotton, and tobacco and the rate of growing Bambara nuts has been down for long (Hillocks et al, 2012). It is important to point out that the absence of Bambara nuts has been affecting the growth of industrial sector in Uganda. Maize remains the most important food crop grown by small-scale farmers in Uganda followed by cassava, peanut, cowpea, beans, and sweet potato. The highest percentage of land devoted to food crops reflects the paramount importance given to food security through subsistence agriculture, due to failures in rural output markets (MAAIF, 2002). Thus, the small-scale farming sector is by far the most important and most representative agriculture activity in Uganda. Thus in boosting food security, this study intend to investigate the effect of Bambara nuts production on food security in Nyenga Sub-County.

Bi (2010) ascertain that total farm size influence the adoption of Bambara nuts in many households in Africa to either positively or negatively. Increase in farm size could positively influence crop introductions in that larger farm sizes allow for flexibility in crop rotations. On the other hand, smaller farm sizes could encourage more diversification and hence encourage crop introductions. In this case large farm sizes will negatively influence crop introductions. They add that years of farming experience also have a significant influence because the more the years a farmer has been farming the more likely he/she was to adopt a new technology because of accumulated skills. Massawe et al (2005) finds access to off-farm employment to have both positive and negative influence on the adoption of Bambara nuts because people find it relevant to mind about short-term income generating activities that is wasting time in planting it. Therefore, this variable is expected to positively influence the adoption of Bambara nuts in Nyenga sub-county.

Bambara nuts have been adopted by most farmers in Ghana as an alternative source of incomes away from millet, maize and beans (Hillocks et al, 2012). The crop was readily marketed as the demand outstripped supply. The areas which farmers have highest incomes from Bambara nuts are those that are close to major urban consumption areas. Although, Bambara nuts introduction has been adopted, not all components were adopted and some of the recommended technological components were modified depending on farmer preferences and circumstances and this has been the key to varying incomes of some farmers (Ouedraogo et al, 2008).

In terms of area cultivated in the 2013/14 rainy season, coffee was the major cash crop grown by small-scale farmers, followed by sunflower, cotton, and tobacco and the rate of growing Bambara nuts has been down for long in Uganda (UBOS, 2013).

According to Ouedraogo et al (2008), in Swaziland farmers resorted to any available seed in the local markets. Similarly, farmers who experienced poor germination due to too much rain when planting Bambara nuts as recommended (onset of rains) resorted to planting late and this could affect their incomes levels. After the crop introductions, the adopters increased their crop yield due to superior varieties introduced coupled with information on their management.

2.3 Bambara nuts production and food availability

Bambara nuts, an underutilized leguminous crop often referred to as ‘complete food’, not only have the capacity of fighting hunger and malnutrition. The seeds have an excellent nutritive value, with 18 – 26% protein content, which is very rich in lysine, a scarce amino acid in plant protein (Yawson and Wilhelmina, 2004). In addition it contains 4 – 9% fat, 50 – 65% carbohydrate and 3- 5% fibre. This makes the seed an exceptionally balanced food for human consumption (Brink et al, 2006). It is these qualities of the Bambara nuts that this study would like to prove its potential for being the crop of hope for sustainable food security in Uganda. The crop has high potential in meeting the need of poor resource farmers for increased food output in that it is reported to tolerate or even prefer poor soils hence, yield better than most pulses on poorer soils. In fact, it is reported that nitrogen rich soils are to be avoided as they stimulate the plant to produce too much leaf at the expenses of pods and seeds (Baudoin and Margeai, 2001), this alone means the crop can be grown better by most farmers. The crop also has a reputation for resisting pests and disease (Ajayi and Lale, 2001). The region has comparative advantage in

Bambara nuts production as the crop is indigenous to the area, being the centre of origin (Pasquet et al; 1999).

Being that it has ability to fix nitrogen like most other legumes (Dakora, 1998), poor resource farmers can take advantage of it to grow it on large scale, which will also enrich their soil and make it suitable for production of cereals, like maize, sorghum and millet in mixtures or rotation. Besides, the crop yield is comparative to that of other pulses like Bambara nuts, and cowpea given similar management and with growing interest in it as it is believed to be suitable for consumption by people with diabetes, its prices in the market is also close to pulses like cowpea, in fact, sometimes it cost higher as its production is always limited and its demand is increasing. Although it is reported that Nigeria produces one third of total annual world production put at around 300,000 metric tons (Poulter, 1981) this is grossly inadequate to meet with world demand put at over 800,000 metric tons, hence the higher prospect for farmers in the region and indeed Nigeria to increase their production.

Another attribute of the crop which makes it suitable for sustainable production is the availability of varieties with varying maturity period ranging from 3-6 months which makes it suitable for production in even areas with low rainfall like the northern part of the region that have very short rainy season and low rainfall, also it can be harvested early or late with no serious yield losses (Rowland 1993, Mshelia, 2008). The crop also fits well into the cropping system predominantly practiced in the area, which is mixed cropping as it can be grown in mixtures with maize, sorghum, millet and Bambara nuts without much yield loss, although under such practices time of sowing is significant as it must not be delayed too much which may result in poor growth and

yield of the Bambara nuts as a result of high competition for growth resource (Misbalumnair et al 1989; Tanimu, 1996 and Mshelia et al, 2004).

Bambara nuts is suitable for intercropping with other crops and does not take up large areas of land that could be used for other crops considered more important or lucrative. Bambara nuts is useful in crop rotation because it contributes nitrogen to the soil at a level similar to other legumes (20 – 100 kg| ha) (Ncube and Twomlow, 2007). Traditionally, Bambara nuts was seen as a snack or food supplement, but not a lucrative cash crop. In Zimbabwe, the crop is usually grown by women and so, it is often given a lower priority within the village, in the allocation of land. Seeds for growing Bambara nuts are rarely purchased by farmers because the women are responsible for passing the seed down through the generations, and storing the dried beans for food security. Women are usually given seed by female relatives (mother in law) when they are married. Sometimes the local chief gives them the seed when they move into the area (de Kock, 2004).

Bambara nut seeds can be eaten fresh, or cooked while still immature. At maturity, they become very hard and, therefore, require boiling before further preparation. In many West African countries, the fresh pods are boiled with salt and pepper, and eaten as a snack. In Côte d'Ivoire, the seed is used to make flour, which makes it more digestible. In East Africa, the beans are roasted, pulverized and used to make a soup. The flour can also be used to make a stiff porridge. Roasted seeds can be boiled, crushed and eaten as a relish.

In Zimbabwe, the nuts are eaten fresh, and also dried and stored for later consumption. The fresh nuts may also be roasted and eaten as a snack. Bambara nuts can be pounded and made into a fresh mixed with onions, tomatoes and oil. The seeds may be milled into flour and used to make

small flat cakes or biscuits or mixed with cereals and used to make porridge. The seeds are sometimes boiled and eaten together with plantains (de Kock, 2004).

Bambara groundnuts shows potential for the fortification of traditional weaning foods in Africa. Protein content was increased from 10 to 16.4% when boiled Bambara nuts was added to fermented maize dough. The pH decreased with an increase in moisture, fat, ash, lysine and tryptophan content, compared to unfortified maize dough. It was concluded that the most appropriate technique for the production of Bambara nuts. Fortified high protein fermented maize dough, would be to incorporate boiled whole seeds in soaked maize, before milling and fermentation. Organoleptic evaluation indicated that there was no change in the acceptability of the weaning food after the addition of Bambara nuts (Mbata *et al.*, 2006; 2009).

2.4 Bambara nuts production and food access

Research into value added Bambara nuts products, such as high quality flour in Ghana, seems to have been inconclusive and not to have resulted in new value chains (Yawson and Wilhelmina, 2004). The main reason for this failure appears to be the high cost of Bambara nuts, compared to competing products such as cowpea (*Vigna unguiculata*) and beans (*Phaseolus vulgaris*) (A. Graffham pers comm). Natural Resources Institute, UK). This is what this study would like to find out as to how Bambara nuts can improve on food accessibility.

The most substantial effort recently, to develop Bambara nuts have been conducted by the EU funded Bamlink project (Mayes *et al.*, 2009). This project identified that there is insufficient demand in the formal market for Bambara nuts to justify further expensive development research. The conclusions drawn by the only two researchers that have considered the marketing issue, Greenhalgh (2000) and de Kock (undated), a Zimbabwean Bambara nuts canner, are

summarised as follows: Greater volume of product is needed to meet demand and reduce prices; Existing Bambara nuts products are not well marketed or promoted in the local market (or internationally); and New Bambara nuts products are needed that highlight its inherent advantages (e.g. nutrition, taste and tradition).

Closer examination of the few examples of commercial exploitation of Bambara nuts, suggests that compared to Bambara nuts and some other legumes, the issue is rather a lack of promotion of Bambara nuts and little investment in the development of functional value chains, than lack of demand (Yawson and Wilhelmina, 2004). Commercial canning of Bambara nuts has been done in both west and Southern Africa. In Ghana, the nuts were at one time canned in gravy by a Government factory and over 40, 000 cans were produced annually (Doku and Karikari, 1971; Begemann, 1986). During the 1990s, the company ‘Speciality Foods’ based in Harare, Zimbabwe, canned Bambara nuts and marketed it as ‘Tulimara Canned Nyimo Beans; which was available in all the major supermarkets (de Kock, undated). It was mixed with brine (salt water) ready to serve from the can. The Bambara nuts were recommended for addition to soups, stews and salads. There has been a revival of interest in canning Bambara nuts production in Ghana and Nigeria, as a way to make the product available to consumers throughout the year and some research has been conducted on processing methods. Blanching and soaking before canning was found to decrease the content of phytates and tannins which act as anti-nutritional factors (Afoakwa *et al.*, 2007).

Research in Nigeria has shown that flour yield from Bambara nuts can be improved by malting (Uvere *et al.*, 1999), with the added benefit of a decrease in milling energy, which would reduce the tedium of repeated milling and sieving during flour extraction from unmalted Bambara nuts

seeds. However, the malted flour was less acceptable to consumers, due to its darker colour and altered taste which increased with prolonged malting period. Malting resulted in a reduction in flatulence and toxic factors, lectins and trypsin and lessening of the 'beany' flavor of 'okpa' which certain cultures found objectionable.

The possibility of malting Bambara nut seeds for the production of high energy, low viscosity weaning foods merits further investigation, given its high carbohydrate and protein contents. It was concluded in the study that malting for 1–2 days, and drying at 40–50 °C, would produce an acceptable product.

Research conducted at the University of Yaounde in Cameroon, has shown that treatment of Bambara nuts flour with 60% alcohol, decreases antinutritional factors associated with Bambara nuts and eliminates flatulence-inducing sugars (Mune Mune *et al.*, 2007). Blends of the treated flours with freeze-dried fermented maize dough were considered to be good sources of nutrients for young infants. It was concluded that the use of these blends for preparation of gruels in developing countries will require supplementation with minerals and vitamins, as well as addition of an amylase source, to reduce bulk and allow the incorporation of larger quantities of flour blends in the gruels, without changing their semi-liquid consistency.

Brough *et al.* (2003) prepared vegetable milk by soaking shelled Bambara nuts in water overnight, homogenising and removing insoluble material. The bean taste could be removed by dry-frying the beans after soaking and before homogenisation. Milk from Bambara nuts was preferred in taste and colour to those produced from cowpea, pigeonpea and soybean (*Glycine max*)

2.5 Conclusion of the chapter:

The above literature stresses the prevalence of the effect of Bambara nuts production on food security in general form. However, the current literature does not localize the situation in Buikwe District and particularly in Nyenga Sub-county in terms of the effect of Bambara nuts production on food security from different authors do not show that all their views were the same. The literature suggests that Bambara nuts production in Nyenga Sub-county may have a tenuous effect on food security. The study was thus intended to address these research gaps. It was concluded that farmers understand the importance of growing Bambara nuts if it would have a marginable effect on food security in Buikwe district to improve to expectations; it was concluded that Bambara Nuts production had not had a significant effect on food security.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The chapter indicates how data for the study was collected, analyzed and interpreted in order to answer research questions, thereby meeting the purpose of this study. This chapter therefore comprised research design, study population, determination of sample size, sampling techniques, data collection methods, data collection instruments, quality control, and data analysis.

3.2 Research Design

This study used a case study research design. A case study research design was used since the Nyenga Sub-county acted as a representation of other sub-counties in Buikwe district and Uganda at large. The study hence used quantitative approaches during sampling, data collection, quality control, and analysis. At data collection stage, quantitative design involved administering closed ended questionnaire to respondents. Quantitative approach was used because it was important in creating correlations and regressions between research variables. In addition, this study used a quantitative approach because the study called for using statistics to generalize findings. At data collection stage, qualitative approach involved administering open ended questionnaires to the respondents, whilst the quantitative approach involved administering closed ended questionnaires *to* farmers at household in Nyenga sub-county.

3. Area of the study

The study was conducted in Nyenga Sub County, in Buikwe district, in central Uganda. This island has over 1000 households. It is approximately 18kilometers (11 mi), by road, northeast of Buikwe. The sub-county is also located approximately 7.5kilometres (4.7 mi), by road, southwest of Njeru town council the largest metropolitan area in the district. The coordinates of

Nyenga are: 0°22'48.0"N; 33°09'00.0"E (Latitude: 0.3800; Longitude: 33.1500). According to UBOS survey (2014) Nyenga Sub County has over 207,089 people. The major activities done in the sub-country include; trading, tourism activities, sugarcane growing and agriculture. The area is covered with best temperature and rainfall for agricultural production throughout the year due to its nearness to Lake-Victoria. Nyenga Sub County has fertile soils, which wholesomely favor the growth of Bambara Nuts.

3.3 Study Population

The study population consisted of 1000 households, of which 98 People in Nyenga sub-county were considered as engaged in Bambara Nuts production (UBOS household survey, 2014). Using the exclusion and inclusion criteria, only farmers engaging in Bambara nuts production were included and those who were not producing Bambara nuts were excluded. Out of these, 80 were famers, 11 local leaders and 7 operation wealth creation officials/extension workers in the district. The farmers were chosen because they form a big part of people who plant Bambara nuts in the area. The local leaders were chosen because they are aware of long preserved perceptions and measures towards Bambara nuts. Operation wealth creation officials were chosen because they are aware of the challenges faced in recommending people to plant Bambara nuts.

3.4 Determination of the Sample Size

The sample size was determined using the Morgan and Krejcie (1970) table as shown in Appendix III. This therefore means that the sample included 66 farmers, 11 Local Leaders and, 7 Extension Workers.

Table 1: Showing the Sample Size of Respondents and Sampling Technique

Category of Population	Population Size	Sample Size	Sampling Technique
Farmers	80	66	Simple Random sampling
Local leaders	11	5	Purposive sampling
Extension workers/Operation Wealth Creation officials	7	3	Purposive sampling
Total	98	72	

Source: UBOS (2014)

3.5 Sampling Techniques

As indicated in the above table, the study used simple random sampling and purposive sampling techniques to select the sample.

3.5.1 Simple random Sampling Techniques

The study used simple random sampling technique to select 98 respondents in Nyenga sub-, who informed the topic which is under investigation without the bias from the target population and simple random sampling was used to minimize sampling bias. This technique was used during the study simply because it enables all the members of the target population to have equal and independent chance of being included in the sample.

3.5.2 Purposive Sampling Technique

This was employed to select local leaders and extension workers who were targeted due to their perceived knowledge arising out of known experience that they have. This technique was employed following the postulate that if sampling has to be done from smaller groups of key informants, there is need to collect very informative data, and thus the researcher needs to select purposive sampling as a technique to be used in during data collection (Sekaran, 2003).

3.6 Source of Data

This section expounds on the data collection sources used in the study. These included primary and secondary sources of data.

3.6.1 Primary source

Here the researcher used Survey, Interviews, Observation and Focus group discussion as methods used in data collection. Then data was recorded either using qualitative and quantitative methods of data analysis. These tools were selected in line with the nature of data require and the objectives under study

3.6.2 Data collection methods

3.6.2.1 Survey

This was used to collect primary data from local farmers, and, it involved use a semi-structured questionnaire depicted in Appendix 1. The method of survey using a semi-structured questionnaire was deemed appropriate since part of the questionnaire offers farmers a choice of picking their answers from a given set of alternatives while the other part of the questionnaire allows them to qualify their responses.

3.6.2.2 Interview

This was used to collect primary data from Local leaders and Extension workers. It involved use of a semi-structured interview guide depicted in Appendix B. The method of interview using a semi-structured interview guide is deemed appropriate since the aforementioned categories of staff have vital information yet no time to fill in questionnaires (Sekaran, 2003).

3.8 Data collection instruments

3.8.1 Questionnaires

Questionnaires were used to collect data from farmers in Nyenga Sub-county. The questionnaire (Appendix I) was used in this case because it has proved to be an invaluable method of collecting a wide range of information from a large number of individuals especially when it comes to people like the farmers (Sekaran, 2003). The questionnaires are popular because the respondents filled them in at their own convenience and are appropriate for large samples. The questionnaire was designed with both open and closed ended questions (Amin, 2005).

3.8.2 Interview guide

The researcher prepared and used a semi-structured interview guide to conduct interviews with local leaders and Extension workers in Nyenga sub-county. Interviews are chosen because they are thought to provide in-depth information about a particular research issue or question. Still, interviews are chosen because they made it is easy to fully understand someone's impressions or experiences, or learn more about their answers as compared to questionnaires. According to Mugenda and Mugenda (2003), interviews are advantageous in that they provide in-depth data which is not possible to get using questionnaires

3.8.3 Secondary data

This involved reading and quoting other authors information in line with the objective of the study. Key documents from with relevant literature to the research topic was analyzed as secondary sources of data to supplement primary data from survey and interviews (Amin, 2005). This method was adopted because it can easily supplement on the findings that were received by the researcher while using survey and interviews.

3.9 Quality control Methods

It comprises of two instruments which are used in justification and measurement of data consistency, which was collected through administering questionnaires, interviews, Observation and focus group discussions to the respondents. These instruments are explained below,

3.9.1 Validity

Validity refers to the ability of instrument to collect justifiable and truthful data. In other words, it is the ability of the instruments to measure what it is developed to measure. The concept is concerned with the soundness of instruments since it considers what the instrument measures and how well it measures it. A validity test was carried out prior to the administering of the methods used in data collection. This was done in order to find out whether the methods used in data collection are capable of capturing the intended responses. Validity will be determined using Content Validity Index (CVI). $CVI = \frac{\text{Items rated relevant by three judges}}{\text{total number of items in the questionnaire}}$ as shown hereinafter.

$CVI = \frac{\text{Number of items rated relevant}}{\text{Total number of items}}$

Content Validity Index (CVI) was calculated in order to establish the validity of the questionnaires while dividing the number of the questions that were ticked relevant over the total number of questions and the results can be seen in table 2 below.

Table 2: Validity of instrument

Variable	Description	No. of Items	Content validity index
Independent	Bambara nuts production	18	.769
	Household income	4	.865
	Household food availability	4	.765
Dependent	Household food accessibility	5	.788

As recommended by Amin (2005), for the instrument to be valid, the C.V.I should be at least 0.7.

Therefore, since all the items were above 0.7, it was valid for conducting the study.

3.9.2 Reliability

Gay (1996) defined reliability as the degree of consistency that the instrument demonstrates. After pilot testing in the field, reliability of the instrument, on multi-item variables i.e growing of Flue Cured Virginia Tobacco for sustainable livelihood of smallholder farmers was tested using the Cranach Alpha Method provided by Statistical Package for the Social Scientists (Foster, 1998). The researcher used this method because it was expected that some items or questions would have several possible answers. The researcher established reliability of the questionnaires by computing the Cranach alpha coefficient of the items (questions) that constituted the dependent variable and that of the items that constituted the independent variable. The reliability testing was done using;

$$\alpha = \frac{K}{K-1} \left(1 - \frac{\sum_{i=1}^K \sigma_{Y_i}^2}{\sigma_X^2} \right)$$

Where σ_x^2 the variance of the observed total test scores, and $\sigma_{Y_i}^2$ the variance of component i for the current sample of persons (Amin, 2005). The results are indicated in table 3:

Table 3: Reliability indices for the respective sections of the questionnaire

Variable	Description	Anchor	Cranach alpha
Independent	Bambara nuts production	18	.798
	Household income	4	.985
	Household food availability	4	.888
Dependent	Household food accessibility	5	.776

According to Cranach Alpha Coefficient Test (Cranach, 1971), the questionnaire was considered reliable since all the coefficients in Table 3 were above 0.7. After the approval of the proposal, the researcher designed the questionnaire, validated it then tested its reliability using the Cranach Alpha method. After modifying the instrument, the researcher secured a letter of introduction to assist the researcher proceed with the study. Two research assistants were selected to help in data collection from respondents.

3.19 Data management and processing

The data was organized and summarized in one data collection site. The researcher then checked for completeness and accuracy. The raw data was then captured in Excel (spread sheet) before it is entered into SPSS Version 20 for quantitative analysis, interpretation, Cleaning and editing was done before and after entering data into the computer software to examine outliers and inconsistencies of responses.

3.11 Data Analysis

The researcher used qualitative and quantitative methods of data analysis, and was done in line with the research objectives. The data which was obtained from the field was presented and

discussed in different forms i.e. narrative, tables and Statistical Package for Social Sciences (SPSS) Version 20 where Microsoft Excel was used to analyze data from the field using relevant figures. The analysis done using levels which are described below:

3.11.1 Univariate analysis

Here the researcher looked at how many subjects fell into given categories and they were given simpler unit of analysis. Data collected was systematically organized to facilitate analysis. The unit of analysis was the individuals who responded to the survey. The raw data was edited to ensure completeness. Thereafter, it was coded using statistical figures to enable quantitative analysis in SPSS Version 20.

3.11.2 Bivariate analysis

Responses were grouped into repeated subjects. The repeated subjects were presented in the results based on the study objectives. Here a spearman correlation coefficient was used to determine the relationship between the two variables (Bambara nuts production and food security). The spearman coefficient was 0.05 level of significance.

3.11.3 Multivariate analysis

The statistical package was used to analyze quantitative data that goes beyond two variables in this study using SPSS Version 20. Here, multiple regressions were used to determine the degree of relationships between more than two variables. Correlation coefficient was computed to establish the degree of the relationships between the independent variables and the dependent variable and to determine the strength and direction of their relationship.

3.12 Ethical Consideration

The respondents were informed before the interviews were conducted, and the purpose of the research duration, consequences and benefits were explained to the respondents to enable them to freely participate.

The data was collected by use of reliable and valid tools, coded and data collection tools which were used to avoid any form of information misuse.

The researcher ensured that all citations and references of different authors are acknowledged. The researcher maintained confidentiality of the respondents and protected their privacy at all times.

During the study, the researcher made sure that there was voluntary participation of the respondents, and they were free to withdraw from participation if they wanted.

The researcher also respected the dignity of the respondents by not causing physical discomfort to the respondents.

The researcher also ensured objectivity, in that her personal opinions do not over take the respondents opinions.

Lastly, the researcher tried to be considerate during the interactions with respondents.

3.13 Limitations of the study:

The following were the limitations encountered by the researcher during the study.

Time consuming activity; some respondents felt that exercise was time consuming. The researcher however made an effort to not consume too much of the respondents' time and also tried to capture their interest.

Expectation of handouts; some respondents expected to receive a token of appreciation after the interview in form of money, a bar of soap or sugar. The researcher however made an effort to explain to the respondents what the purpose of the study was and how the study will benefit the respondent in the long run.

Interpretation of the questions; this affected the meaning as some respondents had difficulty in interpreting the questions correctly. Efforts were made to explain and interpret for them every time an opportunity occurred.

A finance resource to enable the smooth facilitation to the field and the related items for research i.e stationary was a problem.

3.12 Conclusion

In conclusion this chapter three was about the presentation of the research design, by using the area of the study, the study population, sampling procedures, sample size, sampling techniques, sources of data, quality control methods, data management, data processing, data analysis, ethical considerations and finally limitation of the study.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND INTERPRETATION OF RESULTS

4.0. Introduction

This chapter presents analysis and interpretation of findings on assessing the effect of Bambara nuts production on food security in Buikwe district using a case study of Nyenga Sub County. The findings are presented according to the objectives of the study. In the first section, the social background of the respondents is given. In the second section, the empirical analysis of the study findings are analyzed (evaluating the effect of Bambara nuts production on smallholder farmer's incomes; effect of Bambara nuts production on food availability at household level and the effect of Bambara nuts on food accessibility at household level) in Nyenga Sub County.

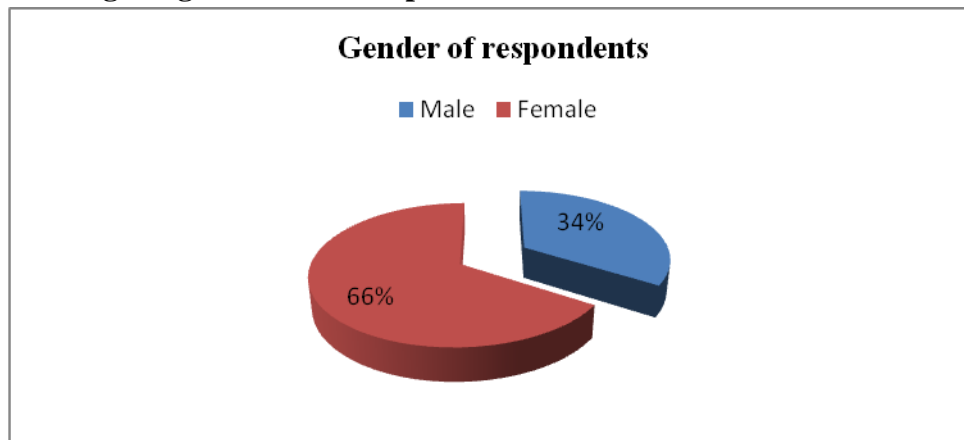
4.1 Background information

This is demographics information about the gender, age, level of education, farm size, land ownership, Income level, households size, marketing problems Extension services, access to credit facilities, of the respondents, which forms the basis under which the interpretations were made

4.1.1 Gender Distribution of the Respondents

This information was necessary to enable the researcher to obtain information concerning which gender percentage is more involved in Bambara nuts production in Nyenga Sub County, as shown in figure 1

Figure 1: Showing the gender of the respondents



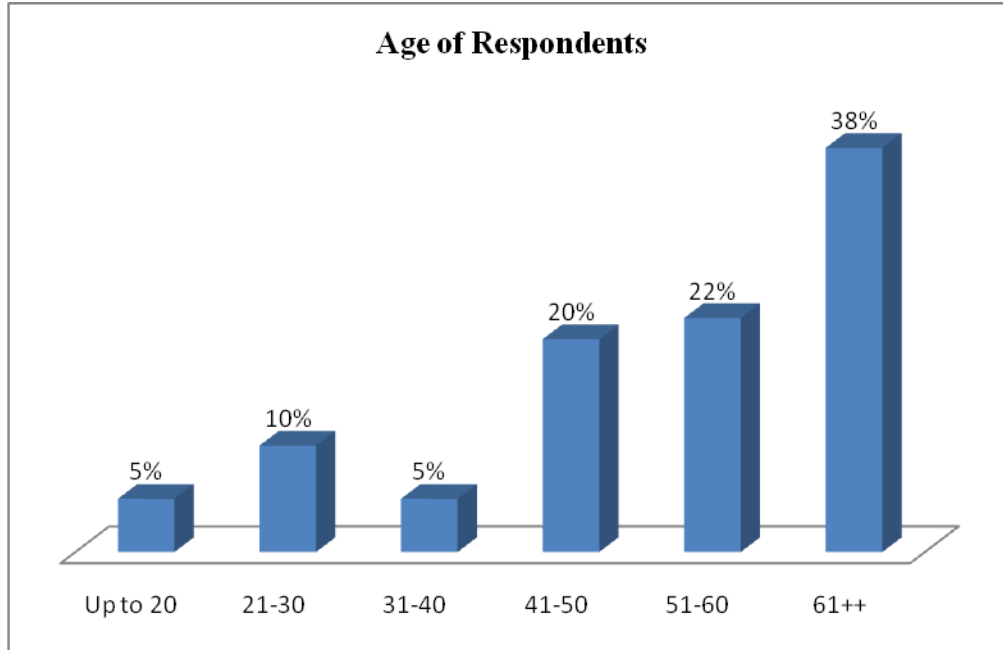
Source: primary data 2015

The figure 1 above presents the distribution and validity of participants of respondents according to gender. The female respondents who constituted 66%, Males on the other hand were represented by 34% of the respondents in this context of the study. This thus justifies the claim that growing of Bambara nuts is so much a female activity in the area since the kind of respondents that were found involved in Bambara nuts production in the area were mostly

4.1.2 Age of Respondents

This information was necessary to enable the researcher to obtain information concerning which age of the respondents is more involved in Bambara nuts production, and this shown in figure 2 as below.

Figure 2: Showing the age of the respondents



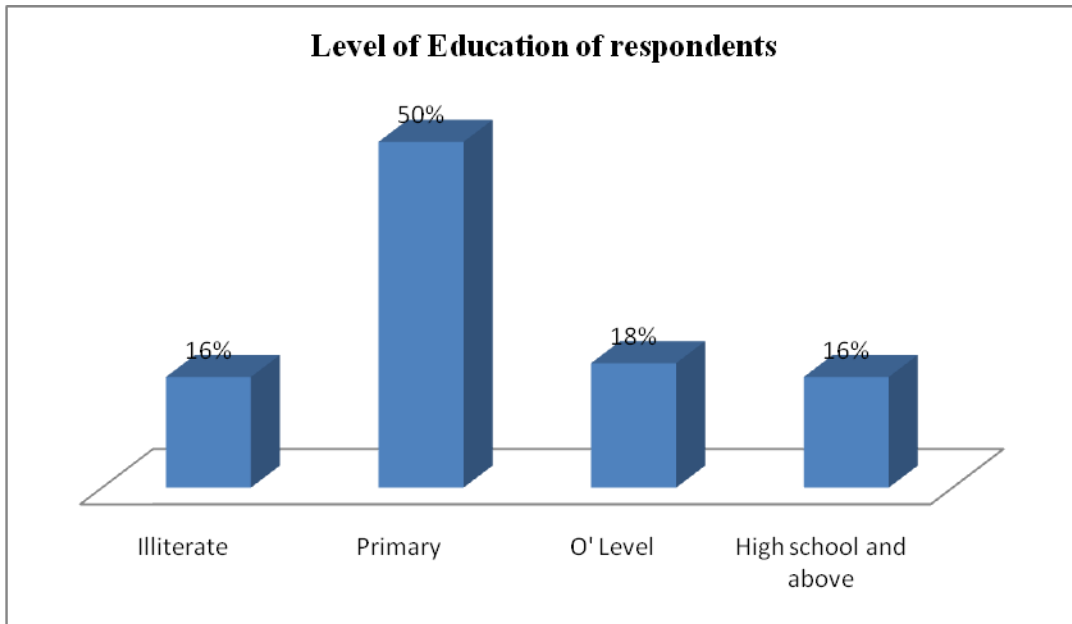
Source: primary data, 2015

From figure 2 above, it can be realized that 38% of the respondents were 61 years and above. 22% of the respondents were 51-60years; 41-50years constituted 20%. Those who had 21-30years constituted 10% of the respondents and 5% of the respondents were of 20years and 21-30years each. In these categories, it can be realized in figure 2 above by age 72% of the respondents were involved in Bambara nuts production and 26% were not. But mostly people above 40years seemed to be involved in Bambara nuts production than those below those years. This is thus contrary to what was had been established before by earlier scholars that Bambara nuts production is a new legume for new generation mostly done by people below 40years.

4.1.3 Level of education of Respondents

The information is necessary to enable the researcher to know the level of education of the respondents who were more involved in Bambara nuts, as shown in figure 3 below.

Figure 3: Education Status of respondents



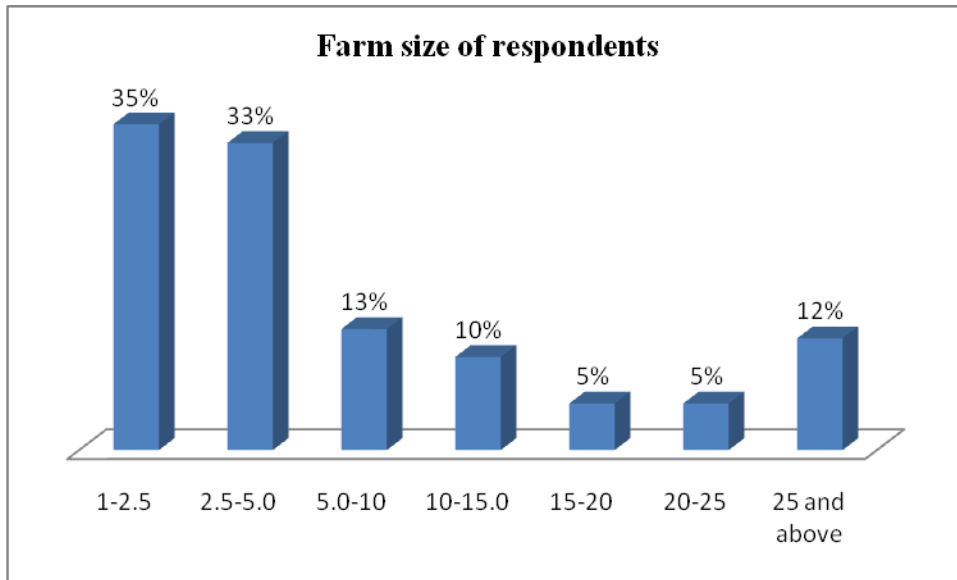
Source; primary data, 2015

The study findings in figure 3 above indicated that most of the respondents had studied up to primary school level and these constituted 50% of the respondents. Those who studied up to ordinary level were 18% and the category of those who were illiterates and studied up to high school level of education constituted 16% each. This means that the lower the education, the higher the possibility of engaging in Bambara nuts production and the higher the education, the lower the engagement in Bambara nuts production. This is probably due to changing attitude towards schooling and more opportunities available than the past. However, overall distribution is more or less same for all age categories.

4.1.4 Farm size of respondents

The researcher wanted to find out which acreage do the respondents use in farming activities, putting much emphasis on Bambara nuts production, and this is shown in figure 4 below,

Figure 4: farm size of respondents



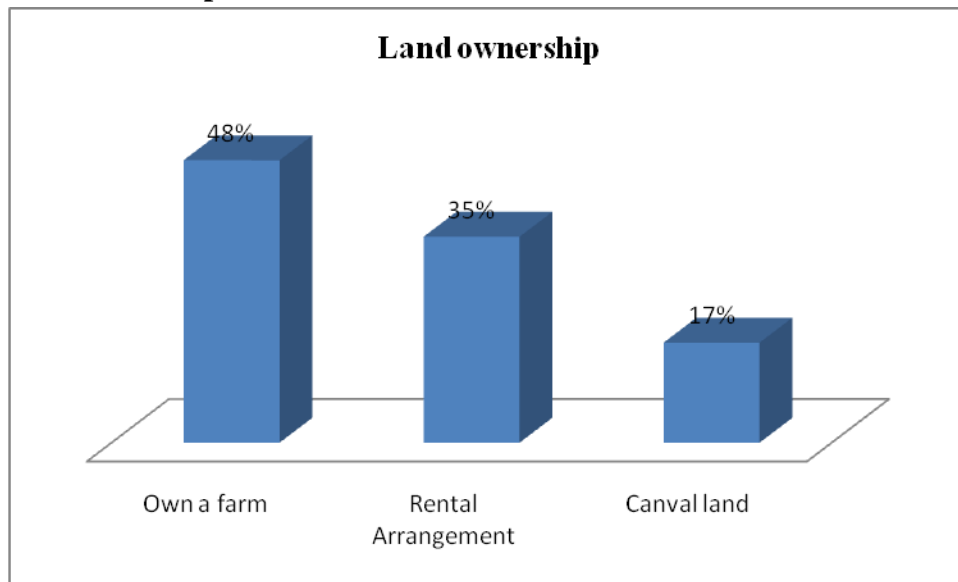
Source: primary data, 2015

The study findings still indicated that 35% of the respondents had between 1-2.5 acreage of land and those who had 2.5-5 acres of land were over 33%. Those farmers who had 5-10 acreage constituted 13% of the respondent, 10% had 10-15acreage of land. 5% had acreage between 15-20acreage and 20-25 acreages. This thus generally means that, most of the farmers who participated in this study had at least 25acreas and below. In relation to Bambara nuts production, it can be realized that the higher the farm size, the higher the possibility of Bambara nuts production and the lower the farm size, the lower the possibility of producing Bambara nuts. This implies that farm size has much influence in production of Bambara nuts in Nyenga sub-county.

4.1.5 Land ownership of respondents

This was necessary for the researcher to understand the nature of land ownership of the respondents as far as Bambara nuts production is concerned, as seen in figure 5 below,

Figure 5: Land ownership



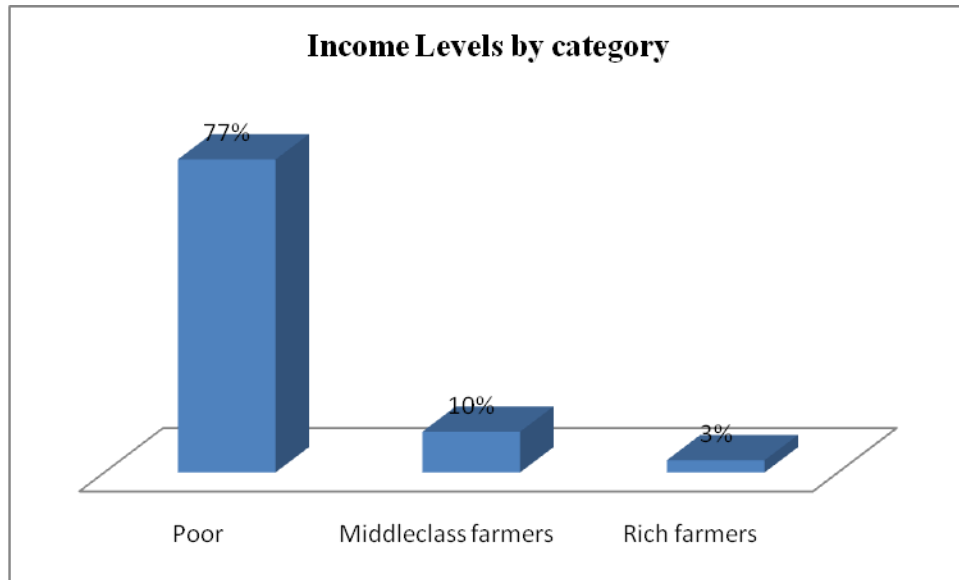
Source: primary data, 2015

The land ownership data indicated that, the majority of respondents had 48 percent owned land. 35% of the respondents were resorting to rental arrangement and carnival land constituted 17% of the farmers. It is evident thus that most of the fields cultivated in the area were inherited from parents. In terms of large land holding, only few of them had 50 acres or over, while a large percentage of respondents (more than half) were small scale farmers in terms of land holding. In relation to Bambara nuts production, it appears that over 70% of the farmers owned their land whilst, 25% rented farm land. This therefore, means that ownership of land has much influence on Bambara nuts production in Nyenga Sub County.

4.1.6 Income levels of respondents

This enabled the research to know the income level of the respondents in line with Bambara nuts production.

Figure 6: Income levels



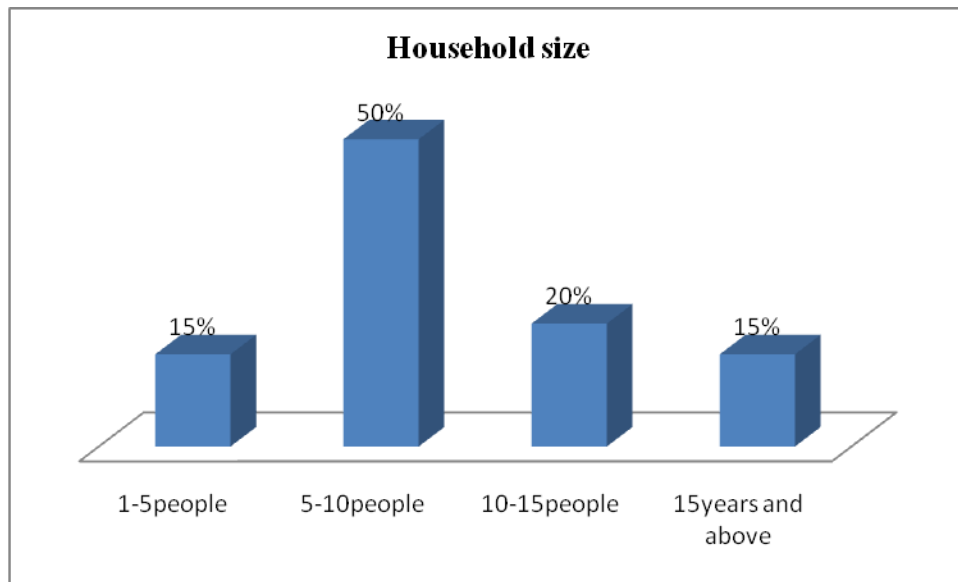
Source: primary data, 2015

On income levels, most of the respondents who participated in this study were categorized as poor and these took over 77%. Then 23% of the respondents fall in middle class and rich categories. In relation to Bambara nuts production, over 50% of the poor farmers planted Bambara nuts and this was attributed to the programs of NAADs currently known as Operation Wealth Creation who gave out free Bambara nut seeds to farmers. And this also means that if poor farmers had enough financial resources, they would engage in Bambara nuts production than the rich or middle class. All rich farmers were involved in Bambara nuts production. This therefore implies that Bambara nuts increase with the increase in income of the farmers.

4.1.7 Household size of respondent

The researcher wanted to know the number of people per household, and how many members in a given household are engaged in Bambara nuts production, as shown in figure 7 below,

Figure 7: Household size



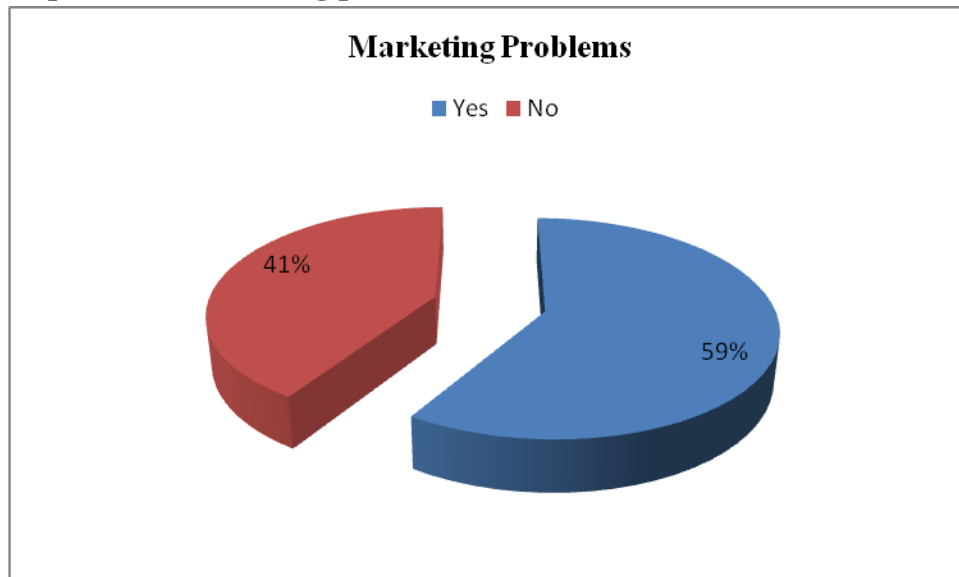
Source: primary data, 2015

The average number of members per household is 6.52. It can be realized in figure 7 above that most of the farmers lived in a household of 10-15 people and this constituted 50%. 10-15people constituted 20%, 15% of respondents were either 1-5people or 15years and above years. In figure 7 above, it can be established that the higher the number of people living in the household, the higher the possibility of producing Bambara nuts and the lower the number, the lower the possibility of Bambara nuts production. This situation may also justify why food security affects so much smaller households than large households in Nyenga sub-county. For instance, households of 1-5people did not have large pieces of land of Bambara nuts compared to households of 10-15 and 15-20 people. This positive relationship is little unexpected, as one may expect small farmers usually having large families and large pieces of land. However, result is quit analogous to the Microeconomic Household Theory of fertility, since farm size is synonymous to wealth and main source of income generation for farmers.

4.1.8 Presence of marketing problems

Here the researcher wanted to find out of the respondents were faced by marketing problems with reference to Bambara nuts, as shown in figure 8.

Figure 8: Responses on marketing problems



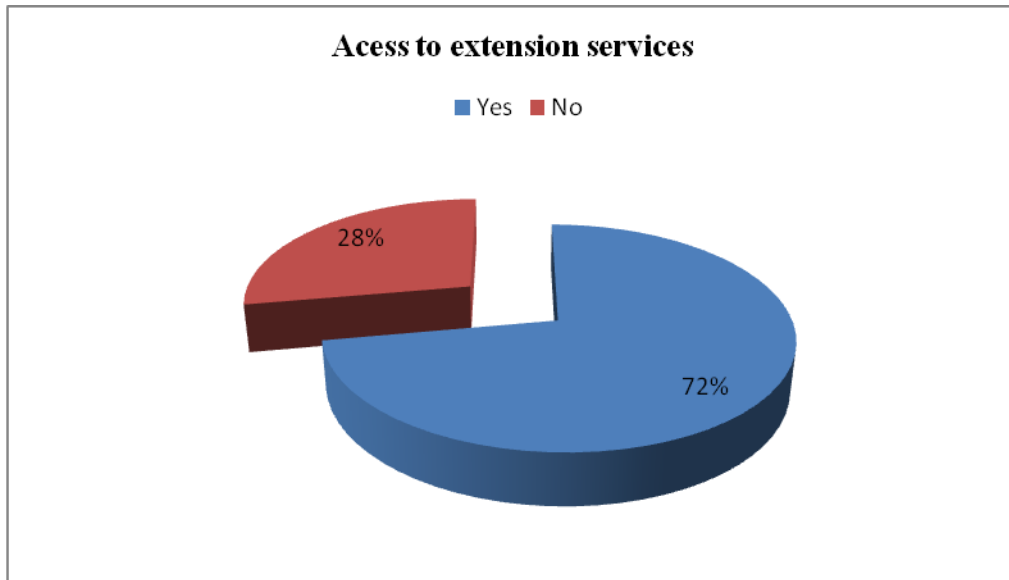
Source: primary data, 2015

It was established from the study that farmers face problems in marketing or selling Bambara nuts in the area. 59% of farmers who participated in the study faced marketing problems and 41% did not. This justifies the claim that Bambara nuts is not a common crop needed by most people in Nyenga Sub-county and this may be among the sources of food insecurity in the area as many farmers avoid planting it and those who plant it do so for home consumption purposes.

4.1.9 Extension service availability

The researcher wanted to understand whether extension services were available for farmers who were engaged in Bambara nuts production, and this is shown in figure 9 below.

Figure 9: Extension service availability



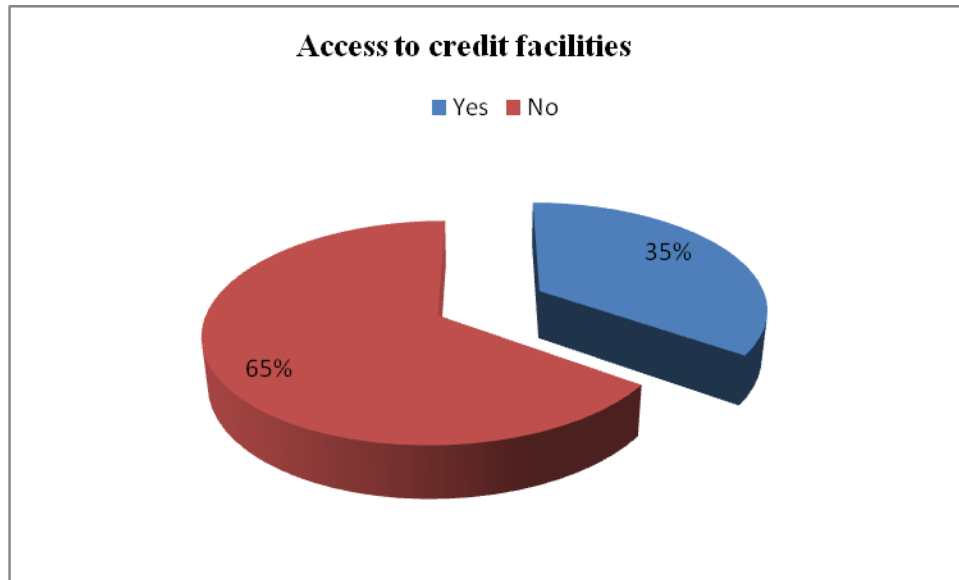
Source: primary data, 2015

As for Bambara nuts production, due to the existing government program of NAADS which is currently known as operation wealth creation, many farmers of Bambara nuts in Nyenga Sub County do have access to extension services. About 72% of the farmers have access to extension workers from the sub-county and the district with in the area. Only 28 said no. This means that Bambara nuts production can fail on other grounds other extension services.

4.1.10 Access to credit facilities

This helped the researcher to understand whether farmers were accessing credit facilities, to boost them in production of Bambara nuts, as seen in figure 10 below.

Figure 10: access to credit facilities



Source: primary data, 2015

Access to credit facilities is one of the problems affecting farmers who were engaged in production of Bambara nuts at household level in Nyenga Sub-county. 65% of the farmers have no access to reliable credit facilities as and this justifies the fact already established that most farmers in the area are poor. The 35% of the farmers who have access to credit facilities seem to have reliable sources of incomes and this boosts their food security.

4.2. Bambara Nuts Production in Nyenga Sub-County

Statements of farmers' perceived attitudes were measured by using rank order of the statement along with mean and standard deviation. As indicated in Table.1 the mean rating of the 20 attitudinal statements ranged from 3.95 and 1.47, with an overall domain mean of 2.17 indicating that farmers in the Nyenga Sub-County had the above average level of perception towards the adoption of Bambara nuts production as a food security crop.

During data analysis when the means of the 20 attitudinal statements were ranked. From these ranking results, it was quite clear that the low uptake of Bambara nuts could be as a result of inadequate knowledge and awareness among the respondents about the significance of Bambara nuts production as a food security and hunger reduction crop, given the perception held by most respondents. Bambara nuts production takes long maturing period. Indeed the length of the maturity period was significant and could contribute to 13.4 % adoption of Bambara nuts production as a food security crop respectively. Table 4 has more details below.

Table 4: Showing farm discussions on the adoption of Bambara nuts Production in Nyenga Sub-County.

<i>Items</i>	<i>N</i>	<i>Mean</i>	<i>Std. Deviation</i>
There lack of enough improved Bambara nuts seeds which affects its adoption in the area	66	1.47	.503
Dry seasons affects Bambara nuts production so much	66	1.56	.500
Bambara nuts production lacks institutional support in Buikwe district (Research, Extension Credit and Market).	66	1.59	.495
The taste of Bambara nuts is not so good	66	1.83	1.001
Bambara nuts are planted on small plots in the area	66	1.85	.789
Bambara nuts production can conserve biodiversity.	66	2.33	1.181
Buyers for Bambara nuts are available in the area	66	2.36	1.285
The planting of Bambara nuts improves soil productivity	66	2.38	1.160
Bambara nuts production is affected so much by pests and diseases	66	2.42	1.241
Bambara nuts in Buikwe district is grown on small scale	66	2.50	1.292
Bambara nuts seeds are available in the area	66	2.58	1.458
Bambara nuts production reduces when intercropped with other crops	66	3.00	1.301
Bambara nuts produced are of high quality	66	3.03	1.228
Soil fertility is not a problem in this area for Bambara nuts Production	66	3.06	1.597
Bambara nuts has high yields compared to other crops	66	3.20	1.112

The nutritional value of Bambara nuts has improved on its adoption and consumption in the area	66	3.26	1.481
Bambara nuts production is entirely a female activity in our area	66	3.27	1.284
Bambara nuts production is not profitable, if neighbor seeks my opinion on in increasing production I will definitely not advice him to cultivate the crop	66	3.27	1.100
Bambara nuts requires less rainfall and is resistant to drought	66	3.85	.965
The maturity period of Bambara nuts is too long	66	3.95	1.156

Source: primary data, 2015

**Scale: N meant Number of respondents. To be able to discuss the data, the higher the mean, the higher the agreement and the lower the mean, the higher the disagreement; and the higher the standard deviation, the less the agreement and the lower the standard deviation, the higher the agreement.*

When the means of the 20 attitudinal statements were ranked during data analysis, it was found that the statement, the maturity period of Bambara nuts is long was ranked first with a mean score of 3.95. From these ranking results, it was quite clear that the low uptake of Bambara nuts could be as a result of inadequate knowledge and awareness among the respondents about the importance of Bambara nuts as food security and hunger disaster risk reduction crop despite its maturity period.

Bambara nuts production is entirely a female activity in our area was ranked with a mean 3.27 see Table 4 above. These results again point the fact that there was of inadequate knowledge and awareness among the respondents about Bambaras nuts cultivation production in study area since the perception held by most respondents was that Bambara nuts production was not profitable enterprise. In fact, maize and beans were grown as first and second priority crops by 50.0 percent

and 30.0 percent of the respondents respectively across the study sub-county. During the interviews with extension workers with farmers, opinion leaders and agricultural officers showed that in most of the Sub-County, did not take Bambara nuts as a priority crop as most farmers (70.5 percent) were growing the crop for subsistence purposes mostly as fourth or fifth priority crop. And taking Bambara nuts production is entirely as female activity in the area also despises its value since men who are the usual head and owner of land may be a strong factor that can hinder the production of Bambara nuts.

Soil fertility was reported as not a big problem in this area. This had a mean of 3.06 and was ranked as an agree opinion by the respondents. Given the fact that the farmers rated lowly the statement it was quite clear that the low uptake of Bambara nuts could be as a result of inadequate knowledge and awareness among the respondents about the soil fertility status in the study area and hence low Bambara nuts as food security and hunger disaster risk reduction crop.

On the other hand, the statement that, Bambara nuts requires less rainfall and is resistant to drought was ranked second with a mean score of 3.85. This on the other hand implies that farmers in the area had some knowledge which may be the reason for the level of adoption in place.

The adoption of Bambara nuts production as a food security crop needs good agronomic practices' and 'most farmers in the area should adopt this. All respondents pointed out the fact that the needed Bambara nuts seeds variety that possessed certain characteristics that would be much more superior compared to the variety which they had in Nyenga Sub-County.

Analyzed data from the study revealed that 92.3 percent of the respondents held a perception production of this crop ensure food security because its drought and pest resistant. Little production could be explained by the fact that there is over reliance on other crops like: maize, beans and sweet potatoes as staple foods. Bambara nuts is basically is grown for domestic consumption was ranked first with a mean score of 3.27. From these ranking results, it was quite clear that the low uptake of Bambara nuts could be as a result of inadequate knowledge and awareness among the respondents about the role of gender in Bambara nuts production as food security and hunger disaster risk reduction crop, given the perception held by most respondents that, Bambara nuts production was only a female activity.

Similarly, the statements that Bambara nuts production is not profitable, if neighbor seeks my opinion on in increasing production I will definitely not advice him to cultivate the crop was ranked second with a mean 3.26 (see Table 4 above) . These results again point the fact that there was of inadequate knowledge and awareness among the respondents about Bambara nuts cultivation production in study area since the perception held by most respondents was that Bambara nuts production was not profitable enterprise (Ngugi, 2007). In fact, maize and beans were grown as first and second priority crops by 50.0 percent and 30.0 percent of the respondents respectively as cross the study districts. During focused group discussions with farmers, opinion leaders and agricultural officers showed that in most of the districts, did not Bambara nuts as a priority crop as most farmers (70.5 percent) were growing crop for subsistence purposes mostly as fourth or fifth priority crop.

Soil fertility was reported as not a big problem and had a mean of 2.31 and was ranked third by the respondents. Given the fact that the farmers rated lowly the statement it was quite clear that

the low uptake of Bambara nuts could be as a result of inadequate knowledge and awareness among the respondents about the soil fertility status in the study area and hence low Bambara nuts production as food security and hunger disaster risk reduction crop.

4.3 Food security in Nyenga Sub-County

Statements of farmers' perceived attitudes were measured by using rank order of the statement along with mean and standard deviation. As indicated in Table 5 below. Most of statements were above 3.5, with an overall domain mean of 3.3 indicating that farmers in the Nyenga Sub-County had adopted Bambara nuts production as food security crop.

During data analysis when the means of the 15 attitudinal statements were ranked, it was found that the statement, increasing production I will definitely not advice him to cultivate the crop, was ranked first with a mean score of 4.48. From these ranking results, it was quite clear that Bambara nuts is not a crop grown to improve household income but rather it is a crop grown for home consumption

Table5:Showing farms discussions on adoption of Bambara nuts as food Security in N Sub-County.

Items	N	Mean	Std. Deviation
<i>Household income</i>			
The planting of Bambara nuts has increased incomes at household levels in Nyenga	66	1.42	.498
Bambara nuts production is not profitable, if neighbor seeks my opinion on	66	2.56	1.437
The market for Bambara nuts in the area is available	66	2.65	1.143
My income has not improved ever since I started planting Bambara nuts	66	2.30	.656
Increasing production I will definitely not advice him to cultivate the crop.	66	4.48	.588

<i>Food availability</i>			
Food obtained from Bambara nuts is found everywhere in the area	66	2.03	1.163
Bambara nuts is cooked often in our household	66	2.38	1.390
Bambara nuts rots very easily	66	3.42	1.138
Food obtained from Bambara nuts has increased	66	3.79	1.234
<i>Food accessibility</i>			
Bambara nuts can be consumed both fresh and cooked	66	2.11	1.139
Bambara nuts production has solved the effects of hunger	66	2.35	1.387
Bambara nuts is cooked often in our household	66	2.38	1.390
Bambara nuts are difficult to prepare as food	66	2.50	1.292
Bambara nuts has improved so much on food access in the area	66	2.79	1.183

Source: primary data, 2015

**Scale: N meant Number of respondents. To be able to discuss the data, the higher the mean, the higher the agreement and the lower the mean, the higher the disagreement; and the higher the standard deviation, the less the agreement and the lower the standard deviation, the higher the agreement.*

When the means of the 14 attitudinal statements were ranked during data analysis, it was found that the statement, “Increasing production I will definitely not advice him to cultivate the crop” was ranked first with a mean score of 4.48. From these ranking results, it was quite clear that Bambara nuts is not a crop grown to improve household income but rather it is a crop grown for home consumption.

Similarly, “my income has improved ever since I started planting Bambara nuts” was ranked with a mean score of 2.30. This confirms the earlier response that Bambara nuts production in Nyenga sub-county is not a crop grown to improve household income but rather it is a crop grown for home consumption.

The third statement that “Food obtained from Bambara nuts has increased” and the fourth “Bambara nuts has improved so much on food access in the area” also confirm the above statements implying that the growing of Bambara nuts in the area has increased among farmers ,thus increasing food availability and accessibility in homes but not as a source of income crop.

Therefore, basing on the above statements in table 5 above, it is clear that farmers have adopted Bambara nuts production for majorly increase food availability and access in the area but not so much to improve their household income. That is why it was reported that the market of Bambara nuts is not prevalent in the area (Mean=2.65) and increasing domestic incomes at (Mean=1.42)

4.4 Effect of Bambara Nuts production on Food security in Nyenga Sub-County

The use of the logit model for this analysis was consistent with the literature on adoption Rogers, (1983) and Alston *et al.* (1995) which describes the process of adoption as taking on a logistic nature. Thus this logic model was used to provide explanation of behavior (empirical estimates) on how the socio-economic, institutional variables influenced the adoption of the Bambara nuts production as a food security crop. This regression model was used because the dependent variable is dichotomous, focused on the decision of respondents to adopt Bambara nuts production and utilization technology or not. The estimates (Table 6) indicated that six variables (63.6 %) were statistically significant ($p < .05$). These were: gender, farm size, on-farm income, marketing problem, extension service and respondents’ access to credit. This meant that gender, farm size, on-farm income, marketing problem, extension service and respondents’ access to credit contributed 63.6% on growth of Bambara Nuts in the area as explained in table 6 below;

Table 6: Showing respondents characteristics influencing the adoption of Bambara nuts production as food Security Crop at household level

		1	2	3	4	5	6	7	8	9
gender1	Pearson Correlation	1								
	Sig. (2-tailed)									
	N	66								
age 2	Pearson Correlation	-.115	1							
	Sig. (2-tailed)	.029								
	N	66	66							
Education3	Pearson Correlation	-.115	.144	1						
	Sig. (2-tailed)	.029	.072							
	N	66	66	66						
land size4	Pearson Correlation	-.115	.144	.055	1					
	Sig. (2-tailed)	.029	.072	.306						
	N	66	66	66	66					
Income5	Pearson Correlation	-.115	.144	.055	-.133	1				
	Sig. (2-tailed)	.029	.072	.306	.016					
	N	66	66	66	66	66				
Marketing problem6	Pearson Correlation	-.115	.144	.055	-.133	-.008	1			
	Sig. (2-tailed)	.029	.072	.306	.016	.880				
	N	66	66	66	66	66	66			
Extension services7	Pearson Correlation	-.115	.144	.055	-.133	-.008	.138	1		
	Sig. (2-tailed)	.029	.072	.306	.016	.880	.007			
	N	66	66	66	66	66	66	66		
Access to credit8	Pearson Correlation	-.115	.144	.055	-.133	-.008	.138	.106**	1	
	Sig. (2-tailed)	.029	.072	.306	.016	.880	.007	.047		
	N	66	66	66	66	66	66	66	66	
Bambara nuts adoption9	Pearson Correlation	.010	-.115	.144	.055	-.133	-.008	.138	.106**	1
	Sig. (2-tailed)	.134	.029	.072	.306	.016	.880	.007	.047	
	N	66	66	66	66	66	66	66	66	66

Intercept 0.766, Sample size 66

Source: primary data, 2015

From Table 6 above, four factors: age, level of education marketing and credit were not significant ($p>0.05$) in influencing respondents' perception of adoption of Bambara nuts as food security crop in Nyenga Sub-County. The factors: level of education, land size, marketing and provision of credit, these factors did not significantly sustain farmers' decision to adoption of Bambara nuts production and utilization as a food security crop and hence need not be considered when designing agricultural intervention for increased adoption of production Bambara nuts as a food security crop. For instance level of education, these results can be explained by that fact that there was no great variation in respondents' level of education and land sizes within the sub-county under study. There is no proper marketing and provision of credit in Nyenga Sub County.

However, other factor like extension services was received by the respondents had a coefficient of positive 0.138. This implies that any change in extension services resulted in 13.8 % increased level farmers adoption of Bambara nuts production as a food security crop. On gender, the coefficient of gender was positive 0.134 meaning gender could contribute to 13.4 % positive perception on adoption of Bambara nuts production as a food security crop.

While on age the coefficient of age was negative 0.115. These results showed that a unit increase in age resulted in 11.5% reduction in the level of perception of Bambara nuts production and its utilization as a food security crop. Thus as farmers become older, they are less likely able to perceive increase in adoption as they become less energetic. Indeed study results shows that over 64.6 % of the respondents across the sub-county were in the age set of 31-50 years. Since there is no much difference in the age bracket among the respondent in the sub-county, study results

shows that there is no significant association between farmer's age and adoption of Bambara nuts production practices.

Similarly on annual earnings from on-farm income the coefficient and t-value, of their annual farm income were negative 0.133 and 2.486 respectively. This inverse relationship implied that a unit increase in annual farm income resulted to 13.0% decrease in level of perception in adoption decision to Bambara nut as a food security crop. Indeed over 83.3 % of the respondents in the study area were low income earners. However, these results disagree with the findings of Akinola *et. al.* (2012) who found income to have a positive significant influence on adoption of mulching technology Yam Osun State, Nigeria.

Similarly, on accessibility of Credit the coefficient of education was 0.106 while the t-value was .990. The positively significant relationship at ($p < 0.05$) implies that credit availability increases the probability of adoption of Bambara nuts as a food security crop by only 10%. Similar results were recorded by Teklewold *et al.* (2012) who found availability of credit to have positively influenced adoption of poultry technology by relaxing the binding capital constraints that farmers face during initial investments. This was also agreed by one of extension worker that, income is not the main reasons as to why farmers adopt Bambara nuts production, the reason is increasing food availability and accessibility at households level.

4.5 Research Questions

This section provides inferential statistics on whether Bambara nuts production has improved on food security. A Pearson Correlation Coefficient was used in this case.

Research Question I: What is the effect of Bambara nuts production on smallholder farmer's incomes?

Table 7: Correlation analysis on Bambara nuts production on smallholder farmer's incomes

		Bambara nuts production	Household income
Bambara nuts production	Pearson Correlation	1	-.141
	Sig. (2-tailed)		.077
	N	66	66
Household income	Pearson Correlation	-.141	1
	Sig. (2-tailed)	.077	
	N	66	66

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

Source: primary data, 2015

Findings show that there was a negative correlation ($= .141$) between Bambara nuts production on income. The coefficient of determination ($= .141$) shows that Bambara nuts production as negatively related to improvement in the incomes of farmers at household level. This thus meant that Bambara nuts production adoption accounted for 14.1% change in household incomes of farmers in Nyenga Sub-county. These findings were subjected to a test of significance (p) and it is shown that the significance of the correlation ($p = .077$) is greater than the recommended critical significance at 0.05. Thus, the relationship was not significant.

The implication of these findings is that Bambara nuts production had not significantly improved on the income of farmers in Nyenga Sub-county. The negative effect implied that a change in the growth of Bambara nuts can contribute to a significant change in income levels of farmers in the area.

Table 8: Regression analysis on Bambara nuts production and smallholder farmer's incomes

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.441 ^a	.407	.403	.321

a. Predictors: (Constant), household income

ANOVA^b						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.906	1	15.906	154.751	.000 ^a
	Residual	6.578	64	.103		
	Total	22.485	65			

a. Predictors: (Constant), Bambara nut production

b. Dependent Variable: household income.

Coefficients^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.224	.109		29.628	.000
	Food Availability	.385	.031	.841	12.440	.000

a. Dependent Variable: Household income

Source: primary data, 2015

There is a lower linear relationship (Multiple R = .441) between Bambara nuts production and household incomes. The adjusted R Square shows that Bambara nuts production account for 40.3% change in household income. These findings were subjected to an ANOVA test, which showed that the significance (Sig F = .000) of the Fishers ratio (F = 154.751) was greater than the critical significance at .05. Hence, the findings were accepted. This implies that Bambara nuts production is not a major determinant of household incomes in Nyenga sub-county.

Research Question 2: What is the effect of Bambara nuts production on food availability?**Table 9: correlation analyses on Bambara nuts production on food availability**

		Bambara nut production	Food availability
Bambara nut production	Pearson Correlation	1	.562**
	Sig. (2-tailed)		.017
	N	66	66
Food availability	Pearson Correlation	.562**	1
	Sig. (2-tailed)	.017	
	N	66	66

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

Source: primary data, 2015

Findings show that there was a positive correlation ($= .562^{**}$) between Bambara nuts production on income. The coefficient of determination ($= .562^{**}$) shows that Bambara nuts production as positively related to improvement in the food availability at household level. This thus meant that Bambara nuts production adoption accounted for 56.2% change in food availability in Nyenga Sub-county. These findings were subjected to a test of significance (p) and it is shown that the significance of the correlation ($p = .017$) is less than the recommended critical significance at 0.05. Thus, the relationship was significant.

The implication of these findings is that Bambara nuts production had significantly improved on food availability in households of farmers in Nyenga Sub-county. The positive effect implied that a change in the growth of Bambara nuts can contribute to a significant change in food availability in the area.

Table 10: Regression analysis on Bambara nuts production and food availability
Regression analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.841 ^a	.707	.703	.400

a. Predictors: (Constant), food availability

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.906	1	15.906	154.751	.000 ^a
	Residual	6.578	64	.103		
	Total	22.485	65			

a. Predictors: (Constant), Bambara nuts production

b. Dependent Variable: food availability.

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.224	.109		29.628	.000
	Food Availability	.385	.031	.841	12.440	.000

a. Dependent Variable: Food availability

Source: primary data, 2015

There is a higher linear relationship (Multiple R = .841) between Bambara nuts production and food availability. The adjusted R Square shows that Bambara nuts production account for 84.1% change in food availability. These findings were subjected to an ANOVA test, which showed that the significance (Sig F = .000) of the Fishers ratio (F = 29.628) was greater than the critical significance at .05. Hence, the findings were accepted. This implies that Bambara nuts production is a major determinant of food availability in Nyenga sub-county.

Research Question 3: What is the effect of Bambara nuts production on food accessibility?

Table 11: correlation analyses on Bambara nuts production and food accessibility

		Bambara nut production	Food accessibility
Bambara nut production	Pearson Correlation	1	.441**
	Sig. (2-tailed)		.022
	N	66	66
Food accessibility	Pearson Correlation	.441**	1
	Sig. (2-tailed)	.022	
	N	66	66

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

Source: primary data, 2015

Findings show that there was a positive correlation (= .441**) between Bambara nuts production on income. The coefficient of determination (= .441**) shows that Bambara nuts production as positively related to improvement in the food accessibility at household level. This thus meant that Bambara nuts production adoption accounted for 56.2% change in food accessibility in Nyenga Sub-county. These findings were subjected to a test of significance (p) and it is shown that the significance of the correlation (p = .022) is less than the recommended critical significance at 0.05. Thus, the relationship was significant.

The implication of these findings is that Bambara nuts production had significantly improved on food accessibility by farmers in Nyenga Sub-county. The positive effect implied that a change in the growth of Bambara nuts can contribute to a significant change in food accessibility in the area.

Table 12: Regression analyses on Bambara nuts production and food accessibility

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.780 ^a	.776	.767	.340

a. Predictors: (Constant), food accessibility

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.906	1	15.906	330.751	.001 ^a
	Residual	6.578	64	.103		
	Total	22.485	65			

a. Predictors: (Constant), Bambara nut production

b. Dependent Variable: food accessibility.

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.224	.109		40.222	.000
	Food Availability	.385	.031	.841	12.440	.000

a. Dependent Variable: Food accessibility

Source: primary data, 2015

There is a higher linear relationship (Multiple R = .780) between Bambara nuts production and food access. The adjusted R Square shows that Bambara nuts production account for 78% change in food access. These findings were subjected to an ANOVA test, which showed that the significance (Sig F = .000) of the Fishers ratio (F = 40.222) was greater than the critical significance at .05. Hence, the findings were accepted. This implies that Bambara nuts production is a major determinant of food access in Nyenga sub-county. The implication of these findings is that Bambara nuts production had significantly improved on food accessibility by

farmers in Nyenga Sub-county. The positive effect implied that a change in the growth of Bambara nuts can contribute to a significant change in food accessibility in the area.

4.6 Chapter Conclusion

In conclusion therefore, it is important to understand that the study findings indicated that Bambara nuts production has no significant effect on farmer's incomes in Nyenga sub-county and this is because most of the farmers grow it on small scale and the crop has low market potential. It was also concluded that Bambara nuts production has a significant and a positive effect on food availability in Nyenga sub-county. This thus means that without other foods, Bambara nuts can be available for home consumption. Lastly it was established that that Bambara nuts production has a significant and a positive effect on food accessibility in Nyenga sub-county. This thus means that most people have a possibility of getting food since Bambara nuts makes food cheaper and accessible to any person in Nyenga sub-county.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

In this chapter, much has been presented on the study findings. This chapter therefore will endeavor to summarize the study findings basing on the study objectives while coming up with conclusions derived from the findings, and the recommendations that will help in understanding the effect of Bambara nuts production on food security in Nyenga Sub County.

5.1. Summary of findings

The study was carried out as an assessment of the effect of Bambara nuts production on food security using a case of Nyenga Sub County.

The specific objectives of the study were;

To evaluate the effect of Bambara nuts production on smallholder farmer's incomes in Nyenga Sub County

To determine the effect of Bambara nuts production on food availability at household level in Nyenga Sub County

To examine the effect of Bambara nuts on food accessibility at household level in Nyenga Sub County

5.1.1. The effect of Bambara nuts production on smallholder farmer's incomes

The study findings indicated that Bambara nuts production has no significant effect on farmer's incomes in the study area. This is because annual earnings from on-farm income, the coefficient and t-value, of their annual farm income were negative 0.133 and 2.486 respectively. This inverse relationship implied that a unit increase in annual farm income resulted to 13.0%

decrease in level of perception in adoption decision to Bambara nuts as a food security crop. Indeed over 83.3 % of the respondents in the study area were low income earners. However, these results disagree with the findings of Akinola *et. al.* (2012) who found income to have a positive significant influence on adoption of mulching technology in Yam in Osun State, Nigeria. This was congruent to what was reported by one of the agricultural extension officer found in the area. In addition, according to the Farmer Participatory Approach (FPA), Bambara nuts were introduced to the farmers (Massawe et al, 2005). Over time, the farmers who adopted Bambara crop varieties, their farm incomes and food supply in the region had improved. Stable farm incomes are necessary for farmers to meet their domestic needs such as health and payment of school fees, besides re-investing in the farm.

5.1.2. The effects of Bambara nuts production on food availability

The study findings indicated that there is a significant and positive effect of Bambara nuts production on food availability. The results from the study revealed that Bambara nuts production is a significant factor in food availability in Nyenga sub-county. This was based on the fact that, most of the respondents were in agreement with the statements that Food obtained from Bambara nuts is found everywhere in the area and cooked often in households. This was in congruent with what Ncube and Twomlow (2007) found out that Bambara nuts are suitable for intercropping with other crops and does not take up large areas of land that could be used for other crops considered more important or lucrative Bambara nuts is useful in crop rotation because it contributes nitrogen fixing into the soil at a level similar to other legumes (20 – 100 kg ha⁻¹). Traditionally, Bambara nuts have been seen as a snack or food supplement, but not a lucrative cash crop. In Zimbabwe, the crop is usually grown by women and so, it is often given a lower priority within the village when allocating land. Seeds for growing Bambara nuts are

rarely purchased by farmers because the women are responsible for passing the seed down through the generations, and storing the dried beans for food security (de Kock, 2004).

Bambara nuts seeds can be eaten fresh, or cooked while still immature. At maturity, they become very hard and, therefore, require boiling before further preparation. In many West African countries, the fresh pods are boiled with salt and pepper, and eaten as a snack. In Côte d'Ivoire, the seed is used to make flour, which makes it more digestible. In East Africa, the beans are roasted, pulverized and used to make a soup. The flour can also be used to make a stiff porridge. Roasted seeds can be boiled, crushed and eaten as a relish (FAO, 2008).

5.1.3 The effects of Bambara nuts production on food access

The study findings indicated that there is a significant and positive effect of Bambara nuts production on food access. The results from the study revealed that Bambara nuts production is a significant factor in food accessibility in Nyenga Sub-County. This was based on the fact that, for most of the respondents were in agreement Bambara nuts can be consumed both fresh and cooked, Bambara nuts production has solved the effects of hunger, Bambara nuts are easy to prepare as food at home and Bambara nuts has improved so much on food access in the area. This is because Research in Nigeria has shown that Bambara nuts is a significant source of flour for malting (Uvere *et al.*, 1999). Uvere *et al.* (1999) argues that Bambara nuts can be added in any form of flour and benefit by decreasing milling energy, which would reduce the tedium of repeated milling and sieving during flour extraction from unmolded Bambara nuts seeds. The possibility of malting Bambara nut seeds for the production of high energy, low viscosity weaning foods merits further investigation, given its high carbohydrate and protein contents. Brough *et al.* (2003) further in support indicated that prepared vegetable milk by soaking shelled

Bambara nuts in water overnight, homogenizing and removing insoluble material. The beany taste could be removed by dry-frying the beans after soaking and before homogenization. Milk from BG was preferred in taste and color to those produced from cowpea, pigeon pea and soybean (*Glycine max*).

5.2 Conclusions

From the summary findings above, it can be concluded that Bambara nuts production is significant in improving food security but not income in Nyenga sub-county. Below are the conclusions of the objective employed in the study;

- It was concluded that Bambara nuts production has no significant effect on farmer's incomes in Nyenga sub-county and this is because most of the farmers grow it on small scale and the crop has low market potential.
- It was also concluded that Bambara nuts production has a significant and a positive effect on food availability in Nyenga sub-county. This thus means that without other foods, Bambaranuts can be available for home consumption.
- Lastly it was established that that Bambara nuts production has a significant and a positive effect on food accessibility in Nyenga sub-county. This thus means that most people have a possibility of getting food since Bambara nuts makes food cheaper and accessible to any person in the area.

5.3 Recommendations of the study

In view that Bambara nut is a food crop with potential to improve nutrition, boost food security and foster rural development, the study recommends that;

- There is need to initiate development of programs and deliberate policies that can enhance farmer's adoption of production of Bambara nuts.
- There is need to improve nutrition of the rural poor and promotion rural development and supporting sustainable land management.
- For purposes of increasing yield and the feasibility of commercial Bambara nuts production agronomists should conduct trails using superior cultivars in areas where Bambara nuts does not do well. In the same line of argument, further trails need to be done to see how modern methods of intensive Bambara nuts can be incorporated in the introduction of other crops so as farmers can use their small plots and have much yields.
- Efforts should be made to improve the management of the crop in the field and this can be done by ensuring that agricultural officers reach to the local farmer at village levels.
- Currently it is only cultivated on small plots, but it has high potential as a field crop. Investigation in areas of mechanized cultivation, harvesting, shelling and processing (especially canning as practiced in Ghana) and of its potentials as cash crop for processed foods and world trade, can also be done in Uganda.
- Another area of need is research to identify cultivars that are resists Bambara nuts diseases and pests, as well as for cultivars which have highly effective Rhizom, both from available rhizobia associated with the plant in its native habitant.

5.4 Areas of further research

In future, researchers should replicate this study to cover other areas in Uganda where Bambara nuts production is taking place. This is because this study was limited to Nyenga sub-county, Buikwe district.

Secondly, there is a need for further studies to find out how Bambara nuts production has improved on employment creation as study was limited on food accessibility, food availability and incomes of smallholder farmers.

There is need to carry out soil analysis, this helps in site selection of soils for Bambara nuts production in Nyenga Sub county so as to enable increased productivity per unit of a given area.

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APPENDICES

APPENDIX I: SELF ADMINISTERED QUESTIONNAIRE FOR HOUSEHOLD FARMERS

Dear Respondent,

The researcher is a student of Master of Science in Agro-ecology at Uganda Martyrs University (UMU), Nkozi, Uganda. She is undertaking a research to generate data and information on “Assessing the Effect of Bambara Nuts Production on Food Security in Buikwe District: A Case Study of Nyenga Sub County”. You have been selected to participate in this study because the contribution you make to your organization is central to the kind of information required. The information you provide is solely for academic purposes and will be treated with most confidentiality. Kindly spare some of your valuable time to answer these questions by giving your views where necessary or ticking one of the alternatives given.

SECTION A: BACKGROUND DATA

- Respondents' gender? _____
- How old are you? _____
- What is your level of education? _____
- Your Land size in acreage? _____
- On farm income? _____
- Any Marketing problem in Bambara nuts? _____
- Extension service availability? _____
- Access to credit facilities? _____

SECTION B: BAMBARA NUTS PRODUCTION

In this section please tick in the box that corresponds to your opinion/view according to a scale of 1 = strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree, 5 = strongly Agree

No	Statement	1	2	3	4	5
1	Bambara nuts production is entirely a female activity in our area					
2	Soil fertility is not a problem in this area for Bambara nuts Production					
3	Bambara nuts require less rainfall and is resistant to Pests and diseases.					
4	Bambara nuts production lacks institutional support in Buikwe district (Research, Extension Credit and Market).					
5	There are no enough improved Bambara nuts seeds which affects its adoption in the area					
6	Bambara nuts are planted on small plots in the area					
7	The maturity period of Bambara nuts is too long					
8	The taste of Bambara nuts is not so good					
9	Bambara nuts production reduces when intercropped with other crops					
10	Bambara nuts has high yields compared to other crops					
11	Dry seasons affects Bambara nuts production so much					
12	Bambara nuts production is affected so much by pests and diseases					
13	Bambara nuts in Buikwe district is grown on small scale					
14	The nutritional value of Bambara nuts has improved on its adoption and consumption in the area					

No	Statement	1	2	3	4	5
14	Bambara nuts production can conserve biodiversity.					
15	Bambara nuts seeds are available in the area					
16	Buyers for Bambara nuts are available in the area					
17	Bambara nuts produced are of high quality					
18	The planting of Bambara nuts improves soil productivity					

SECTION C: FOOD SECURITY

In this section please tick in the box that corresponds to your opinion/view according to a scale of 1 = strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree, 5 = Strongly Agree

No.	Statement	1	2	3	4	5
	Household incomes					
1	Bambara nuts production is not profitable, if neighbor seeks my opinion on Increasing production I will definitely not advice him to cultivate the crop.					
2	The planting of Bambara nuts has increased incomes at household levels in Buikwe					
3	The market for Bambara nuts in the area is available					
4	My income has improved ever since I started planting Bambara nuts					
	Food availability					
5	Food obtained from Bambara nuts has increased					
6	Food obtained from Bambara nuts is found everywhere in the area					
7	Bambara nuts rots very easily					

No.	Statement	1	2	3	4	5
	Household incomes					
8	Bambara nuts is cooked often in our household					
	Food accessibility					
8	Bambara nuts can be consumed both fresh and cooked					
9	Bambara nuts has improved so much on food access in the area					
10	Production of Bambara nuts is one of the ways of improving household nutritional status.					
11	Bambara nuts production has solved the effects of hunger					
11	Bambara nuts are difficult to prepare as food					

THANK YOU FOR YOUR PARTICIPATION!

APPENDIX II: INTERVIEW GUIDE FOR LOCAL LEADERS, AND EXTENSION OFFICIALS

- a. When was Bambara Nuts production introduced in Buikwe district?
- b. Why was Bambara nuts introduced in the area?
- c. Has Bambara nuts legumes been utilized in the area?
- d. If not, why?
- e. Has consumption of Bambara nuts increased in the area?
- f. What factors affecting Bambara nuts consumption in the area?
- g. What are the nutritional values of Bambara nuts?
- h. Are people interested in nutrition value of Bambara nuts compared to other crops?
- i. Are Bambara nuts seeds well spread in Buikwe district? If no why?
- j. Does Bambara nuts has market potential in the area compared to other crops? Give reasons for your answer
- k. Is cultivation of Bambara nuts in the area expanded over the years? Support your answer
- l. Has Bambara nuts production improved on household income of farmers in Buikwe district? Give reasons
- m. Has Bambara nuts production improved on food availability of farmers in Buikwe district? Give reasons
- n. Has Bambara nuts production improved on food accessibility of farmers in Buikwe district? Give reasons

THANK YOU SO MUCH

APPENDIX III: TABLE FOR DETERMINING SAMPLE SIZE FROM A GIVEN POPULATION

<i>N</i>	<i>S</i>	<i>N</i>	<i>S</i>	<i>N</i>	<i>S</i>
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	100000	384

Source: Krejcie & Morgan (1970, as cited by Amin, 2005)

Note.—*N* is population size.