CONTRIBUTION OF SORGHUM PRODUCTION TOWARDS HOUSEHOLD FOOD SECURITY IN TANZANIA: A CASE STUDY OF SINGIDA REGION

DAVID BROWN

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ABSTRACT

Sorghum is one of the most drought tolerant cereal crops currently under cultivation. Semi-arid regions in Tanzania are among of the areas cultivating sorghum to a large extent, and these regions are most vulnerable to food insecurity. Despite the assumption that sorghum has contribution on household food security, a wide assessment has not been done in Tanzania to examine the extent of its contribution. The study intended to: determine the quantity of sorghum and other grains produced in households per year, assess the consumption pattern of sorghum grain in households in Singida District, assess food sources in the household(that is,purchased, home produced or acquired in kind) and compare the food status of sorghum producers' and non-producer' households. In Singida District food insecurity is still persistent to a large extent; so the district was taken as the case study. A cross- sectional research design was used during data collection. Various methods were used in data collection in which focus group discussion, key informant interviews and questionnaire survey were employed. Descriptive statistics and regression analyses using Statistical Package for Social Sciences were employed. Based on binary logistic regression, education, employment, household size and age were not significant in influencing household food security. Extension service was observed to have positive significant ($p=0.034$) influence to the household on becoming food secure. Sorghum was observed to contribute about 25% to household food consumption. From these results sorghum contributed to households' food security to the large extent in semi-arid areas. Hence in the semi-arid regions in which vulnerability to food insecurity is high, sorghum production should be more emphasized so that to reduce the issue of chronic food insecurity due to the fact that this crop is tolerant to drought conditions.

DECLARATION

I, David Brown, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and has neither been nor concurrently being submitted for a higher degree award in any other Institution.

_____ _____

David Brown Date

(Candidate)

The above declaration is confirmed by

_____ _____

Dr. E.E. Chingonikaya Date

(Supervisor)

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DEDICATION

This valuable work is dedicated to my beloved mother Tusaniege Andrew Mwankanye, I LOVE YOU MOTHER, NO ONE LIKE YOU!

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS

AATF	African Agricultural Technology Foundation
ARI	Agriculture Research Institute
CIMMYT	*Centro Internacional de Mejoramiento de mai y Trigo*(International Maize and Wheat Improvement Centre)
DEC	Dietary Energy Consumption
EAAFRO	East Africa Agricultural and Forestry Research Organization
EAC	East African Community
FAO	Food and Agriculture Organization
ICRISAT	International Crops Research Institute for Semi-Arid Tropics
IFPRI	International Food Policy Institute
IFWH	Institute for Work and Health
JGDPG	Joint Government and Development Partner Group
MAFC	Ministry of Agriculture Food Security and Cooperatives
MAC	Maricopa Agricultural Center
NSGRP	National Strategy for Growth and Reduction of Poverty
NSMIP	National Sorghum and Millet Improvement Program
PADEP	Participatory Agricultural Development and Empowerment Project
SADC	Southern African Development Community
SMIP	Sorghum and Millet Improvement Program

UA	African Union
UN	Union Nation
UNICEF	United Nations Children's Fund
URT	United Republic of Tanzania
WFP	World Food Program
WFS	World Food Summit

CHAPTER ONE

1.0 INTRODUCTION

1.1. Background Information

1.1.1. Sorghum production

Sorghum (*Sorghum bicolor* L. Moench) is one of the five most important cereal crops in the world; it is the fifth most widely produced crop in the world (Doggett, 1988). According to FAO (1995) as reported by (Samm, 2009), sorghum is one of the most drought tolerant cereal crops currently under cultivation. Its morphological and physiological characteristics contribute to its adaptability to drought conditions, including an extensive root system, waxy brooms on the leaves that reduce water loss, ability to stop the growth in periods of drought and to resume growth when conditions are favourable, and tolerance to water-logging. The crop adapts well to different soil types and toxicities.

Grain sorghum is the third most important cereal crop grown in the United States and the fifth most important cereal crop grown in the world (Kimber, 2000). Sorghum is a very important cereal in the semi-arid areas of the tropics and subtropics in Africa. Nigeria is among the best producers of sorghum in the world, it produces about115000 tonnes which is equal to 19.3% of all grains produced in the world (AATF-Africa, 2012). Sorghum in Nigeria is essential for improving food security since it is highly consumed. The uses of sorghum in Nigeria can be grouped into two: traditional and industrial. The traditional uses include a variety of traditional foods, beverages and drinks while non-food traditional uses include: thatching of the roof and fencing of compounds. Sorghum consumption is in the form of flour or paste processed (Ogbonna, 2008). Tanzania produces over 500 000 tonnes of sorghum and 200 000 tonnes of pearl millet per year.

These are second and fourth most widely grown cereal grain crops in the agricultural economy. Yet, virtually the entire production is carried out on a subsistence basis. Less than 2% of the harvest enters the farm market; the remainder is consumed on the farm (Rohrbach and, Kiriwaggulu, 2007). In Tanzania sorghum is more grown in the central zone parts than in other zones. Semi-arid areas include Dodoma, Singida, Tabora, Shinyanga and Mwanza. These together produce 50% of the country's commercial sorghum output (Msambichaka, 1999).

1.1.2. Food Security in Tanzania

Food Security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (WFS, 1996). Tanzania is a least developed and food deficit country, in which more than 40% of the population live in chronic food deficit regions, where irregular rainfalls cause recurring food shortage (IFPRI, 2011; WFP, 2011). Nine regions of Tanzania, namely Arusha, Manyara, Kilimanjaro, Shinyanga, Dodoma, and Iringa, Mwanza, Mara and Tabora are caught up in chronic and transitory food insecurity due to poor or no harvests. Most of these areas are semi-arid and/ or share the same ecological zone with the drought prone areas of East Africa (Gouel, 2012). Food insecurity is one among the challenges facing Tanzania development andthis is partly due to population increase and climatic change. The central part of Tanzania shows the highest proportion of households that are food insecure. URT (2006) in regions such as Dodoma, Singida and Tabora 45-50% of the households are food insecure. Due to the senses that, sorghum production is mainly consumed in the farm market it can have an impact on food security.

1.2. Problem Statement

In the 2011 Singida Region faced an acute food shortage of 77 369tonnes forcing its people to seek relief food from government (Daily News 2011). There is a high dependency of the people on agriculture for their livelihood. More than 70% of the work force of Tanzania depends on agriculture, but the productivity of the sector is low (URT, 2009). Increasing the potential of dry-land cereals like sorghum presents an opportunity in reversing this trend and reducing the incidence of poverty and food insecurity (Cavatassi, 2011). Despite the fact that sorghum is grown in Singida Region still food insecurity persists to a large extent. Little has been done to assess the role of sorghum in this semi-arid region in Tanzania (Minde and Rohrbech, 1993; Mwanga 2002; Mafure *et al*., 2007; Nathali, 2009; Robble, 2001; Makindara *et al*.,2011). Still there is a lack of knowledge on the extent of contribution of sorghum in household food security. Therefore, this study aims at filling the gap of knowledge.

1.3. Justification of the Study

The study will provide information on sorghum production and its contribution to household food security in the Singida Rural District; it will inform the development practitioner, policy makers and other stakeholders through findings so that they amend and implement national and international policies and development strategies in an effective way. Some of the strategies include vision 2025 and the National Strategy for Growth and reduction of poverty (NSGRP) cluster one and two which aim and strategize on the alleviation of poverty and improvement of peoples' well-being (Yonah and Cons, 2005) also Millennium Development Goal one which looks to eradicate extreme income poverty and hunger (UN, 2010). In additional Kilimo Kwanza pillar number four (4) activities one which identifies priority areas for strategic food commodities for the

country's food self-sufficient that insist put in place production of crops like sorghum (JGDPG 2009).

1.4. Objectives of the Research

1.4.1. General objective

The general objective of the study was to investigate the contribution of sorghum production towards household food security in semi-arid areas**.**

1.4.2. Specific objectives

The specific objectives of the study were to;

i. determine the quantity of sorghum and of other grains produced in households per year;
ii. assess the consumption pattern of sorghum grain in households in Singida District;
iii. assess food sources in the household (that is, purchased, home produced or acquired in kind); and
iv. compare the food security status of sorghum producers' and non-producers' households.

1.5. Research Questions

i. What amount of sorghum and other grains produced in households per year?
ii. What is the rate of consumption of sorghum grain in household level?
iii. What are the sources food (that is, purchased, home-produced, or acquired in kind)
iv. Is sorghum producing households more food secures than non-producers?

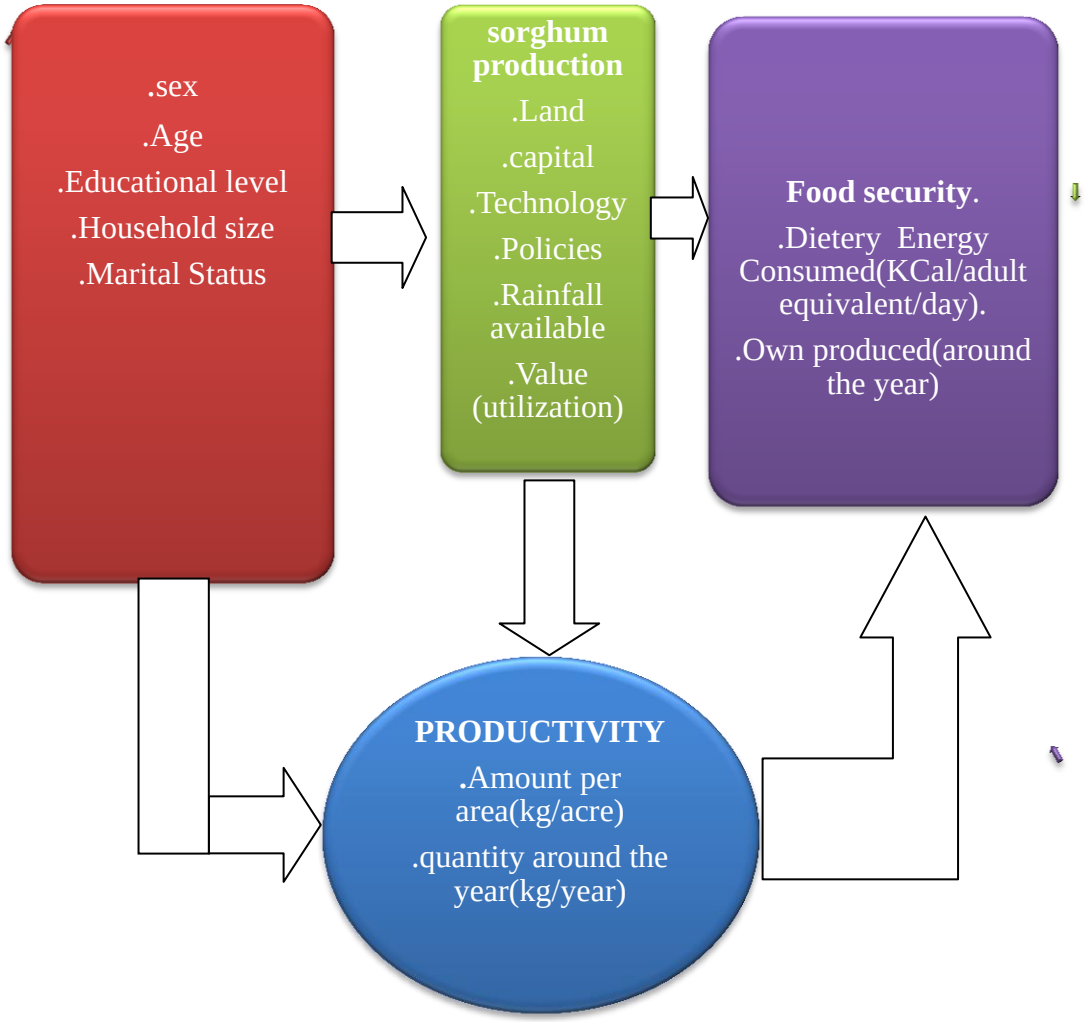

Figure 1: Conceptual Framework for sorghum production and food security

1.6. Conceptual Framework

Assumption of the study is that, to any society facing with food insecurity as the result of climatic change like chronic drought may adopt the situation by utilizing the endowment surrounding them. Sen (1986) defines an entitlement as the full range of goods and services that he or she can acquire by converting his/her endowment. In his argument said that ‘‘individuals face starvation if they face starvation if their full entitlement set does

not provide them with adequate food for subsistence''. The entitlement approach describes all legal sources of food into four categories, that is production base entitlement ''growing food", trade base entitlement ''buying food", own-labor entitlement ''working for food'' and inheritance and transfer entitlement 'being given food by others"(Devereux, 2001).

Entitlements can be said to fall into any one of four categories. Firstly, "trade-based entitlements" were by one is entitled to own what is obtained by trading something one owns with a willing party. Secondly, "production-based entitlement" whereby one is entitled to own that one produces using one's own resources, or resources hired from willing parties meeting the agreed conditions of trade. Thirdly, "own-labor entitlement" whereby one is entitled to one's own labor power, and thus to the trade-based and production-based fruits of one's labor. Fourthly, "inheritance and transfer entitlement" whereby one entitled to own what is willingly given to one by another who legitimately owns that which is given (Sen, 1981).

From this theory, the model tries to explain the availability of food in semi-arid region comes from using the resources surrounding. By considering the independent which is sorghum production in the semi - arid region to be source of entitlement growing food with other indicator labor (own labor), capital, policies, value of utilization and technology that have an influence on the dependent variable which is food security in terms of own produced and number of meals taken in the household. The diagram below presents the concept of the study.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. Definition of Key Concepts

Sorghum is a genus of numerous species of grasses, one of which is raised for grain and many of which are used as fodder plants either cultivated or as part of the pasture. The plants are cultivated in warmer climates worldwide (Harlan, 1997).

Household food security refers to the ability of the household to secure, either from its own production or through purchases, adequate food for meeting the dietary needs of all members of the household. Households are food secured when they have year round access to the amount and variety of safe foods their members needs to lead active and healthy lives (FAO, 2010). Broadly, the concept of food security is built on three pillars: i) Food availability: sufficient quantities of food are available to people on a consistent basis; ii) Food access: people have sufficient resources to obtain appropriate foods for a nutritious diet; iii) Food utilization: people have sufficient knowledge of nutrition and care practices and access to adequate water and sanitation to derive sustenance food. There is a direct and cyclical relationship between poverty and food insecurity, whereby poverty contributes to food insecurity, which contributes to poor nutrition, health, and cognitive development, which in turn contribute to poverty.

2.2. Theoretical Context

There are various theories explaining food insecurity, among which are as follows: Pessimistic (Malthus and Neo-Malthusian) theories, optimistic theories and entitlement to food security. According to these theories, each tries to give it focus and outlooks. Malthus contended that ‘‘food insecurity is due to too many people compared to the

amount produced'' also explained that population when unchecked increases geometrically (i.e. compound) ratio while subsistence (i.e. food production) increases arthematically (Malthus, 1798/2001). Optimistic like Boserup argued that ''technological development could boost food production enough to keep with population growth for many years'' (Marquette, 1997). Also entitlement theories argued that ''people do not usually starve because of insufficient supply of food at the local, national or international level but because they have insufficient resources include money (entitlements) to acquire it'' (Devereux, 2001).

This study is guided by entitlement approach theory which describes all legal sources of food into four categories, that is production base entitlement ''growing food", trade base entitlement ''buying food", own-labor entitlement ''working for food'' and inheritance and transfer entitlement 'being given food by others.

According to these theories, the concept of food insecurity has been explained well but little has been taught about the impact of climate change on food production. This study provides the awareness on adapting climate change on food production and Sorghum is among of the crop that can enhance food security.

2.3. Situation of Food Security in Tanzania

Tanzania is a politically stable country and the biggest and constant threat to food security, is the generalized poverty that exists throughout the country .Food insecurity and vulnerability is present everywhere in Tanzania but varies regionally. In developing countries like Tanzania, poor and food-insecure people most often live in marginal or unfavourable agricultural zones such as semi-arid areas. Nevertheless, these regions were often neglected in the past (Lipton, 2005; Pingali and Rosegrant, 1998). Although the

country is not drought prone, but food insecurity in the country is both transitory and chronic in nature. Transitory food insecurity arises from instability of food production, food prices, or household's income is common in marginal areas of the central and northern regions of Dodoma, Singida, Shinyanga, Tabora, some parts of Tanga, Arusha, Kilimanjaro and Manyara. The central band of Tanzania shows the highest proportion of households that are food insecure ranging 45- 55% (Afrol News, 2013).

2.4. Sorghum Production in Tanzania

Sorghum is a major cereal crop in hot-semi-arid tropical environments with 400-800 mm of rainfall that are too dry for maize (Warburton *et al*., 1995; ICRISAT, 1999). According to Rohrbach *et al*. (2002), sorghum is the second most important staple food after maize, benefiting about 80% of Tanzanians. In Tanzania, sorghum is mostly grown under rain-fed condition and has multiple uses including human food, animal feed, soil erosion control, thatching materials; brew preparation, and traditional ceremonial activities. Tanzania is the largest producer of food grain sorghum in Southern Africa, which occupies 663,000 ha in the southern region and covers 21 % of the total cereal area in the country (SADC/ICRISAT SMIP, 1998). The average sorghum yield for Tanzania is estimated to be approximately 1000 kg ha-1, too low to sustain an average farm family for 12 months (FAO, 2008). Despite the fact that production of sorghum increase due to different factors such as adoption of improved seeds and application of agrochemicals, the area cultivated these cereals does not show any uniformity. The area planted with sorghum fluctuated from one year to another. The area planted with sorghum decreased from 874 220 hectares in 2008/09 to 618 369 hectares in 2009/10. This is equivalent to 29.27% decrease. The highest yield of 1.3 tons per hectare was recorded in 2009/10 agricultural year (MAFC, 2010).

2.5. Tanzania Staple Food in Diet

Maize and cassava are the most important staple foods in Tanzania. Per capita consumption of cassava (157 kg per capita) is twice that of maize (73 kg per capita). Because of its greater caloric density, however, maize is more important as a source of calories, contributing 33% of the total compared to 15% for cassava.Also other important crops are rice, wheat, and sorghum that contribute in food intake (Table 1). In this regard, Tanzania is more dependent on maize than Uganda or Ethiopia but less so than Malawi or Zambia.

Table 1: Importance of Staple Foods in Diet of Tanzania:

Commodity	**Quality Consumed**	**Daily Caloric Intake**	**Share of Caloric Intake**
	Kg/person/year	Kcal/person/day	Percentage
Maize	73	655	33
Cassava	157	298	15
Rice	16	154	8
Wheat	10	79	4
Other		809	40
Total		**1995**	**100**

Source: FAO 2009

2.6. National Sorghum and Millets' Improvement Program (NSMIP)

The importance of sorghum in household food security in semi-arid areas of Tanzania necessitated the initiation of research activities. Thus in 1932 sorghum and the millets' improvement research program was initiated by the colonial government at the Ukirigulu Research Station and later moved to Ilonga Agricultural Research Station in 1972. After independence and formation of the East African Community (EAC), Sorghum and millet research was co-ordinated by the East Africa Agricultural and Forestry Research

Organization (EAAFRO) based in Serere Uganda. After the collapse of EAC in 1977, research activities on sorghum and millet were carried over by the National Sorghum and Millet Improvement Program (NSMIP), which was formally formed in early 1980's. NSMIP is based at ARI-Ilonga in Morogoro region and Hombolo sub-station in Dodoma region. The two stations (Ilonga and Hombolo) have a mandate for research on drought tolerant crops.

The main objective of NSMIP was to promote the production of small grain by providing farmers with improved varieties with high grain yields, desirable agronomic characteristics, and resistance to major pests and diseases (Sadan and Mndolwa, 1999). In 1992/1993 the NSMIP research activities were prioritized following the limited resources allocated to the program. Other activities included variety development, crop protection, seed production and distribution, to develop linkages between grain producers and industrial consumers and finally promote processing, marketing storage and utilization.

The NSMIP conducted research in collaboration with the International Crops Research Institute for Semi Arid Tropics (ICRISAT) based in India. There also collaboration with the Sorghum and millet Improvement Program (SMIP), an organ of the Southern Africa Development Community (SADC) /ICRISAT based in Bulawayo, Zimbabwe. Through institutional collaborative activities in sorghum and pearl millet research, several improved varieties and appropriate agronomic packages were developed and disseminated to farmers.

Under NSMIP, the main research activities involved development of improved varieties and appropriate agronomic packages. However Tanzania, just like many other developing countries is said to be characterized by low utilization of biological, chemical, mechanical

inputs and limited use of improved varieties (Msambichaka and Mashindano, 1999; Heisey and Mwangi, 1996).

According to Myaka *et al*. (1999), NSMIP scientist based at Ilonga and Hombolo research stations have released several improved technologies. These include three sorghum and two pearls millet commercial varieties, management practices namely tillage and preparation, sowing methods and sowing dates, spacing and plant population, pest control, disease control land inter-cropping. Others are inorganic fertilizer, and farmyard manure application, harvesting and storage. Sorghum and pearl millet require the same management recommendation for most practices.

2.7. Sorghum and Food Security

According to Taylor (2003), sorghum and millet are vitally important cereals for the maintenance of food security in Africa. The same notion is supported by FAO (2008) that small grains are the answer to chronic food shortages to rural communities who reside in semi-arid regions especially of the sub Saharan region. This is because of their high levels of adaptation to African conditions (Taylor, 2003).

They represent about half the total cereal production on the continent and as such are a major source of protein for the population. The same conclusions were made in a study that was conducted by Alumira and Rusike (2005) which revealed that new sorghum and millet varieties can reduce the probability of zero yields. Thus, they can make a significant contribution to household food security in drought years. However, Alumira and Rusike (2005) argued that changes in varieties alone could not guarantee increased yields from sorghum and millet. Rather they have to be accompanied by improving crop management methods such as better soil fertility management.

Regardless of this, Taylor (2003) argues that sorghum and millets are still under reached compared to other cereals. In view of that, Taylor (2003) advocates that with proper research, sorghum and millets could play a more important role and will offer long term food security than maize. This is because sorghum, pearl millet and finger millet are indigenous African cereals that, unlike maize and wheat, are well adapted to African semi-arid and sub-tropical agronomic conditions (Taylor, 2003). In addition evidence is provided by Taylor (2003) that these grains represent the major source of dietary energy and protein for some one billion people in the semi-arid tropics. The same considerations were mentioned before by Rohrbach (1991) that sorghum and millet present potential food staples for many of the poor farm households in semi-arid areas. Furthermore, this is despite that in recent years these crops have been relegated to semi-subsistence status in favor of maize (FAO, 2008).

2.8. Insights from a literature Review

From the literature review, it has been shown that sorghum has the potential to enhance household food security in semi-arid areas. This is because it is better adapted to these environments compared to maize. However, this is regardless of the challenges that they offer to farmers in producing them. Nevertheless, many authorities seem to reach a consensus that not much is being done to tap into the potential of this crop.

CHAPTER THREE

3.0 METHODOLOGY

3.1. Study Area

The study was conducted in Singida Region particularly in Singida district. The region was selected due to being among the area having a high rate of food insecurity, and good production of sorghum in Tanzania. The region is located below the equator between latitudes $3^0$52' and $7^0$34'. Longitudinally is situated between $33^0$27' and 35^0 26' east of Greenwich (URT, 2013).

In regard to climate there are two key features which are temperature and rainfall. The region forms part of the semi- arid central zone of Tanzania which experiences low rainfall and short rainy seasons which are often erratic with fairly widespread drought in one year out of four. The two major economic activities of the indigenous people in the Singida District are agriculture and animal keeping. The major crops grown in the Singida District include: sorghum, millet, maize, finger millet, bananas, sugarcane, sweet potatoes, tomatoes, beans, onions, cabbages, cassava, sunflower, cotton (the last two named are recent in some parts of Singida), ground nuts and others which are usually grown for sale. Population size based on household number is 78 494 households according to 2002 census. The main ethnic group of the Singida Rural Area is Nyaturu (URT, 2006).

3.2. Research Design

A cross- sectional design was used during data collection. In this; information was collected at once in time per point. This means that researchers' record information about their subjects without manipulating the study environment (IFWH, 2009). The technique

was selected due to the nature of the study where exposures and outcomes were observed and measured simultaneously in a population. In general, this technique is fast and fewer resources are needed because there is no follow-up.

3.3. Sampling Procedures and Sample Size

Both probability and non-probability sampling were employed**.** Purposive sampling was used to select two wards that are Sepuka and Mtinko. These wards were selected purposefully because they are among the wards that produce sorghum with high quantity in Singida District. Also this technique was used to find a key informant like Agricultural extension officers in both district levels up to ward level. Probability sampling was useful in selecting villages in the wards in which two villages were selected from Sepuka ward and only one from Mtinko ward. Stratified sampling was used for categorising households into two homogeneous mutually exclusive strata of sorghum producer and non-producers. This was based on the sampling frame provided by the headman of each village with the assistance of extension officers. In each village, at least 2% of households were randomly selected to give the total of 120 households (Table 2). The sample size was providing needed information on sorghum grain contribution to household food security.

Table 2: Sampling Intensity

Village	Households	Sub-Sample	Intensity
Malolo	874	60	6.86%
Msungua	847	30	3.54%
Msimi	1012	30	2.96%
Total/Average	**2733**	**120**	**4.45%**

Source: Mtinko and Sepuka Ward Excutive Offices 2012

3.4. Method of Data Collection

Data collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes (Dodge, 2003). For this study both primary both Primary and Secondary data were collected. For primary data, a questionnaire survey, focus group and key informant interview methods were employed. Secondary data were collected through reviewing various reports.

3.4.1. Focus group discussion

A focus group discussion is a structured discussion used to obtain in-depth information (qualitative data-insight) from a group of people about a particular topic (Gerritsen, 2011). The checklist was used as a tool in collecting information, from the household sorghum grower, Non-growers and agriculture extension in order to examine the quantity of sorghum and other grain produced per household and challenges facing on it, the group of 10-12 participants were taken to accomplish the discussion.

3.4.2. Key informant interview

Key informant interviews are qualitative in-depth interviews with people who know what is going on in the community (Carter and Beaulieu, 1992). This method in which there were verbal interaction between interviewee and interviewer. In depth-personal approach was applicable during the administration of questionnaires. The researcher was able to get responses from respondents who are head of household or one who is responsible to prepare food in the household, the respondent was asked various question especially concerning meals, data obtained from this was helpful in calculating DEC and examining the household food security status (Appendix 3).

3.4.3. Questionnaire survey

A questionnaire formulated of both open-ended and closed-ended questions were used in surveying. Development of this data collection tool intended to capture data according to the objectives of the study. This tool helped a researcher to collect data in a wider area with little amount of fund and moreover it gave the respondents freedoms and confidence to express themselves. This method was used for the household member especially those are able to write and read.

3.5. Method of Data Analysis

Both quantitative and qualitative methods of data analysis were used. For quantitative data, descriptive statistics employing frequencies, percentages, mean and other measures of variations were used. For qualitative data analysis method collected through focus group, key informant interview and survey were analyzed using structural function content analysis method. The structural function content analysis method is used to analyze data collected through key informant interview and field observation by

summarizing important information related to the study objective by taking transcriptions of recorded verbal communication.

Dietary energy consumed (DEC) was calculated based on only grains consumed because grains are the main staple foodstuffs in the research study area. Basing on the literature that in Tanzania cereals supply 80% while other foods supply 20% of dietary energy (Ashimogo, 1995), using only grains, DEC obtained has to be inflated by multiplying it by 100/80 to cater for energy from other foodstuffs

In an inferential analysis aided by Statistical Package for Social Science software (SPSS) Binary logistic regression was used to identify the influence of sorghum production and other selected factors on household food security.

Model:

The binary logistic regression model:

$$Y_i = \frac{P_i}{1 - P_i} = b_0 + b_1 X_1 + b_2 X_{2+} b_3 X_3 + \ldots\ldots b_5 X_5 + \varepsilon_i$$

$$\frac{P_i}{1 - Pi} = \frac{Odd}{1 - Odd} = \frac{exp\,(B)}{1 - exp\,(B)} = \frac{e^{(b_0 + b_1 X_1 + b_2 X_2 + \ldots.. b_5 X_5)}}{1 - e^{(b_0 + b_1 X_1 + b_2 X_2 + \ldots.. b_5 X_5)}}$$

Whereby;

- Y*i*, stands for food security with binary indicators that take values; 1;if household is food security; and 0 if the household is food insecure;
- P_i or Odd or exp*(b)* is a chance for a food secure household to occur;
- $_{b0}$, and $_{\varepsilon i}$ are the intercept and error term respectively;
- b_o is unbiased estimator for $b_{0;}$
- b_1, b_2 , …….. b_n are coefficients that measure a corresponding change in odds (*exp*(*b*)) brought by a unit change in X_1, X_2,….. $X_{n;}$
- b_1, b_2,b_3,b_4,b_5. Are unbiased estimators for b_1, b_2 , …….. b_n
- X_1, X_2,….. X_5 are independent variables

However, variables and corresponding measurements used in logistic regression model have been presented in Table 3.

Table 3: Variables and indicators used in logistic regression model

Variables	Measurements
Dependent Variable	
Food Security	• 1, if a household is food security • 0, if a household is food insecure
Independent Variables	
Sorghum producer	• 1, if household produces sorghum; • 0, otherwise
Extension Agent	• 1, if farmer contacted with extension agent; • 0, otherwise
Education	• Education Level (1, no formal education; 2, Primary education; 3, Secondary education; 4, Tertiary educational)
Household Size	• Number of household members
Employment	• 1, if peasant; • 0, otherwise

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1Background Information of the Respondents

The survey gathered information from household respondents of different background characteristics. Such characteristics included sex, age, education level, marital status, employment and household size.

4.1.1 Age and sex of the respondents

Based on sex representativeness, the study involved a total of 58 males (48.3%) and 62 females (51.7%) that make the sample of 120 of household respondents (Table 4). Observed data imply that women participate more in farming activities than men in the study area. The same observation reported by UNICEF (1990) that; women constitute a large portion of all subsistence farming in Africa reaching to 80% and that farming is a woman's principle duty.

Based on age distribution of respondents, the study observed the majority of respondents (50%) constituted the age groups of 30-39 years and 40-49 years and therefore the sample was rich in respondents who were within the active working group. Very few respondents (15.8%) were within the age group of 60-69 years and above (Table 4). The maximum age was 80 and the minimum was 21, average age of the respondents was 43.88±14.04. This is supported by Akudugu, Guo and Dadzi (2012) on their study that about 93% belong to the economically active group belong to the age of 18 and 60, and their technology adoption behaviors are critical for the improvement of agricultural productivity and farm household welfare.

Table 4: Characteristics of the Respondent Based on Sex and Age

Variables	Frequency	Percentage
Sex		
Male	58	48.3
Female	62	51.7
Age		
20-29	21	17.5
30-39	31	25.8
40-49	29	24.2
50-59	20	16.7
60-69	13	10.8
70 and Above	6	5.0

4.1.2 Education and marital status of respondents

The results showed that the respondents surveyed, the majority (55%) of the respondentshad attained primary school education, while very few respondents (8%) were identified to have no formal education. On the other side, 28% and 9% of respondents were observed to be possessing secondary school and tertiary education certificates respectively (Table 5). Such observation of education level among farmers demonstrates the fact that, there is a high literacy level in the study area though the majority of farmers observed to have primary education. The results are in agreement with that of CIMMYT (1993) which also finds the same and hence reported that in Tanzania, most farmers have primary education and rely on traditional farming practices.

Table 5: Characteristics of Respondents based Education Level and Marital Status

Variables	Frequency	Percentage
Education Level		
No Formal Educational	9	7.5
Primary Educational	66	55
Secondary Educational	34	28
Tertiary Educational	11	9.2
Marital Status		
Single	16	13.3
Married	81	67.5
Widow	14	11.7
Divorced	9	7.5

According to the marital status, the study observed that about 68% of respondents were married, while 13. % were single, 12% widows and 8% were divorced. However, the majority of respondents were married, and this implies that married or couple families they are more participating in agriculture production as observed in the study area (Table 5). Igben (1988) in his study finds that married farmers are likely to be under pressure to produce more, not only for family consumption but also for sale. The desire to produce more could lead to agricultural information seeking and use. Similarly, the availability of family labor could be an incentive to the married farmer to cultivate more crops and to use agricultural information.

4.1.3 Household size and occupation

(a) Household Size

The household size constituted by the majority (47.5%) of households ranged within a group of 6-10 people while a single household was observed to have 20 household members (Table 6). The average household size which was observed in the study area was 7±3.4 members. While the minimum and the maximum household size was 1 and 20 members respectively. With respect to family size results show that households having more than two members are likely to have more production than those having one. This supported by Liberio (2012) in his study observed that families had more than three members with an exception of one family, this enabled farmers to engage more in agricultural production because of the labor force available in the household, many time it is farmers with more labor that are able to take advantage of high production in agriculture.

(b) Occupation of the Respondent

The study observed that the majority (57%) of respondents identified to be peasants depending on agriculture, 26% were formally employed while the rest were pensioned and self-employed (Table 6). These results indicate that 57% farmers in the ward had no other means of sustaining their livelihoods apart from farming. Findings show that many people are employed in farming activities because agriculture is the main economic activity in the study area. This comply with that of URT(2010) which asserts that agriculture is the source of food and provides employment opportunities to about 80% of Tanzanians. Those responded are self-employed, said that agriculture is not only or main occupation they depend on as their source of income but other activities like carpenter, tailoring and selling foods ‘‘ *mamantilie*”or local beers.

Table 6: Characteristics Respondent shows Household Size, Occupation and Farm Size

Variables	Frequency	Percentage
Household Size		
1-5	42	35
6-10	57	47.5
11-15	20	16.7
16-20	1	0.8
Occupation		
Peasant	68	56.7
Formally	31	25.8
Employed		
Pensioner	8	6.7
Self-employed	13	10.8

4.2 Household Sorghum Production and other Grain per Year

4.2.1 Land size ownership

According to the land ownership majority (85%) of household respondents mentioned to own the farm size range from 0.25 to 4 acres. Very few respondents (2.5%) possessed the farm size of 20 acres and above. Furthermore, 10.8% and 17% of farming households identified to own farm sizes ranged 5 to 9 acres and 10 to 14 acres respectively (Table 7). Maximum land size owned by household was 27 acres while the minimum land size was 0.25 acres possessed by households; the identified average was 2.56±3.78 acres. The major limitation on the size of land holdings is the heavy reliance on the hand hoe as the main cultivating tool. However, small holdings in some farming system are a product of land scarcity and population pressure. Mnenwa and Maliti (2010) observed that most of

the households in Tanzania owned between zero and two acres of cultivated land, and only one third of households utilizing more than two acres.

Table 7: household Farm Size in acres

Variables	Frequency	Percentage
Farm Size		
0-4	102	**85**
5-9	13	**10.8**
10-14	2	**17**
15-19	0	**0.0**
20 and above	3	**2.5**

4.2.2 Status of soil fertility

Land fertility varies among households, in the surveyed area indicates that 48.3% had land with no fertility, 45% had land with moderate fertility while only little households that is 6.67% land were very fertile (Fig 2). Surveyed data indicate that most of the farms had no fertility and this is due to the fact that most of the surveyed area covered by sand soil type with low fertility. This supported by information provided by selected key informants that farmers and village extension agent argued that despite the fact that farmers devote in agriculture production still there is low agricultural output and this influenced by poor soil fertility. Prasad and Staggenborg (2012) argued that poor soil fertility (nutrient), soil quality, limited use of fertilizer (both organic and inorganic) and limited availability of high yielding lead among the factors to low agricultural productivity.

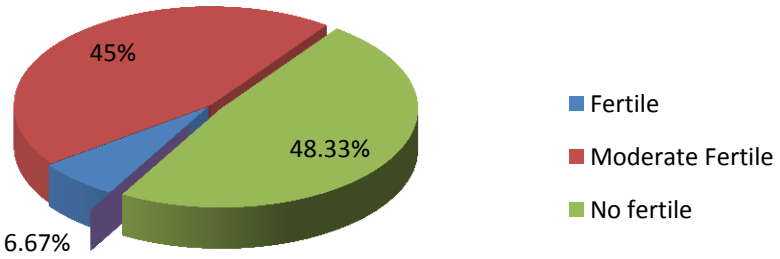

Figure 2: Status of Soil Fertility in Percentage (n=120)

4.2.3 Contact with extension officers

Surveyed data from the study area shows that; about 48% of farmers they got service or reached by extension village agents. In which they have advised them on adopting agricultural innovations such as the use of improved seeds, spacing, double strand, harvesting methods, and storage techniques. While about 52% of farmers were not reached by these extension officers. More over farmers claimed that it is not a work of extension to look for you but it will depend on your effort how to find them. From this it, revealed that most of the farmers they use their traditional ways of farming due to lack of advisement from the experts. Ban and Hawkins (1996) in their study stated that, extension plays a great role in popularizing farm technologies. Hence, to make farmer competent, it is expected from the extension agent to work closely with farmers. Then if; there will be poor communication between farmers and extension officers automatically there will be poor agricultural production due to crude technology.

4.2.4 Adoption of technology

(a) Fertilizer application

Based on fertilizer application, data from the survey indicate that most of farmers 53.3% were using organic fertilizer, 33.3% were applying both organic and inorganic, only few about 13.3%use inorganic fertilizer only (Fig 3). This indicates that most of farmers prefer organic fertilizer rather than inorganic.

Based on information from Village Agricultural Extension Officers as key informants who explained that most farmers use organic fertilizer which are manure and animal products due to the fact that at least each household keep animals. Not only that but also most of the farmers believe in using manure and animal product as the way of preserving soil nutrients. They added that lack of agricultural credits to farmers hinder them to purchase a variety of fertilizer like that from industries (inorganic fertilizer). Focus group discussion with selected farmers revealed that organic fertilizer is most preferred by farmers because it does not deplete the land compared to chemical fertilizers

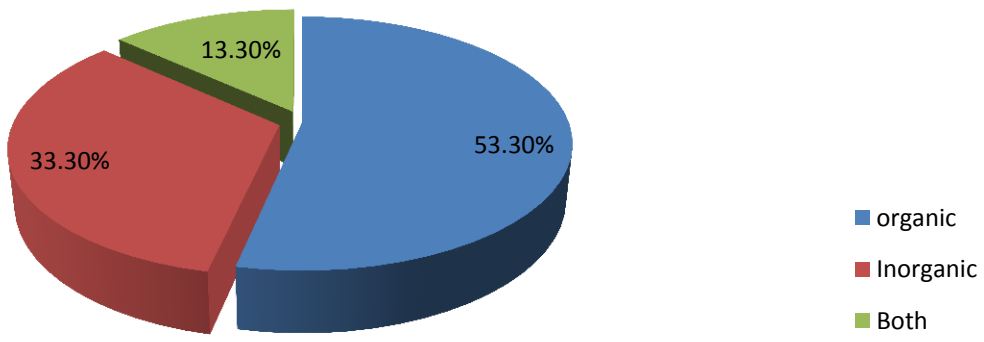

Figure 3: Fertilizer Application on Sorghum Production (n=60)

(b) Adoption of Improved Sorghum Seeds

In surveyed area, information obtained revealed that there are different varieties of sorghum cultivated in the area. This kind of produced sorghum includes improved seeds and local seeds applied. Among of the cultivated sorghum varieties in this area are as follows local seeds ((*langilanga*) 90%, Macia 51.6%, Tegemeo 36.6%, Wahi 40%, Hakika 53.3%, Kuhi30%, Serena 30% and Pato 23.3%. Obtained data show that although there is an effort to increase improved seeds but still most of the people maintain local seeds (Figure 4). This supported by Monyo *et al.* (2004); observed that as a result of the seed systems work and extension promotion, by the 1999/2000 season, 22% of sorghum growers in Tanzania were planting Pato; 13% were growing Tegemeo while 13% were growing Serena.

Through focus group discussion selected, farmers gave different reasons for adoption of new or improved varieties of seeds; they argued that improved varieties are disliked because; first they cannot keep their viability so that they can be used as seed for the next crop. Second, they cannot be stored long so that they can ensure household food security as insect pests, particularly *Sitophilu spp* attack them easily, third, due to some of them having a big proportion of floury endosperm, dehulling losses are higher than those of the local varieties. This makes farmers reluctant to accept varieties with poor dehulling qualities.

The traditional or local varieties have a large proportion of corneous endosperm that increases their resistance to pest attack. Fifth, although they yield low, traditional varieties are more palatable than the improved varieties. Sixth lack of money to afford the expense of the seeds, insufficient information on introducing improved seeds and knowledge on how to care when planted. Farmers added that improved seeds give more yield but are

more vulnerable to birds like *quelea quelea spp*. The red-billed Quelea (*quelea quelea*) is the most numerous terrestrial birds and destructive avian pest of small-grain crops throughout sub-Saharan Africa. The birds occur in 60% of t the cereal production areas of Tanzania almost every year and can cause serious local damage to millet, rice wheat and sorghum and cause considerable hardship to subsistence farmers (Mtobesya, 2012). However most of farmers observed to have no specific reason rather than their conservative on indigenous varieties in which they believe it is good in taste and more weighted than others.

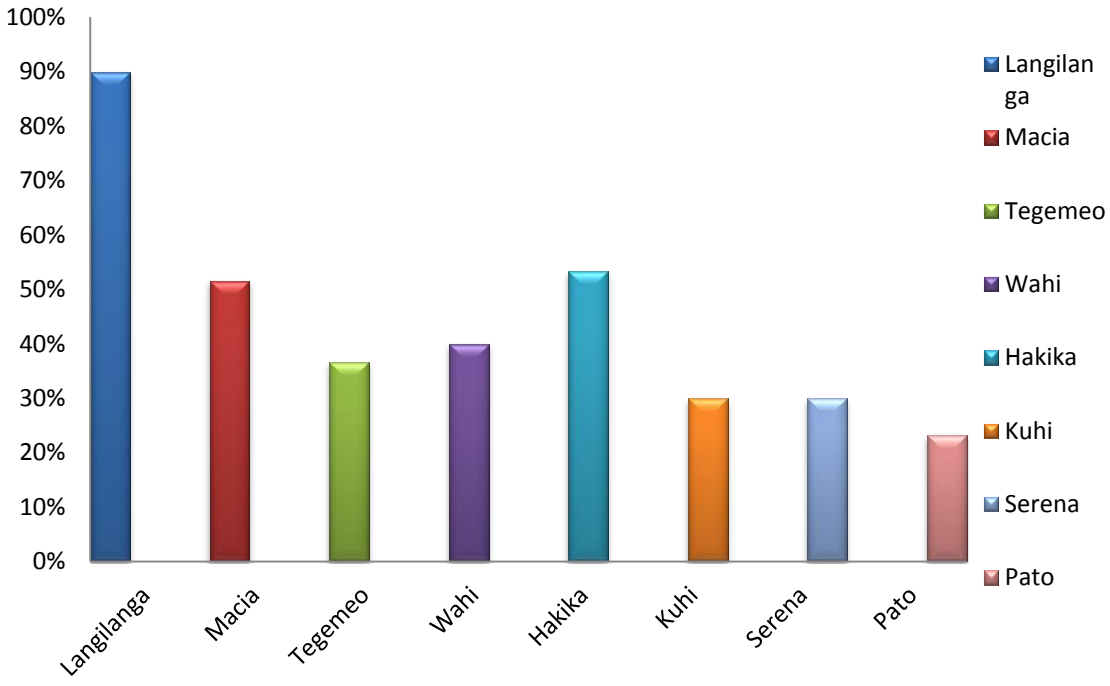

Figure 4: Adoption of Improved Sorghum Seeds Per acre in % (n=60)

(c) Adoption to modern Machine

In the surveyed area taking 120 respondents, most of the farmers (about 59%) used hand hoe, 32 (27%) used ox-plough and only about 14% they used a tractor during farm preparation (Fig 5). This indicates that the application of simplified farm machines in the Singida District is still low. Lyimo (2011) documented that; in Tanzania smallholder

farmers cultivate between 0.2 and 2.0 ha and the level of mechanization is low with hand hoes dominating in the farming systems. The use of animal traction is estimated at 24% while mechanical power is estimated at 13%.

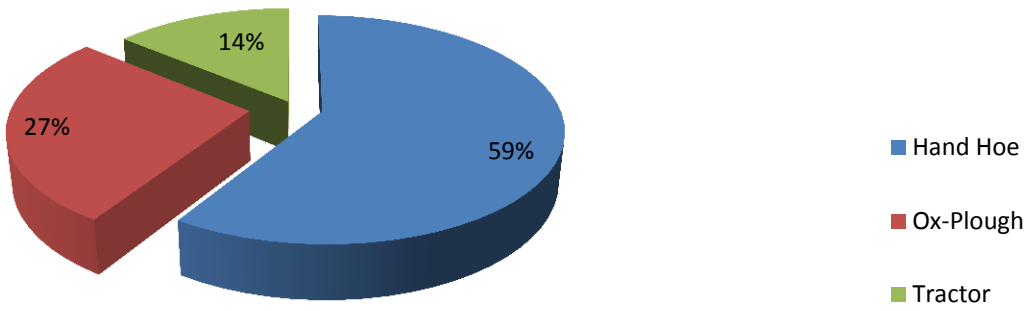

Figure 5: Adoption of Modern Machine (n=120)

(d) Obstacles on Adopting Modern Technologies

Village Extension Officers and selected farmers as key informants gave information on challenges and obstacles facing farmers in adopting modern technologies. They mentioned poverty as the main root cause hindering practicing of this innovation of using a simplified machine that enhances productivity like ox-Plough and tractors. Most of the farmers had insufficient financial capital to afford hiring or purchasing these machines.

Also interviewed respondents added that, poor supply of inputs like seeds and fertilizer, poor research-extension linkage are among of the challenges facing smallholders on using modern technology. For instance they explained that the seeds and fertilizer are supplied not in the right time. Similar findings from sub-Saharan as reported by Muza (1996) cited in Muzari(2012) observed that among of the limitations increasing agricultural

productivity in smallholder agriculture in sub-Saharan Africa include; lack of small scale irrigation facilities; insufficient selection of suitable crop varieties, especially for the marginal areas; poor research-extension linkages; poor supply of inputs, especially seed and fertilizers; infertile soils; and failure of the smallholder farmer to adapt to changing environments and adopt new technologies .

4.2.5 Household's labor source

According to its importance in the implementation household economic activities, identification of the means of labor force used by the household is much important for the Study. The surveying study identified three categories of household means of labor namely: family, family and hired labor, and hired labor. However, family labor was observed to be mostly used by the majority (52.5%) of households (Fig 6) followed by the combination of family and hired labor (32.5%). Few households (15%) were observed to be using hired labor only. These data revealed that family labor is highly applicable as the source of labor in Singida in their farm activities. The study done by Akulumuka and Madulu (2006) argued that in Tanzania farmers rely on family labor and hand hoe for cultivation in which in turn produce low agriculture output make insufficient to their food

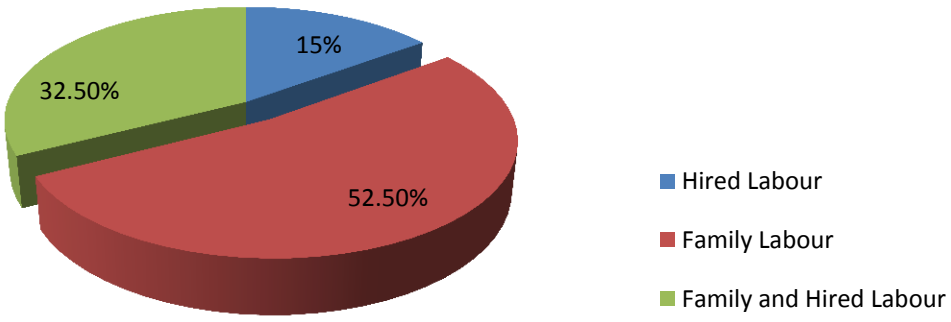

Figure 6: Major Household Source of Labor (n=120)

4.2.6 Household sorghum production and other grain

The study gathered information pertaining to household sorghum production and other grains and revealed different observations. Based on key informants who were agricultural extension officers and selected farmers, the study revealed that the main cereal crops cultivated in the study area are Pear millet, Finger millet, Sorghum and Maize. Furthermore, the study observed 330±137.717kg being the average of household sorghum production while the maximum and minimum sorghum production stood at640kg and 20kg. Maize production was observed to account for the average of 264±114.175kg whereas 750kg was the maximum and 40kg being the minimum household maize producer.

On the other side, the average household millet production identified to be 289±126.929kg while the maximum and minimum household millet production stood at 820kg and 60kg respectively. Moreover, household finger millet production averaged at 228±126.59kg whereas 600kg being the maximum while 20kg was the minimum

production (Table 8). These observations are parallel to that reported by Rohrbach *et al*. (2002) who noted that maize crop is not tolerated in semi-arid region including Dodoma, Singida, Tabora and Shinyanga but Millet, Sorghum, finger millet, and wheat are tolerant crops in these regions. The production of grain in the study area still low to sustain the household consumption per year or per season, this is due to poor agriculture technologies they use and climatic condition since many smallholders in developing countries depends on rain fed. Food production has remained low, falling to meet household and national requirements this made the Tanzania economy more vulnerable to both external and internal shocks, given the lack of other important productive sectors such as manufacturing (Runyoro, 2006).

Table 8: Household Sorghum Production and other Grain in kg (2011-2012)

Grain Type	Total	Average	Maximum	Minimum
Sorghum (n=60)	19800	330±137.717	640	20
Maize (n=103)	27213	264±114.175	750	40
Millet (n=66)	19090	289±126.929	820	60
Finger Millet (n=19)	4340	228±126.590	600	20

± is the SD of the real mean Value

4.3. Household Sorghum Consumption Pattern

4.3.1. Utilization of sorghum

Base on the utilization of sorghum in the study area, the study observed majority (88.3%) of sorghum producing households being utilized sorghum for preparing a variety of food such as *ugali, kande*, *wali* and making drinks such as local juice known as *magaye* and local beer known as *mtukuru* innyaturul language. The remaining (11.7%) respondents were utilizing sorghum for the purpose of making diet only and not otherwise.

4.3.2 Preference in sorghum prepared food

The study revealed information on the preference of consumers on the diet prepared from sorghum. The findings based on color, taste and texture featuring the sorghum prepared food stuffs. Therefore, the study observed that; 43.3% of respondents prefer food prepared from sorghum with white or *khaki* color; 30% prefer sorghum prepared food with sweet taste while 6.7% mentioned sorghum flour with a sticky feeling in hands being not preferred by their families. The rest (20%) was observed to have no decision of preference about sorghum prepared food stuffs (Fig 7). Using in-depth interview, respondents mentioned to have interest in white or khaki food color while justifying that the red color of sorghum prepared foodstuffs do not attract even eyes and therefore children often dislike eating such a colored sorghum prepared food. This a comply with the study done by Mafuru *et al.* 2007 observed that; consumer preference on sorghum *ugali* by both rural and urban consumers color was the most important acceptability. Preferences are highly on white and or khaki color, while red and or brown colors were the least preferred.

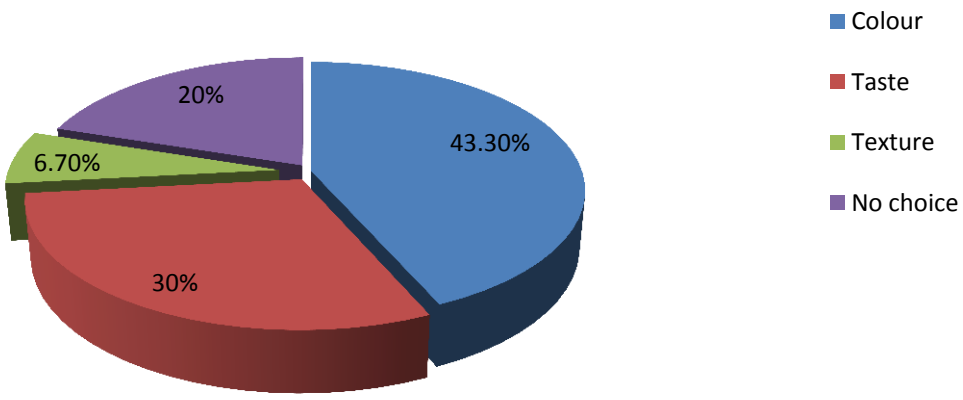

Figure 7: Preference of Consumer on Sorghum Preferred Food (n=60)

4.3.3 Contribution of sorghum to household food security

a) Household food consumption pattern

Grains consumed in household level normally based on availability of grain in which not only obtained from home produce but from any other sources like purchasing food. According to the grain consumption survey undertaken, the study identified an average household grain consumption of 84kg per month, and this is equivalent to about 80% of all diet consumed in household level. Ashimogo (1995) argues that grain supplies 80% of dietary energy while other foodstuffs supply 20% of dietary energy. Basing on sorghum consumption the average of 20.9kg observed to be consumed by household per month. In addition to that, sorghum contributes about 24.95% of the household food supply with reference to total grain consumed. However, the sorghum percentage contribution in household food consumption was almost the same in all three villages where the survey was undertaken (Table 9).

Based on the observation, generally sorghum has a vital contribution to household food security especially in dry areas despite the existence of other grains such as maize. Even though food insecurity was determined by using percentage of household grain consumption which is regarded as poor indicator of food security, but can help to draw a picture on the situation of the area? Maxwell and Frankenberger (1992) argue that by using energy contained in grains consumed there is too much focus on calories, and too little focus on protein and micronutrient consumption in defining food security.

Table 9:Household Sorghum Consumption pattern in selected villages per month

Village	**Household Grain Consumption in Kilograms**		
	Average Grain Consumption	Average Sorghum Consumption	% of Sorghum Consumption
Malolo (n=60)	84.68±50.50	23.79±19.29	28.09
Msungua (n=30)	71.93±37.49	16.38±11.24	22.77
Msimi (n=30)	95.58±40.39	22.68±17.91	23.65
Overall (n=120)	**84.06±41.34**	**20.92±18.8**	**24.95**

± is the SD of the real mean Value

b) Number of Meals eaten by Household

According to household food consumption surveyed information, the study observed that the majority (56%) of households were able to take three meals and above per day. Households which were able to take two meals accounted for 40.8%, while very few households (2.5%) were surviving using one meal per day (Table 10). From this information implies that although about half households they able to take three numbers of meals per day but others do not. This marks the attention of presence to food deficit in many households which alert coming or presence of food insecurity. Mwakalobo *et al*. (2009) argued that during food shortages and high food prices, households tend to reduce food consumption, indicated by a declining number of meals per day, with serve consequences for the household's nutritional and health status.

The information observed from the focus group discussion with selected sorghum producing farmers reveals that, during harvesting period household consumption of

maize, millet and sorghum are almost the same but sometimes household maize consumption exceeds other cereals. This is due to the fact that most consumers prefer the maize taste to other available cereals excluding rice but in the period when food is scarce especially within the last five months from August up to January most of households suffer from food shortage. During this period most of families tend to consume most sorghum compared to other cereals. Although the maize crop is not tolerated in dry condition, still almost all households cultivate it.

Table 10:Number of Meals eaten by Household

Usual Number of Meals eaten Per Day	**Households**	**Percentage**
1 Meal	3	2.5
2 Meals	49	40.8
3+ Meals	68	56.7
Total	**120**	**100**

4.4 Household Food Source

During the period of stock run-off, the interviewed household respondents clarified that, farmers tend to use various coping mechanisms to endure the harshest periods of food grain scarcity. Afrol News (2013) said that; the central regions of Tanzania are not typically surplus areas, so it is common for households in this area, especially the poorer ones, to run out of their own food stocks before the beginning of the next harvest (April/May).

In January of a typical year, however, most households are usually still able to meet food needs from their stocks and are busy cultivating their fields. When the harvest nears and

stocks run out, they turn in the market, selling livestock or labor to earn the cash necessary to buy food. Based on the survey involved both households sorghum producers and non- sorghum producers, the study observed about 80% of surveyed households being able to purchase food; 8.3% used to consume own farm produced food; 5.8% acquires in kind; while the remaining (5.8%) used other means of supplementing household food requirements to reach the coming harvest season including f food support from friends and relatives they called it *kuhemea* (Figure 7). Study done by Boudreau (1999) comes with similar observations on household sources that; household own produced food, purchased and food acquired in kind (gift) where the main food sources in Babati District.

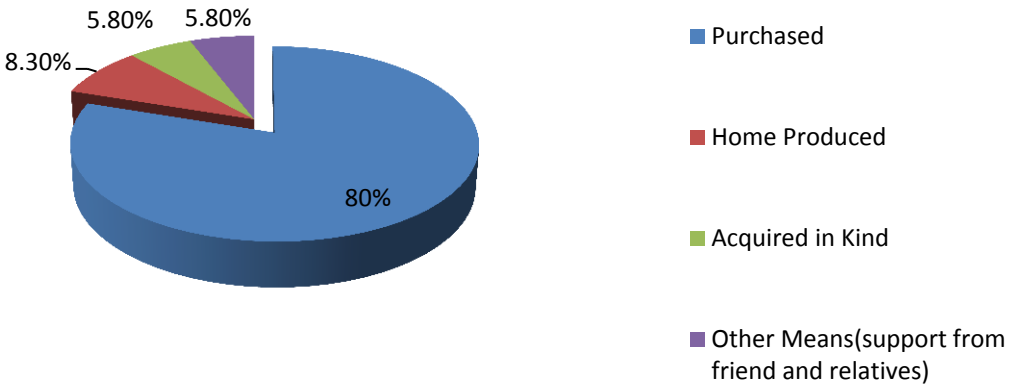

Figure 8: Households Means of Getting Food When Stock Run-off in % (n=120)

4.5 Sorghum Production and Household food Security Status

4.5.1 Household food security status

Following the undertaken Household Dietary Energy Consumption survey as part of the study which delivered energy consumption in terms of Kcal/adult equivalent per day, the study identified that 18 (15%) of the surveyed households were food insecure with reference to the food poverty line of 2200kCal/adult equivalent per day (Table 11). Among of the 18 household food insecurity 10 were from the group of non-sorghum producer household while 8 from sorghum producer households. The maximum DEC identified was 4224kCal/adult equivalent per day and the minimum was 772kCal/Adult equivalent per day while the average DEC observed was 2681±602.45kCal/Adult equivalent per day. Generally majority of surveyed households (85%) observed to be food secure.

Since the study observed 24.95% contributed by sorghum in households food consumption pattern (Table 9), therefore, the same contribution also masked in household food security in the study area. Moreover the influence of sorghum production can be observed through understanding the household food security status in the study area.

Table 11: Household Dietary Energy Consumption (DEC) in Kcal/Adult Equivalent/Day) Observed Per Month

Kcal/Adult Equivalent/day	Frequency	Percentage
600 -1132	1	0.8
1133 -1665	5	4.2
1666-2198	12	10
2199-2731	44	36.7
2732-3264	34	28.3
3265 and above	24	20
Total	**120**	**100**

4.5.2 Influence of sorghum production on household food security

Based on the contribution of sorghum production on household food security, the study revealed information concerning the influence of the sorghum crop and other associated factors to household food security using Binary Logistic Regression Analysis, using binary indicators food security which is: 1-household food security, 0-household food insecurity. The extension agent observed to have positive significant (p=0.034) influence to the household on becoming food secure. This implies that the improving extension service would have influence in sorghum production and other grain which in turn will help in reducing household food insecurity. However sorghum producing household was also observed to increase the chance for the household to be food secure by 1.504 despite its insignificance (Table 12). Other factors influencing food security although not significantly were education, employment and household size. In addition, households headed by peasants as employment status observed to be vulnerable to food insecurity though the influence is not significant. Most of the household headed by peasants are

vulnerable to food insecurity due to the fact that their main source of food comes from farm production since they are producing insufficiently and they have low purchasing power to meet the annual food requirements.

Table 12: Binary logistic regression analysis presenting the influence of sorghum production and other selected factors on food security

Variables	**B**	**S.E**	**Wald**	**P-Value**	**Exp. (B)**
Constant	-0.888	1.789	0.247	0.620	0.411
Sorghum Production	0.408	0.562	0.527	0.468	1.504
Extension Service	1.219*	0.576	4.488	0.034	3.385
Education	0.093	0.498	0.035	0.852	1.098
Employment	-0.701	0.769	0.832	0.362	0.496
Household Size	0.136	0.092	2.171	0.141	1.146
N=120					

*Significant at $p < 0.05$.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The study documented the contribution of sorghum to household food security, in this it is evident that farmers in semi-arid regions produce and consume sorghum. Uses of sorghum are mainly for consumption, and they use for making meals like *ugali*, *kande* and *wali* also sorghum is used in making local bear known as *mtukuru* and juice known as *magaye* in Nyaturu language.

Sorghum proved to have contribution in food security since it contributes about 24.9%to household grain food supply. Food security status in semi - arid regions where sorghum and other tolerant crops are grown for large extent food insecurity incidence is still persisting. In this study observed that both farmers produce sorghum and not producing are vulnerable to food insecure. Some factor identified to have influence in food security status in the household such as contact with extension agent which influence significantly. In addition production of sorghum in households increase the chance of household to become food secure though it is insignificant. Other factors influence is like education, employment and household size .As observed that households headed by peasant are vulnerable to food insecure despite of its insignificance. It is potential to improve extension service so that to increase agriculture productions, especially to these tolerant crops in semi-arid regions like sorghum and others which in turn will reduce food insecurity among households.

5.2 Recommendations

In correspondence to the findings and conclusions the following are recommended

- In regions where there is persistent drought like central zone of Tanzania, cereal grain crops such as sorghum and millet should be given more priority due to its tolerant in such condition so that can help to fight for or reduce food shortages in households.

- Farming Technologies produced should be affordable to farmers based on farmer's scarce resources, so as to enhance technology transferring with the available extension and research supports and are sustainable over the long term.

- Extension services should be properly linked to farmers especially those smallholder sorghum producers by involving them in experimentation of innovations such as how to produce new variety seeds, application of pesticides, and means of storing and processing sunflower and dissemination of those innovations to their fellow farmers which will motivate them to adopt these scientific achievements.

- Effective introduction of on-farm seed production should be enhanced to enable farmers produce on-farm seeds within their community in order to alleviate the seed shortage. Also strengthening the farmers' knowledge on quality seed production, management and marketing systems.

- The government should make sure rural transportation and infrastructures are improved to make them passable in all seasons in order to make many producing areas access to input and output market and contribute to timely input delivery.

Government and other development agencies should make sure smallholder farmers get agricultural technologies such as tractors and irrigating machines at affordable prices as well as increasing agricultural subsidies such as fertilizers.

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APPENDICES

Appendix1: Questionnaire for household respondents

Number……

SECTION ‘‘A’’

Background Characteristics for Respondent

1. Name of respondent……..
2. Name of ward…….
3. Name of village…….
4. Relation to the household…….
5. Gender…….(tick)

1. Male ( ) 2. Female ( )

6. What is your age? .....(year)
7. Marital status …..1. Single ( ) 2. Married ( )3.widowed ( ) 4.Divorced( )(Tick one)
8. How many are you in this household? .....
9. What is the highest level the head of household has completed? (tick one)

1. No formal education ( ) 2. Primary School( ) 3. Secondary/ High school ( )

4. Tertiary education ( ) 5. Other ( ) specify…….

10. What is your occupation apart from being a farmer? (Tick appropriate)

1. Peasant ( ) 2. Formally employed ( ) 3. Pensioner( ) 4. Self Employed ( )

SECTION ‘‘B’’

Land ownership and type of crop grown

11. How much land do you own in acres? ……..

12. Are you satisfied with the size of land ……..1.YES ( ) 2.NO ( ) (Tick one)

13. If **NO** in (11) how big would you want to be…….

14. Do you consider your land to be...……..(tick one)

1. Fertile ( ) 2. Average ( ). 3. Not fertile ( )

15. What kind of fertilizer do you apply in your farm?.....(tick one)

1. Organic ( ) 2. Inorganic ( ) 3. Both ( )

16. 16. Do you get some extension service from Agriculture Extension –Officer pertaining the crops that you produce?

1. YES 2.NO. (circle one)

17. If “**YES’’** in (16) how often? _____

18. What type of information do you get from extension officers? _____

_____

19. Do you cultivate sorghum? .....(tick one)

1. Yes ( ) 2. No ( )

20. If **YES** in (19) which kind of variety of sorghum do you cultivate

Sorghum Variety	**Area cultivated in acres**
1……	……
2……	……
3……	……
4……	……
5……	……
6……	……
7……	……
8……	……

21. Which kind of work force do you use during farm cultivation?(Tick one)

1. Hand hoe ( ) 2. Ox-plough ( ) 3. Tractor ( )

22. What challenges or obstacles are you facing in adopting new technologies?

I. ……

II. ……

III. ……

IV. ……

V. ……

VI. ……

23. What are the sources of labor in household farming activities? (tick one)

1. Family labor ( ) 2. Family and Hired labor ( ) 3. Hired labor ( )

24. Which grain crops among of these do you cultivate?(You can tick even more than one)

Grain Crop	**Area devoted to crop(acres)**	**Yield in kg.**
Maize ( )		
Sorghum ( )		
Finger millet ( )		
Millet ( )		
Other. .(specify) ( )		

Others ……

25. Fill amount of grain you consumed per meal per day in your household (use the form provided-appendix. i i).

26. Does your member in households eat meals made from sorghum?.....(tick one)

1. YES ( ) 2.NO ( )

27. (a)If "**YES''** in (26), are there any choices they make?_____

1. None ( ) 2. Taste preference ( ) 3. Color Preference ( ) 4.Others_____ ( ) (specify)

…….

…….

(b)If, "**NO"** in (26), what sorghum used for?

……

……

28. According to grain crops you mentioned in (24), which crop do you prioritize to plant first during the beginning of the season? And why? (Mention the crop from the one start to the least).....

Type of crop	**Reasons**
1……..	i. ……
2----------	i. …….
3----------	i. ……
4----------	i. ……..
5----------	i. ……

29. What kind of assistance do you have in order to increase crop output especially sorghum and household food security?

END!

THANK YOU.

Appendix2: Checklist for focus group discussion and key informant

SECTION A

Group number……

Number of people…….

SECTION B

1. What are the challenges do you facing in your agricultural production?
2. In your area which kind of fertile preferred by most farmers in term of organic or inorganic?
3. What are types of sorghum varieties cultivated in your area?
4. Are there any constraints/challenges facing in production of sorghum?
5. Are there any obstacles facing on adopting agriculture modern technology?
6. Based on your experience do the rate of grain consumption is the same for all grain throughout the season?

THANK YOU FOR YOUR COOPERATION

Appendix 3: A Copy of the household grain consumption

FORM: RECORDS OF AMOUNT OF GRAIN CONSUMED BY ALL MEMBERS FOR 30 CONSECUTIVE DAYSDAYS: (1/10/2012 - 31/10/2012).

Number of Household member.....

Number	**Gender**		**Age**
	male	**female**	
***1**	V		**49**
1			
2			
3			
4			
5			
6			
7			

Date	**Morning** (Amount Consumed in Kg)	**Afternoon/ Lunch** (Amount consumed in kg)	**Evening/Dinner** (amount consumed in Kg)
1*	Maize flour: 1/2kg	Sorghum flour:2 Kg	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			

23			
24			
25			
26			
27			
28			
29			
30			
31			

Thanks for your cooperation.

Appendix4: Household food security status (DEC), based on dietary energy consumption in terms of kcal/adult equivalent per day.

	Dietary Energy Consumption of the Households	
	Household Sorghum producer	**Household Non-Sorghum Producer**
Malolo	3471.25	2688.17
	2784.0	2596.2
	2235.0	2682.11
	1178.0*	2804.07
	1703.2*	2068.0*
	2213.0	3295.0
	2433.0	2930.0
	2382.7	2864.05
	1497.0*	2621.0
	2764.0	2585.0
	3111.1	2744.0
	772.0*	2262.0
	3173.9	1447.0*
	3288.9	1380.0*
	1621.9*	1717.0*
	3792.0	2678.0
	2839.0	2502.0
	2240.0	2089.0*
	2748.0	2462.0
	2214.0	2446.0
	2416.0	3675.0
	2429.0	2230.0
	2286.0	2729.0
	1775.0*	2582.0
	2915.0	3356.0
	2372.0	1746.0*
	2541.0	3135.0
	3412.0	3056.0
	2744.0	2942.0
	2845.0	2478.9
Msimi	3484.0	2309.0
	2550.0	2473.0
	2353.0	2634.7
	3381.0	2743.8
	3271.0	3889.0
	3161.8	2758.7
	2477.5	3239.0
	2091.8*	3092.0
	3494.0	1956.5*
	2806.0	2001.0*
	2348.0	3614.0
	2618.9	2971.9

	4224.0	2224.0
	3710.0	2461.0
	2200.8	2096.0*
Msungua	3408.0	3295.7
	3544.0	2607.0
	2892.0	3407.0
	2343.7	3414.0
	3059.9	2329.0
	2303.0	2257.0
	3031.6	2283.8
	2275.0	2892.9
	3029.0	3181.0
	2760.0	3085.0
	3304.0	1751.0*
	3442.0	3184.0
	2099.0*	3004.0
	3364.0	3393.0
	2268.0	2928.0

Note: * *means; Food Insecure Status*

Appendix5:Operational Definition

Concept	**Operational definition**	**Measurement level**	**Units**
Age	Number of years since one was born	Ratio	Numbers
Sex	Being male or female biologically	Nominal	1=Male, 2=Female
Education level	Number of years one went to school	Ratio	Net years
Household size	Number of members in a household	Ratio	Number of members
Land	Land owned in terms of size cultivated per hector	Ratio	Unit per area
Technology	Application of: Hybrid seeds, Fertilizer Machine	Nominal	1=Use 2=Not use
Policies	Presence of policies supporting sorghum production	Ratio	1=Yes 2=No
Value (utilization)	Amount of sorghum flour undertaken per household in kg/day	Ordinal	$kg/year/$ household
Labor	Smallholders; Number of labor force participate in agriculture activities.	Ratio	Labor force/ha
Productivity	Kg/acre kg/year	Ratio	Kg
Food security	Kcal/day/household	Ratio	Kcal
Sorghum	Varieties of Sorghum	Nominal	Types