PROJECTION OF SORGHUM PRODUCTION RESPONSE THROUGH MULTIPLE USES PROMOTION STRATEGIES IN SELECTED DISTRICTS OF TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURE ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE.MOROGORO, TANZANIA.

2015

ABSTRACT

The study intended to assess sorghum production responses through multiple uses promotion strategies. The inspiration of this study was inadequately information on how much sorghum can be put into multiple uses thus can be used as a pull factor in increasing smallholder's production. Specific objectives were (i) examine multiple uses of sorghum in each district, (ii) determine the influence of sorghum multiple uses on sorghum production and (iii) predict future production of sorghum based on the previously production. This study was conducted in five districts namely Kongwa, Singida Rural, Iramba, Kondoa and Serengeti. Primary data and time series data were used. About 508 smallholder farmers were interviewed for this study were descriptive statistics, multiple liner regression and liner form of ARIMA model were used. The result shows that, uses of sorghum vary significantly in the five districts surveyed. Majority of respondent in all districts use sorghum for human food specifically stiff porridge (87.25%), animal feed (80.87%) and porridge (57.39%) while few responses have been observed on uses such as alcoholic brew (36.82%), non alcoholic drinks (23.77%) and (2.32%) on fried products. In terms of food utilization like stiff porridge Serengeti is the leading district followed by Kondoa and Singida. Multiple regression model reveal that, amount sold, amount used in stiff porridge, porridge, and mixed sorghum flour with other cereal are statistically significance at ($p<0.00$ and $p<0.05$) levels while local brew and other uses are not statistically. Future production of sorghum was expected to increase up 911 530 tonnes by year 2025 showing a positive increasing trend. The forecasted yield would be helpful for policy maker and sorghum stakeholder to foreseen future requirements of grain. The study concluded that, sorghum utilization in food consumption and amount sold are the major uses that influence small holder production, so more effort, support and motivation to farmers is needed so as to make sorghum as profitable crop.

DECLARATION

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

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ACKNOWLEDGEMENTS

This dissertation would not have been completed without the help, support and encouragement from many people. They are too many to mention by name, but their contribution is much appreciated.

Sincere gratitude goes to my supervisor Prof. Joseph P. Hella for his invaluable comments, suggestion, encouragement and reference materials from the very beginning of this work. Special thanks to Dr. Jeremia Makindara for his constant encouragement, communication and support to make sure this work is finished. Nothing to say but God bless you all.

It is a great pleasure to express my heartfelt gratitude to International Crop Research Institute for Semi Arid Tropics (ICRISAT); SMU project for financial support for data collection for this study. Without their support its completion would not have been possible in such successful way.

I would like to express my special thanks to District Agriculture and Livestock Development Officers (DALDO), extension officers, ward executive officers (WEO) and Village chair person in all places where the study was conducted for their unreserved assistance during data collection. Further, I would like to extend my sincere gratitude to all academic staff in the Department of Agriculture Economics and Agribusiness, my colleges Emmanuel John Temu and Revocatus Kayaga Ntengo for their support and encouragement throughout my study period at SUA.

Special thanks to my family especially my brother Frank Fredson Noel for his financial support and encouragement during the course of study. Above all, thanks to almighty God for his help throughout the complicated situations I faced for while pursing this study.

DEDICATION

This dissertation is dedicated to my family especially my mother Elizabeth Mtui and my husband Mr. Essau. Wawa for their spiritual support and encouragement throughout my study time at the University. May the Almighty reward them abundantly.

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LIST OF ACRONMYS

ABSF	African Biotechnology Stakeholder Forum
AFRIPRO	African Professional Network
ARMA	Autoregressive Moving Average Model
DALDO	District Agriculture and Livestock Development officer
DDGS	Distillers Dried Grains with Soluble
ECARSAM	Eastern and Central African Regional Sorghum and Millet
FAO	Food and Agriculture Organization
FAOSTAT	FAO Statistics
GAP	Good Agriculture Practices
ICRISAT	International Crop Research Institute for the Semi –Arid Tropics
INTSORMIL	International Sorghum and Millet Collaborative Research Support Program
ISNM	International Sorghum and Millets Newsletter
KIRDI	Kenya Industrial Research and Development Institute
MAFC	Ministry of Agriculture Food Security and Cooperation
NBS	National Bureau of statistics
NFGR	National Food Grain Reserve
NGO's	Non Governmental Organization
PMO-RALG	Prime Minister's Office-Regional Administration and Local Government
SADC	Southern African Development Committee
SMIP	Sorghum and Millet Improvement Program
SMU	Sorghum for Multiple Uses
SPSS	Statistical Package for Social Scientists

SSA	Sub Sahara Africa
SUA	Sokoine University of Agriculture
TBL	Tanzania Breweries Limited
TFNC	Tanzania Food Nutrition and Cooperative
URT	United Republic of Tanzania
USA	United States of America
USAID	United States Agency for International Development

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Sorghum is one of the top cereal crops in the world ranked as the fifth most important cereal crop in production and acreage after wheat, rice, corn and barley (Smith, 2010). It is a staple food crop for over 750 millions of the poorest and most food- insecure people in the semi-arid tropics of Africa, Asia and Central America (Food Security Department, 2004). The crop is genetically suited to hot and dry agro-ecologies areas where it is difficult to grow other food grains, these areas are frequently drought-prone and characterized by fragile environments (ICRISAT, 2004).

Globally, sorghum is grown in 46 million hectares accounting for an annual production of 60 million tonnes (FAOSTAT, 2013). In 2013, the USA was the world's largest producer of sorghum with total production of (8.8 million metric tonnes annually), followed by India (7.0 tonnes), Mexico (6.9 tonnes), Nigeria (4.8 tonnes) and Argentina (3.6 tonnes) (FAOSTAT 2013). In Sub Sahara Africa (SSA) sorghum is reported as the second most important cereal after wheat with total production of 20 million tonnes per annum (Taylor, 2003). This is about one-third of the world crop production whereby Nigeria, Sudan, Ethiopia, Burkina Faso and Tanzania are the largest producers of sorghum accounting 75% of African's production (Taylor, 2011). Other countries include Ghana, Togo, Niger, Mali, Egypt, and Uganda (FAO, 2010).

According to (FAO, 2008 and Rohrbach *et al.,* 2002) sorghum is the third most important staple food in Tanzania after maize and rice benefiting about 80% of Tanzanians. It plays

a significant role to the smallholder farmers as a chief source of food and income especially those who live in semi- arid agro ecological zones (URT, 2002). It also acts as a food support whenever there is shortage during drought and when other grains fail to grow (Okuthe *et al*., 2009).

The average yield for sorghum in Tanzania is estimated to be approximately 1000 kg ha^{-1} which is too low to sustain an average farm family for 12 months (FAOSTAT, 2008). From the past ten years sorghum production in Tanzania has increased from 670,000 metric tonnes in the year 2000 to 900 000 tonnes in 2010 (URT, 2013). It has been reported that, about three quarter of total production is produced on the Central and Western zone of Tanzania i.e. Dodoma, Singida, Tabora, Shinyanga, Mwanza, Mara and Morogoro. Only smaller quantities are harvested in the South-East regions of Tanzania (Wortmann *et al.,* 2006).

Despite an increase in yield from the past ten years, sorghum is still produced under small scale farming with poor management and other production constrains such as low soil fertility, bird damage, striga weed infestation, use of cultivars with low yield potentials, poor technology and other socio-economic factors (Bucheyeki *et al.,* 2010). Only few farmers' use improved varieties of sorghum use fertilizer and follow good agronomic practices (GAP) (Rorhbach and Kiriwaggulu, 2007).

1.2 Sorghum Utilization

Sorghum, like many grains has a diversity of uses, including human consumption and animal feed. In the USA and other developed countries, sorghum is used largely for animal feeding. In developing countries, especially in Africa and Asia, it is used primarily as human food (Mella, 2011). Grain sorghum is used as a flour to make porridge, side

dishes, malted, distilled beverages, and specialty foods such as popped grain (Parthasarathy *et al.,* 2010). In terms of animal feeding Sorghum is also considered to be a significant crop whereby, grain sorghum is used for silage where cattle and sheep are frequently pastured on grain silage after harvest (Heuze *et al.,* 2013). Sorghum fibers are used in wallboard, fences, biodegradable packaging materials and solvents. Dried stalks are used for cooking fuel, dry season fodders, fencing materials and dye can be extracted from the plant to color leather (House, 2005).

A more recent use of sorghum is for ethanol by-products from ethanol production, such as sorghum-DDGS (distillers dried grains with soluble) which is the dried by-product of the manufacture of alcohol (beverage or fuel) from sorghum grains or from grain mixtures in which sorghum grain predominates (Tokach *et al.*, 2010). In agronomic part it makes an excellent rotational crop with other crops such as cotton, soybeans and rice. Grain sorghum in a rotation has been reported to reduce incidence of various disease and pests such as nematodes (Tokach *et al.,* 2010). Therefore, there are good prospects for the expansion of the industrial market for sorghum if its yields can rise fast enough to catch up with yields of other competing cereals (FAO/ICRISAT, 1996).

1.3 Problem Statement and Justification

Area under sorghum cultivation SSA has steadily increased over the years, but the average yield trends are decreasing (Olembo *et al.,* 2010). Despite the efforts that have been undertaken in diffusing large number of new varieties with traits such as; high yielding, high nutritional value, resistant to pests and diseases, resilient to climate change especially drought condition, there are still constraints towards sorghum productivity in

Tanzania. The situation is worsened by problems such as poor soil fertility, drought, and poor technology (Bucheyeki *et al.,* 2010).

Numbers of studies and programs have been implemented in Tanzania to support sorghum production, its utilization, technology adoption and marketing. Among of these include Mwanga (2002) on adoption of improved technologies for sorghum and peal millet production, Laswai *et al. (*2003) on sorghum utilization in food, INTSORMIL (2006) program with the goal of improving nutrition and increase people income in developing countries and in the United States of America, building a sustainable infrastructure for product development and food entrepreneur/industry technical support. A strategy to Promote increased use of sorghum and millet in East Africa, (Mosha, 2009), Assessment of the role of institutional and transaction cost in sorghum supply chain; Makindara (2012), Sorghum value chain analysis, Sorghum and Millet improvement program SMIP which was conducted by International Crop Research Institute for Semi Arid Tropics (ICRISAT) with the aim of improving sorghum and millet productivity in SADC countries.

Despite, all the above mentioned studies and programs, still there is paucity of knowledge on how expanding multiple uses of sorghum which can act as pull factor in increasing smallholder production. Recently new schools of thought argue that, limited uses of sorghum affect its demand and production with negative impact to producers. Along this line of thinking the ICRISAT decide to fund the SMU project aimed at putting more sorghum to uses in Tanzania and Kenya with the expectation that, if the utilization base is expanded through putting more emphasis on uses, it will bring changes at farmer's level through price change; hence farmers will be motivated to increase production (SMU project document, 2012). However little evidence to defend this proposition, hence this

study was proposed to establish the responses to production through expanding the consumption base. This result provides additional information that helps to explore more opportunities on uses and contributes to a better understanding so as to enhance production.

1.4 Research Objectives

1.4.1 Overall objective

The overall objective of the study was to establish the sorghum production responses from its multiple uses promotion strategies.

1.4.2 Specific Objectives

i. To examine multiple uses of sorghum in selected districts
ii. To determine the influence of sorghum multiple uses on sorghum production
iii. To predict future production of sorghum based the previously production

1.4.3 Hypothesis

i. Putting sorghum into multiple uses has no significance influence on production
ii. Previously sorghum production has no significance influence on its future production

1.5 Organisation of the Study

This report is organised into five chapters. Chapter one covers the introduction with sections on background information, problem statement, objectives and hypotheses. Chapter two present the literature review where reviewing matters pertaining to the specific objectives such as sorghum production, utilization, projection studies and the model used in this study. Chapter three covers the methodology used include description of the study, conceptual frame work, sample size, data collection and how the models

were used. Chapter four present the main results of the study and finally chapter five present conclusion and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Frame Work

Based on this study, sorghum is considered as one of the main cereal crop in Tanzania that has multiple uses but, the utilization for it has not been fully exploited, this make farmers to be reluctant in production. This assumption is based on demand theory, that there is an inverse relationship between the price of sorghum and the demand, whereby its demand in the country is still low due poor exploitation on alternative uses as compared to other cereals. Farmers are reluctant in production, and the production is still under small scale farming with poor management and other production constrains that results to low yield and makes market price to be high. Sorghum like any other cereal has the potential to improve welfare of small holders if its utilization was fully exploited especially on new market such as breweries industries, animal feed industry, red to use food, pastas, steam food and confectioneries. These create a huge potential for demand increase as the demand increase small holders will increase the production to meet the demand. The increased production will in turn increase farmer's income and their wellbeing. Therefore, there are good prospects for the expansion of the industrial market for sorghum if its yields can rise fast enough to catch up with yields of other competing cereals.

2.1.1 Sorghum production in Sub Sahara African Countries

The annual production of sorghum worldwide is over 60 million tonnes, out of which Africa produces about 20million tonnes (Taylor, 2003). In terms of tonnage sorghum is African second most important cereal and Nigeria is the leading producer in Africa

followed by Sudan, Ethiopia Burkina Faso and Tanzania (Taylor, 2011). According to FAO data (as quoted by Taylor, 2003). SSA alone produce about 18 million metric tonnes of sorghum annually of which Tanzania its self accounting for 75% of Africa's production (FAOSTAT, 2010). Production of sorghum varies from country to country and this disparity is caused by the degree of commercialization and the corresponding low levels of adoption of new technologies and use of improved varieties (FAO, 2010).

Table 1: Sorghum production in Sub Sahara African Countries in (1000MT)

Country	2007	2008	2009	2010	2011	2012	Average
Nigeria	10 000	11 000	6600	6750	6900	5943	7866
Sudan	4999	3869	4192	2630	4605	4524	4137
Ethiopia	2659	2619	2971	3960	3951	3604	3294
B.Faso	1507	1875	1522	1990	1500	1924	1720
Mali	901	1027	1466	1257	1191	1212	1176
Tanzania	971	552	710	800	807	839	780
Egypt	844	867	781	702	839	757	798
Chad	577	685	600	680	648	1172	727
Cameroon	906	931	1060	1099	1150	1100	1 041

Source: Index mundi. www.indexmundi.com/agriculture 20/6/2014

2.1.1.1 Sorghum Production in Tanzania

Sorghum production in Tanzania in a recent year has an average of 671 000 (which is a little lower than 750 000 tonnes in 2003 (FAOSTAT, 2010). Despite the fact that its production has decrease the amount of sorghum produced in Tanzania is higher when compared to the sorghum output of other sub-Sahara counties. Area under sorghum production has 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). At farmer level average yield of 0.6 tonnes per acre which is far lower than production in other Africa countries where the average yield is 4 tonnes per acre (URT, 2012).

Table 2: Sorghum production in Tanzania for the past ten Years

Year	Area harvested in(000 ha)	Yield in (000 tonnes)
2004	697	649
2005	737	730
2006	716	712
2007	818	971
2008	597	551
2009	874	710
2010	618	800
2011	811	807
2012	839	839
2013	850	800

Source: Index mundi. www.indexmundi.com/agriculture 20/6/2014

2.1.1.2 Sorghum production in Regions

Sorghum is produced in many parts of Tanzania but higher production is experienced in Western Zone (Tabora Region) Central Zone (Dodoma and Singida Regions), and Lake Zone (Shinyanga, Mwanza and Mara Regions) (Wortmann *et al*., 2006). In general Central and Western zone account more than 50% of the area under sorghum production in the country while Southern highlands and Northern Zone are the least sorghum production areas. At nation level total area planted with sorghum in 2007/2008 was (568 650 ha) where 566 728ha in Tanzania mainland and 1922 ha in Zanzibar (URT, 2008). The highest proportional of land planted with sorghum was in the three regions of Shinyanga (98 145 ha or 17.3%) Singida (97 513 ha or 17.2%) Dodoma (96 147 ha or 16.9%) Mara (73 615 ha or 13%) Tabora (45 837 ha or 8.1%) and Lindi (38 023 ha or 6.7%) (URT, 2008). Production in the country is mainly for home consumption and is a key factor in household food security, particularly in marginal areas with low rainfall and poor soil fertility (Monyo *et al.,* 2004).

Table 3: Sorghum production areas and yield in Tanzania year 2007/2008

Production zone	Planted area in (Ha)	Average yield in t/ha	%
Central	293 497	1	51.8
Lake	207 989	0.8	36.2
Coastal	73 617	0.7	12
Southern highland	34 885	0.9	6
Northern	10 733	1	2
Total	566 728		100.0

Source: (URT, 2008)

2.1.2 Factors Limit Sorghum Production

2.1.2.1 Pest and disease infestation

Farmers are lacking knowledge on the agronomic practices to control pests and disease hence resulted to yield decrease and this has been reported as the major problem that hinders production (Marangu, 2012). Good Agronomy Practices and use of fertilizer (micro dosing) is expected to increase the productivity to about 1.5 to 2.0 tonnes per ha (SMU project document, 2012). The increased productivity will also increase available biomass which can be used as livestock feed and also produce organic fertilizer (SMU project document, 2012).

2.1.2.2 Low rate adoption of improved varieties

The rate of adoption of new sorghum cultivars in Tanzania is low and many farmers still prefer landraces (Bucheyeki, 2010). Although landraces are late maturing and photoperiod-sensitive, they are well adapted to local stresses (Bucheyeki, 2010). Effort have been undertaken to diffuse more varieties that are high yielding and adopted to climate condition but, still farmers are recycling local seeds (Makindara, 2012). Experiment conducted in Nzega with the aim of assessing improved cultivars Tegemeo, Pato and Macia to the commonly used landrace in terms of yield, farmer's preferences

and assesses economic potential of improved sorghum cultivars. The result reveled that Tegemeo was the best which yield 2580kg/ha (Bucheyeki, 2010). An economic analysis indicated that there is potential of doubling sorghum grain yield from 1000 to 2000 kg ha-^{1} and income from 525 600 to 928 800 Tsh / ha-^{1} if farmers will adopt improved varieties (Bucheyeki, 2010).

2.1.2.3 Market availability

Lack of a commercial market has limited farmer interest in improving the management of this crop as a result; average sorghum yields have changed little over the past 15 years, although the area under production is still increasing (Rohrbach and Kiriwaggulu, 2007). Absence of market has made farmers to produce other crop that have market other than sorghum; Most immediately the size of the market for sorghum in Tanzania needs to be more methodically tested, this includes; the use of different advertising media, diversity in value addition and product promotion to encourage consumers to try the new meal product (Makindara, 2012). There is high demand for sorghum mainly in brewing industry to replace barley, yet the amount produced by farmers is too low to satisfy the market demand. Sorghum yields in Africa are low with an average of 0.85 t/ ha-^{1} (Muui *et al.,* 2013).

2.1.2.4 Poor quality of Sorghum grain

One of the main constrain in utilizing sorghum grain especially in opaque beer manufacture like Dar brew was poor quality of grain available in the local market (Rohrbach and Kiriwaggulu, 2007). Farmer's bit sorghum heads on the ground, this Process contaminates the grain and the value goes down hence low price. The brewery must have clean grain in order of reducing wear and tear on its steeping tanks (Rohrbach

and Kiriwaggulu, 2007). Despite limited investments in improved crop management, Tanzania average sorghum yields are among the highest in Southern Africa (Taylor, 2011). This reflects the relatively long growing season and favorable soils found in the country sorghum production zones. Nonetheless, average grain yields can still be at least doubled through the adoption of improved inputs and the extension services offered through efforts of the NGO's. Small-scale farmers can readily achieve sorghum yields above 2 t ha^{-1} through the use of better seed and small quantities of chemical fertilizer (Quinones *et al.,* 1991).

2.1.3 Sorghum utilization

2.1.3.1 Global sorghum utilization

Sorghum is used for two distinct purposes namely human food and animal feed, i.e. 42% of total sorghum produced worldwide is used for human food consumption while 48% was used for animal feeds (ICRISAT and FAO, 1996). The USA is the major producer and the production is highly commercialized with a good integration between farmers and utilizing industries (FAOSTAT, 2009). In developed countries like USA, Mexico, Japan and, the former Soviet Union these are the main consuming countries, account about 80% of sorghum as a demand for feeding purposes with an annual production of approximately 60-65 million tonnes while in Africa and Asia more than 95% of sorghum produce is used for human consumption mainly as food made direct from sorghum or as a raw- material for industries (Kleih *et al.,* 2000).

2.1.3.2 Sorghum utilization in brewing industries

Sorghum has been used all over the African countries as the raw material in manufacturing of opaque beer, larger beer and non alcoholic malts drinks (Dendy, 1995;

Taylor, 2002). In southern Africa among of the industries using sorghum for opaque beer production include South African brewing industry, Zimbabwe opaque beer industry, Malawi industries, Zambia and small opaque beer industry in Botswana (Taylor, 2003). In these industries sorghum malt is used as an important ingredient with or without maize in production of opaque beer.

Sorghum is also used in the production of larger beer, among of the African country uses sorghum for larger beer production include Nigeria, Uganda, South Africa, Tanzania and Rwanda (Taylor, 2003). In Nigeria, most of the sorghum being used in the lager beer industry is for starch either white sorghum or maize is used, depending on which cheaper (Rohrbach and Kiriwaggulu, 2001). Several smaller breweries also use sorghum malt (probably in combination with industrial enzymes) in the production of lager beer (Rohrbach *et al*, 2001). In addition, Nigeria has a rapidly growing industry for sorghum-based non-alcoholic malt drinks (Bogunjoko, 1992). In South African the South African Breweries –Miller group which runs many breweries throughout Africa has been successful in production of Eagle beer made from sorghum since 2002 after negotiating a tax incentive from the government to use locally growing material (Taylor and Belton, 2003).

In Rwanda, sorghum has been used as both malt and starch in the manufacture of traditional beer, Ikigage or Amarwa is the traditional beer made from malted sorghum in Rwanda and is most appreciated in various festivals and ceremonies (e.g., marriage, birth, baptism, dowry, etc.) (Lyumugabe *et al*., 2014). In Tanzania Darbrew, TBL, and Serengeti breweries has been reported to use white and red sorghum in production of clear beers like Senetor and Eagle (Makindara, 2012). Grain has been used to make local

brew like chibuku, Togwa, Mwamba. Other traditional African beers made from malted sorghum include Merissa of (Sudan and Ethiopia), doro or chibuku of (Zimbabwe and Ziambia), dolo (Bukinafaso) and Amaruwa of (Rwanda) (Lyumugabe *et al.,* 2014).

2.1.3.3 Food consumption

Sorghum is used as food primarily in developing countries, and is eaten in a variety of forms that vary from region to region (Yetneberk *et al*., 2004). In general, it is consumed as whole grain or processed into flour, from which traditional meals are prepared (Wambugu, 2011). The main food products prepared include thin and thick porridges, fermented and unfermented breads, alcoholic beers and beverages, malted flours for brewing, malted porridge mixes and weaning foods (Food Security Department, 2004). In Kenya and South Africa, there is a small but growing market for pearled sorghum as an alternative to rice (Gomez *et al*., 1992). In India, proposals have been made for use of dehulled sorghum within feeding regimes for infants and children (Parthasarathy, 2010).

Additionally, new value added/processed food products for human consumption are emerging such as popped sorghum, biscuits, simple cakes, cookies and instant soft porridge (Morvite) a product of King Food in South Africa (Taylor, 2003). Morvite is a pre-cooked sorghum dry powder added vitamins, citric acid, sugar and other sweeteners prepared simply by adding either hot or cold water or milk to make an instant breakfast porridge or beverage (Taylor, 2003).

In Ethiopia sorghum flour is used in preparation of Injera large circular, fermented pancake-like bread, is the staple food of Ethiopia (Taylor, 2003). In Tanzania especially

Central part Sorghum flour is used to make ugali uji and non-alcoholic drink known as *Togwa* (URT, 2012).

2.1.3.4 Sorghum utilization in livestock and poultry feeding

More than 95% of the sorghum produced in higher income, industrialized countries such as United States, South America, and Australia is used primarily for livestock feed particularly in poultry, beef and pork industries (ICRISAT and FAO, 1996). In Nigeria crop residual grazing is the major mode of utilization of sorghum straw in ruminant diet to maintain animal live weight especially during dry seasons. Other methods of utilization of straw involve stalk feeding of supplemented treated or non treated straw (ICRISAT, 1990). On the current knowledge with increase use of sorghum grains in breweries and milling industries in Nigeria the by-products are becoming available as the source for energy for livestock use such as poultry, rabbits swine and ruminant (Taylor, 2000).

In India Sorghum straw has been reported as is an important feeding material for livestock especially for draft and dairy animals particularly in the dry seasons when other feed resources are in short supply. Hence, dual purpose types that produce both grain and stover are the preferred types (Kelley *et al*., 1993; Kelley and Parthasarathy, 1994 Hall, 2000). In poultry feed, sorghum cultivars with low tannins and less susceptible to moulds has been used as alternative feeding material to maize (Smith, 2005). Poultry feed trials conducted India at poultry sciences department collage of veterinary science have explored that, sorghum can replace maize completely in poultry feed especially in broilers in terms of growth rate, livability, egg production and weight (Tulasi *et al*, 2004 and Rajashekher *et al*, 2005). In Tanzania sorghum straw is used for feeding purpose and mostly the straw are left in the field, while the grains used for chicken feeding but this is not common due to the effect of tannin to some cultivars (Taylor, 2000).

2.1.3.5 Variation in sorghum utilization in different part of the world

Sorghum utilization tends to vary from one country to another; its varies in terms of preparation and names for traditional food, tradition beers and feeding material made from sorghum especially in Asia, Africa and United state (Mamoudou *et al.,* 2006). In African and Asian subcontinents most of the grain produced in these countries is utilized for human consumption (Ratnavathi and Patil, 2013). It is estimated that more than 300 million people from developing countries essentially rely on sorghum as source of food (Godwin and Gray, 2000).

The grain sorghum is utilized in preparation of many traditional foods and in bakery preparations like bread, cakes and biscuits while in United States, Australia, and other developed nations essentially grain sorghum is for animal feed (Ratnavathi and Patil, 2013).

The main traditional foods prepared with sorghum in India include unleavened flat bread (roti) and kanji (thin porridge) which are mostly consumed in the southern parts of India. Other are Upma of South Indian being used as breakfast food or snack, annum or soru boiled sorghum (rice-like) most common items cooked and its account for about 10% of the total sorghum grain produced (Parthasarathy *et al.,* 2010 and ICRISAT, 2004). In Africa traditional food prepared from sorghum include; Ogi (thick porridge consumed in Nigeria) Tuwo thin porridge (Nigeria), Injera leavened flat and round bread (Ethiopia), kisra thin pancake (Sudan), couscous steamed granulated products (North Africa), Ugali (stiff porridge) in Tanzania, Uganda, Rwanda (Bogobe) sorghum porridge consumed with vegetable, sankati, annam and ganji (thin porridge) in southern India (Ratnavathi and

Patil, 2013). Popped sorghum and sorghum noodles are eaten as breakfast or snack foods in India (Irene, 2012).

Table 4: Summary of Sorghum utilization by countries

Courtiers	Multiple uses		
	Brewing industries	Traditional foods	Feed industries
Nigeria	Larger beer and opaque beer	Thick porridge (ogi)	stalk feed
	Sorghum malts	thin porridge (towo)	gluten feed
	Non alcoholic malts drinks	by products in brewing and milling for poutry feed	
Sudan	traditional beer (merrisa)	pancake (kisra)	
Ethiopia		Fermented pancake (injera)	
B.faso	traditional beer (Dolo)		
Tanzania	larger beer Eargle and Senetor	steef porridge (Pure ugali)	straw animal feed
	Local brew chibuku, mwamba	Porridge	graind locl chicken
	Non alcoholic drinks (Togwa)	boiled sorghum grain(makande)	
		spiced sorghum grain(pilau)	
		cakes, buns, biscuts, cookers, popped grain, chapatti	
Rwanda	Malts aand starch for traditional beer		
	(Ikigage or amaruwa)	steef porridge (Pure ugali)	
Zimbabwe	opaque beer and		
	tadition beer (doro or chibuku)		
S.Africa	Larger beer (Eargle)	Morvite (instant feed)	
India		unleaved flat bread (roti)	straw for draft and dairy animals
		thin porridge(kanji)	gluten feed
		boiled sorghum rice like (soru)	grain with low tanning poutry
		Breakfast snacks polished with sorghum grain (upima)	
		noodles and pasta (supergates)	
		cakes, buns, biscuts, cookers, popped grain	

2.1.3.6 Multiple uses of sorghum by districts

Sorghum utilization tends to vary across the districts, according to Singida District Profile (2012) reported that, sorghum grain is used for food consumption (Ugali), making of local brew, and non alcoholic drinks (Togwa) mainly semi arid areas of the county. Other uses include cake baking, preparation of nutritional flour for porridge (sorghum flour mixed with other cereals) pilau, (sorghum grains mixed with spices) popped grain and other minor products (Singida District Profile, 2012). Kondoa district profile (2012) reported that, sorghum grain is used mostly in local brew, and porridge i.e. stiff and soft; But according to the baseline study survey funded by ICRISAT on SMU project in nine district of Central and Eastern zone of Tanzania on development of robust commercial sustainable multiple use of sorghum value chain in Tanzania reported that, sorghum grain is used mainly for preparing porridge, pure ugali, mixed ugali, local brew and fried products like chapatti and popped grain (Hella, Makindara and Mgonja, 2013). This utilization varies significantly from one district to another. The overall results concluded that in districts like Iramba, Kondoa, Singida, Kongwa, and Serengeti which are dry most of the time and maize production is low porridge and ugali made from sorghum flour are the main dishes.

Other uses were green cereal, dry cereal, stove and leaves that's vary significantly in the Districts. Use of sorghum as green cereal was famous in Singida, Iramba, Serengeti and Kondoa. Surprising use of sorghum leaves was common in Singida, Iramba and Kondoa where relatively a large proportion of land is allocated for grazing. Use of sorghum as stove was common in Kondoa, Serengeti and Singida as a supplement to firewood (Hella, Makindara and Mgonja, 2013).

2.1.3.7 Types of sorghum varieties grown and its multiple uses

Popular and widely sorghum varieties are grown across the country, among of these varieties cultivated in Eastern and Central zone of Tanzania include Macia, Langalanga, Lugugu, Wegita, Mkombituna, Pato, Robiogote, Serena, Tegemeo and Wahi (Hella, Makindara and Mgonja, 2013). This report explore more that, despite the variation in varieties grown there is significance different in amount of sorghum harvested and consumed across the districts. The highest amount of sorghum harvested and consumed is found in Serengeti while in Singida, Iramba, Kondoa and Kongwa high proportional of sorghum harvested is for commercial purpose.

2.1.4 Sorghum multiple use promotion strategies

Sorghum like any other cereal has the potential to significantly improve food security and the incomes of smallholder subsistence farmers, especially those that live in dry areas where maize production has dropped due to low rainfall (Okuthe *et al*., 2009).

To be encouraged to grow sorghum, farmers need to have access to seeds, extension service and sustainable market as it known that; there is a market demand for their harvested grain but production is low. In Tanzania various effort through Government, NGO and other sorghum stakeholder have been initiated to promote sorghum utilization. Among of these include INSTROMIL program and the main goal was advocating for the nutritional and health benefits of sorghum through promoting production and consumption of sorghum in six regions (INSTROMIL, 2006). Under this program small scale women processors were educated on how to process sorghum into different product, among of the product prepared include sorghum pilau, coconuts flavored porridge, stiff porridge, buns, flat bread, donate and popped grain (TFNC, 2013). This activity was done

through media (TV, radio and printed material) media seminars were organized and different articles were broadcasted (TFNC, 2013).

Other program like SMU project funded by ICRISAT on development of a robust commercially sustainable Multiple Uses Sorghum (SMU) value chain in Kenya and Tanzania. Its objective was to support the development and demonstration of new sorghum multipurpose varieties that are higher yielding and adapted to both biotic and abiotic stresses in arid and semi-arid agro ecologies.

Promotion strategies that have been carried out in Africa and West Africa include; Establishment and revival of food plants utilizing sorghum as raw material in malt, malt drinks and beverages. Establishment of both cottage and medium scale facilities for production of fortified complementary /weaning foods using sorghum along with other legume like Soy-Akammu (soybean: sorghum flour blend), for infant, school feeding program, food aid and export commodities. Production of ready-to-use foods such as tuwo meal/flour, noodles, pastas including macaroni, spaghetti, couscous, composite flour (up 20%) for making bakery; steam food like burabusko confectioneries like biscuits and pancakes.

2.1.5 Demand theory

Demand is the rate at which consumers want to buy a product. Economic theory holds that demand consists of two factors: taste and ability to buy. Taste, which is the desire for a good, determines the willingness to buy the good at a specific price. Ability to buy means that to buy a good at specific price, an individual must possess sufficient wealth or income. Both factors of demand depend on the market price. When the market price for a

product is high, the demand will be low. When price is low, demand is high. At very low prices, many consumers will be able to purchase a product. However, people usually want only so much of a good. Acquiring additional increments of a good or service in some time period will yield less and less satisfaction as a result, the demand for a product at low prices is limited by taste and is not infinite even when the price equals zero. As the price increases, the same amount of money will purchase fewer products. When the price for a product is very high, the demand will decrease while consumers may wish to purchase a product very much, they are limited by their ability to buy.

2.2 Empirical Analysis

2.2.1 Crop yield projection concept

Yield projection is an art of forecasting crop yield (tonnes/ha) or (kg/ha) and production before the harvest, actually take place a couple of months in advance. Crop projection philosophy is based on time series data collected from different sources such as meteorological data, agro meteorological, remotely sensed, National agricultural statistics (FAO, 2013). Timely and accurate crop yield projection are essential for future crop production, marketing, storage, and transportation decisions and they help managing the risk associated with these activities (FAO, 2013). Understanding the stochastic behavior of crop yield is an essential part at all levels (Kantanantha, 2007). At the country level, yield projection is used in the determination of national food security, crop insurance policy, import and export plans, and government aid for farmers (Kantanantha, 2007). Historical crop yield information is also important for supply chain operation of companies engaged in industries that use agricultural produce as raw material Livestock, food, animal feed, chemical, poultry, fertilizer pesticides, seed, paper and many other industries that uses agricultural products as intergradient in their production processes (Manrikovic *et.al.,* 2010).

2.2.2 Review of analytical tool for yield projection

Over the last few decades, statistical methods have traditionally been used for projection and classifications. Some of the common traditional statistical techniques used for projection and classifications are Integrated Moving Average (ARIMA), Multiple Regressions spatial autoregressive model and Exponential Smoothing. Three main types of statistical approaches are found in the literature, those based purely on time series data from a single point or area (time series methods), those based on variations both in time and space (panel methods), and those based solely on variations in space (cross-section methods) (Lobell and Burke, 2010). Time-series models are generally believed to have the advantage of capturing the behavior particular to the given area, whereas panel and cross-section methods must assume common parameter values for all locations, and cross-section methods in particular are prone to errors from omitted variables such as soil quality or fertilizer inputs that vary spatially (Lobell and Burke, 2010). On the other hand, time-series models are often limited by data whereas panel and cross-section methods can aggregate data from multiple sites. The main advantages of statistical models are their limited reliance on field calibration data, and their transparent assessment of model uncertainties. For example, if a model does a poor job of representing crop yield responses to climate, this will be reflected in a low coefficient of determination (R2) between modeled and observed quantities, as well as a large confidence interval around model coefficients and predictions (Sheehy *et al.,* 2006). Statistical models are not without serious shortcomings, however, and in particular they are subject to problems of co-linearity between predictor variables (Sheehy *et al.,* 2006).

2.2.2.1 Autoregressive moving average (ARIMA)

ARIMA model has been frequently employed to forecast the future requirements in terms of internal consumption and export to adopt appropriate measures (Muhammad *et al.,* 1992). ARIMA is the most general class of models for forecasting a time series (Kumari *et al.,* 2014). Different series appearing in the forecasting equations are called "Auto-Regressive" process. Appearance of lags of the forecast errors in the model is called "moving average" process (Kumari *et al.,* 2014). The ARIMA model is denoted by ARIMA (p,d,q), where "p" stands for the order of the auto regressive process, 'd' is the order of the data stationary and 'q' is the order of the moving average process (Kumari *et al.,* 2014). In contrast to the regression models, the ARIMA model allows time series to be explained by its past or lagged values and stochastic error terms (Iqbal *et al*., 2005).

2.2.2.2 Exponential smoothing

Exponential smoothing schemes weight past observations using exponentially decreasing weights. This is a very popular scheme to produce a smoothed Time Series. Whereas in Single Moving averages the past observations are weighted equally, Exponential Smoothing assigns exponentially decreasing weights as the observation get older. In other words, recent observations are given relatively more weight in forecasting than the older observations. In the case of moving averages, the weights assigned to the observations are the same and are equal to 1/N. These methods are most effective when the parameters describing the time series are changing slowly over time.

2.2.2.3 Multiple Regressions

Multiple regression analysis is the statistical method that is used when one dependent variable is to be examined in relationship to any other factors (expressed as independent

or predictor variables) (Cohen *et al.,* 2003). A multiple regression allows simultaneous testing and modeling of multiple independent variables (Palmer, 2009). This type of technique allows for prediction of someone score on one variable on the basis of their scores on several variables or more than one variable is used to predict the criterion (Gujarati, 2003). The linear regression model based on the ordinary least square (OLS) estimation is a commonly used method for crop yield predicting although it is not adequate in many cases because spatial autocorrelation among variables may violate the underlying assumption that observations are independent (Zhang *et al.,*2010).

A number of studies have been conducted that used multiple regression in analysis, in projection of crop yield some of these include Ansigan, *et.al.* (2010) used multiple regressions to predict corn yield using climatic variables, such as temperature, humidity, rainfall, wind speed, and solar radiation. The results of the study showed that climate variability significantly affects crop yields. Boonprasom *et al.* (2002) carried out a study on projection of tangerine yield by using multiple regression models in his study, weather parameters were considered as influencing factors and nine years data relating to yield and weather parameters were collected. The study indicated that the amount of rainfall had strong influence on yield of tangerine while average temperature had less influence. Moyo (2010) used multiple regression in identify the transaction cost related factors that affect the quantity of grain sold by sorghum and millet. The results of this model show that previously agreed prices are significant at five percent level in influencing the quantity of grain sold while road access, confidence and trust in the buyer and membership in a farmer group was not significant in influencing the quantity of grain that a farmer sold. Although these three explanatory variables were not significant and the R-squared value is low the F-statistic of 6.5 is significant with a p-value of 0.00.

The p-value of the F-statistic indicates that overall the multiple regression models was significant and together all the explanatory variables have a significant impact on the quantity of grain sold. Makindara (2012) used multiple regression analysis on his study for sorghum value chain analysis to determine consumer influence on sorghum clear beer value chain. The result reveal that price and test of sorghum based clear beer influenced customers to shift to sorghum based clear bear (Eagle), (Bongiwe, 2013) examined the factors affecting the productivity and profitability of vegetable and determining the future production of vegetable in Swaziland. The study showed that access to credit, selling price, fertilizer quantity and gender were significant and positively related to the productivity of the vegetable farmers while distance to market was negatively related to productivity. Profitability of vegetables was influenced by farmers' level of education and land under vegetable production, while selling to NAM Board negatively affected profitability.

(Erbaugh, 2008) study profitability of sorghum farming in Tanzania used regression model in order to test factors that might have influenced gross margin and hence profitability of sorghum production. The gross margin variable was regressed on the farm size used to produce sorghum, farm gate price, farm production costs, farm location, the interaction between production costs, farm gate prices, seed variety used, technology used such as fertilizer, the interaction between seed variety, fertilizer applied and production technology used. Zulu (2011) used multiple regressions to study profitability of smallholder cowpea production in Zambia to find out the influence of different factors on profitability. Gross margin was regressed on farm size, farm gate price, farm production costs, seed variety used, a set of dummy variables for tillage methods used, age of the farmer, education level of the farmer, gender of the farmer, a dummy variable

for the type of power source, the land tenure i.e. whether the farmer owned the land or rented it and a set of dummy variables Several factors were found to affect profitability of cowpeas, such as production costs, yields, area planted, farm gate price and land tenure. Yields, land tenure and farm gate price had a positive influence on profitability were as production costs and area had a negative influence on profitability. Based on the results of the study production of smallholder cowpeas in Zambia was found to be profitable (Zulu, 2011).

2.3 Conceptual Frame Work

Conceptual framework according to (Smyth, 2004); are structured from a set of ideas and theories that help researcher to properly identify the problem they are looking at. From this theory the model try to examine the multiple uses of sorghum in semi arid areas and how it can influence sorghum production by considering the significance contribution of increase sorghum use to the overall future utilization.

Based on this study, the conceptual framework taking into account the promotion strategies explained by INSTROMIL (2006), SMU project (2012) and TFNC (2013). From the conceptual framework the first stage are sorghum stakeholders whose establish several promotion strategies in sorghum production like introduction of new varieties that has multiple uses, technology improvement in production and advocating of nutritional and health benefits through consumption of sorghum in different products.

Apart from that food security policies like Kilimo Kwanza pillar number four (4) activities one which identifies priority areas for strategic food commodities for the 4 country‘s food self-sufficient that insist put in place production of crops like sorghum.

All of these affect the demand and price for sorghum whereby as the demand increase small holders will increase the production to meet the demand. The increased production will in turn increase farmer's income.

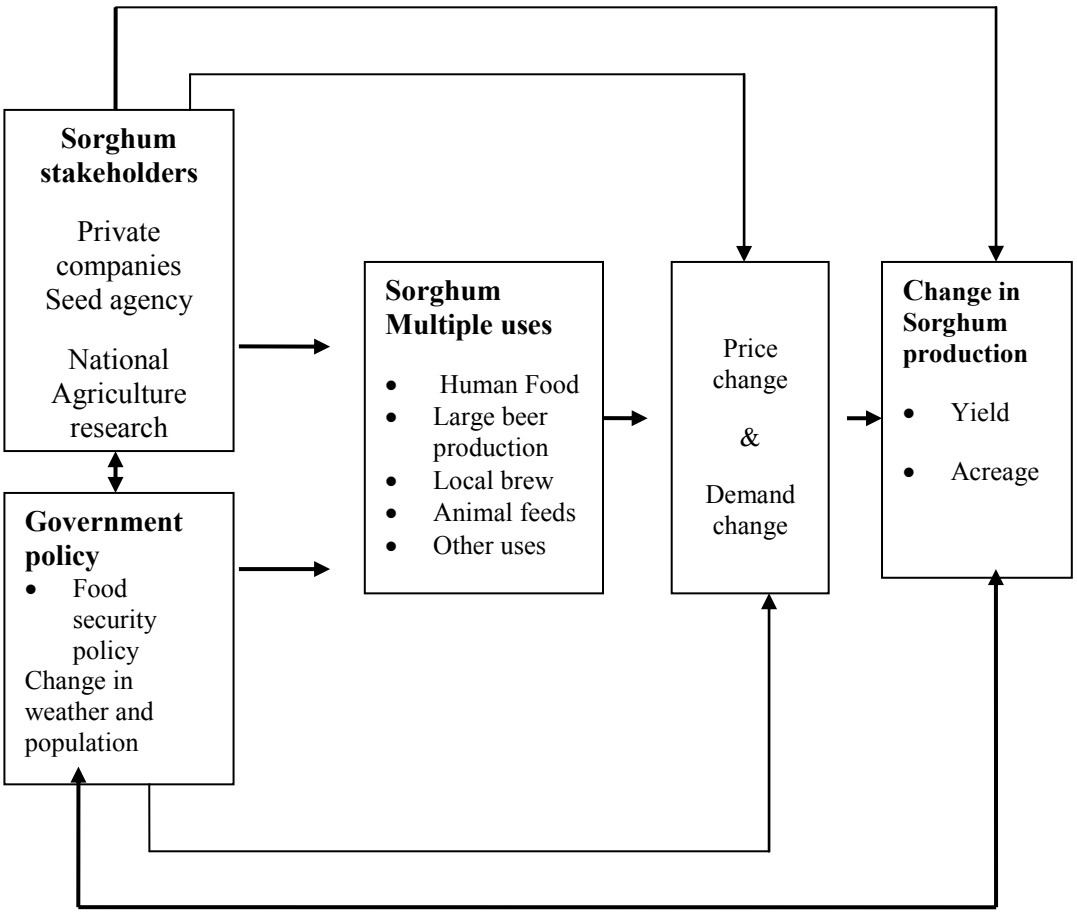

Figure 1: Conceptual framework Show the link between sorghum multiple uses and production

2.6.2 Limitation of the methodology

Regression techniques have a long history of use as projection tools in multiple disciplines. Regression models have the advantage of simple computation and easy implementation. Due to the nature of linear relationship in the parameters, regression models may not provide accurate predictions in some complex situations such as non-

linear data and extreme values data. Regression model also have limitation such as the need to fulfill regression assumptions and multiple collinearity between independent and dependent variables causes regression model to be inefficient (Molazem *et al.,* 2002; Zaefizadah *et al.,* 2011).

CHAPTER TRHEE

3.0 METHODOLOGY

3.1 Study Area and Justification for Selection

This research was conducted in five district of Tanzania namely Singida rural, Iramba, Kondoa, Kongwa, and Serengeti. The decision for sites selection based on the fact that, three-quarter of annual sorghum harvest is produced from these areas which are semi – arid were other cereal such as maize the production is low and this crop is used as a measure against food shortage.

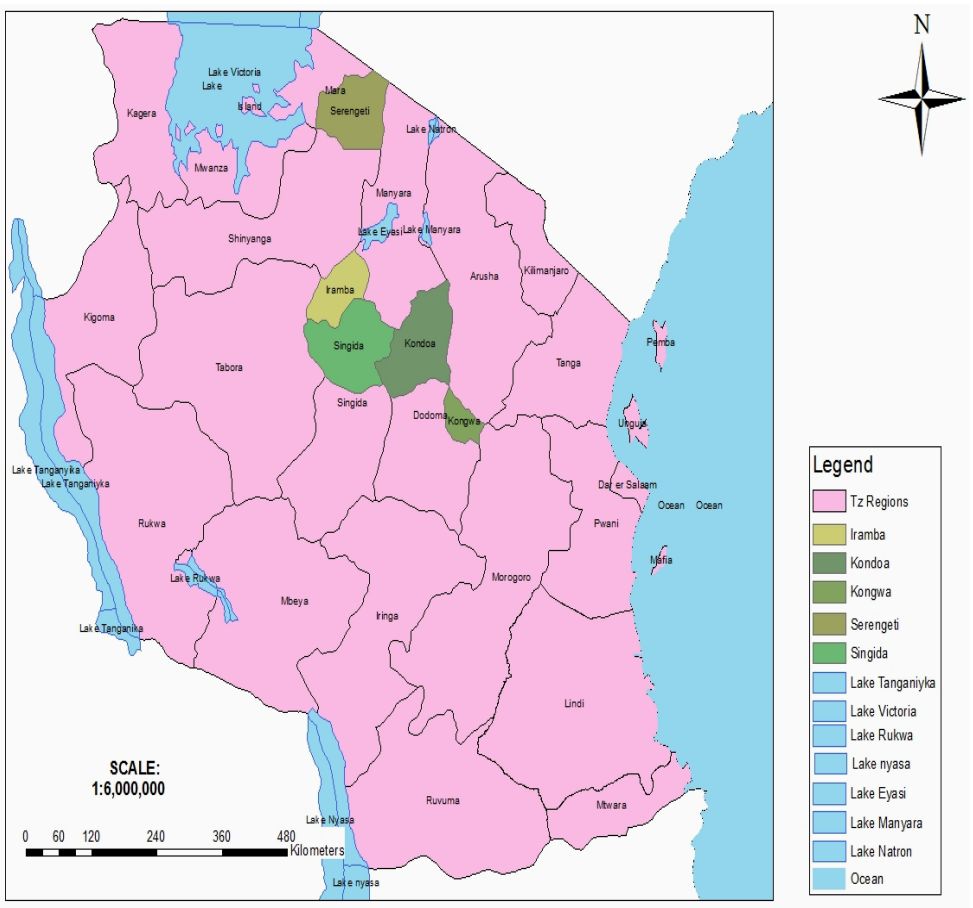

Figure 2: Map of Tanzania Showing Study Areas

3.2 Description of Study Site

3.2.1 Singida rural district

Singida Rural District is located in Singida region in Central Tanzania. The District is borderes Tabora to the West, Iramba to the North, Hanang' to the East, Kondoa to the South – East and Manyoni to the South. The current population is 497 562 whereby (51%) are Females and (49%) are males. The main ethnic group found in the district are Wanyiramba, Wakimbu, Sukuma, Wanyaturu, watindiga and watataru other people are immigrant groups who are employed in the districts either by private sectors or Government. The main economic activity is farming and livestock keeping, other are small scale mining, fishing, beer keeping, small busness, and small industries such as sunflower oil milling. Main food crops produced include Maize, Sorghum, millet, paddy, beans, cassava and sweet potatoes while cash crops are sunflower finger millet and groundnuts. Sorghum is one of main crop produced in the district and its production and area under production has increased since 2006- 2011 from 24 311tonnes to 32 836 tonnes and 26 065ha to 61 186ha while production per ha has increased from 1.5tonnes/ha to 2.1tonnes/ha

3.2.2 Iramba district

Iramba District Council is within Singida Region, Kiomboi is the district headquarters which is 100 kilometer away from Singida Town. Iramba borders with Meatu and Mbulu Districts, to the North, Hanang' District to the East, Singida District to the South and Shinyanga districts to the West

According to the approximation made by the National Bureau of Statistics the District population in 2010 were 449 994 where males are 218 596 and females are 231 398. Main

economic activities are Agriculture, livestock keeping and industry such sunflower oil processing, construction and small mining & quarrying. Food crops such as sorghum, maize bulrush millet, paddy rice, sweet potatoes are the main crops produced in the district, Sorghum is the main crop produced and its production has increased since year 2006/2007 to 2011/2012 from 47 879 tonnes to 94 253 tonnes while area under sorghum production has increased from 42 387 ha to 62 838 ha since 2006-2011(Iramba District profile, 2012).

3.2.3 Kongwa district

Kongwa District is one of the six Districts in Dodoma Region .The District lies between latitude 5° 30- 6° South and longitudes 36° 15° – 36 East of Greenwich Meridian. Its altitude stretches between 900 and 1000 metres above sea level. Kongwa town is the District headquarters and is located about 86 kilometres from Dodoma town. The District borders with Chamwino District in the western front; Kiteto District (Manyara Region) in the North; Kilosa District (Morogoro Region) in the East and Mpwapwa District in the southern front. The total population was 318 995 for the year 2013 out of these, 156 982 are males and 162 013 are females. The dominant tribe in the district is Gogo. Economic activities in Kongwa district council are mainly farming and livestock keeping as well as informal sector activities such trade. Agriculture is the major base for economic activities into which subsistence farming and livestock keeping (local breeds) are dominant mode of production. The main food and cash crops grown include maize, Sorghum, millet, groundnuts, cassava, sunflower, beans and horticulture crops.

Sorghum is the second crop that is grown mainly for food or as cash crop its production (Yield in tonnes) has been fluctuating since growing season 2007/08 to 2010/11 although area under production is almost the same. This fluctuation may due to many factors like

changing in weather condition, low rate of adoption of improved varieties, and inadequate knowledge on production. See table below

Table 5: Sorghum production trend for season 2007/08 to 2010/11 in Kongwa

Year	Area under production (Ha)	Yield tonnes
2007/08	30 528	28 179
2008/09	30 528	10 706
2009/10	25 243	12 617
2010/11	34 880	34 880

Source; Agriculture and Livestock department 2012

3.2.4 Kondoa district

Kondoa, is among of districts in Dodoma, located in the North of Dodoma region about 160 km from the capital town Dodoma District borders with Babati in the North, Kiteto in the East and Hanang in the North West. New district of Chemba boarders in the south and south west which boarders Manyoni in the South West, Chamwino in the south, Bahi in the south east, Singida in the West. Kondoa District Council including Chemba, has a total population of 483 939 people, whereby 234 998 are males and 248 941 are female. The average population growth rate is 1.7 % per annum. Economy of the district is entirely dependent on crop and livestock products. Sub sector like industry, mining, forest, fishing and bee-keeping play insignificant role in the economy of the district Agriculture is the main economic activity carried out in the district. Main food crops are maize, pearl millet, sorghum, beans and other food crops are cassava and sweat potatoes while cash crops are sunflower, sim-sim, groundnuts, pigeon peas, finger millets and currently the district is struggling to develop cashew nuts as a perennial cash crop as well as to invest more in Sunflower production and processing

Table 6: Sorghum production trend in Kondoa District

Year	Area (Ha)	Harvest (Tonnes)
2008/2009	32 521	22 765
2009/2010	20 906	18 806
2010/2011	28 746	34 496
2011/2012	20 906	19 900

Source: (URT, 2012)

3.3 Research Design

The study used a cross-section research design. This design allows data to be collected at a single point in time from a sample representative of large population. The design is suited for descriptive studies and for determination of relationship between and among variables. It is also economical in terms of time and financial resources (Babbie, 1993).

3.4 Sampling Technique and Sample Size

Sample size was based on the number of household cultivating sorghum in the general population. The exactly number of household with sorghum was not clear documented, therefore this was estimated on the bases of 50% which is the ratio accepted to be used if the actual ratio is not available. Stratified sampling method was used in selecting villages for this study, village which are closed to urban and villages which are typically situated interior rural areas to make a total of four villages in each district. The main point was to increase diversion in utilization. Then respondent for questionnaire survey were selected randomly whereby about 26 (± 2) respondents were chosen taking into consideration the gender, income and other social groups' diversity.

The following formula was used to determine sample size $n_o = z^2pq/e^2$ Where n = required sample size t = confidence level at 95% (standard value of 1.96) p = proportion of number of household cultivating sorghum in the project area (50% estimated -no data) m = margin of error at 5% (standard value of 0.05) Using the above equation a sample of 508 sorghum farmers were selected for this study.

Table 7: Sample size summary

Region	District	Village	Male	Female	Total
Singida	Iramba	Ilunda	15	6	21
		Malaja	13	9	22
		Msiu	16	9	25
		Nkungi	15	10	25
Sub Total			**53**	**34**	**93**
	Singida rural	Malolo	12	14	26
		Mwasauya	19	7	26
		Msunguwa	11	15	26
		Ngamu	14	12	26
Sub Total			**56**	**48**	**104**
Mara	Serengeti	Ngalawani	20	5	25
		Kenokwe	19	7	26
		Mbalibali	26	0	26
		Miseke	16	10	26
Sub Total			**81**	**22**	**103**
Dodoma	Kondoa	Mangoroma	16	10	26
		Makorongo	16	11	27
		Mondo	14	12	26
		Pahi	20	6	26
Sub Total			**66**	**40**	**105**
	Kongwa	Msingisa	10	16	26
		Vilundilo	14	11	25
		Manungu	6	20	26
		Laikala	15	11	26
Sub Total			**45**	**58**	**103**
Grand Total			**307**	**201**	**508**

3.5 Data Collection

Both secondary and primary data was used for this study. Primary data was collected from sorghum producers through personal interviews using structured questionnaires adopted and modified from (ICRISAT) (see appendix). Information gathered include sorghum household social economic characteristics (age, sex, education, marital status, and family size) experience on crop production especially sorghum, knowledge on sorghum varieties and source of information, types of sorghum varieties grown and their characteristics, sorghum production, sorghum input for production such as quantity used and cost for the input, labour cost, technology used in productions, sorghum utilization, market and storage activities for sorghum. Secondary data which was time series data for sorghum production in country were obtained from National Bureau of Statistics (NBS), literature sources, research papers, District profile reports.

3.6 Data Analysis

In analyzing data Statistical Package for Social Science (SPSS) version 16 was used to convey a good overall picture and facilitates different computations in answering the research objectives.

3.6.1 Examine multiple uses of sorghum in selected districts

Descriptive statistics include percentages, frequency tables and cross tabulation was used to examine sorghum multiple uses in all district so as to known which uses are more frequently used than the other in all districts. In addition cross tabulation was used to examine sorghum multiple uses in relation to other factors such as age of the respondents,

gender, location of respondent, varieties grown and distance to the local market (Table below summaries the methodology for objective one).

Table 8: Summary of methodology and expected results on sorghum multiple uses

Problem	Method of data analysis	Type of results expected
Multiple uses of sorghum	Frequency table, cross tabulation and percentages	Percentage of respondent used sorghum in multiple ways in all district
Multiple uses in relation to other factors (age, sex, variety and market distance)	Cross tabulation and percentage Regression method	Percentage in multiple uses in relation to age of respondent, sex, varieties and distance to local market
Influence of sorghum multiple uses		Utilization of sorghum in multiple ways has significance influence on production

3.6.2 Influence of sorghum multiple uses on sorghum production

Determine the influence of sorghum multiple uses on its production multiple liner regression model were adopted to this study

The model is thus specified as follows;

$$\mathbf{Y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \alpha_5 x_5 + \alpha_6 x_6 + £} \quad \text{.....(1)}$$

Where:

Y= Sorghum production **(kg/acre)**

α_0= Intercept

X_1= Amount sold (kg)

X_2= Amount used for Local brew include non alcoholic drink (kg)

X_3= Amount used for steef porridge

X_4 =Amount used for porridge

X_5 = Sorghum flour mixed with other cereals (kg)

X_6 = other uses (kg) includes new emerging products like fried roasted grain, banking product (maandazi, breads, biscuits and cakes).

£= error term

Table 9: Variables and Indicators used in multiple regressions method

Variables	Measurement
Dependant variable	
Sorghum production	
Independent variables	
Amount of sorghum grain sold	Kg
Amount of sorghum grain processed and used in preparation of alcoholic brew	Kg
Amount used for steef porridge	1, if household used sorghum for steef porridge 0,otherwise
Amount used for porridge preparation	1, if household used sorghum for porridge 0,otherwise
Sorghum flour mixed with other cereals	1, if household mixed sorghum flour with other flour 0 otherwise
Other uses	Kg

The assumption behind on this objective is that, farmers are able to separate the amount used in each uses especially those who are making local brew because they must have exactly amount of sorghum flour which is supposed to mixed with other ingredients to make a brew for the case of steef porridge and porridge these were termed as dummy variables.

3.6.3 Predicting future production of sorghum

In predicting future production of sorghum time series data was used. Data was obtained from (NBS) that covered the Period of 2000- 2014. Linear time series model was applied on the data. This model is commonly known as Autoregressive Integrated Moving Average Model (ARIMA Model). An ARMA model predicts the value of the target variable as a linear function of lag values (this is the auto-regressive part) plus an effect

from recent random shock values (this is the moving average part). This model is limited by the linear basic function.

The ARMA model was specified as follows;

$Y_{t+1} = \beta_0 + \beta_1 Y_t + \beta_2 Y_{t-1} + \beta_3 Y_{t-2} + \beta_4 Y_{t-3} + £t$..... (2)

Where; Y_{t+1} =Future sorghum production, $\beta_{0=}$ constant, $Y_{t=}$ current sorghum production at time t, Y_{t-1} = previous production, $Y_{t-2=}$ two years back production

Y_{t-3} three years back production $£_t$ = error term.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Respondent's Social- Economic Characteristics

The study assessed social economic characteristics of the respondents in terms of age, sex, marital status, education level, and household family size. Results are presented in tables below.

4.1.1 Age and sex of the respondents

Table (10) shows the distribution of the respondent by age and sex whereby the mean age is 46. The majorities of the respondents in all district lies between the age of 36 – 50 i.e. Iramba (49.5%) Kondoa (37.1%) Kongwa (45.6%) Serengeti (52.4%) and Singida (45.2%) respectively. This implies that the majority of the respondent in the surveyed areas were matured people within the active working age group who can take farming responsibilities. However, age determines individual maturity and ability to make rational decision in farming activities like what to plant, when, how, where and how to sell. The same observation has been reported by Brown (2013) Akudugu, Guo and Dadzi (2012) on their study that about 93% of respondents are economically active group belong to the age of 18 and 60.

Sex of the respondent has the implication on the society based on the roles and responsibility of respondent. The study results reveal that, majority of the respondent were male that account (73.6%) Iramba, (59.6%) Kondoa, (52.9%) Kongwa, (81.6%) Serengeti and (60.4%) Singida. Meaning that, in all districts male are more involved in Agriculture production than female. The highest proportional of female is observed in

Kongwa (47%) while the lowest proportional was in Serengeti (18%). The same result was observed on the SMU baseline report which reported that the average proportion of the female farmers involved in the study is 0.35 while the rest was man (Hella, Makindara and Mgonja 2014). Since the respondent interviewed where the household heads and its known that according to African traditions male are the one who own a piece of land so for that case they must be involved much in production while female are too occupied in taking care of the family.

Table 10: Respondent age and Sex

	District				
	Iramba	Kondoa	Kongwa	Serengeti	Singida
Age group					
18 – 25	3(3.2)	4(3.8)	10(9.5)	3 (2.9)	10(9.6)
26 – 35	15(16.1)	35(33.4)	36(35.2)	26(25.3)	21(20.2)
36 – 50	46(49.5)	39(37.1)	47(45.6)	54(52.4)	47(45.2)
> 50	29(31.2)	27(25.7)	10(9.7)	20(19.4)	26(25.0)
Sex					
Male	67(73.6)	62(59.6)	54(52.9)	84(81.6)	61(60.4)
Female	24(26.4)	42(40.4)	48(47.1)	19(18.4)	40(39.6)

(Note: Numbers in brackets are percentages)

4.1.2 Education and household family size

Education level of the respondent was categorized as illiteracy, able to read and write primary education, Secondary and Diploma or university. Based on the experience theoretically and practically education level plays a significance role in human lives such as means of acquiring their basic needs management of productive activities and decision making.

The results in (Table 11), revealed that majority of the respondent in all districts have acquired primary education i.e. (79.75%) Iramba, (68.57%) Kondoa, (76.70%) Kongwa,

(67.96%) Serengeti and (85.58%) Singida. Low level of illiteracy observed in all districts meaning that in all surveyed areas more than half of the respondent are knowledgeable and it easy for them to adopt any new ideas offered by researchers in their specific areas. Household family size considered in this study was the family members who are closely contacted and sharing the resource such as family basic needs food, shelter and clothes. The results indicate that average family size was 6 with relatively high population in Serengeti, Iramba and low in Kongwa, 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.

Table 11: Education and Family size

Variable Education	Iramba	Kondoa	Kongwa	Serengeti	Singida
Illiteracy	6(6.5)	14(13.33)	13(12.62)	14(13.59)	5(4.81)
Read &write	5(5.32)	12(11.43	5(4.85)	12(11.65)	6(5.77)
P. Education	74(79.75)	72(68.57)	79(76.70	70(67.96)	89(85.58)
S. Education	7(7.52)	3(2.86)	3(2.91)	6(5.83)	3(2.88)
University/diploma	0(0.00)	1(0.95)	0(0.00)	0(0.00)	1(0.96)
Other	1(1.07)	3(2.68)	3(2.92)	1(0.97)	0(0.00)
Family Size					
Mean household size	6.7	5.9	5.4	6.9	6.3

Note: (Numbers in brackets are percentages)

4.1.3 Marital status of the respondent

Marital status for this study was categorized as married living with spouse, married living alone, divorced, widow and single (Table 12), summaries the results for each district

where by majority of the respondent in all districts are married and living with their spouse i.e. Iramba (52.7%) Kondoa (74.8%), Kongwa (49.0%), Serengeti (65.0%) Singida (74.8%), this implies that, the surveyed society is highly composed with stable family and they can concentrate much on fulfilling family basic needs. Married status may persuade someone to work hard due to family responsibilities (Shimbe, 2008).

Table 12: Marital Status of the Respondent

District	Marital status married + spouse	married alone	Widow	Single
Iramba	49(52.7)	35(37.6)	6(6.5)	2(2.2)
Kondoa	77(74.8)	26(25.2)	0(0.0)	0(0.0)
Kongwa	50(49.0)	44(43.1)	0(0.0)	8(7.8)
Serengeti	67(65.7)	33(32.4)	2(2.0)	0(0.0)
Singida	77(74.8)	25(24.3)	0(0.0)	1(1.0)

4.2 Multiple uses of sorghum

Descriptive statistics analysis i.e. frequency, percentage, cross tabulation and charts was conducted to examine multiple uses of sorghum in each district. Sorghum multiple uses has been categorizes in many uses include human food such steef porridge, porridge, grain mixed with beans (makande), fried products, local brew, non alcoholic drinks, animal feed and other uses.

4.2.1 Multiple uses of sorghum across the districts

Cross tabulation methods was used to show percentage of the responses on sorghum multiple uses across the districts so as to see which district utilize sorghum more and on what purpose are summarize in Table 13.

Table 13: Multiple uses of sorghum across the Districts

District	Animal feed	Fried Products	Local brew	Grain Mixed	Non alcoholic	Other uses	Stiff porridge	Porridge
Iramba	15.36	0.58	2.32	7.54	11.01	6.38	11.30	6.09
Kondoa	25.51	0.00	9.57	4.06	0.87	6.67	19.71	15.36
Kongwa	7.54	0.29	3.77	4.93	0.58	3.77	15.36	10.14
Serengeti	15.94	0.00	17.97	0.29	1.16	5.80	22.90	13.91
Singida	16.52	1.45	3.19	14.20	10.14	12.75	17.97	11.88
P-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	80.87	2.32	36.82	31.01	23.77	35.36	87.25	57.39

The findings show that, multiple uses of sorghum varies significantly in the five Districts surveyed. That is the majority of respondent in all districts use sorghum for human food specifically stiff porridge i.e. (Ugali) (87.25%) followed by animal feed (80.87%) porridge (57.39%), while few responses have been observed on uses such as local brew (36.82%) non alcoholic drinks (23.77%), other uses (35.36%), and fried products (2.32%). In terms of food utilization like stiff porridge and porridge Serengeti is the leading district (22.90%) (13.91%) followed by Kondoa (19.71%) (15.36) and Singida (17.97%) (11. 88%). In these areas maize production is low; sorghum is used for making porridge and pure ugali as a measure against food shortage. Apart from that, animal feed shows more response in Kondoa (25.51%) than any other district. This results support the other studies conducted by(FAO/ICRISAT, 1996); (Laswai *et al.,* 2003) and (INSTROMIL, 2006) on sorghum utilization these studies pointed out that sorghum as a cereal crop cultivated in semi- arid part of Tanzania has multiple uses but the major uses are human food and animal feeds. Other studies on sorghum utilization like (Ratnavathi and Patil, 2013), (Mamoudou *et al.,* 2005) and (CFC and ICRISAT, 2004) reported that, most of the grain produced in Africa and Asia are used for human food that account more than (50%) of the total produce. Nevertheless, Further more in districts wise Singida shows many responses in all utilization i.e. (88.1%) followed by Kondoa (81.75%)

Serengeti (77.97%), Iramba (60.58%) and Kongwa(46.38%) for this case Singida is the leading district in Sorghum utilization, this is because a lot of sorghum intervention like seminars and conferences on sorghum utilization has been conducted in Singida. Apart from that, Singida District profile (2012) reported that, sorghum crop is given priority as food crop by the district and each farmer is motivated to grow sorghum e.g. of the motivation that has been put forward at farmers level include conduction of 28 sorghum farmers field schools, installation of 2 sorghum dehulling machines in two wards, farmer groups training on agronomic practices and different uses of sorghum, conduction of trials on different sorghum participatory varieties selection in collaboration with researchers and other sorghum stakeholders and use of improved drought tolerant sorghum varieties.

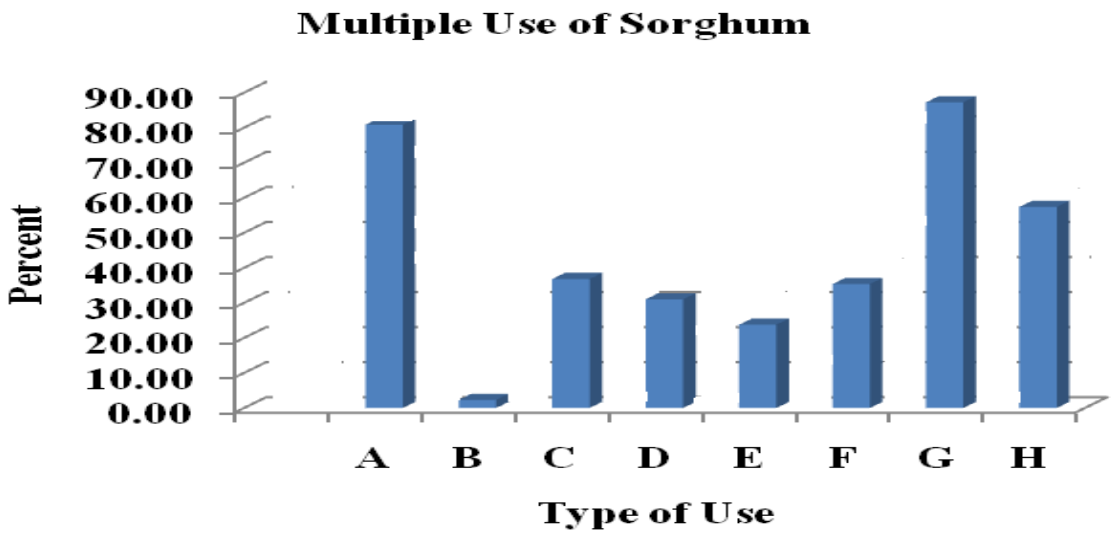

Figure 3: Multiple uses of soghum in a surveyed District
(Note: Animal feed condired here are sorghum straws after harvest)
Where A= Animal feed, B= Fried products C=Local brew D=Grain mixed E=Non alcoholic F=Other uses G=Steef porridge and H=Porridge

4.2.2 Multiple uses of sorghum and variety grown

Table 14 below, shows that local varieties have higher percent in all utilization than improved. High percent has been observed on food utilization specifically on stiff porridge (44.06%) non alcoholic drinks (8.99%) and local brew (5.51%) while lower percentage (0.58%) was found in fried product in both varieties. Despite of the good characteristics of improved varieties like high yields, early maturity, drought resistance and striga tolerance still its utilization at district level is low. Surprising utilization in porridge and fried products shows the same percentage in all varieties. Variation on variety utilization was much influenced by the level of adoption, experienced in production and utilization of such variety. Baseline survey conducted in Tanzania under SMIP project (2003), shows that level of adoption on improved varieties is low range from 5%-36% and experience in production and utilization have been observed on local varieties than improved (SMIP, 2003). Currently the varieties being grown are the high tannin red sorghums mainly for food consumption while the demand for white sorghum varieties is high especially in brew industries (SMU project document, 2012).

Table 14: Sorghum utilization and variety grown

Variety	Anima l feed	Fried product	Local brew	Grain mixed	Non alcoholic	Other uses	Porridge	Steef Porridge
Improved	2.03	0.58	2.32	1.74	4.64	1.45	10.72	13.33
Local	1.74	0.58	5.51	2.32	8.99	0.87	10.72	44.06
Total	3.77	2.90	7.84	31.01	23.77	35.07	57.39	87.25

4.2.3 Multiple uses of sorghum and sex of respondent

In general, results in Table 15 below show that, male farmers realize significant amount of sorghum utilization in all uses compared to female farmers and the reason behind is respondent interviewed were the household heads of which most of them are male

farmers who have access to large proportion of land for crops production than their counterparts so they have more chance in production and utilization

Table 15: Sorghum utilization by sex

Sex	Animal feed	Fried Products	Local Brew	Mixed with Beans	Non Alcoholic	Other Uses	Porridge	Steef Porridge
Male	56.52	0.58	24.93	18.26	13.91	20.87	37.39	58.55
Female	23.77	2.32	11.6	12.46	9.28	13.91	19.71	28.12
P-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	80.29	2.90	36.53	30.72	23.19	34.78	57.10	86.67

4.2.4 Multiple use of sorghum and age of respondent

Multiple uses with age of the respondent where summarized in Table 16 whereby, respondent with the age between (26-35) and (36-50) shows high percentage in sorghum utilization than the youngest group (18-25) meaning that, the sample was rich in respondents who were within the active working group and are the household heads who are matured people and have ability to utilize the crop in multiple ways for the purpose of generating income to their family

Table 16: Sorghum utilization by age

Age groups	Animal feed	Fried Products	Local Brew	Mixed with Beans	Non Alcoholic	Other Uses	Porridge	Steef Porridge
18 – 25	3.19	0.00	1.77	1.16	0.87	2.03	2.90	4.06
26 – 35	18.84	0.58	7.83	6.67	3.48	10.14	14.49	22.03
36 – 50	37.97	2.32	19.13	14.78	12.75	15.65	24.93	37.97
> 50	20.58	0.00	8.41	8.12	6.09	6.96	14.78	22.61
Total	80.29	2.90	37.14	30.72	23.19	34.78	57.10	86.67

4.2.4 Multiple use of sorghum and distance to the local market

Distance to the local market was used to examine if there is different in utilization in relation to those who are close to market and far to the market. Table below 17 shows that

multiple uses of sorghum varies significance at ($p<0.00$) with the distance to the local market i.e. below 1km have high percentage in all utilization compare to those who are far from the market i.e. beyond 20km Kundi (1998) reported that Consumer acceptance study of dehulled sorghum products conducted in Dodoma region revealed that high demand for high quality processed sorghum products existed in Dodoma urban. Apart from that stiff porridge has shown high percentage (19.42%) followed by animal feed (16.52%) and porridge (12.46%) while small percent has been observed in fried product (0.29%) and local brew (3.48%). This result are consistence with the study conducted by Wambungu *et al* (2011) reported that utilization of sorghum has remained concentrated in semi-arid rural areas and has mainly used for porridge. Also percentage in utilization tend to decrease from those who are close to market and far from the market i.e. below 1km and beyond 20km and this has been observed in stiff porridge, porridge and animal feed

Table 17: Sorghum multiple uses and local market distance

Distance	Animal feeds	Fried products	Local Brew	Grain mixed	Non Alcoholic	Other Uses	Porridge	Steef Porridge
< 1	9.57	0.29	2.90	4.06	5.80	4.35	4.64	8.12
1 - 5 Km	0.58	0.00	0.58	0.29	0.00	0.00	0.58	0.58
5.01 - 10 Km	1.16	0.00	0.00	0.29	0.00	0.87	1.74	3.19
10.01 - 20 Km	3.77	0.00	0.00	0.00	0.00	0.00	3.77	5.51
Beyond 20 Km	1.45	0.00	0.00	0.00	0.00	0.00	1.74	2.03
P-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	16.52	0.29	3.48	4.64	5.80	5.22	12.46	19.42

4.3 Influence of Sorghum Multiple Uses on Sorghum Production

The second objective of this study was to assess the influence of sorghum multiple uses on its production where multiple regression model was used. The response variables were quantity in kgs of sorghum sold, quantity in kgs used in local brew, sorghum utilization in porridge , sorghum utilization in steef porridge, quantity in kgs used for mixed flower and

other uses these were assumed to be potential determinant of sorghum production through its multiple uses. Table 18 below summarize the results.

Table 18: Multiple regression for sorghum multiple uses

Variable included	Coefficient	Std. Error	t	Sig.	
(Constant)	35.515	44.04	0.806	0.420	
Amount sold	0.965	0.063	15.359	0.000	***
Local brew	87.158	166.558	0.523	0.601	
Stiff porridge (Dum1)	150.666	74.192	2.031	0.043	**
Porridge (Dum 2)	131.717	68.085	1.935	0.054	**
Mixed flour	318.829	130.223	2.448	0.015	***
Other uses	96.516	186.547	0.843	0.520	
R^2 0.67					
Y=sorghum production					

***** Indicates significant at 1% and ** significance at 5%**

Multiple liner regression shows that, amount sold, amount used in stiff porridge (Dum1), porridge preparation (Dum 2), and mixed sorghum flour with other cereal are statistically significance at one and five percent levels respectively. Local brew and other uses are not statistically significant meaning that these factors have no influence on sorghum production. Consistent with this results, it indicates that a unit increase in stiff porridge consumption leads to increase production of sorghum by factor of 150.66 while a unit increase in porridge utilization increase production by factor 131.7, this results are statistically significance at ($p<0.05$). However with mixed sorghum flour and other grain a unit increase in utilization increase production by unit factor 318.829 and this results are statistically significance at ($p<0.00$). This finding of positive association between sorghum consumption as food and production is consistent with the initial assumption and also supportive with other findings from the study conducted by Wortmann *et al.* (2006) find that sorghum consumption in Tanzania is within house hold level mainly for food consumption which consumes about 56% of the produces. FAO and ICRISAT (1996)

observed that 42% of sorghum produced worldwide is used for food consumption .Other studies like (Kleih *et al*., 2000); (Parthasarathy *et al*., 2010) and (Laswai *et al.,* 2003) reported that sorghum in Africa and Asia sub continent is used mainly for food consumption. Amount of sorghum grain sold was found to be statistically significance at ($p<0.000$) meaning that a unit increase sorghum grain sold increase production by factor 0.965. This finding is true due to the new emerging market that demand a huge amount of sorghum grain especially in manufacture of clear beer (Makindara *et al.,* 2010).

Sorghum utilization in local brew was assumed to have positive relationship on sorghum production. Surprising the results from regression reveal that, local brew is not statistically significance at ($p<0.00$) due to the fact that, at farmers level most of the produced are for home food consumption and the surplus is for commercial market like brewing industries, milling and processor industries and animal feed so farmers are opting to sell out surplus produces so as to earn more profit for other economic activities rather than consuming more time in preparation of brew. This result is supportive with the study conducted by Makindara (2012) which indicated that large industries like Dar brew, TBL and Serengeti breweries purchase sorghum grain for manufacture of clear beer like Senetor and Eagle. Other uses that include sorghum utilization in new emerging processed products like fried roasted grain or popped sorghum, biscuits, simple cakes, cookies and instant soft porridge were not statistically significantly at ($p<0.000$) due to the fact that at farmers level most of them they don't have knowledge on how sorghum can be utilized in bakery activities. Apart from that study conducted by Laswai *et al.,* (2003), Asante (1995) find that sorghum utilization in processed products is still low due to poor technology in producing industrial sorghum flour i.e. available sorghum

processors are small women and their production capacity is still very low (Makindara *et al.*, 2010).

4.4 Predict Future Production of Sorghum

Yield estimation prior to crop yield is possible by using time series analysis in a forecast of yield in the following year. In this study, ARIMA model of liner form was used in prediction of sorghum yield using production time series data covering the period of 2000-2014. The assumption behind was future production of sorghum is influenced by current and previously production. The results revealed that, current and previously production has significant influenced sorghum production.

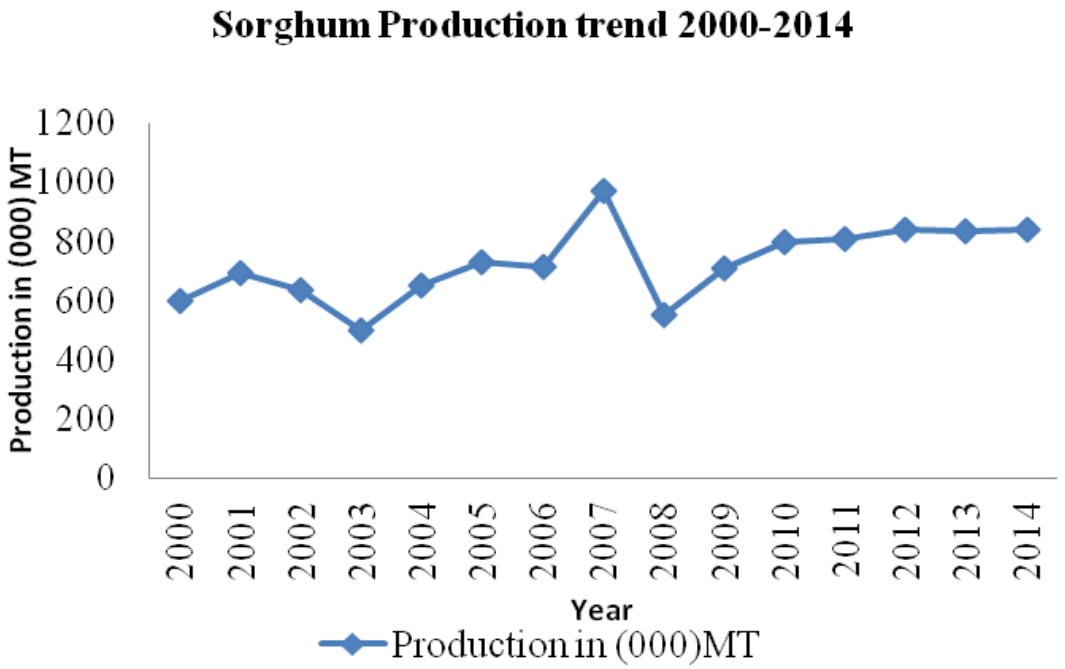

Figure 3: Trends of sorghum production for the past 10 years

Looking on the previously situation on sorghum production there is long term upward and downward trends during 2000- 2009. Production grew more rapidly in 2007 up to 917 000 tonnes and fall rapidly in 2008 to 551 000 tonnes and after its maintained a slightly positive increasing trend up to 2014.

Table 19: Prediction of sorghum production using liner form of ARMA model

	Coefficients	Std. Error	T	Sig.
(Constant)	636582.876	438360.062	1.452	0.197
Current production	0.023	0.342	0.067	0.029***
Previously production	0.141	0.339	0.415	0.035***
production in two years back	0.078	0.354	0.22	0.833
Production in _three years back	0.06	0.361	0.17	0.871
Dependent: Future production				

Note: *** = indicate significance at 1%

Sorghum yield was predicted for tens years and the results in Table 19 below shows the maximum production for sorghum will be 911 530 tonnes by the 2025 with the minimum production of 885 764 in 2015. The results in figure 4 clearly revealed an increasing trend for the upcoming years. This can be attibuted with the on going promotion strategies which have been implemented by ICRISAT through its project of SMU aiming at increasing commercial suistanable utilization of sorghum in multiple use through value chain addition. The increased production is more as comparative to increase area under sorghum production as well as utilization which will create the demand. This results are consitence with the study conducted by Ariyo and Badmus (2011) on forecasting of maize production in Nigeria and the results revereled that maize production and crop area can increase in future up 9952 thousand tonnes and 9229 thousand hectors by the year 2020.

Table 20: Predicted yield

Predicted Year	Predicted Yield (Tonnes)
2015	885764
2016	888937
2017	895732
2018	902367
2019	907004
2020	907882
2021	909480
2022	910355
2023	910710
2024	911301
2025	911530

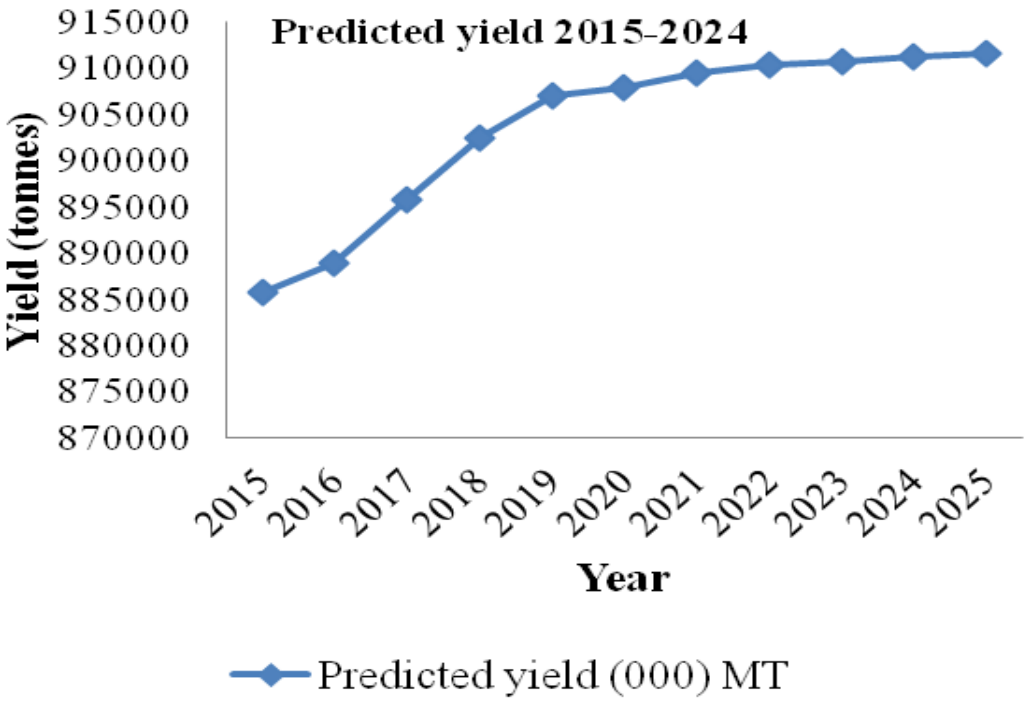

Figure 4: Predicted sorghum yield from 2015-2025

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDETIONS

5.1 Conclusion

The overall objective of the study was to assess sorghum production responses from it multiple uses promotion strategies in five districts. Specifically, the study examines multiple uses of sorghum in each district; determine influence of sorghum multiple uses on sorghum production; and predict future production of sorghum.

The targeted population was farmers in five district of semi arid area namely Singida rural, Iramba, Kondoa, Serengeti and Kongwa whereby sample 508 farmers were interviewed for the study.

The first objective was to examine multiple uses of sorghum in each district where descriptive statistics through cross tabulation was used to answer this objective. The study revealed that multiple uses of sorghum varies significantly in five district surveyed at ($P < 0.00$), among the multiple uses that have been point were utilization in food consumption, animal feeds, local brew and other uses. Majority of respondent in all districts use sorghum for human food specifically stiff porridge i.e. (Ugali) (87.25%) followed by animal feed (80.87%) and porridge (57.39). While few responses have been observed on uses such as local brew, non alcoholic drinks, other uses and fried products. In terms of food utilization like stiff porridge and porridge Serengeti is the leading district for such utilization followed by Kondoa and Singida but for animal feed Kondoa showed more response than other district. However in districts wise Singida shows more responses in all utilization followed by Kondoa, Serengeti, Iramba and Kongwa. Nevertheless this study explore the influence of other factors on sorghum multiple uses;

such factors were age, sex, varieties grown, and distance to the local market. The result found that there is variation on variety grown and multiple uses whereby local varieties are more utilized than improved specifically on food consumption like stiff porridge and porridge, in terms of sex male farmers shows significance amount in all utilization than female while respondent with the age of 36-50 show more response in all utilization than youngest group 18-25 this is because majority of the respondents interviewed were the household heard. Distance to the local market varies significance at ($p < 0.00$) with the sorghum multiple uses i.e. respondent below 1km have high percentage in all utilization compare to those who are far from the market i.e. beyond 20km.

The second objective was to determine influence of sorghum multiple uses on its production using multiple liner regression analysis and the results shows that, amount of sorghum sold, sorghum utilization in food consumption specifically stiff porridge, porridge, and mixed sorghum flour were found statistically significantly at ($p < 0.001$ and $p < 0.05$). Meaning that, these were the factors that influence production while other use, i.e. new emerged processed products like breads, buns , simple cakes cookies, and dried roasted grain and local brew were found insignificantly factor that influence production at farmers level.

The third objective was to predict future production of sorghum using time series data covered from 2000-2014 where liner model of ARMA with lags values was developed. The assumption was future production of sorghum is influenced by current and previously production. The results revealed that, current and previously production has significant influence on future production at ($p < 0.001$) with a positive increasing trend of production each year. Maximum Production is expected in 2025 with 911 530 tonnes.

Finally, based on the tested hypothesis i.e. “Putting Sorghum into multiple uses has no significance influence on production”, this was not supported by utilization in food consumption specifically stiff porridge, porridge, mixed grain and amount sold but supported by other uses and local brew. Previously and current production shows significance influence on future production with the positive trend and maximum yield of 911 530 tonnes by 2025 hence the second hypothesis was not supportive.

5.2 Recommendations

(a) Recommendations to sorghum producers

Sorghum as one of the most important crop in semi arid area of the country after maize its play a significance role for income generation and in food consumption when other grains fail. Based on the results majority of the respondent in all district surveyed use sorghum for food consumption especially steef porridge and porridge. In contrast with the new emerging market producers are recommended to use improved varieties that has multiple use so as to expand their market as well as production which is dominated by small scale farmers who produce mainly for home consumption with limited resources such poor production technology which results to low yield of 3-4bags/acre which is too low even to sustain family food throughout the year. Farmers are recommended to use good agriculture practices (GAP) and production inputs i.e. Proper land preparation, improves seeds that are highly demanded by the market, fertilizer and farmyard manure, pesticides, weeding and proper harvesting techniques so as to have high yield of good quality that is demanded by the market. On post harvest activities farmers are recommended to use proper technology during threshing so as to avoid mixing of grain with sand that lead to price reduction during selling, proper storage facilities where they can store their produce for more than a year without any loss in order to meet good price in future time. Farmers

are also recommended to form farmer's group association that will help to have large scale farming with contractual agreement with new markets like brewing companies. Also these associations will assist to get easy support from Government, or other stakeholders who supply development services to smallholder farmers. Most important thing these associations will help them to have a common say when it's come to price change for selling their produces.

Women farmers are also encourage learning more on sorghum utilization so as to expand their knowledge in utilization especially in food consumption where they can prepare several sorghum by product for their family and surplus for sell rather than consuming as steef porridge and porridge. Instant soft porridge which is pre cooked sorghum dry powder added vitamins as used in South Africa can act as good source of income and nutritional improvement especially for the children who are under five years of who most of them are facing the problem of malnutrition.

(b) Recommendations to policy makers

Government itself must motivate sorghum crop the same way like other cereal (maize and rice) by giving it priority as food crop and cash crop at the same time. Together with this government policies and intervention should encourage farmers who are living in semi arid areas to grow sorghum as first crop and provision of subsidy like maize crop**.** Government through Ministry of Fisheries and livestock keeping should motivate feeds industries to incorporate sorghum grain as part of feed mixture so as expand the utilization. Government should improve and support extension services by provision of seminars and training that focus more on sorghum utilization and production then, empower farmers to produce for market by linking them to potential market within and outside the county through contractual agreements

(c) Recommendations to sorghum stakeholder

Sorghum stakeholders such as ICRISAT, ASERECA, Africa harvest breweries industries and other research institutions should work more on introducing new varieties with multiple uses so as to increase consumption base of sorghum to include grains, stalk and leaves and associate by products. Research institutions should work on introducing new varieties that can be used in bio fuels and wax manufacturing like United States, it is estimated that annual Sorghum grain makes up 4% of the total grain used for ethanol production in the U.S. (Renewable Fuels Association, 2007).

Subsidize like sorghum inputs, quality seeds, recommended fertilizer, herbicides and insecticides so as to motivate farmers to grow sorghum and sell as long as the market is available rather than cultivate maize that cannot withstand dry season. .

Finally Government and sorghum stakeholders should seek for new technologies and opportunities outside our county for expansion of existing sorghum utilization especially in livestock and poultry feeding industries, because in Tanzania sorghum residual without processed are mostly used to feed animal and is during dry season. In other countries like India based on the study conducted by (Tulasi *et al.,* 2004, and Rajashekher *et al.,* 2005) reported that, Poultry feed trials conducted at poultry sciences department collage of veterinary science have explored that, sorghum can replace maize completely in poultry feed especially in broilers in terms of growth rate, livability, egg production and weight. In Nigeria sorghum grain by product from milling and breweries industries are processed and mixed with other cereal by product to make animal feed. Therefore, this study recommend that government should subsidize this crop and put more emphasize on utilization through expansion of existing utilization and introduction of new utilization

that are not within our country so as to stimulate the demand. Hence farmers will be motivated to produce more and even to export their produce.

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APPENDICES

Appendix 1: Questioner for Development of Robust Commercially sustainable SMU Value Chain in Kenya and Tanzania

Baseline survey Instrument

0.0 Survey quality control

Date of interview: Day……Month…….....Year.....
Interviewed by.....
Starting time: …… Ending time: ……
Date checked: Day: ……Month ……Year.....
Checked by.....
Date entered: Day: .....Month..... Year: .....
Entered by :.....

1.0 Respondent and site identification

Please confirm that the person you interview is the head of the household or that s/he is able to answer questions concerning the agricultural production and other household issues. If the respondent is not able to do so please stop the interview and arrange another date to interview the head of the household. Please explain the respondent that we also like to ask some questions to his/her spouse. Ensure that s/he is available around 2 hours after the interview started.

1. Respondent name ……
2. Respondent sex |_____| **1= Male, 2= Female**
3. Region……District …….. Division .....…… Village ……
4. Number of years the respondent is living in the village……..
5. Do you have collective market for crops in your village?|_____| **1=Yes, 2=No** ward|_____| **1=Yes, 2=No**
6. Distance to the main market (km**)…**..……
7. Type of road to main market:[1] …..…….Quality of road:[2]…..……
8. Number of month's road to the main market is passable for trucks in a year |_____|
9. Distance to the extension officer in **km**…… **and/or** hours ……

[1]. **Type of Road:** 1=Non-paved dirt/dust road, 2=Paved dirt road, 3=Paved gravel road, 4=Tarmac road

2. Quality of road: 1 = Bad, 2 = Good, 3 = Very Good

2.0 Household composition

2.1 How many members are living in your house?.....

(Please fill the table for all household members who were in the last 12 month living in your household, ***fill also for non-permanent members)***

Name of HH member (start with respondent)	Relation to HH **Code A**	Gender **(0=male;1= female)**	Marital status **Code B**	Age **(years)**	Education level **Code C**	Main occupation **CODE D**	Farm labour participation **Codes E**
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							

Codes A
1 Household head
2 Spouse
3 Son/daughter
4 Parent
5 Son/daughter in-law
6 Grand child
7 Other relative
8 Hired worker
9 Other, specify……

Codes B
1 Married living with spouse
2 Married but spouse away
3 Divorced/separated
4 Widow/widower
5 Never married
6 Other, specify……..

Code C
0 None (illiterate)
1 Basic (can write and read)
2 primary education
3. secondary education
4. Collage
5. Other specify.....

Code D
0 No occupation
1 Farming (crop + livestock)
2 Salaried employment
3 Self-employed off-farm
4 Casual labourer on farm
5 Casual labourer off-farm
6 Herdsboy/girl
7 Housekeeping
8 Non-farm agribusiness
9 Other business (shops, trade, tailor, etc)
10 Other, specify……

Codes E
0 None
1 Full time
2 Part-time
3 Weekends and holidays
4 Other, please specify
……..

3.0 Land Holding

3.1 Please fill the following Table about land holdings during the 2010/2011 planting season **(in acre)**

		Total	Cultivated land	Fallow land	Other, specify**
Land owner ship	Own				
	Rented in				
	Rented out				
Total					

**Specification……

If no land is rented in or out skip to 2.0 at the next page.

3.2. *If land is rented in*: How much did you pay in TSh or in kind in the planting season 2010/2011 for the total area you rented in? .....

3.3. *If land is rented out*: How much did you receive in TSh or in kind in the planting season 2010/2011 for the total area you rented out? .....

4.0 EXPERIENCES IN CROP CULTIVATION

4.1 Experience in **(years)** for the crop listed below

Type of crop	If cultivated**1=Yes 0=No**	No. Years	Priority in crop cultivation
Sorghum			
Groundnuts			
Maize			
Beans			
Sunflower			
Pigeon peas			
Cassava			
Irish potatoes			
Sweet potatoes			
Rice			

5.0ANIMAL PRODUCTION

5.1 Animal production and feeding

Type of Animal	No. of animals	Feeding Methods	Purpose for keeping animal
Cow			
Sheep			
Goat			
Pig			
Local chicken			
Broiler chicken			
Layer's chicken			

5.2 How do livestock assisting in sorghum cultivation?

Livestock type	**Means**

1=Manure2=plough ling, 3=Transportation 4= Harvest 5=Weeding 6=Not used, 7= Other specify

6.0 VARIETY ADOPTION AND SOURCES OF INFORMATION AND SEED

6.1: Knowledge of Varieties, Sources of Information and Seed Adoption and Dis adoption

Crop (**Codes A**)	Planted area in Ha	Crop variety	**Main** source of variety information **Codes C (Rank 3)**	Year variety known	**First seed**				Future Adoption	
					Main source of first seed **Codes F**	Quantity of first seed **kg**	Means of acquiring first seed **Codes G**	If bought, Price/kg	Will you plant the variety in future? **Codes D**	If No, why? **(Codes E) Rank 3**

Codes A
[Use the CROP CODE sheet] (Use codes in pg 18)

Codes Code B
variety names

Codes C
1. Improved
2. .Local

Codes A	**Codes B**	**Codes C**	**Codes D**	**Codes E**	**Codes F**	**Codes G**
1. sorghum, 2. cowpea, 3. green gram 4. lablab	Use variety list provided (see last page)	1. Government extension 2. Farmer club 3. NGO 4. Research centre: on-farm trials/demos/ field days 5. Seed/grain stockist 6. Another farmer/ neighbor 7. Radio/newspaper/TV 8 Other, specify…...……	0. No 1. Yes	1. Cannot get seed at all 2. Lack of cash to buy seed 3. Diseases & pests 4. Poor taste 5. Requires more rainfall 6. Low yielding variety 7. Poor prices 8. No market 9. Requires high skills 10. Seeds are expensive 11. Other, specify……	1. Research PVS 2. Extension demo plots 3. Farmer club 4. Local seed producers 5. Local trader or agro-dealers 6. Farmer to farmer seed exchange (relative, friend, etc) 7. NGOs 8. Govt agency 9. Inherited from family 10. Other (specify)……	1. Gift/free 2. Borrowed seed 3. Bought with cash 4. Payment in kind 5. Exchange with other seed 6. Other, specify…..

7.0 Characteristics of crop production plots in the 2010/2011 Main season (all crops grown)
7.1 How many farms do you have? .....

Plot code (number starting from nearest plot to house)	**Crop grown (go to last page) (Codes A)**	**Variety name (Codes B)**	**Variety type (Code C)**	**Was variety Intercropped? (0=No; 1=Yes)**	**If yes, with which crop? (go to last page)**	**Plot size (acres)**

8.0 SORGHUM VARIETY, CHARACTERISTICS AND USES

8.1Mention sorghum varieties used and which one is given first priority

Sorghum Variety	**Good characteristics of the variety**	**Bad characteristics of the variety**
1.		
2.		
3.		
4.		

Type of Animal	Type of food	Feeding method (use codes)
5.		

8.2 Farmers experience in utilization of sorghum product

Name of the Variety	**Sorghum Flour**	**Sorghum grain**	**Sorghum stalk and leaves**	**Other uses.....**
	Use 1	Use 2	Use 3	Use 4
1.				
2.				
3.				
4.				
5.				

8.3 Do you use Sorghum to feed animals**? 0. No 1. Yes**

If yes which type of animal and how do you feed them?

Type of animal	Type of feed	Feeding Methods
Sheep		
Goat		
Pig		
Local chicken		
Broiler chicken		
Layer's chicken		

Code 1=Stalk 2= Green folders 3= Dry folders

8.4 S*orghum* inputs and output in the 2010/11 planting season

Crop variety Code	Manure (kg)			Fertilizer				Seed			Field pest chemical		Hired oxen (TSH)	Total family Labour (labour days)						Total amount paid for labour (TSh)*
	Own (kg)	Bought		DAP/TSP/Minjingu		CAN/Urea/SA/NPK		Own saved/gift (kg)	Bought		Litres/Kg	Price (TSh/litre/Kg)		Ploughing, harrowing & planting	Weeding	Chemical application	Harvesting	Threshing/shelling	Total family labour	
		Kg	Price (TSH/Kg)	kg	Price (TSH/Kg)	kg	Price (TSH/Kg)		Amount (kg)	Price (TSH/kg)										

9.0FARMERS TECHNOLOGY IN SORGHUM PRODUCTION

Please let the farmer choose one of the plots on which s/he grew sorghum in the 2010/2011 planting season and fill the following Table

Operations	**Recommended technologies for sorghum**	**Tick if used**
1. Land preparation (Ploughing)	Animal traction	
	Tractor plough	
	Power Tiller	
	Hand hoe	
	Zero Tillage	
	Other, specify……..	
.Compost/Manure application	Farmyard manure	
	Compost manure	
	Other, specify……..	
3.Seed treatment	*fungicides*	
4. Planting/Sowing	Row planting 60cm x 15cm	
	60cm x 30cms	
	75cm by 15 cm	
5. Fertilizer application	40-60Kgs N /ha	
	Microdosing 17KgsN/Ha	
	90Kgs N/ha split application	
	Other, specify……..	
6. Weeding/Herbicide application	Hand weeding 1 times	
	Hand weeding 2 times	
	Herbicide –pre emergence	
	Herbicide post emergence	
	Other, specify……..	
8.Plant protection - Spraying/Dusting/ Shaking /Hand picking)	Insecticide for stalk borer	
	Other, specify……..	
9. Irrigation	In situ water harvesting	
	Other, specify……..	
10. Watching (Birds, Pigs etc.,)	Bird scaring, specify how ……	
	Other, specify……..	
11. Harvesting	Manual harvesting (Cutting the	
	Other, specify……..	
12. Threshing	Threshers	
	Animal tramping	
	Manual (beating)	
	Other, specify……..	
13 Post-harvest activities	Insecticide	
	Other, specify……..	
14 Post-harvest activities: Milling	Dehulling	
	Milling without dehulling	
	Hand milling	
	Hammer mill	
	Wet milling	
	Other, specify	

9.1 Sorghum utilization

Utilization of S*orghum* from the 2011/2012 planting season (please use three rows per variety to add all consumption specifications; if information cannot be given per variety it should be given per crop)

Sorghum variety	Amount harvest (Kg)	Amount **sold** in **kg**	Amount saved as seed **kg**	5. Amount **consumed** in kg	Consumption specification, rank 3 **(Code A)**	8. Amount **(kg)** used for other purposes	Purpose **(Code B)**	Stover is used **(0=no;1=yes)**	*If yes:* Purpose **Code C**	*14. Sum of column 3+4+5+7*	*Check difference column 11 and12*

Code A		**Code B**	**Code C**
0 Porridge	4 Non alcoholic drink	0 Gift	0 Animal fodder
1 Ugali (pure sorghum/finger millet)	5 Fried/roasted grain	1 Stored to sell at another time	1 House construction
2 Ugali mixed with other cereals/tubers	6 Other, specify……	2 Stored to consume at another time	2 Sold
3 Alcoholic drink		3 Other, specify……	3.Firewood
			4. Mulching
			5 Other, specify……

10.0 MARKETING AND STORAGE OF S*ORGHUM*

10.1 How easily is it to get the market for Sorghum and its product
Code; **1**=very easily **2**=not easily

10.2 Where is the market for selling Sorghum**?**

Code; 1=village market 2=District market 3=Region market 4= outside the region 5=other**.....**

10.3 Please fill the following Table for marketing of s***orghum,*** in the 2010/2011

Name of crop variety **Crop code**	Sold product **Code A**	Buyer **Code B**	Place of selling **Code C**	Mode of transport **Code D**	Transport time **(hrs)**	Transport costs/ transport **(TSh)**	Kind of selling **Code E**	*If no grade*: Product quality **Code G**	Amount sold in **unit of grain**	Tax free price/kg/grade or quality **(TSH)**	Sales tax/ charges **(TSh)**

Code A
1 Grain
2 Flour
3 Alcoholic beverage
4 Non-alcoholic beverage
5 Fodder
6 Other, specify……..

Code B
1 Consumer or other farmer
2 Rural assembler (vendor)
3 Broker/middlemen
4 Urban grain trader
5 Exporter
6 Other, specify……..

Code C
1 Farm gate
2 Village market
3 Town market
4 Factory/mill
5 Other, specify……

Codes D
1 Bicycle
2 Hired truck
3 Public transport
4 Donkey/ox cart
5 Head/back load
6 Other, specify….

Code E
0 Loose
1 Packed

Codes G
1 Poor
2 Medium
3 Good
4 Mixed
5 Other, specify……..

10.4 Do you sell other sorghum products? **0=No 1=Yes**
10.5 If yes how do you add value for the sorghum products?

Ways of adding value	**Product after adding value**

10.6 What are the major constraints/limitations in selling **S*orghum*** please mention the first two (*do not read out the reasons. Assign the farmers' answers to the given categories).*

Constraint

Codes
(a). Lack of information about buyer preferences ----------
(b). Lack of information about places where to sell ------- ---------
(c). Low price
(d). Need to travel long distances ---------
(e). Lack of information about prices ---------
(f) Broker fixes the price
(g). others (specify)……..

10.7 Do you have collective activities for marketing sorghum in your village? **1=Yes 2=No**
10.8 If yes in question **10.7**; Do you involved **1=Yes 2=No**
10.9 If yes explain how.....
10.10 Why did you never sell your crops through collective action?

1 Didn't have enough grain 2 Collective action is too strict on quality

3 Collective action is not paying immediately 4 Collective action prices are lower than those of marketing options

5 Other, specify ……..

10.11Have ever sell any of your crops apart from sorghum in collective market? 0=N0 1=Yes
If no check question 11 if yes fill the table below

Name of collective action	Collective action **Code A**	Crop **(Crop codes)**	**Year** when collective action started	**Year** when collective action stopped	In how many **years** were you not active in the collective action?	*If action is not ongoing*: Why did you stop the collective action? **Code B**

Codes A	**Codes B**
1 Transport 2 Marketing 3 Purchase inputs together 4 Price setting 5 Other, specify …….	1 Didn't have enough grain 2 Collective action was too strict on quality 3 Collective action was not paying immediately 4 Collective action prices were lower than those of marketing options 5 Other, specify ……

11.0 Residue Management methods

Residue management methods(see codes below)	Proportion of total quantity (%)

Code 1- Residue management methods	
1=left in the field	5= taken from the field by others for free
2=stubble grazing animals	6=taken home for stall feeding
3=burnt	7=taken home for fuel
4=taken from the field and sold by owner	8=taken home for housing
	9=others specify

11.1 Where do you store sorghum produce?

Storage place: 0= I do not store any produce 1= At home in bags 2 =In private storage facility

3 =At home and in private storage facility 4=At home in air tight drums, 5= Public storage

12.0HOUSEHOLD FOOD SECURITY

12.1 Was the household able to produce and/or purchase enough food for the past two years (to be consumed throughout the year)? 1. Yes 2. No

12.2 If no, how long does food from own production last? (Specify number of months also)_____

01 one to three months
02 four to six months
03 seven to nine months
04 more than nine months

12.3 If your HH did not have enough food in any one of the years what were the reasons?

01	Drought	07	Not enough labour
02	Draught power shortage	08	Not enough seed
03	Crop damage due to pest & diseases	09	Lack of fertilizer
04	Land shortage	10	Sold most of the harvest
05	Poor soils	11	Other Specify
06	Excessive rain		

12.4How does the household supplement to cover-up the deficit?

01	Purchase with own cash	07	sale of HH assets
02	gifts (in kind) from relatives/friends	08	sale of firewood
03	**G**ifts (cash) from relatives /friends	09	petty trading
04	sell of livestock	93	others (specify)
05	food for work		
06	aid (govt, NGOs)		

12.5 Which of these statements best describes the food eaten in your household in the last 12months?

1. we always have enough to eat and the kinds of food we want;
2. we have enough to eat but not always the kinds of food we want;
3. sometimes we don't have enough to eat; or
4. often we don't have enough to eat

12.6 Explore more information about the household based on the following questions

1. Never 2. Rarely 3. Sometimes 4. Mostly 5. Always						
Question	**1. Yes 2. No**	**If yes, how often?**				
12.6.1. In the last 12 months, did ***you or other adults*** in your household ever ***cut the size of your meals or skip meals*** because there wasn't enough money for food?		**1**	**2**	**3**	**4**	**5**
12.6.2In the last 12 months, were you ever ***hungry but didn't eat*** because you couldn't afford enough food?		**1**	**2**	**3**	**4**	**5**
12.6.3 In the last 12 months, did ***you or other adults*** in your household ever ***not eat for a whole day*** because there wasn't enough money for food?		**1**	**2**	**3**	**4**	**5**
12.6.4 In the last 12 months, did you ever ***cut the size of any of the children's meals*** because there wasn't enough money for food?		**1**	**2**	**3**	**4**	**5**

13.0 How is the availability of sorghum, from your **own harvest** throughout the year, *(please start with the month of harvest)*

Month	Indicate month of harvest for sorghum,	Status of Crop availability **Code A**	Strategy in times of shortage **Code B**
1. January			
2. February			
3. March			
4. April			
5. May			
6. June			
7. July			
8. August			
9. September			
10. October			
11. November			
12. December			

Code A
1 Plenty
2 Enough
3 Shortage

14.0 ACCESS TO INFORMATION AND PARTICIPATION IN TECHNOLOGY TRANSFER

14.1Do you have access to electricity? 0 No 1 Yes

14.2 Do you have access to a governmental extension officer? 0 No (skip to 5.3) 1 Yes

Issue	Source of Information
1. New varieties of crops	
2. Crop storage	
3. Output markets and prices	
4. Input markets and prices	
5. Crop management	

14.3 *If yes in 5.1:* How often **per year** do you consult the extension officer?

Rank your 3 major sources for information on the issues below. Consider information for all crops. *(Use Codes A*

Codes A

1 Extension officer
2 Research centre
3 Newspaper
4 Seed traders/Agro-dealer
5 Other private shops
6 Radio/TV
7 Mobile phone
8 Neighbour/ other farmers
9 NGOs
10 Cooperative
11 School
12 Other, specify……

to rank the issues)

14.4 Do you get water? 0 No 1 Yes

14.5 *If yes in 14.4: mention the source*

Code1 River **2** Tape water **3** lakes **4** other.....

Asset name	Number	Current unit value **(TSH)**	Total value *(in case unit value cannot be given)* **(TSH)**	Year of acquisition of this kind of item
1.Ox-ploughing set				
2.Ox-cart				
3.Sickle				
4.Panga knife				
5.Axe				
6.Spade/Shovel				
7.Hoes				
8.Sprayer/ water pump (electric)				
9.Sprinkler set/drip irrigation				
10.Harvester/thresher/shellers				
11.Wheel barrow				
12.Bicycle				
13. Other motorized vehicles				
14.Broad bed and furrow (BBF) marker				
15.Radio/radio cassette				
16.Mobile phone				
17. Phone				

15.0HOUSEHOLD ASSET

16.0 CREDIT ACCESS AND SOCIAL ASSETS

16.1 Do you have credit organization in your village? 0 No 1 Yes
16.2 If Yes in 16.1 do you involve in any of credit organization 0 No1 Yes
16.3 If no 16.2 explain why.....

16.4 Did you **try** to obtain a formal credit in the last 12 month?

0 No 1 Yes *(skip to 6.5.4)*

16.5 *If no in 16*:4 if you would have been in need of a credit would you be able to get one?

0 No Yes,
Please rank the two most important sources *(afterwards skip to 6.5.6)*

1 NGOs___ 2 Banks___ 3 Saving sacas___ 4 Village money lenders___
5 Farmers/traders____ 6 SACCOs___ 7 Family/friends___
8 Other, specify …… ___

16.6 *If no in 16:5* why would you not have been able to obtain a credit? Please give the first two most important reasons

16.7 *If yes in 16:4*Did you get the credit? 0 No 1 Yes

16.8 *If no in 16.4* Why did you not get the credit? Please give the two most important reasons

16.9 *Continue with **all**:* Do you have any credits that are not paid back yet? 0 No 1 Yes

14.7 *If yes in 16:7* Please fill the following table for each loan/credit

Source of credit **Code A**	Purposes of the credit **Code B**	Amount of initial loan/credit in **TSh or kind**		Did you get the amount (kind or TSh) you requested **(0=no; 1=yes)**	HH member that applied for the credit **Code C**
		Quantity	Unit		

Code A	**Code B**		**Code C**
1 NGOs	1 Buying seeds	9 Non-farm business or trade	1 Household head
2 Banks	2 Buying fertilizer	10 Buying food	2 Spouse
3 Saving sacas	3 Buy other agricultural inputs	11 Children's education	3 Son/daughter
4 Village money lenders	4 Farm equipment/implements	12 Family health/medical	4 Parent
5 Farmers/traders	5 Buying oxen for traction	13 Buy land	5 Son/daughter in-law
6 SACCOs	6 Buy other livestock	14 Improve your house	6 Grand child
7 Family/friends	7 Soil and water conservation	15 Social obligations	7 Other relative
8 Other, specify ……	8 Invest in irrigation	16 Other, specify …….	8 Hired worker
			9 Other, specify……

15 HOUSEHOLD INCOME, EXPENDITURE AND ASSETS

Main sources of income and expenditure for the household in last 12 month (calculate/annum)

INCOME SOURCES	**EXPENDITURE**

Crops	**TZS**	**Agricultural related code 2**		**TZS**	**Other sources Code**		**TZS**	***Main Expenditure* Code**		**TZS**
		Agric. wage labourer	01		Fishing	01		Food	01	
		Dairy/ beef Livestock	02		Formal employment	02		Health	02	
		Poultry	03		Pension	03		Transport	03	
		Land rents	04		Remittances	04		Housing	04	
		Equipment hire	05		Carpentry	05		Land rents	05	
		Goats/sheep	06		Tailoring	06		Equipment hire	06	
					Business	07		Remittances (gives out)	07	
					Gifts	08		Gifts (gives out)	08	
					Aid (govt, NGOs)	09		Business	09	
								Agricultural Inputs		
								School Fees		
								Groceries		