ADOPTION AND ECONOMIC IMPACTS OF IMPROVED SORGHUM VARIETIES IN SEMI-ARID AREAS OF TANZANIA: A CASE OF SINGIDA RURAL DISTRICT

BY

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ABSTRACT

The use of improved crop varieties by small-scale farmers in Tanzania has increasingly been important especially under the prevailing shocks and stresses of climate change and variability. This study was designed to assess adoption and economic impacts of improved varieties of sorghum to small-scale farmers in Singida rural district. Both formal and informal surveys were conducted in the study area. A total of 180 households were interviewed during a formal survey. Heckman two-step analysis was employed to determine the key factors that influence farmers in making decision on the incidence and intensity of planting improved sorghum varieties. On the other hand, the effect on adopter and non-adopter was employed as a counterfactual approach to assess the impact accrued from adoption of these varieties. A combination of livelihood assets and institutional factors was modeled in both steps of Heckman to see if they have an influence on farmers' incidence and intensity of planting improved varieties. All institutional factors namely, frequency of visits by agricultural extension officers, credit accessibility, market accessibility, timely availability of improved varieties, and a livelihood asset, household size were significant and positively influenced farmers' in making decision on whether or not to grow improved sorghum varieties. On the other end of the spectrum, availability of improved varieties and market accessibility were once again significant on influencing intensity of cultivating improved sorghum varieties. Generally, the adoption rate was low in the study area. Unavailability of these improved varieties was found to be the most notorious constraint against the adoption as observed in both surveys. Despite the low rates of adoption, the impact indicators; productivity and food security status were found to be

statistically different ($P<0.01$) between adopters and non-adopters. The study recommends immediate institutional arrangements and adjustments as well as carrying out of further research in the areas of breeding, soil, post-harvest processing, engineering and agricultural markets in the study area.

DECLARATION

I, **Mwaluko Mpangwa,** hereby declare to the Senate of Sokoine University of Agriculture that this thesis is my own original work, and that it has not been submitted for a higher degree award in any other university

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DEDICATION

To my beloved parents, Christopher Mpangwa (the late) and Mrs. Rhoda N. Mpangwa who laid the foundation of my education.

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ABBREVIATIONS AND ACRONYMS

ARI	Agricultural Research Institute
CDF	Cumulative Distribution Function
CIMMYT	International Centre for Maize and Wheat Improvement
DAEO	Division Agricultural Extension Officer
DALDO	District Agricultural and Livestock Development Officer
DFID	British Department of International Development
EAC	East Africa Community
EAAFRO	East Africa Agricultural and Forestry Research Organization
FGD	Focus Group Discussion
FAO	Food and Agricultural Organization
FNT	Fews Net Tanzania
ha	hectare
ICRISAT	International Crops Research Institute for the Semi-Arid Tropic
INTSORMIL	International Sorghum and Millet
ILCA	International Livestock Centre for Africa
KI	Key Informants
LGA	Local Government Authority
LPM	Linear Probability model
m	meter
MDB	Market Development Bureau
MAFCs	Ministry of Agriculture, Food security and Cooperatives.
MNL	Multinomial Logit
MNP	Multinomial Probit
NAPA	National Adaptation Programme of Action
NSMIP	National Sorghum and Millet Improvement Programme
SACCoS	Savings and Credits Cooperative Societies
SADC	Southern African Development Community
SGR	Strategic Grain Reserve
SLA	Sustainable Livelihood Approach
SMIP	Sorghum and Millet Improvement Programme
SPSS	Statistical Package for Social Sciences

STD	Standard Deviation
SUA	Sokoine University of Agriculture
t	tonnes
TBL	Tanzania Breweries Limited
TLU	Tropical Livestock Unit
Tsh	Tanzanian shillings (local currency)
URT	United Republic of Tanzania
VAEO	Village Agricultural Extension Officer
VEO	Village Executive Officer
WAEO	Ward Agricultural Extension Officer
WB	World Bank

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Africa is highly vulnerable to climate change because majority of the continent's population primarily depends on rain fed agriculture (Boko *et al*., 2007). Tanzania is not exceptional on this as agriculture is the key sector of the country's economy; it accounts for about one quarter of the GDP and three-quarters of merchandise exports, and employs more than 70% of the labour force in the country (WB, 2009). The sector contributes to the non-farm sector by providing raw materials to agro-processing industries. More important, nearly 75 % of the Tanzania rural population is employed by this sector (URT, 2010). However, recent studies show that there has been a constant crop failure due to persistent drought (Paavola, 2004; URT, 2007; Shemsanga, 2010). In view of the above, the future of the country's small scale farming population looks grim, unless something is done to ensure availability of enough improved agricultural technologies.

Sorghum, whose adoption and economic impact assessment of improved varieties are the major concern of this study, is an important crop for food security both nationally and globally. For example, sorghum is the second most important cereal grain in Africa after maize and covers a significant land size in the continent. The crop covers nearly 31% of total land devoted to cereals in Africa (Armah *et al.,* 2010). Tanzania is ranked in the sixth position in Africa for the production of this crop whereby about 500 000

tonnes are reported to be produced annually (Rohrbach and Kiriwaggulu, 2007). Moreover, within the country, the crop is among the major six food crops ranked in the fourth position after maize, paddy, and wheat based on production volume (FAO, 2001).

The drought resistant nature of sorghum plays an important role in the prevailing threat of climate change. Projection models indicate that rainfall will decrease by 20% in semi arid areas by 2100 which is estimated to decrease national grain production by 10% before 2080 (Mwandosya *et al.,* 1998). This implies that crops which need more water will have greater chance of failing; thus, drought resistant crops like sorghum will help in solving the problem of food shortage resulting from drought caused by climate change.

Nevertheless, there is a plethora of literature showing the potentials of increasing income from sorghum. The demand for the crop offers a great opportunity for increasing sources of income to small-scale farmers in semi arid areas which are highly vulnerable to poverty. Developed and expanded food processing, feed concentrates and clear beer brewing together have enhanced the market for the crop. For example, Tanzania Breweries Limited (TBL) has recently established brewing of a clear beer from sorghum known as eagle lager (INTSORMIL, 2007). More importantly, according to FNT (2006) the crop has been included in the Strategic Grain Reserve (SGR) stocking. This has also expanded the market for the crop hence increased income generating potentials. Furthermore, sorghum is considered to be one of the popular crops since for many years

the crop has been helping to cub hunger problems in the semi arid areas of Tanzania (Ishuza, 1994; Msambichaka & Mashindano, 1999; Rohbach & Kiriwaggulu, 2007).

Despite the food and economic importance of the crop and the efforts made by the government and nongovernmental organizations like ICRISAT to promote the crop, the adoption and incidence of its improved technologies in the semi arid areas of Tanzania is far from reality. This trend is reflected by the continuing food shortages in the area. According to reports, for the past ten years nearly 70% of the population in this area has been faced with food insecurity (URT, 2010). The indicators of food shortages in the area are also clear. As Lamboll and Mwanga (2002) reveal, the number of severely and moderately underweight children normally exceed 30% in the central semi arid zone. Furthermore, up to 60% of the population in the zone is affected by Trachoma, a blind disease which is an indicator of widespread poverty, malnutrition and lack of sanitation (Mecaskey *et al.*, 2003).

1.2 Problem Statement and Justification

From the above discussion it is clear that sorghum is important for food security and income to rural areas and the whole of the country in general. Therefore, intensification of improved technologies for crop production which would lead to increased yields of sorghum is indispensable. Recognizing the importance of the crop, the government and nongovernmental organizations started to conduct research on the crop aimed at improving the yields as well as perseverance to drought conditions. However, low

adoption and incidence of use of improved varieties in the zone frustrate the stakeholders' efforts of reducing food insecurity and income poverty. In this regard therefore, it is important that the factors that influence farmers' decision in adopting improved varieties are well understood.

To get more farmers involved in adopting improved varieties we need to understand the factors conditioning farmers' decision to adopt or not to adopt such varieties as well as the level of adoption for the purpose of designing the best way of promoting the varieties in the area. This necessarily implies addressing a number of issues. Developing a technology such as improved sorghum varieties is one issue and its disseminating is another completely different issue. And in the view of this study, these aspects are more fundamental, and involving things such as clarifying questions like what factors influence farmers' decision in adopting and using improved sorghum varieties? What could be the impact of adopting improved sorghum varieties? It is these questions that this study is designed to address.

1.3 Objectives

1.3.1 Overall objective

To assess adoption of sorghum improved varieties and their economic impacts towards livelihood of small-scale farmers in the study area.

1.3.2 Specific objectives:

Based on the above overall objective, three specific objectives were put forward;

i. To identify the main economic activities and livelihood portfolios of people in the study area.

ii. To determine key factors that condition farmers' decision on incidence and intensity of adoption of improved sorghum varieties in the study area.

iii. To assess the benefits accrued from the adoption of improved sorghum varieties in the study area.

1.4 Hypotheses

In achieving the above stated specific objectives the study performed formal tests on the following hypotheses;

i Farmers' livelihood assets and institutional factors enhances their decision on incidence and intensity of adoption for improved sorghum varieties in the study area.

ii The adoption of sorghum improved varieties significantly improve farmers' productivity and food security.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter highlights the literature relevant to the subject matter of this study. It largely explores experiences from past studies in both Tanzania and other parts of the world. Particular interest was paid to methodologies employed in the adoption and impact assessment studies for agricultural innovations.

2.2 Smallholder Farmers and Climate Change in Tanzania

As pointed out earlier, the Tanzanian agricultural sector is dominated by small-scale, subsistence farmers who depend fully on rain fed agriculture. High dependence on rain has put the sector and farmers at a greater danger from the effects of climate change. Climate change has affected the Tanzanian agriculture sector by shifting agro-ecological zones, prolonged dry episodes, unpredictable rainfall inception, increased weed competition with crops (for moisture, nutrients, and light) and ecological changes for pests and diseases (URT, 2007). These effects of climate change have huge negative impact on the livelihood of the poor communities implying that the employer of the country's largest population is in the verge of collapsing.

Realising the challenges facing the sector, the government of Tanzania in collaboration with local and international organizations like ICRISAT initiated a number of

programmes including developing and introducing high yielding and drought resistant varieties. However, smallholder farmers have low coping capacity to these challenges. As revealed by Shemsanga *et al.* (2010), most of the smallholder farmers fail to cope with the challenges of climate change because they rely on their indigenous skills. Moreover, most of their traditional coping strategies are only applicable in a short term and/or less severe impacts (Orindi & Murray, 2005

2.3 The Role of Crop Improved Varieties in Cubing the Impacts of Climate change in Tanzania

Tanzania requires a wide range of measures in dealing with the issue of climate change. Several measures and strategies have been put forward by the government particularly in the agricultural sector. Investment in research and development on improved varieties with early maturity rate, drought and diseases tolerance is one of the key strategies to climate change (URT, 2007). The paramount advantage of employing improved varieties to fight against the threat of climate change is clear. As Ortiz (2002) and Monyo *et al*., (2004) report the use of these varieties reduces the risk of crop failure and gives a yield advantage which is more pronounced in poor rainfall seasons. Therefore, apart from other adaptive strategies against the threat of climate change, targeting improved varieties with desirable attributes is likely to reduce the threat.

2.4 The Previous and Current status of Sorghum Improvement Programmes in Tanzania

The history of research for sorghum dates back to 1932 when the sorghum and millet improvement programme was initiated by colonial government at Ukiriguru Research Station and later moved to Ilonga Agricultural Research Station in 1972. After independence and the formation of the East Africa Community (EAC), sorghum and millet were co-ordinated by the East Africa Agricultural and Forestry Research Organization (EAAFRO) based at Serere, Uganda. After the collapse of EAC in 1977, research activities on sorghum and millet were carried over by the National Sorghum and Millet Improvement Programme (NSMIP) based at ARI-Ilonga in Morogoro region. Since then, NSMIP has been conducting research in collaboration with the Sorghum and Millet Improvement Programme (SMIP), an organ of the Southern Africa Development Community (SADC) based in Zimbabwe and with the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) based in India.

For more than a quarter of a century, breeding work was geared towards the development and testing of new varieties that are high yielding and well adapted to farmers' actual environment (Rohrbach, 1999). Before the collapse of EAC, three sorghum varieties namely Dobbs, Serena and Lulu were developed and widely used in Tanzania in the 1960s and 1970s. So far, the International Crop Research Institute for Semi Arid Tropics (ICRISAT) in collaboration with NSMIP have developed and

released several improved sorghum varieties. In addition to that, ICRISAT (2009) reported to increase foundation seeds to ensure the needed quantities are available for further multiplication.

2.5 Improved Varieties of Sorghum and their Characteristics

Each variety has got its own distinguished attributes. The major attributes are seed size, seed colour, height of the plant, maturity rate, yielding capacity as well as degrees of drought, diseases and weeds resistance.

Dobbs is a variety selected in Western Kenya during colonial era and was recommended to be suitable along the shores of Lake Victoria (Ackland, 1971). The variety was channeled to central Tanzania through charity aids and relief food supply during famines. It is brown seeded and matures at about four months.

Serena was developed in Serere research station in Uganda and released in 1960's. It is brown seeded, is medium in height (1.5m high), resistant to shoot fly and partial resistant to striga infestation. It is a high yielding variety with half the time in early maturing, about three and half months (Ackland, 1971).

Lulu was released in the 1960s. It is a high yielding variety of about 1.8t/ha, early maturing with short stems and white grains. Unfortunately, the variety is highly susceptible to grain and mould disease, resulting in poor viability and poor storability

(Saadan and Mdolwa, 1999). Due to grain moulds it is not suitable for livestock feeds and human consumption.

Tegemeo was released in Tanzania in 1999. It is an open pollinated (pure line) variety, semi-dwarf to semi-tall, 1.3-1.6m. It has a tan plant color with a semi compact, oval, medium-large head panicle with good exertion. It is a medium maturing variety (63-69 days to 50% flowering). The grains are white and light brown glume colour and have no testa. The variety adapts itself to short to medium season and has a yield potential of 3.5 to 4.5t/ha (ICRISAT, 2009).

Macia is a variety released in Tanzania in 1999. It is also an open pollinated (pure line) semi-dwarf 1.3 to 1.5m tan plant with a semi-compact large bulbous head. It matures early and has 60-65 days to 50% flowering, 115-120 days to maturity. It has white bold grains and black glumes. It is adapted to areas with medium season and has a yield potential of 3-6t/ha. It has multiple uses (ICRISAT, (2009).

Pato was fully released in 1995 as a medium stalk height variety with white bold grains and black glue. The variety is an open pollinated (pure line) of purple plant with a semi loose head. It matures early and has 65-70 days to 50% flowering, 116 days to 75% maturity. It is adapted to medium season and has a yield potential of 2.5-4t/ha (ICRISAT, 2009).

Hakika is a striga resistant variety originating from Purdue. It is an early maturing variety (110 days) and has white bold grains. The variety is targeted to Dodoma, Singida and Lake zone of Tanzania and its yield potential is 2.5-3.5t/ha. Similarly, Wahi is a striga resistant variety originating from Purdue. It is an early maturing variety (100 days) and has white bold grains. The variety is targeted to Dodoma, Singida and the Lake zone of Tanzania and its yield potential is 3 to 5 t/ha.

2.6 The Concepts of Improved Agricultural Technology Adoption and Intensity

2.6.1 Improved agricultural technology adoption

Different scholars conceptualize agricultural technology adoption differently. Rosenbaum and Rubin, (1983) conceptualize adoption as a multi-stage decision process involving information acquisition and learning by doing by growers who vary in the risk preferences and their perceptions of riskiness of an innovation. Feder *et al.,* (1985) conceptualize adoption as the degree of use of a new technology in a long run equilibrium when a farmer has full information about the new technology and its potential. Van de Ban and Hawkins (1996) considered agricultural technology adoption as a series of changes that take place within an individual with regard to an innovation, and start from the moment the farmer first becomes aware of that innovation to the final decision to use it or not.

The time frame between first incidence and the start of full practice of the agricultural innovation appears to be common in all definitions. However, the primary question in

adoption studies is what constitutes adoption? What is the minimum proportion of farmer's field that should be planted with new variety for them to be called adopters?

2.6.2 Intensity of agricultural technology adoption

Intensity of adoption is defined as the level of use of a given technology. When technology is adopted it is important to understand the extent to which the technology has been used by the intended group. Shiferaw *et al*., (2007) stipulated intensity of adoption as a measure of depth of adoption in terms of parameters such as the number of hectares planted with improved seed or the amount of fertilizer applied per hectare.

The concept is necessary as adopters may claim that they have adopted the technology but comparatively they have not met the required standards (CIMMYT, 1993). Similarly, as Kisusu (2003) points out intensity use normally provides a correct measure on policy reform. For instance, low intensity may indicate that the technology introduced is not effective although it has been adopted. This avoids the generalization of technology having been adopted but in actual fact only a small amount is actually being used.

2.7 Review of the Factors Influencing Agricultural Technology Adoption

Literature reveals that adoption of a particular technology is influenced by a number of factors. These factors have been classified into four broad categories namely demographical, institutional, environmental and farmers' subjective perception of

agricultural technology (Achour, 1990; Adesina and Zinna, 1990; Akimwuni, 1995; Anandajayasekeram *et al*., 1996). Examples of demographical factors include education level, gender, experience, age, religion, and marital status. Institutional factors include extension services, input and output marketing system, credit facilities, land tenure system, information, and communication infrastructure. Farmer's perception is associated with the characteristics of technology as perceived by them, such as palatability, cooking time, seed colour, and seed size (Bisanda and Mwangi, 1996). Some technologies may have a relative advantage, for example high yielding variety. Others may be easy and compatible to the existing farming system while others may be complex and incompatible.

However, small-scale farmers in developing countries are farm households who are engaged in both production and consumption of the same products. Smallholder farmers in many rural areas are semi-subsistent producers and consumers partially integrated into imperfect rural markets. The theory of farm household economics has demonstrated that when institutional factors are imperfect, production and technology adoption decisions are influenced by the level of poverty and asset ownership of the farmer (Singh *et al.,* 1986; de Janvry *et al.,* 1991). This implies that assuming imperfections in credit, input and output markets, household characteristics and assets including family labor force and livestock and non-livestock asset endowments would be important factors in technology adoption decisions.

Many adoption studies conducted show that the use of agricultural technologies is strongly linked to the asset base (Adato and Meinzen-Dick, 2002). Based on the same economic theory, Rosebaum and Rubin, (1985) point out that resource endowment is one of the major determinants of the observed adoption behaviour, where lack of access to capital and inadequate farm size could significantly impede adoption decisions. Thus, Adato and Meinzen-Dick (2002) observe that the use of agricultural technology by a farmer is a function of livelihood assets owned by farmers that are influenced by policies, institutions and processes. Based on the above reviews, this study modeled livelihood assets of farmers integrated with institutional processes to influence adoption of improved sorghum varieties.

2.8 Approaches and Methods of Assessing Agricultural Technology Adoption

Agricultural technology adoption is based on farmers' utility or profit maximizing behaviour models (Norris and Batie, 1987; Senkondo *et al.,* 1998; Pryanishnikov and Katarina, 2003). The assumption is that farmers adopt a new technology only when the perceived utility or profit from using this new technology is significantly greater than the traditional or the old method.

Utility refers to desirability of an outcome (or process) to the consumer or beneficiary. A utility function summarises the preferences or satisfaction of the individuals own process or outcome that is affected by a variety of factors (Nicholson, 2002). In this study, a utility model has been adopted because the majority of farmers in the semi arid zone are

subsistence farmers and highly vulnerable to climate shocks. The satisfaction of basic needs like food stuffs to this kind of farmers is a foremost concern. Employing the model in this study, the introduction of new sorghum varieties to a farmer who is growing local varieties can be adopted provided the adoption will maximize the expected utility of the farm household.

It follows that, the utility (μ) of a farmer (j) to adopt the new variety (i) of sorghum will depend on the combination of livelihood assets and institutional factors (y_i) (in the context of this study), vector of covariates (z_j) and error term (ε_{ij}) (known to a farmer but unknown to a researcher)

$$\mu_{ij} = \mu_i(y_{i,}\ z_{j,}\ \varepsilon_{ij}) \quad \text{.....(1)}$$

Rewrite (for quality Δ);

$$\mu_{oj} = \mu(y_{i,}\ z_{j,}\ q^{0}_{,}\ \varepsilon_{0j})$$

$$\mu_{ij} = \mu(y_{i,}\ z_{j,}\ q^{1}_{,}\ \varepsilon_{ij})$$

A farmer will adopt a new sorghum variety if;

$$\mu_1(y_{j,}\ z_{j,}\ \varepsilon_{ij}) > \mu_0(y_{j,} z_{j,}\ \varepsilon_{0j})$$

In analyzing adoption determinants and choice problems that farmers/consumers face, three types of probabilistic models; (i) Linear probabilistic model (LPM) (ii) Probit model (iii) Logit model have commonly been used in the literature (Bisanda, *et al*., 1998; Feder, *et al*., 1985; Madala, 1983; Ichino, 2003). In situations where the number

of choices is limited to two values, the linear probabilistic, probit and logit (CDFs) are used. This is probably because most models used in adoption studies fail to meet the statistical assumptions necessary to validate the conclusion based on the hypothesis being tested (Feder, *et al*., 1985).

However, although the linear probabilistic model is the simplest compared to probit and logit models, it has the disadvantage that the estimated probability value of prediction can fall outside the interval 0-1. It also suffers non- normality and heteroscedasticity problems (Gujarati, 1995). To avoid the problem of out of range probabilities in the linear probabilistic model, non-linear probabilistic Logit and Probit models (CDFs) which fall between 0-1 are used. These models are appropriate tools in situations where there is a dichotomous output that is thought to be influenced by levels of some independent variable(s). These models have several advantages over the others; first, probit and logit models transform the distribution of the attribute variables x into a probability density function that guarantees non-violation of the probability axiom of 0-1. Second, in the transformation, probit and logit models maintain the condition that an increase or decrease in the x-attributes is associated with increase or decrease in the dependent variable for all possible values of x (Maddala, 1983; Ichino, 2003). Third, the models are quiet appropriate in analyzing cross sectional data with binary dependent variable. In some cases, they have been used to analyze time- series-cross-section data (Nathaniel and Jonathan, 1997).

The extensions of these models are most often referred to as multivariate models. They are employed when the number of choices available is more than two. The most commonly cited multivariate choice models in unordered choices are multinomial logit (MNL) and multinomial probit (MNP) models. Multivariate choice models are advantages over their counterparts of binomial logit and probit models in two aspects (Wu and Babcock, 1998). First, they allow exploring both factors conditioning specific choices or combination of choices and second, they take care of self- selection and interactions between alternatives.

The review has identified that most studies on adoption of agricultural and environmental conservation technologies as well as consumer choices (Adesina *et al*., 1995; Baidu-Forson, 1997; Mkenda, 1997; Senkondo *et al*., 1998; Kalineza *et al*., 1999; Kuperis *et al*., 1999; Mwanga, 2002; Kisusu, 2003; Mafuru, 2007) have applied these dichotomous models which assumes a discrete choice of yes or no. However, the dichotomy of adoption or rejection in this model has proved too simple. First, it is not always clear whether a farmer should be characterized as an adopter or a rejecter of a technology as pointed by Mwaseba *et al*., (2006). Secondly, as observed by Feder *et al*., (1985), farmers may be an adopter of some elements and a rejecter of other elements of the introduced technology.

To correct the above weaknesses of dichotomous models, this study has employed the Heckman's two-step procedure model (Heckman 1976) to analyse the two-step

processes of adoption and intensity cultivation of improved varieties. Deressa, (2010) observed that models with two-steps are employed to correct for the selection bias generated during the decision making processes by farmers to adopt a new technology. Similarly, Yirga, (2007) pointed that Heckman's two step procedure has advantages over the other models such as multinomial logit and multinomial probit model as these models are suitable for analyzing the two step procedure of adoption.

Both Heckman probit and Heckman logit model have been widely used to examine the characteristics associated with two step procedures of adoption studies. At the first step the normal dichotomous model which assumes a discrete choice of yes or no is employed. Although Probit and Logit models usually give similar results for most problems and it is difficult to distinguish them statistically (Amemiya, 1981), this study choose to use Probit model (Heckprob) in the first step because economists tend to favour the normality assumption of error term; as such the Probit is more popular than Logit model in econometrics (Woodridge, 2003). The second step employed a tobit regression model to estimate determinants of adoption intensity. Tobit model fits well with a model of dependent variable on a set of independent variables where the censoring values are fixed (Maddala, 1983). Censored outcomes are those where observations are clustered at a lower threshold (left censored), an upper threshold (right censored) or both.

Like other models, Heckman two-step procedure model has been widely used in both agricultural and environmental conservation technologies adoption studies. For instance Nkonya *et al*., (1997) used the model to simultaneously analyze factors affecting adoption of improved maize seed and inorganic fertilizer. William and Stan, (2003) employed the Heckman's two- step procedure to analyze the factors affecting the awareness and adoption of new agricultural technologies in the United States of America. The first stage was the analysis of factors affecting the awareness of new agricultural technologies and the second stage was adoption of the new agricultural technologies. Yirga (2007) employed the Heckman's selection model to analyze the two-step processes of agricultural technology adoption and the intensity of agricultural input use. Again, Deressa (2010) employed the same model in the study of assessment of the vulnerability of Ethiopia to climate change and farmers' adaptation studies. All these studies were successful in explaining key determinants of individuals' adoption in two steps.

2.9 The Concept of Impact Assessment.

International agricultural research has for a long period of time faced reduced funding from governments and increased criticism from some scholars who claim that the green revolution, and thereby the research that produced the green revolution technologies, has done more harm than good (Shiva, 1991). Thus, a need emerged to show that agricultural research was beneficial to the society and that investments in agricultural research were attractive. To meet this need of applied impact assessment studies has

been emphasized by international agricultural research organizations (Morris *et al.,* 2003).

Impact assessment can be defined as a special form of evaluation that deals with the intended and unintended effects of a project output on the target beneficiaries (Anandajayasekeram, *et al.,* 1996). Baker (2000) and Prennushi *et al.,* (2000) defined impact assessment as an assessment of the extent to which interventions have resulted in desired changes in the well-being of the target population such as individuals, households, organizations, communities or other identifiable units to which interventions were directed. Similarly, DFID (2001) defines impact assessment as the process of identifying the anticipated impacts of intervention on social, economic and environmental factors of which the intervention was designed to affect or may inadvertently affect.

The focus of impact assessment goes beyond the products of research (such as improved variety) to determine the effects of adoption of its products. In other words, adoption of the products of research is a prerequisite for attaining impact. Impact assessment is done for several reasons including accountability, improving future design, prioritizing and implementation of similar programme. As FAO (2000) put it; the results of this process provide continuous feedbacks to the project planning, prioritizing and implementation. It can be undertaken before initiating the project (ex-ante), during the project period (mid-term) or after the completion (ex-post) of the project or activity (Anandajayasekeram, *et al.,* 1996).

In many agricultural extension and research programmes, the fundamental goal is to eradicate poverty and protect natural resources in order to achieve sustainable food security (FAO, 2000). Therefore, impact assessment examines differences between outcomes for project participants and non- participants.

However, it is difficult to evaluate impacts in terms of the ultimate broader goals of poverty alleviation and environmental sustainability. Instead, impacts can be measured using intermediate goals and objectives of an intervention or project. Intermediate goals such as increased sustainable agricultural productivity through development of improved technologies can easily be measured in terms of cause and effect, and impact (FAO, 2000).

2.10 Approaches of Impact Assessment

There has been a continuous development in the impact assessment approaches from conventional through participatory to the livelihood approaches (Ashley and Hussein, 2000), all of which are interlinked or related to each other. The conventional-assessment approaches are focused excessively or exclusively on how much cash, how much increased production or how many jobs generated, rather than on a broad range of livelihood issues.

2.10.1 Conventional approaches

Previous impact studies mainly used conventional approaches in which measurement of impact intended to focus on tangible impacts such as income, productivity, cost-benefit ratio, economic rate of return and assets which lend themselves to only quantitative assessment (Ezemenari *et al.,* 1999). Only few parameters of economic issues were selected based on the knowledge of the outside experts (Ezemenari *et al.,* 1999). These conventional approaches failed to capture important benefits accruing to people as a result of the project because they tended to create a degree of distance between those assessing impacts and project participants or beneficiaries (Ashley and Hussein, 2000).

2.10.2 Participatory approaches

Participatory approaches make use of a range of techniques and tools to assess the impact of an intervention or project (Estrella and Gaventa, 1998). It involves all project actors including implementers, policy makers and beneficiaries to decide together on

how progress or success should be measured and results acted upon (IDS, 1998).Outcome indicators are participatorily developed together and all actors are involved in data collection and analysis. Participatory methods are flexible and open-ended, and are not always restricted to a predetermined set of variables, outcomes or questions (Ezemenari *et al.,* 1999). However, the success of this type of approaches relies to a great extent on qualitative judgements made by beneficiaries (local people) and project staff rather than on the interpretation of quantitative data by outside experts. Nevertheless, they concluded that even if the principles and general outlook of conventional and the participatory approaches are clearly different, they complement each other.

2.10.3 Livelihood approaches

The livelihood approach differs from the conventional and participatory approach in its central focus on peoples' lives rather than on resources or defined project outputs (Ashley and Hussein, 2000). Impact assessment in this is based upon a prior understanding of peoples' objectives, how their lives are constructed and which factors are the essential causes and manifestations of their poverty. The sustainable livelihood approach (SLA) assumes that increasing access or entitlement to capital (or assets) is cruel for ensuring sustainable livelihoods (Carney, 1998).

A livelihood defined by Dorward *et al.,* (2001) comprises "the capabilities, assets and activities required for a means of living". A livelihood is sustainable when it can cope

with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in future, without undermining the natural resource base (Carney, 1998). Livelihood outcomes are the achievement of livelihood strategies. When it come to impact assessment, this means that measurable changes (e.g cash, yield) must be assessed not in their own right, but in terms of contribution they make to livelihood (Ashley and Hussein, 2000). As explained earlier, the contribution of technology may be direct (e.g adding to household income and food availability) or indirect (affecting their assets, activities and options, and ability to cope with shocks, that is reducing vulnerability)

2.10.4 Counterfactual Analysis

Many impact assessment studies have shown that "netting out" the effects of a project from other factors is facilitated if treatment and control groups are well defined (Ravallion, 1994). The treatment group is a group of those who receive the intervention or project participants or adopters of technology, while control group is a group of those who not received the intervention or non-project participants or non-adopters of a technology. The control group must have similar background characteristics as those receiving the intervention, that is, the treatment group. Defining these groups correctly is a key for identifying what would have occurred in the absence of the intervention. Control groups can be determined at different levels; region, district, village, community, household or intra-household depending on the coverage of a project or intervention. According to Pitt and Khandker (1996) and Bauer (2001), the

counterfactual analysis can be enhanced through two approaches; before and after approach and with and without approach.

2.10.4.1 Before and after approach

This approach compares the conditions of the same households before the project was introduced and after the termination of the project. This approach has got major problems. First, often the base line informations are not available and secondly, isolation of influence of exogenous factors (e.g. government policy and market conditions) is rather difficult (Bauer, 2001)

2.10.4.2 With and without approach

This approach compares the conditions of the farmers involved in the project and the conditions of the farmers without the project activities. Pitt and Khandker, (1996) noted that the with and without approach is considered more appropriate in a situation where obtaining baseline data is problematic. Moreover, isolation of influence of exogenous factors with this approach is relatively easier than the former one. Several impact assessment studies employed the said approach (Karki and Bauer, 2004; Kadigi *et al.,* 2007; Shiferaw *et al*., 2007). All these studies generated plausible results.

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter describes the methodology used in this study. It is divided into three main sections. Section one presents conceptual framework of the study. Section two describes geographical location and socio-economic profiles of the study area. Section three presents the survey design, explains the sampling procedures, data collection, analytical methods and model specifications**.**

3.2 Conceptual Framework

The conceptual framework of this study (presented in figure 1) has been derived from the Sustainable Livelihood Framework of DFID (2002).

Livelihood has been defined differently to provide appropriate meaning in different societies. According to DFID (2002), a livelihood comprises the capabilities, assets (including both material and social resources), and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.

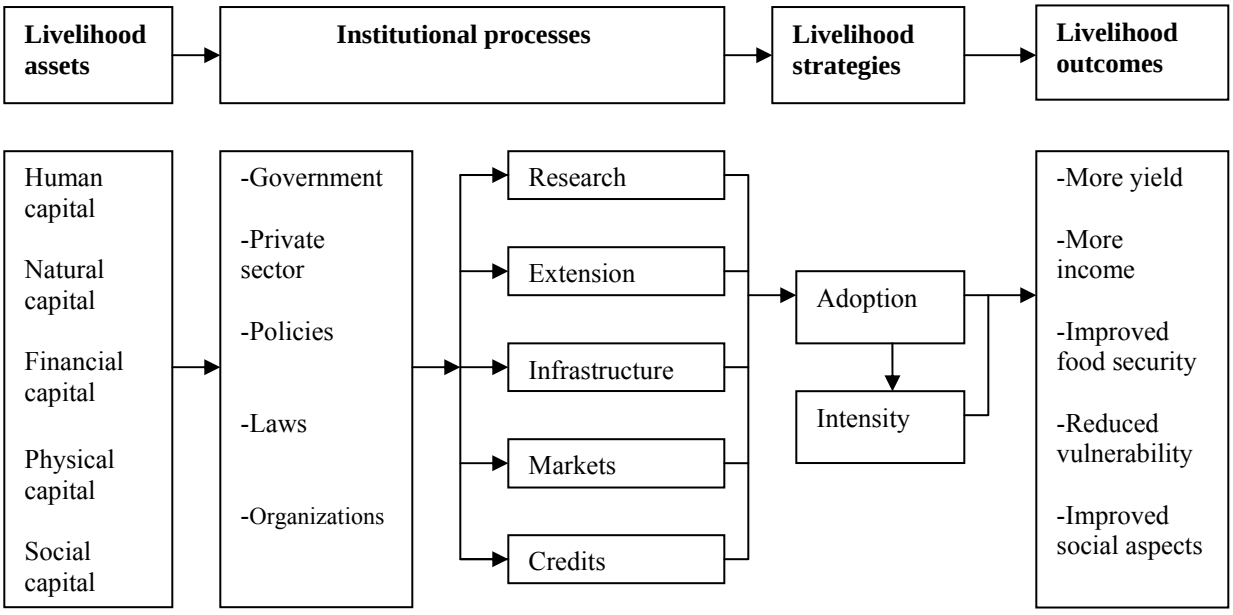

Figure 1: A conceptual frame work derived from Sustainable Livelihood Framework of DFID (2002)

3.2.1 Livelihood assets

Livelihood assets are mainly in five categories; human capital, natural capita, financial capital and physical capital. These are types of assets upon which individuals draw to build their livelihoods.

Human capital represents the skills, knowledge, ability to work and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives (DFID, 2001). At the household level it varies according to household size, skill levels, leadership potential, health status, etc. and appears to be a

decisive factor besides being intrinsically valuable in order to make use of any other type of assets.

Natural capital is the term used for the stocks of natural resources from which resource flows and services (such as land, water, forests, air quality, erosion protection, biodiversity degree and rate of change, etc.) useful for livelihoods are derived. It is of special importance for those who derive all or part of their livelihoods from natural resource-based activities. (Bebbington, 1999)

Financial capital denotes the financial resources that people use to achieve their livelihood objectives and it comprises the important availability of cash or equivalent that enables people to adopt different livelihood strategies. (Kollmair and Gamper, 2002)

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods, such as affordable transport, secure shelter and buildings, adequate water supply and sanitation, clean, affordable energy and access to information.

Social capital in the context of the Sustainable Livelihood Approach is taken to mean the social resources upon which people draw in seeking for their livelihood outcomes, such as networks and connectedness, that increase people's trust and ability to cooperate or membership in more formalised groups and their systems of rules, norms and sanctions. (Kollmair and Gamper, 2002)

However, this study has focused on three categories of livelihood assets; human, natural and financial capital. The selection is based on the quantification and relationship of these assets towards farmers in the study area.

3.2.2 Conceptualization of adoption of improved sorghum varieties within the framework.

It has been conceptualized that, an individual draws to build livelihood through livelihood assets (human, natural and financial capital in this context). Once these have been put into productive use, the intervention from the institutions (both public and non public organizations, policies, laws and cultural norms in this context) would lead to transformation through utilization of research on improved technology activities, improved extension services, restructured input and output markets, improved credit accessibility and improved physical infrastructures. When these targets are adequately realized a way would be paved for farmers to adopt and make an intensity use of improved varieties as a livelihood strategy in achieving livelihood goals. Livelihood goals in this context are improved food security, increased income, reduced vulnerability and improved social aspects such as sending children to school and accessing health care services.

3.3 Description of the Study Area

3.3.1 Location

The study was carried out at Rural Singida district in Singida region. Rural Singida is one of the four districts of Singida region. The district borders with Singida Urban district to the East, Iramba district to the North, Manyoni district to the South and Tabora region to the West. It lies between Latitude 3 N - 7 S and Longitude 32 W -35 E. It occupies an area of 12,164 square kilometers of which 12,114 square kilometers are land area and only 50 square kilometers is occupied by water.

3.3.2 Population

According to census of 2002, the population of Rural Singida district was 401 850 which is equivalent to 37% of Singida regional population. Population growth rate is 2.5% as compared to regional and national growth rate of 2.3% and 2.9% respectively. Rural Singida is sparsely populated with population density of 33 people per square kilometer and an average household size of 5.1 (URT, 2005)

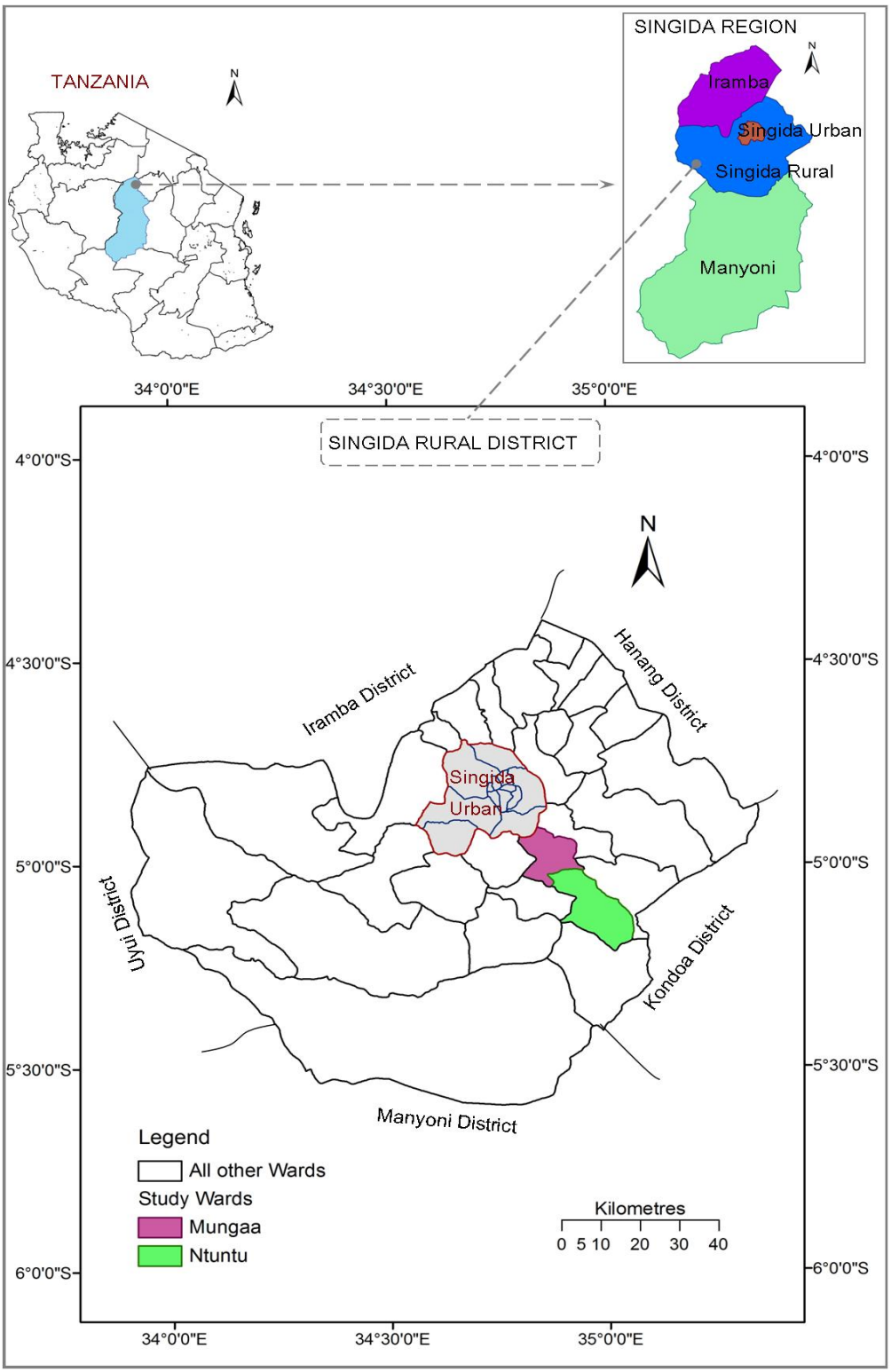

Figure 2: Map of the study area in Rural Singida district

3.3.3 Climate and Topography

The district has semi – arid climatic conditions. There are two seasons; the dry season which is the longest season from April to November and the rainy season which starts in December to March. The average rainfall is between 600mm-700mm per annum while the average minimum temperature is 15C - 30C. Part of the land area composed of highland of the central plateau where as the rest land composed of lowlands and plains.

3.3.4 Farming systems.

About 90% of population in the district depends agriculture as the main source of their livelihood (URT, 2005). The dominant farming system in Rural Singida district is agro-pastoral system. However crop production ranks first followed by livestock production in their contribution to the district economy. The majority of the people still use poor and primitive farming methods and implements such as traditional hand hoes. Agriculture is characterized by low productivity as a result of low and erratic rainfall, high rate of evaporation and low moisture holding capacity of the soil. According to URT (2005) the total land under cultivation is 112 516 ha which is equivalent to 9% of total land in the district. The major food crops are maize, bulrush millets, paddy, sorghum, sweet potatoes and food beans. While the major cash crops are sunflower, ground nuts, cotton, finger millet and pigeon peas.

Livestock categories found in Rural Singida include cattle, goats, sheep, donkeys, pigs and poultry. Livestock forms an important part of family wealth and savings. It provides

an essential source of income to the owners. Despite of farming activities, fisheries and beekeeping are potential economic activities found in the district. (URT, 2005).

3.4 Rationale for Selecting Rural Singida District as a Study area.

The study was undertaken in Singida rural district of Singida region. The district was selected because it is a good representative of the other districts in the zone. The climate and farming systems in the zone does not vary significantly. The zone experiences several stresses and shocks caused by frequent droughts and other climate variables. For example in year 2004, 2005 and 2007 the district received 1126, 453 and 679 tonnes of food aid respectively as the result of climate variability (URT, 2010). Under such circumstances, improved varieties become one of mitigation since they have potential attributes such as high yielding, early maturity, drought and disease resistances.

Identification of specific adoption needs and their impacts towards improved sorghum varieties are the major concern of this study. Sorghum is one of the abundant food crops in the zone. The results will provide insights on basic information support required for the farmers to adopt improved varieties as a coping strategy to shocks. The insights will assist in formulating procedures to design an institutional framework for improving adoption of new agricultural technologies in the district and the semi arid zone at large.

3.5 Research Design

The research was designed such that data were collected in two stages; formal survey and informal survey. Formal survey was carried in September to October 2010 by ICRISAT, Nairobi. The informal survey was carried in March 2011 by the author.

3.5.1 Formal survey

The formal survey was conducted to quantify the findings of the study. A cross-sectional research design was used in this survey. The cross sectional research design allows data to be collected at a single point in time that may be used in descriptive analysis and for determination of relation ship between variables (Bailey, 1998).

3.5.2 Informal survey

The aim of the informal survey was to collect qualitative information. The main activities during this survey included key informants (KIs) interviews and focus group discussions (FGDs). The survey was conducted in all villages where formal survey was conducted. For each village, the participants were the Village Agricultural Extension Officer (VAEO), Village Executive Officer (VEO), seed stockist, farmers growing improved sorghum varieties in a significant farm area and other farmers not growing improved sorghum varieties but they grow local varieties in a significant farm area. In certain stages of interviews, farmers were required to disintegrate into two groups based on whether they grow improved sorghum varieties or not in 2009/2010 season. In all discussions, a checklist (Appendix 2) was used for guidance.

3.6 Sampling Procedure

3.6.1 Population

The population of the study was all crop cultivating farmers for the 2009/2010 season in Singida rural district. The entire sample size from which information was collected is 180 respondents from two wards; Mungaa and Ntuntu.

3.6.2 Sampling

The formal survey was conducted due to two reasons. First, to provide information about the current adoption levels of improved sorghum varieties. Second, to serve as a baseline to assess changes of adoption levels in the course of time. Therefore, here groups were defined; a treatment, diffusion and control group. The treatment group consists of three villages in which ICRISAT is promoting improved sorghum varieties through the HOPE project. The diffusion group consists of three villages which neighbour the treatment villages. Spillover effects are expected in these villages. The control group consists of three villages with similar agro-ecological conditions than the other two groups, but within a larger distance to them. This group serves as the comparison group. In each group, farmers were randomly sampled in the respective villages. The sample consists of 90 farmers in the treatment and 45 farmers each in the two other groups respectively.

In all the above three village groups, survey indicated 108 farmers cultivated sorghum in 2009/ 2010 season. Among this, only 14 farmers cultivated improved sorghum varieties where as the remain 94 farmers cultivated local sorghum varieties.

Table 1: Categorization of wards and villages surveyed in the study area

Groups	**Treatment (n =90)**	**Diffusion (n = 45)**	**Control (n = 45)**
Wards	Mungaa	Mungaa	Ntuntu
Villages	Mungaa	Miyinga	Ntuntu
	Makiungu	Kimbwi	Ntewa A
	Unyaghumpi	Kinku	Ntewa B

3.7 Analytical Framework

3.7.1 Descriptive analysis

Through SPSS package and Micro office excel, descriptive analysis mainly frequency distributions, cross tabulation, multiple responses and comparison of means were done to summarize formal survey data. The aim of summarizing the data was to facilitate scientific interpretation.

3.7.2 Adoption decision and intensity analysis: The two steps model

The decision to adopt and intensify cultivation of improved sorghum varieties is a two-stage process; first deciding whether or not to grow improved varieties and then allocating how much area to grow. This leads to sample selectivity problem since only those who decided to grow improved varieties will allocate land. This implies the use of

Heckman's sample selectivity probit model (Maddison, 2006). Heckman probit model was estimated for adoption in step one whereas Tobit model was estimated for intensity of adoption in step two. LIMDEP was the econometric package used to analyse the models.

The probit model for sample selection assumes that there exists an underlying relationship.

The latent equation given by:

$$y_j^* = x_j \beta + \mu_{1j} \quad \text{.....(2)}$$

Such that we observe only the binary outcome given by the probit model as;

$$y_j^{probit} = (y_j^* > 0) \quad \text{……(3)}$$

The dependent variable is observed only if the observation *j* is observed if the selection equation:

$$y_j^{select} = (z_j \delta + \mu_{2j} > 0) \quad \text{……(4)}$$

$$\mu_1 \sim N(0, 1)$$

$$\mu_2 \sim N(0, 1)$$

$$corr\ (\mu_1, \mu_2) = \rho$$

Where x is a k - vector of regressors, z is an m - vector of repressors; μ_1 and μ_2 are error terms.

When $\rho \neq 0$, standard probit techniques applied to equation (1) yield biased results. Thus, the Heckman probit (heckprob) provides consistent, asymptotically efficient estimates for all parameters in such models.

Tobit regresson model is given by;

$$y^* = \beta_i x_i + \mu_i \quad \text{.....(5)}$$

$$y_i = \begin{cases} y_i^* & if \quad y_i^* > 0 \\ 0 & if \quad y_i^* \leq 0 \end{cases}$$

Where is y^* the latent variable , β is a (kx1) vector of unknown parameters, x_i is a (kx1) vector of known constant and μ are residual that are independently and normally distributed.

The Tobit model is a special case of a censored regression model because the latent variable y^* cannot always be observed while the independent variable x_i is observable. A common variation of the Tobit model is censoring at a value y_L different from zero:

$$y_i = \begin{cases} y_i^* & if \quad y_i^* > y_L \\ 0 & if \quad y_i^* \geq y_L \end{cases}$$

3.7.2.1 Model specification and dependent variables

As earlier stated, the first stage of the Heckman probit model is the perception to grow improved sorghum varieties, this is the selection model. The second stage model is

whether the farmer has allocated a significant area on improved varieties, conditional on the first stage that he decided to grow any improved variety. This second stage is the outcome model.

Based on the structure of two - steps procedure, two dependent variables were estimated one for each step. The first dependent variable (step one) is decision to grow any improved sorghum variety in 2009/2010 season as a binary variable (1 = grow any improved variety; 0 = otherwise). On that matter an adopter of improved sorghum in this study is a farmer who grows any improved sorghum variety in 2009/2010 season. The second dependent variable (step two) is the area share cultivated improved sorghum varieties to the total area cultivated sorghum crop.

From equation (1) and (2), the probit model for step one can be written as;

$$p_i = y_i = \beta_i x_i + \mu_i \quad \text{.....(4)}$$

Where;

P_i is the probability that a farmer grow any improved sorghum variety, otherwise 0

X_i is a vector of explanatory variables

β_i are parameters to be estimated corresponding respectively to the matrix of explanatory variable X

μ is an error term

Results of the first step show the influence of the independent variable on the probability of adopting improved sorghum varieties ($\frac{\partial p}{\partial x}$).

3.7.2.2 Description of explanatory model variables

A list of explanatory variables that cover aspects from livelihood assets to institutional factors influencing adoption of agricultural technologies have been accommodated in the models. The same explanatory variables have been employed to both steps except one variable; number of extension visits. This variable has not been included in step two to avoid biasness of Tobit model results.

a) Age of household head: Aged farmers may have more resources to access improved technologies, but risk averseness increase with age. Hence both signs (positive and negative) have been hypothesized to influence adoption.

b) Farming experience: This was measured in terms of years of household head involved in crop farming. Experienced farmers are likely to try innovation than inexperienced ones. The expected sign is positive.

c) Household members aged between 15 and 65 years: The influence of household size on technology adoption can be seen from two angles. The first assumption is that households with large family members may be forced to divert part of the labour force to off-farm activities in an attempt to earn income in order to ease the consumption pressure imposed by a large family size (Yirga, 2007). The other assumption is that high number of family members is normally associated with a higher labour endowment, which would enable a household to

accomplish various agricultural tasks. For instance Croppenstedt *et al*., (2003) argue that households with a larger pool of labour should be more likely to adopt agricultural technology and use it more intensively because they have fewer labour shortages at peak times. In this context both signs are expected.

d) Gender of household head: Dummy variables were used; 1=male and 0=female. Male-headed households are often considered to be more likely to get information about new technologies and take risky businesses than female-headed households (Asfaw and Admassie, 2004). This study based on similar findings. The positive sign has been hypothesized.

e) Years of formal schooling for household head: Level of education is believed to be associated with access to information on improved technologies and productivity consequences (Norris and Batie, 1987). Evidence from various sources indicates that there is a positive relationship between the education level and adoption. The expected sign is positive.

f) Land owned (in acres): The large-scale farmers have more freedom in allocating land to new crops. They also have access to information and credit since land is used as collateral. Thus, the hypothesized sign is positive.

g) Average livestock owned (in TLU): This quantified all livestock kept in the household into TLU (Tropical livestock unit) as suggested by ILCA (1990) and Jahnke (1982). (Appendix 3). Livestock stands for wealth in agro-pastoral society. In general terms, rich farmers are better placed in terms of risk bearing ability, access to information, extension services, resources and commercial

orientation. Moreover, livestock plays a very important role by serving as a store of value, source of traction (specially oxen) and provision of manure required for soil fertility maintenance (Yirga, 2007). Based on that, a positive sign has been hypothesized.

h) Current value of production implements/tools: The use of superior tools is expected to promote adoption. The hypothesized sign is positive.

i) Current value of non- production items: Affluent households are expected to adopt faster than poor households due to capacity to acquire technology.

j) Off farm occupation: Dummy variable was used; 1 = Having non-farm income, 0 = Otherwise. It is regularly hypothesized that the adoption of agricultural technologies requires sufficient financial wellbeing (Knowler and Bradshaw, 2007). On this line of argument, other studies, which investigate the impact of income on adoption, revealed a positive correlation (Franzel, 1999). Higher income farmers may be less risk averse, have more access to information, have a lower discount rate and longer term planning horizon (CIMMYT, 1993). Hence, the expected sign is positive.

k) Output market accessibility: This variable was proposed to be measured in terms of distance of the household from the output market. But during the survey it was impossible to get that since there is no formal output markets where farmers gather and sales their produces, instead village and urban traders are the one who buys produces at the farmers' home bases. Hence a dummy variable was used, (1= if a farmer sale his/her sorghum produces in 2009/2010 season, 0

otherwise). It is hypothesized that market access has positive correlation to adoption since market serves as a means of exchanging information with other farmers.

l) Number of extension visits in 2009/2010 season: It was measured as a continuous variable. The more visits the farmer gets from extension agent the more informed about the innovations the farmer becomes. Hence positive sign was hypothesized.

m) Availability of improved sorghum seeds in time: It was measured as a dummy (1= available in time, 0 otherwise). Timely availability of improved variety in the season has a positive correlation to adoption. Again positive sign has been hypothesized.

n) Credit accessibility: It was measured as a dummy variable. (1= if a farmer accessed a credit at least once, 0 otherwise). Availability of credit eases the cash constraints and allows farmers to buy purchased inputs such as fertilizer, improved crop varieties and irrigation facilities. Researches on adoption of agricultural technologies indicate that there is a positive relationship between the level of adoption and the availability of credit (Pattanayak *et al*., 2003).

Table 2: The summarized description of explanatory variables

Variable	Variable description	Expected sign
AGE	Age of household head (years)	+ or -
EXPERIEN	Farming experience of household head (years)	+
HHSIZE	Household members aged between 15 and 65 years	+ or -
GENDER	Sex of household head (1=male, 0= female)	+
EDUCAT	Years of formal schooling for household head	+
LAND	Total land owned (acres)	+
LIVESTOC	Livestock units owned (in TLU)	+
VALUEPRO	Current value of production tools (Tsh)	+
VALUENON	Current value of non-productive assets (Tsh)	+
OFFARM	Off farm occupation (1 = Having at least one off farm occupation, 0 otherwise)	+
MARKETAC	Market accessibility (1= If accessed in 2009/2010 season, 0 otherwise)	+
EXTENSIO	Frequency of extension visits in 2009/2010 season	+
TIMELYAV	Timely availability of improved varieties in 2009/2010 season (1= If seeds were available in time, 0 otherwise)	+
CREDITAC	Credit accessibility (1= a farmer accessed a credit at least once in two years before 2009/2010 season, 0 otherwise)	+

3.7.3 Analysis of Impact Outcomes

Adopters and non-adopters have been employed in this study as a principal approach of counterfactual analysis. Independent sample t - tests have been used for comparison of means. The model was specified such that it could be used to compare the effects of *adopters* and *non-adopters* of improved sorghum varieties. Two impact indicators; productivity and food security status with respect to sorghum have been tested. How many months after harvest is sorghum still available for consumption was the food security index employed in this study. Descriptives of household food sufficiency levels towards the next harvest supplemented the results.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

This chapter discusses the results of the study. It includes the positioning of sorghum, overall economic activities and endowment of livelihood portfolios in the study area. The chapter also disintegrates the surveyed sample into adopters and non–adopters where their socio-economic characteristics and associated institutional supports are presented. It explores farmers' perception towards improved varieties, intensity of cultivation and constraints of adoption of sorghum improved varieties. Furthermore, it presents the factors influencing decisions to adopt and intensify cultivation of these varieties**.** Lastly, it discusses the impact outcomes resulted from the adoption.

4.2 Position of Sorghum in the Study area

The results show that sorghum is a crucial crop in the surveyed households and in the district in general. Farmers ranked sorghum as the most important food crop in the area followed by maize and lastly, pearl millet. However, maize was mentioned as the major crop which is available during food shortages. This probably is because maize is supplied in the central zone during food shortages from other zones like southern highlands of Tanzania. In the last five years, about 43% of the surveyed households reported that their area under sorghum has been constant, whilst 31% reported to have increased the area and 25% reported to have decreased the area.

For a long time, local landraces of sorghum were dominant in the study area. About 94% including adopters of improved sorghum varieties grew the famous local sorghum variety known as *langalanga* in the 2009/2010 season. They perceive the variety as suitable for food consumption and for brewing. Despite the continued growth of local varieties, a larger percentage of the surveyed households admitted that the 2009/10 season harvest for these local varieties was bad (66%), about 22% reported the season harvest was normal and only 12% reported that the reason was good. Table 3 shows major reasons for failure of local varieties. As it was expected, majority of the farmers mentioned climate variability as a major reason for crop failures.

Table 3: Reasons for production failure of local sorghum varieties

Reasons	Frequency	Percent
Climate variability	125	51
Low soil fertility	54	22
Pests and diseases	40	16
Lack of varieties	24	11
Total	**245**	**100**

4.3 Economic Activities of the Study Area

Different economic activities were scouted during the household survey. The results indicate the study area to be comprised of diverse economic activities implying diversified livelihood strategies. The economic activities found were crop production only, crop production and livestock keeping, livestock keeping only, petty trading, charcoal making, fishing, masonry, carpentry, local brewing, beekeeping and formal employment. Crop production only had high responses (49.8%) followed by both crop

and livestock (22.7%). Formal employment was the last activity having little responses (0.4%). (Table 4). Generally, the results are inconsistency with findings of URT (2005).

Table 3: Distribution of economic activities in the study area (n = 180)

Economic activities	Frequency	Percent
Crop production only	123	49.8
Both crop production and livestock	56	22.7
Petty trading	26	10.5
Local brewing	12	4.9
Fishing	9	3.7
Carpentry	6	2.4
Charcoal making	4	1.6
Masonry	4	1.6
Livestock keeping only	3	1.2
Bee keeping	3	1.2
Formal employment	1	0.4
Total	**247**	**100**

Note: Frequency totals to 247 due to multiple responses.

4.4 Livelihood Portfolios Across the Study area

4.4.1 Human capital

Human capital is a decisive factor in order to make use of any other types of assets. The household head age, education level, farming experience and household size were quantified in the study area. The mean age was 47 years which indicates the study area is endowed with active labour force. Likewise the area has an average farming experience of household head of about 25 years. The mean years spent in formal education was 7. This figure implies that the majority of people in the area have completed primary school education. Results further reveal that the average household size was 3.8.

4.4.2 Natural capital

Natural capital in this context comprises of land assets owned by farmers in surveyed households. In average, the land owned per household in the study area was 4.02 acres and standard deviation of 2.08. The standard deviation indicates a narrow dispersion of land size distribution in the sample surveyed. These results suggest that farmers in the study area are typical small-scale farmers as categorised by World Bank (2009) that small scale farmers of Tanzania usually owns land of 2 to 7 acres.

4.4.3 Financial capital

Livestock assets, level of production equipments, value of non-production assets and off farm occupations lies under an umbrella of financial capital in surveyed households of this study.

Livestock is one of the key sources of generating financial capital in the study area. It is considered to be a storage of wealth. The survey revealed that households with livestock mainly used to sell them as a coping strategy to get money for buying food during food shortages. Also, health and children's education costs depend on livestock as a financial source. Results show that the average Tropical Livestock Units (TLU) was 4.5. The figure is in consistency with URT (2005) that states that the majority populations in the region are agro pastoralists.

The mean value of farm production equipments in Tsh was 96 075. On the other hand, the mean value of non-production assets across the area was Tsh 54 263. The availability and accessibility of electricity and phone communication to some areas of the study area has accelerated the ownership of these non production assets especially mobile phones. Off farm occupations also exists in the area. Nearly 31% of the surveyed household apart from farming activities they do involve in off farm activities.

4.5 Livelihood Portfolios and Institution Supports with Respect to Adopters and Non-adopters

The livelihood assets and institutional supports forms the explanatory variables in the model analysis. The descriptive results of these explanatory variables have been summarised in table 7.

4.5.1 Age of household head

The majority of studies reported that adoption has a negative relationship with age of household head. The older the farmer becomes the more risk averseness increases. The mean age for adopters and non adopters of improved sorghum varieties were 46.47 and 47.67 respectively and the standard deviation were 10.95 and 10.56. The age difference between adopters and non- adopters were not statistical significant at any level of significance. The minimum and maximum age for adopters was 28 and 61 respectively. The minimum and maximum age for non-adopters was 27 and 75 respectively.

4.5.2 Education characteristics

Education has a positive influence on the adoption of new technologies especially in terms of accessing information. About 95% of' household heads of adopters was literate. Seventh eight (78%) percent of adopters had attended primary school as opposed to 74% of non-adopters. Likewise, 56% of adopters had attended secondary school as opposed to only 1% of non-adopters (Table 5). Taking years of formal schooling for household head, the average years for adopters and non adopters were 7.55 and 7.03 years respectively. However, there was no significant difference observed between the average formal school for adopters and non-adopters.

Table 4 Education levels among adopters and non adopter

Education level	Adopters (n=14)	Non-adopters (n=94)
Illiterate (%)	5.3	4.2
Primary (%)	78.0	74.0
Secondary (%)	56.0	1.4

4.5.3 Household size and labour hiring

The variable household size here is used to refer all members (number of people) dwelling and eating in the same pot for each household interviewed. However, in order to target the labour force within the household, the variable household size was taken as a number of all family members aged 15 to 65 years. The mean household size for adopters and non adopters were 2.00 and 5.5 persons per household respectively.

Contrary to this, labour hiring for farming activities was higher for adopters (49%) as compared to non-adopters (30%). The statistical significance difference was observed at 5% level of significance for household size and none for labour hiring.

4.5.4 Farming experience

Adopters had 25 years in farming experience which is lower as compared to 27 years of non-adopters. Although the old farmers have more experience, they are likely to be slow in adopting new ideas because of low education levels, negative attitude towards changes and lack of willingness to change. Again, there was no any statistical difference between the two categories (adopters and non-adopters) with regard to farming experience in years.

4.5.5 Gender characteristics

Male-headed households had more adopters than female headed households. About 93% of adopters were male-headed households against 84% of non-adopters among female headed households. These results comply with other findings that male-headed households are often considered to be more likely to get information about new technologies and take risky businesses than female-headed households (Asfaw and Admassie, 2004). Despite of the difference observed among the two, there was no statistical significance.

4.5.6 Land ownership

The average land owned by adopters (4.7 acres) was slightly higher than the average land owned by non-adopters (3.9 acres). These results suggest that farmers owning large land have more freedom in allocating new crops than is the case with those owning small land sizes. Meanwhile, there was no statistical significant difference between the groups of farmers. Furthermore, there was renting in and out of land within the household sample. Both in cash and in kind mode of payment was observed**.** About 21% of the adopters had rented in the land as opposed to 24% of non-adopters. On the other hand, 5% of the adopters had rented out land as opposed to 10% of non-adopters. However, there was no any significant difference between adopters and non-adopters in this aspect.

4.5.7 Livestock ownership

Livestock ownership influence adoption of technology as it stands for wealth and provision of both traction and manure. Results show that the majority household responded to keep chicken (96%), followed by cattle (40%) and goats (39%). Pigs were the last, kept by only 1%. The mean TLU for adopters was 4.63 TLU which is slightly higher than the mean for non adopters which is 4.43 TLU. However, no significantly difference was observed between the two means.

4.5.8 Level of production equipments

The use of modern and superior tools has an influence in adopting agricultural technologies. Overall, hand hoe continues to be dominant tool to small holder farmers (Table 6). The responses for owning hand hoes by farmers were 25%, followed by axes (23%). Despite of the government to insist the use of power tiller under agriculture first "*kilimo kwanza"* campaign, none of the surveyed household owned a power tiller.

Table 5 Production equipments ownership

Farm equipment	Frequency	Percent
Hand hoe	89	25.0
Axe	84	23.0
Panga	72	20.0
Spade	51	14.0
Bicycle	43	12.1
Ox- plough	5	1.9
Wheel barrow	4	1.8
Ox- cart	3	0.8
Sickle	3	0.8
Sprayer	1	0.3
Sprinkler	1	0.3
Total	**356**	**100**

Note: Frequency totals to 356 due to multiple responses.

About 94% of surveyed household sample use hand hoe during land preparation for sorghum fields. Almost 100% of these households also use hand hoe during weeding of a crop. Nearly 10.5% of adopters use ox-plough during land preparation as compared to 4.2% of non-adopters who uses ox-plough in land preparation. Although the mean current value of all production implements for adopters was bigger (Tsh 116 720) as

compared to non-adopters (Tsh 93 781), there was no statistical significant difference between them.

4.5.9 Non-production assets and off farm occupation

Non-production assets such as radio, mobile phones and television influences adoption of agricultural technologies through enhancing farmers to agricultural informations. According to Kinabo and Abeli (2007), radio can be very useful in dissemination of technologies and market information. About 78% of surveyed households in the treatment villages possess radio, 60% possess mobile phones and 1% possesses motorbike. None of the farmer in a surveyed sample possesses television.

Large number of adopters possesses radio and mobile phones as compared to non-adopters. Radio and mobile phones were 88% and 89% respectively for adopters, 16% and 44% respectively for non-adopters. The mean total current value of all non-production assets for adopters was Tsh 160 720 which is significantly higher at 5% level of significance than Tsh 42 434 for non-adopters. Meanwhile, there was no any statistical difference in off farm occupations among adopters and non-adopters. About 45% and 37% of adopters and non-adopters respectively had off-farm occupations.

4.5.10 Extension services

Effective extension service is crucial in adoption of improved technologies. In this study, frequency of visits of agricultural extension agents to farmers per year has been

used as a proxy for extension services. The more visits the farmer gets from extension agents the more informed about the innovations the farmer becomes.

Table 7 indicates about 67% of sample household did not receive at all any visit by extension agent in year 2009. This is probably due to shortage of extension officers and lack of reliable transport facilities. 89% of the adopters were accessed by the extension agents as compared to only 18% of non-adopters accessed. The average number of extension visits for adopters was 4.8 which is significantly higher (at 5% level of significant) than 0.28 for non adopters. Results further reveals in overall, the mostly focused crop during those visits was sorghum, followed by finger millet and maize.

Table 6: The average livelihood assets and institutional factors associated to adopters and non-adopters

Variables	Adopters (N =14)		Non-adopters (N =94)	
	Mean	Std	Mean	Std
Human capital of household head				
Age (years)	46.47	10.95	47.67	10.56
Education (years)	7.55	1.33	7.03	1.3
Household size	3.90**	2.51	7.5	1.85
Farming experience (years)	25	12.3	27	15.17
Labour hiring (%)	49		30	
Gender: Male (%)	93		84	
Female (%)	13		12	
Natural capital				
Land owned (acre)	4.7	2.27	3.9	2.5
Area cultivated (acre)	3.8	2.17	3.4	2.18
Land rented in (%)	21		24	
Land rented out (%)	5		10	
Financial capital				
Livestock ownership (TLU)	4.63	3.44	4.43	4.60
Production equipments (Tsh)	116 720	128 068	93 781	82 475
Non-productive assets (Tsh)	160 720**	376 233	42 434	42 903
Off farm occupation (%)	45		37	
Institutional factors				
Extension visits	4.8**	2.15	0.28	1.27
Agricultural credit (Tsh)	161 167**	51 153	50 000	22 120
Technology transfer (%)	79***		25	
Output market accessibility (%)	15		12	

Note***, **, * indicates significance at 0.01, 0.05 and 0.1 levels of significance respectively:

4.5.11 Credits accessibility

Credit is another important institutional support for capital provision. According to Kashuliza *et al*., (1998) access to credit enables farmers to invest on technologies that improve productivity and tap the economic opportunities. Results from formal survey shows that only 36% of adopters and 2% of non-adopters have received agricultural credits. The average initial credit value received by adopters was significantly higher than for non-adopters at 5% level of significance. Savings and Credit Cooperatives Societies (SACCOS) was a source of credits for all borrowers. Surveyed households also mentioned five major barriers to them for not getting credits; little or lack of knowledge about credit services, unavailability of services, failure to meet credit required conditions, fear to risk, bureaucracy and lack of interest (Table 8). Of these, little or lack of knowledge about credit services was the major barrier (44.5%) followed by failure to meet required conditions (19%). Lack of interest was the most minor barrier.

Table 7: Barriers for credit accessibility for a sample household

Barriers	**Frequency**	**Percent**
Little or lack of knowledge on credit services	49	45
Failure to meet credit required conditions	21	19
Unavailability of services	12	11
Bureaucracy	11	10
Fear to risk	9	8
Lack of interest	8	7
Total	**110**	**100**

Note: Frequency totals to 110 due to multiple responses

4.5.12 Participation in technology transfer activities

Participation in any technology enhances exposure towards agricultural technology for a particular farmer. About 37% of surveyed household have participated at least once per year on technology transfer activities. Among adopters, 79% participated where as only 25% of non-adopters participated (Table 9). The activities attended were on farm trials, farmers field days, farmer training centre, learning from lead farmers and own plot PVS.

Table 8: Farmers participation in technology activities.

Activity	Frequency	Percent
On farm trials	19	58
Farmers' field days	6	18
Own plot PVS	4	12
Learning from lead farmers	3	9
Farmer training centre	1	3
Total	**33**	**100**

4.5.13 Input use and its market

About 29% of household surveyed reported to use farm yard manure in sorghum fields respectively in 2009/2010 season. Most of farm yard manure users are livestock owners. Non-livestock owners are required to buy in cash or in kind from livestock owners.

The use of inorganic fertilizer seems to be a rare practice mainly due to high prices and low precipitation in the study area and central semi-arid zone at large. Only one household reported to have used inorganic fertilizer in 2009/2010 season. None of the

other inputs such as pesticide, herbicides and insecticide reported to have been used in 2009/2010 season. This implies that even the formal markets for inputs are not seen clearly. However, during the survey some farmers requested the provision of subsidized inorganic fertilizer from government since they perceive most of their soils have lost nutrients.

4.5.14 Output markets

Accessibility to output markets is a driving force towards adoption of improved varieties. Market interactions also enhance farmers to exchange informations within themselves. Results of this study show that although farmers in the study area sell their sorghum, none of the formal market or system exists to facilitate the process.

About 15% of sorghum improved varieties adopters accessed sorghum market in 2009/2010 season harvest as compared to 12% of non-adopters. These low marketing levels of sorghum for both adopters and non-adopters probably have been attributed to the popular use of the crop as a major food crop in the area. However, when farmers were asked to state their view with respect to market access, 53% stated it is a major problem, 24% normal problem and 23% stated it is a minor problem.

4.6 Adopters' Perceptions towards Improved Sorghum Varieties and their Attributes

The results show that only 13% of the surveyed households were adopters of different sorghum improved varieties. Five improved sorghum varieties were adopted; these are macia, tegemeo, pato, hakika and serena. Among these, macia and pato are grown by majority of the adopters (27.78% each) followed by tegemeo (Table 10). The results show further that government extensionists are the major sources of these varieties to adopters.

Table 9: **Distribution of adopters by improved sorghum varieties**

Variety	Frequency	Percent
Macia	3	22
Pato	6	43
Tegemeo	2	14
Hakika	2	14
Serena	1	7
Total	**14**	**100**

Three attributes of sorghum varieties yielding capacity, early maturity, and drought resistance were found to attract farmers in adopting a particular variety (Table 11). This can be attributed to the recurrent food shortages in the central zone due to drought. The attribute drought resistance appears to have a high frequency meaning that it attracts the majority of adopters, this attribute is followed by yielding capacity and early maturity of

the varieties. The rest of the attributes resistance against striga, food taste, seed colour, seed price and brewing quality appear to be less important in influencing farmers' decision.

Table 10: Adopter's perception towards attributes of improved sorghum varieties

Attributes	Adopter's responses on attributes					
	Macia	Pato	Tegemeo	Hakika	Serena	**Total**
Yielding capacity	2	3	0	2	0	**7**
Early maturity	2	5	2	1	1	**11**
Drought resistance	2	6	2	2	1	**14**

Source: Formal survey (2010)

4.7 Farmers Future plans on Improved Sorghum Varieties

A high percentage (59%) of non-adopters of improved sorghum varieties indicated their plan to start growing the improved varieties as soon as seeds are made available. The major reason is that they perceive improved varieties as having high yielding potential, expressed by 82%, others (68%) attributed willingness to adopt the varieties to drought resistance, and yet others (46%) attributed their positive attitude to improved varieties to early maturity. About 94% of the adopters indicated their plan to increase the area of cultivation for improved sorghum varieties. The reasons for this plan are drought resistance (89%), yielding capacity (79%) and early maturity (57%).

4.8 Intensity of Adoption

As earlier stated**,** intensity of adoption is a measure of depth of adoption in terms of parameters such as the area share planted with improved seeds. The results show that in

2009/2010 cropping season, the average area share planted with sorghum in total cultivated area was 1.5 acre per household (37%). Furthermore, the area share planted with improved sorghum varieties in total cultivated land was 0.6 acre (14%) per adopter. This area is equivalent to 39% (per adopter) of the total area cultivated with sorghum crop. Generally, results suggest adoption intensity of sorghum improved varieties in the study area is low as the average area planted is less than one acre.

4.9 Constraints of Adopting Improved Sorghum varieties.

Table 12 depicts the constraints hindering farmers from adopting improved sorghum varieties. Although majority of the surveyed households have been hearing about the improved varieties, yet very few of these farmer have adopted the varieties. During the survey, farmers cited unavailability of improved sorghum varieties in the area as the major factors which hinder adoption of improved varieties. Qualitative information from key informants and FGDs also reveals the same results. Other constraints like susceptibility to diseases and pests as well as low yielding for these improved varieties was not mentioned at all.

Table 11: Farmer's constraints towards adoption of improved varieties

Constraints	Score	Rank
Unavailability of improved varieties	13	1
Poor taste of improved varieties	3	2
Lack of cash to buy improved seeds	2	3
Can't get credit	1	4

Note: Frequency totals to 151 due to multiple responses

Source: Informal survey (2011)

However, qualitative informations through focus group and key informants discussions, participants who were non-adopters mentioned what should be done to them so that they can adopt improved sorghum varieties. Table 13 depicts the suggestions. Making the improved varieties available to them was the top ranked suggestion.

Table 12: Farmer's suggestions on what should be done for them to adopt

Suggestions	Score	Rank
Making the improved varieties available	8	1
Provide us knowledge on improved varieties	6	2
Make us accessible to inputs	3	3
Make us accessible to credits	2	4

Source: Informal survey 2011

4.10 Factors that Condition Farmers' Decision on Incidence and Intensity of Adoption of Improved sorghum Varieties

4.10.1 Factors that condition farmers' decision on incidence of adoption

Factors which influence adoption decision and intensity use of improved sorghum varieties (objective ii) were analysed using Heckman two-steps procedure model. The first step model predicts the probability of factors influencing farmer's adoption decision. The second step model predicts the probability of factors that influence farmers on intensity use of the improved varieties through allocating a significant land for cultivating those improved varieties. In first step a binomial probit model (Heck-probit) has been used where as Tobit model has been used in the second step.

4.10.2 Results of probit model (first step) for adoption decision of improved sorghum varieties

Empirical results of the econometric models used to determine factors influencing an individual decision to adopt improved sorghum varieties are summarized in Table 14. These results are reasonable for cross-sectional data since statistics shows that the specified models fit well. One of the explanatory variable (number of sources of income) was dropped from the model to avoid multicolinearity with other independent variables. The Chi-square shows the probit model is highly significant at 1%. Likewise, using 50% as the cut-off probability of being willing to adopt improved varieties, the model correctly predicted 85.56% of respondents willing to adopt improved sorghum varieties. Mean while, five out of fourteen explanatory variables were statistically significant at various specified levels of significant. More importantly, except for one explanatory variable, the rest agreed the same hypothesized coefficient signs.

Table 13: Parameter estimates of probit model (first step)

Variables	Probit coefficient	Standard Error	Marginal probability	P[|Z|>z]
AGE	-8.232E-02	7.888E-03	-3.113E-03	0.693
EXPERIEN	1.949E-01	6.693E-03	7.373E-03	0.270
EDUCAT	9.718E-01	5.379E-02	3.676E-02	0.494
HHSIZE	- 0.287**	4.329E-02	-0.108	0.012
GENDER	- 0.271	0.162	-0.102	0.525
LAND	0.117	3.527E-02	4.416E-02	0.211
LIVESTOC	1.534E-02	4.266E-02	5.801E-02	0.892
EXTVIS	0.210**	3.489E-02	7.950E-02	0.023
CREDITAC	0.900**	0.154	0.329	0.032
MARKETAC	0.710*	0.161	0.265	0.060
VALUEPRO	0.966	0.165	0.357	0.193
VALUENON	3.381E-06	9.844E-07	1.282E-06	0.959
TIMELYAV	8.548E-08**	6.374E-07	3.233E-08	0.030
NONFINC	0.242	5.959E-02	9.144E-02	0.125
Number of observations	108			
Log likelihood function	-27.62			
McFadden	0.55			
Threshold value of predicting (Y=I)	0.5			
Chi-square	67.92			
Percentage of correct predictions	85.56			
Percentage of predictions failure	14.44			

Note***, **, * indicates significance at 0.01, 0.05 and 0.1 levels of significance respectively:

Results further indicate except family size, the rest livelihood assets (human capital, financial capital and natural capital) explanatory variables were not statistically significant in farmers' decision to adopt improved sorghum varieties. Contrary to that, all institutional variables were significant. This implies that institutional supports are the key determinants on farmers' decision to adopt improved sorghum varieties. On the other hand, the model results tallies with the opinion observed in Focus Group Discussions (FGDs) when they were asked to mention and rank important factors for them to adopt sorghum improved varieties.

Family labour size was a significant determinant of adoption at P<0.05 level. Results further show that the variable has negative association with adoption decision as it was hypothesized earlier. The negative association implies that farmer's with small family labour size are more likely to adopt improved sorghum varieties than larger families. Larger families tend to use most of their labour to off farm activities which have immediate returns to ease the pressure of living costs rather than depending on agriculture solely.

Frequency of extension visits exhibited positive sign and it was statistically significant at P<0.05 level as it was hypothesized. This can be explained that an increase in one more visit of an agricultural extension officer to a farmer will increase the probability of this farmer in deciding to adopt improved sorghum varieties. As observed during the FGDs, farmers have very little knowledge pertaining to improved sorghum varieties although they have been hearing about them.

The finding shows agricultural credit significantly influenced adoption of improved sorghum varieties. Availability of credit eases the cash constraints and allows farmers to purchase inputs such as seeds of improved varieties as well as modern equipments. Very few farmers in the surveyed sample accessed credits for agricultural purposes indicating the existence of obstacles to access the service. However, the major obstacles in the study area have been mentioned by farmers.

Coefficient of market accessibility as well positively influence adoption decision and was significant at P<0.1 level of significance. Assurance of sorghum market to farmers in the study area acts as a driving pull to adopt sorghum improved varieties. When farmers are well informed with the varietal attributes of improved varieties, they will tend to adopt aiming to increase the yield which in turn will be used for food and selling the surplus.

Availability of improved sorghum varieties in sufficient amount and at a light time was significant at P<0.01 level and positively influence decision to adopt as it was expected. Again, this is compatible with FGDs results as most of non-adopters of improved varieties claim on unavailability of improved sorghum varieties in the study area.

4.10.3 Factors that determine the intensity of adoption of improved sorghum varieties

Tobit regression analysis was conducted to determine the factors that influence the adoption intensity of the new sorghum varieties. The adoption intensity was measured in terms of area share planted with improved sorghum varieties in the total area planted with sorghum per household. As earlier explained, the same explanatory variables employed in probit model were as well employed in tobit model except one; number of extension visits. This is because Heckman two step analysis requires one explanatory variable which has been included in the probit model but has no any relevance of influencing the second step to be dropped so as to reduce the biasness of results. In this

case extension visits to farmers might promote adoption but do not have any association with the area share a farmer can allocate for improved sorghum varieties.

Of the five variables that were significant in explaining the decision to adopt new varieties, two variables; availability of improved sorghum varieties and market accessibility were also significant in explaining the intensity of adoption (Table 15). This implies that availability of sorghum improved varieties before the start of crop season will not only drive farmers in deciding to adopt, but also will motivate them in allocating significant area to grow the varieties. Likewise, apart from household food security, farmers are curious in generating income from sorghum. This reflects that if farmers will be assured with a fair market for sorghum, they will be able to cultivate improved varieties in a significant area in order to get more yield which in turn will be used both for food and income generation.

Table 14: Parameter estimates of Tobit model (second step)

Variables	Tobit coefficient	Standard error	P[|Z|>z]
AGE	2.143E-03	4.387E-07	0.625
EXPERIEN	5.161E-04	5.785E-03	0.929
EDUCAT	1.888E-02	4.746E-02	0.691
HHSIZE	1.480E-03	2.793E-02	0.958
GENDER	-2.785	2.536E-01	0.272
LAND	7.418E-03	3.469E-02	0.830
LIVESTOC	8.802E-03	2.361E-02	0.709
CREDITAC	2.200E-02	1.852E-01	0.906
MARKETAC	8.716E-02*	1.806E-01	0.062
VALUEPRO	5.749E-07	4.183E-06	0.891
VALUENON	2.966E-06	2.448E-06	0.226
TIMELYAV	3.665E-01***	1.251E-01	0.003
NONFINC	6.553E-07	5.527E-07	0.236
Log likelihood function	14.04		
Number of observations	14		

Note***, **, * indicates significance at 0.01, 0.05 and 0.1 levels of significance respectively:
Source: Formal survey (2010)

4.11 Impact Analysis

Two impact outcomes, productivity and food security were focused to identify the livelihood outcomes accrued from the use of sorghum improved varieties (Objective iii). The principal approach employed in netting out the effects of technology adoption from other factors is a comparison between "adopters" and "non-adopters" of improved sorghum varieties.

As noted before, the number of months in which sorghum is still available for consumption after harvest (sorghum being the major food crop in the study area) was the proxy used to determine food security. The food sufficiency levels used to supplement the results were none, shortage, plenty and enough. The results show that 15% of the adopters have food shortages towards the next season against 87% of non-adopters (Table 16). Moreover, about 85% of the adopters had enough food against only 13% of non-adopters. None of the surveyed household reported to have either none or plenty of food.

Table 15: Food security status among adopters and non-adopters (%)

Sufficiency level	Adopters (n =14)	Non-adopters (n = 94)
None	_	_
Shortage	15	87
Enough	85	13
Plenty	_	_

The analytical results of the impact of improved sorghum varieties on yield and food security have been presented in Table 18. The analysis was done in order to find out if there are statistical significant differences in the production (bags per acre) and food security per the whole season between adopters and non-adopters in the surveyed households using independent sample t-test. The result shows that adopters have both high yield and food security status as opposed to non-adopters. The differences were statistically significant at $P< 0.01$ level of significance. Most interesting, these results suggest that if the improved sorghum varieties are adopted under intensity cultivation, the frequent food shortages and poverty caused by climate change and variability towards people of the study area will be highly reduced.

Table 16: Comparison of Yield (bags/acre) and Food security status (number of months for consumption) between adopters and non-adopters of improved sorghum varieties respectively.

Impact outcome	**Group statistics**	**Adopters**	**Non-adopters**	**Total**
Yield	N	14	94	108
	Mean	5.67	3.18	
	Std	5.33	2.69	
	Mean difference			-2.4889***
	95% CI of difference	Lower		-3.9795
		Upper		-0.9983
Food security	N	14	94	108
	Mean	10.44	4.39	
	Std	2.30	2.72	
	Mean difference			6.0525***
	95% C I of difference	Lower		4.7334
		Upper		7.3715

Note: *** indicates significance at P<0.01 level

4.12 Farmers' Perceptions on the Impacts of Improved Sorghum Varieties towards their Livelihoods

Despite the low level of adoption of improved sorghum varieties in the study area, qualitative information from focus group discussions (FGDs) and key informants (KIs) tallies with the previous findings of this study that if improved sorghum varieties are well adopted, peoples livelihood and well being in general would be improvement. Farmers expressed their optimism that selling the surplus of sorghum from improved varieties would increase household income and thereby helping many households to cover their basic expenses. Indicators of these changes include good clothes for family members, uniforms for school going children and improvement of school attendance.

This was pointed out in all the FGDs that were held. Furthermore, an increase in yields through improved varieties is perceived by farmers as having the potential of improving nutritional and health status of family members.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study aimed at determining the factors influencing decision on the incidence and intensity of adoption of improved sorghum varieties as well as the economical impacts of these factors in Singida rural district, the central semi-arid zone of Tanzania. The decision of assessing the adoption of improved varieties of the mentioned crop in this study is not regrettable. The evidence from the study findings shows that currently sorghum is the most popular food crop followed by maize and pearl millet in the study area. This implies that the crop plays a pivotal role in food security and improvement of people's livelihood in general within the study area.

Farmers adopt technologies that meet their expectation in production. The study results show that varieties with early maturity, high yielding and drought tolerant were what farmers expected the most. However, the adoption rate of these improved varieties was very low. Low adoption rate also positively affected the adoption intensity; the intensity of adoption was determined by the area under different improved sorghum varieties during 2009/2010 season in the total area under sorghum cultivation.

The said speed of adoption and intensity of the cultivation of these improved varieties as observed by this study do not match with the speed at which livelihood vulnerability has been increasing in the study area. Farmers in Singida rural and central semi arid zone in

general are highly vulnerable in terms of livelihood due to unfavorable weather conditions which have currently been severe due to climate changes and variability. Rapid adoption of improved technologies could be one of the possible coping strategies in absorbing this shock. This study has put forward measures and recommendations for what should be done based on the results.

Nevertheless, the study identified such institutional factors as frequency of extension visits, credit accessibility, market accessibility and timely availability of improved sorghum varieties as the main factors influencing decision making as whether or not to adopt improved sorghum varieties. The study also identified household size as the only livelihood asset which influences the decision on whether or not to adopt improved sorghum varieties. Furthermore, two factors namely, timely availability of improved sorghum varieties and market accessibility were also significant in influencing intensity of adoption. These results strongly support the first hypothesis that institutional factors and livelihood assets have an influence on incidence and intensity of adoption of improved sorghum varieties in the study area.

On the other hand, although the rate and intensity of adoption was very low, yield and status of food security show statistically significant difference between adopters and non-adopters of improved sorghum varieties in 2009/2010 harvest season. This makes the study results support the second hypothesis of this thesis that adoption of sorghum improved varieties significantly improved farmers' productivity and food security.

5.2 Recommendations

Based on the findings of this study, most of the recommendations have focused to solve the observed weaknesses mostly being the institutional arrangements in fast-trucking adoption processes within the study area and the central semi arid zone in totality.

5.2.1 Research interventions

Intensification of research in agriculture is one among the ten pillars of agriculture first campaign *"kilimo kwanza"* of the government of Tanzania. However, what has been done in the field at the moment is not enough. There is a need to continue with the process of improving sorghum variety. Farmers need a larger basket of varieties than what is currently available so that selection can be made as a way to diversify solutions to their needs. Some of variety attributes which have been observed to be valuable to farmers such as food tastes and brewing qualities have not been intensively focused by breeders. Therefore, breeding work should be linked to farmers as target beneficiaries of the research outputs in order to accommodate their opinions.

Soil scientists should extend their research work to this area of study. Some farmers claim that their soil has lost nutrients in recent years. There is a need to analyse the soils so that its nutritive status could be known. Irrigation and agricultural engineers should also embark on finding the solution of agricultural water problems in the area. Further research need to be carried out focusing on rain water harvesting techniques,

underground water drilling and dams construction. Food technologists should embark on sorghum post- harvest processing and utilization programme to promote their consumption. In order to achieve the above, the government should continue to invest in human capital by recruiting more scientists in agricultural research institutes. The government should also put agricultural institutions in close proximity to farmers by establishing at least one such institute in every region unlike in the current situation where these are put on zonal basis.

5.2.2 Agricultural extension services

The findings of this study from both formal and FGDs show that farmers-agricultural extension officer interface is very minimal. When farmers were asked to give their suggestions on what should be done for them to facilitate the adoption of improved sorghum varieties**,** knowledge provision on improved varieties was among the top ranked suggestion. More efforts are required to reach more farmers particularly in remote areas. This is a challenge for government to recruit more extension officers than what are currently available. One extension officer per ward is not enough, it should go down to village level. However, having extension officers is one thing, ensuring performance is another thing. Salary promotion and improving working facilities should also be considered. In this study, a certain division agricultural extension officers reported that for three months he had not been paid fuel allowance for his motorbike.

5.2.3 Seed supply system

Evidence from this study shows that there is no clear route to where farmers can get improved seeds varieties. Despite that many farmers are aware of improved varieties, they do know where to get them. This was mentioned as the most notorious constraint against the adoption of improved sorghum varieties. Most farmers believe that they would get improved seed varieties from their extension officers, something which is not the case. The government through the Ministry of Agriculture, Food security and Cooperatives (MAFCs) and Local Government Authority (LGAs) should devise a system of encouraging private sector to participate in seed supply. The informal seed sector should also be involved in complementing the efforts. The supply approach should involve going straight down to the villages where small holder farmers are found rather than passing through several middle agents.

5.2.4 Agricultural credit accessibility

The findings of this study show that credit accessibility has influence on the adoption of improved sorghum varieties. However, the service is very unpopular in the study area. Farmers cited little knowledge on credit service as the leading barrier for them to access the service. A joint programme approach between agricultural extension officers and credit service provider institutions should educate farmers on this aspect.

5.2.5 Enhancement of sorghum market opportunity

Sorghum market developments such as food processing, feed concentrates clear beer brewing and energy markets have not been clearly observed by this study though they have been well documented in some literature. Local selling of raw sorghum among farmers in the area has been clearly found to to exist. However, local selling appears to be unprofitable to producers. As pointed out earlier in this chapter, more research is required on these areas of market.

5.2.6 Market Development Bureau (MDB)

Market development bureau of Ministry of Industries, Trade and Markets should look for external markets to encourage export of sorghum. Market promotions are required to encourage local consumption of sorghum products.

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APPENDICES

Appendix 1: Questionnaire for formal survey

HOPE: Baseline Survey Instrument in Tanzania

DRD, Central Zone

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:

.....

....

Region…….. District ……

Village location: Treatment area…… Diffusion area…… Control

area……

Household ID:

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 0 male 1 female

3. Ward…….Village …….

Sub Village……

4. Phone number…… mobile

5. Number of years the respondent is living in the village……..

6. Does your village have access to electricity? 0 No 1 Yes

7. Does your household have access to electricity? 0 No 1 Yes

8. Distance to the main market (*guliyo/mnada*) in **km…**..……(OR **hours** on foot)……

9. Name of the market…..……

10. Type of road to main market:[1] …..……..Quality of road:[2]…..……

11. Number of months road to the main market is passable for trucks in a year:… ……

[1]. **Type of Road:** 1=Paliro, 2=Imelimwa bilachangarawe, 3=Imeliimwa inachangerawe, 4=Paved asphalt (tarmac)
2. Quality of road: 1 = Bad, 2 = Good, 3 = Very Good

12. Experience **(years)** in own farming activities ……

13. Experience **(years)** in cultivating: i) Sorghum…… ii) Finger Millet…… iii) Pearl millet ……

14. Distance to the nearest agricultural extension officer in **km**…… **and/or hours** ……

2.1 Household composition *(Please fill the table for all household members who were living in the household for the last 12 months.* ***Fill also for non-permanent members (eg. temporary migrants, children living away at school))***

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**	Religion **Code D**	Number of month s/he was living in the hh	pa **C**
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								

Household occupation. Please fill the Table for all the household members who were living in the household during the last 12 months. **Fill also for non-permanent members (eg. temporary migrants, children living away at school).**

Codes A	**Codes B**	**Code C**		**Codes D**	**Codes E**
1 Household head	1 Married living with spouse	0 None (illiterate)	5 High education (13 -14)	0 Moslem	0 None
2 Spouse	2 Married but spouse away	1 Basic (can write and read)	6 College	1 Christian	1 Full time
3 Son/daughter	3 Divorced/separated	2 Lower primary (1-4)	7 Vocational training	2 Other, specify …… ……..	2 Part-time
4 Parent	4 Widow/widower	3 Upper primary (5-7)	8 Not applicable		3 Weekends and holidays
5 Son/daughter in-law	5 Never married	4 Secondary (9-12)	9 Other, specify ……..		4 Other, please specify …… ..
6 Grand child	6 Other, specify……..				
7 Other relative					
8 Hired worker					
9 Other, specify……					

Code A		**Code B**	
1 Farming (crop + livestock)	5. Casual labour on another farm.	1 Rented out land	6 Pension income
4 Casual labourer on farm	6. Non-farm business	2 Rented out oxen for ploughing	7 Drought relief
3 Herdboy/girl	7. Salary)	3 Sale of dung cake for fuel	8 Remittances (sent fro family and relatives)
4.Housekeeping	8 Other, specify……	4 Sale of own trees (firewood, etc)	9 Marriage gifts (e.g., c
		5 Sale of own brewed drinks	10 Other, specify ……

Name of HH member (start	Main occupation **Code A**	Yearly net income in TSh if **NOT** farming	2nd important occupation **Code A**	Yearly net income in TSh if **NOT** farming	Other income sources **Code B**	Yearly income other in sour
	Total	Cultivated land		Fallow land	Rented out	Other,
Owned land						
1.						
2.						
Rented –in land						
3.						
4.						
Total land						
5.						
6.						
7.						
8.						
9.						

3.0 Agricultural production

3.1 How much land did the household have in the 2009/10 season?

***Specification ……(eg. From relative)*

16. *If land is rented in*: How much did you pay in TSh or in kind in the planting season 2009/2010 for the total area you rented in?.....

17. *If land is rented out*: How much did you receive in TSh or in kind in the planting season 2009/2010 for the total area you rented out?.....

3.1 Characteristics of all plots (cultivated or fallow) in the 2009/2010 planting season .

Plot number (starting from nearest plot to	Plot name	Plot distance to residence	Plot size (acre)	Soil fertility **Code**	Soil type **Code**	Soil slope **Code C**	Soil water conservation

house)		Dist.	Unit **(1=hrs; 2=km)**		**A**	**B**		**(0=no; 1=yes)**	
1									
2									
3									
4									
5									
6									
7									
8									
9									
					Code A 1 Poor 2 Medium 3 Good	**Code B** 1 Finyanzi (clay)) 2 Tifutifu (loam)) 3 Kichanga (sandy) 4 Other (specify)		**Code C** 1 Gently slo (flat) 2 Medium slope 3 Steep slop	

3.2 Characteristics of crop production in the 2009/2010 planting season *(information has to be filled per plot and variety for the previous planting season. Each plot and each variety at the same plot have a separate row)*

Plot name	Crop grown **Crop codes**	Area cultivated with respective crop (acre)	Total amount harvested			Amount used for home consumption	Intercropping **(0=no; 1=yes)**	*If intercropping:* With which crop? **Crop codes**	Irriga **(0=n 1=ye**
			kg	Bags	Tins				

Crop codes

1 Sorghum
2 Finger millet
3. Pearl/bulrush millet
4. Maize
5. Sunflower
6. Pigeonpea
7. Cowpea
8. Groundnuts
9. Bambara nuts
10.Simsim
11. Other (specify)

3.3 Crop production inputs in the 2009/2010 planting season (*Please ask for all inputs per plot and crop level. If a farmer cannot give these estimates please ask per crop. If a farmer still faces difficulties ask per last 12 month.)*

Plot name (from Table	**Crop grown (from**	**Seeds**		**Fertilizer**			**Manure/ Compost**		**Field chemical**		
		/gi ft	Bought	DAP	Urea	TSP	wn (kg	Bought	Pesticide	Herbicide	

3.2) Table 3.2)

Operations	kg	Price in TSh/kg	Family labour: Total Days of family labour	Price in TSh/kg	Gender Code A	Days by gender	Price in TSh/kg	Hired labour: Total mandays for hired labor	Tons	Price in TSh/kg	Hired oxen: Total number of days oxen was hired	kg	Price in TSh/kg	Family ox: Total numb days own o was use
1 Land preparation (Ploughing primary and secondary tillage)														
2. FYM/C Compost/Manure application														
3. Seed treatment														

3.4 Labour input in total for all cultivated area (Please fill the following table for the 2009/2010 planting season)

3.5 Please let the farmer choose one of the plots on which s/he grew finger millet in the 2009/2010 planting season and fill the following Table for labour inputs for this plot.

Plot name of referred plot:…….

Date of sowing: ……week……..month Start of rains: …….week……..month……

Activity	Total paid to hired labour		Total paid for hired oxen		Total paid for hired eq	
	in TSh	in kind	in TSh	in kind	in TSh	in k
Land preparation						
Weeding						
Harvest						
Other,……						
In total *(if answers cannot be given according to activities)*						
Total paid to *permanent hired labour*	No. of permanent hired labourer		Wage per labourer per year in TSh		Wage per labourer /ye kind	

4. Planting/Sowing and fertilizer application						
5.Weeding/Herbicide application						
6. Plant protection (Spraying/ Dusting/Shaking)						
7. Irrigation						
8.. Watching (Birds, Pigs etc.,)						
10.. Harvesting						
11. Threshing						
12. Seed cleaning, purification						
13. Storage (including transport)						

Code A

1. Male labor
2. Female labor
3. Child labor
4. Both male and female

3.6 Ask the farmer to choose ONE of the plots on which he or she grew sorghum and one on which he or she grew finger millet in the 2009/10 season. If you have filled in Table 3.5, fill in this table for the same plot as Table 3.5.

Plot name sorghum:……. Plot name finger millet: ……

Operations	**Recommended technologies for sorghum**	**Tick if used**	**Recommended technologies for finger millet**
1A. Land preparation (Ploughing primary and secondary tillage)	Animal traction		Animal traction
	Tractor plough		Tractor plough
	Power Tiller		Power Tiller
	Hand hoe		Hand hoe
	Zero Tillage		Zero Tillage
	Other, specify……..		*Other, specify……..*
2. Compost/Manure application	Farmyard manure		Farmyard manure
	Compost manure		Compost manure
	Other, specify……..		*Other, specify……..*
3. Seed treatment	Fungicide		Fungicide
	Ash		
	Neem products		
	Other, specify……..		*Other, specify……..*
4. Planting/Sowing	Row planting 60 x 20cm		Row planting 40cm x 10cm
	90cm X 30 cms (local)		30cm x 15 cms
	80cm X 30 cms (improved)		*Other, specify……..*
	Other, specify……..		
5. Fertilizer application	40-60Kgs N /ha		40-60Kgs N /ha
	Microdosing 17KgsN/Ha		Microdosing 17KgsN/Ha
	90Kgs N/ha split application		90Kgs N/ha split application
	Other, specify……..		*Other, specify……..*
6. Weeding/Herbicide	Hand weeding 1 times		Hand weeding 1 times

Operations	Recommended technologies for sorghum	Tick if used	Recommended technologies for finger millet
application	Hand weeding 2 times		Hand weeding 2 times
	Herbicide –pre emergence		Herbicide –pre emergence
	Herbicide post emergence		Herbicide post emergence
	Other, specify……..		*Other, specify……..*
7. Striga control	Mechanical (weeding/hand pulling)		Mechanical (weeding/hand pulling)
	Intergragted striga management (ISM)		Intergragted striga management (ISM)
	Other, specify……..		*Other, specify……..*
8.Plant protection - Spraying/Dusting/ Shaking /Hand picking)	Insecticide for stalk borer		Insecticide for stalk borer
	Other, specify……..		*Other, specify……..*
9. Irrigation	In situ water harvesting		In situ water harvesting
	Other, specify……..		*Other, specify……..*
10. Watching (Birds, Pigs etc.,)	Bird scaring, specify how ……		Bird scaring, specify how ……
	Other, specify……..		*Other, specify……..*
11. Harvesting	Manual harvesting (Cutting		Manual harvesting (Cutting
	Other, specify……..		*Other, specify……..*
12. Threshing	Threshers		Threshers
	Animal tramping		Animal tramping
	Manual (beating)		Manual (beating)
	Other, specify……..		*Other, specify……..*
13 Post-harvest activities: Dressing	Insecticide		Insecticide
	Other, specify……..		*Other, specify……..*

Operations	Recommended technologies for sorghum	Tick if used	Recommended technologies for finger millet
13 Post-harvest activities: Milling	Dehulling		Dehulling
	Milling without dehulling		Milling without dehulling
	Hand milling		Hand milling
	Hammer mill		Hammer mill
	Other, specify		*Other, specify*

4.0 Sorghum and finger millet production

4.1.1 Which other crops besides sorghum and finger millet do you grow? Please list the two most important.

1)…… 2)……

4.1.2 Please first rank the importance of each crop for each reason:.

1 = Most important 2 = Important 3 = Not important

Reason	Sorghum **Code B**	Finger millet **Code B**	Pearl millet/ bulrush millet **Code B**	Maize **Code B**
1. Needed for home consumption				
2. Needed for animal consumption				
3. Cash income				
4. Others (specify)……				

4.1.3 Is the area under sorghum and finger millet on your farm:

Sorghum: 0 constant 1 increasing 2 decreasing in the last five years?

Finger millet : 0 constant 1 increasing 2 decreasing in the

4.1.7 How often do you grow sorghum/finger millet on the same land (crop rotation)?

0 Every year *(skip to 4.2)* 1 Every second year 2 Every third year 3 Other, specify……

4.1.8 What is the average yield of sorghum in different years?

	Sorghum			**Finger Millet**		
Year	Quantity harvested	Bags	Area under cultivation in acres	Quantity harvested	Bags	Area unde cultivatio acres
Normal year						
Bad year						
Best yield recorded so far						

4.1.9 How would you judge the harvest of the 2009/2010 planting season?

Sorghum: 1 Bad 2 Normal 3 Good year **Finger millet**: 1 Bad 2 Normal 3 Good year

4.1.10 RANK the following problems in importance for your sorghum and finger millet yields.

1 Very important 2 = Important 3 = Not important

Problem	Sorghum	Finger millet	Problem	Sorghum
Climate variability			Pests and diseases	
Low soil fertility			Weeds including striga	
Lack of varieties			Other, specify……	

4.2 Knowledge of sorghum and finger millet varieties, sources of information and seed adoption and disadoption

4.2.1 Please fill the following Table for all crop varieties of sorghum/finger millet a farmer knows (also those s/he doe not plant her/himself)

Crop varieties **known**	**Main** source of variety information, (choose 1)	Ever planted? **(0=no; 1=yes)**	If **NO,** Why? **Code B**	If **YES,** year first planted	Reasons for planting **Code C**	**First seed**			Planted variety in 2009/10 season? **(0=no; 1=yes)**
						Main source of **first** seed **Code D**	Quan-tity **kg**	Means of acquiring first seed **Code E**	

Code A
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

Code B
1 Cannot get seed at all
2 Lack of cash to buy seed
3 Susceptible to diseases & pests
4 Poor taste
5 Theft during green stage
7 Low yielding variety
8 Poor prices
9 No market
10 Requires high skills
11 Seeds are expensive
12 Other, specify……

Code C
1 No other variety available
2 Best adapted variety
3 High yields
4 …..
…… *(please fill name)* recommended it to me
5 Other, specify

Code D
1 Research PVS
2 Extension officer
3 Bought from local seed producers
4 Bought from local trader or agro-dealers
5 Farmer to farmer seed exchange

Code E
1 Gift/free
2 Borrowed seed
3 Bought with cash
4 Payment in kind
5 Exchange with other seed
6 Other, specify…..

4.2.2 What were your main sources of inputs for sorghum and millet in the 2009/10 planting season?

Input	Two most important sources **Code A**	Payment **Code B**	Distance **(km)** to the place to buy	Mean of transport **Code C**	Costs of transport **(TSH)**	Codes	Codes
DAP						**Codes A** 1 Voucher system 2 Other farmers 3 Local trader or agro-dealers 4 Provided by NGOs 5 Extension officer 6 Other, specify…… …… …… **Codes B** 1 Cash 2 Credit 3 Other	**Codes C** 1 Human back 2 Animal back 3 Bicycle 4 Public transport 5 Other, specify…… ……
DAP							
Urea							
Urea							
TSP							
TSP							
Pesticides							
Pesticides							
Herbicides							
Herbicides							
Other							

4.2.3 What were your **two** main sources for **seeds** for sorghum and finger millet in the 2009/2010 planting season?

Variety planted	Quantity of seed from major sources (kg)							
	Source 1				Source 2			
	Code A	Reason for the source **Code B**	Amount **(kg)**	Quality (purity +viability) **Code C**	**Code A**	Reason for the source **Code B**	Amount **(kg)**	Quality (purity +viability) **Code C**

4.2.4 What factors do you consider most when purchasing seeds, please rank the first two important (*do not read out the reasons assign the farmers' answers to the given categories))*

(a) Yielding capacity …….……

(b) Early maturity …….

(c) Drought resistance…….

(d) Resistance to pests…….

(e) Fair price ……

.

(f) Others (specify) ----------

Code A		**Code B**	**Code C**
1 Voucher system	5 Extension officer	0 No other source	0 Poor
2 Farmer to farmer	6 Research PVS	available	1 Good
seed exchange (relative,	7 Bought from local seed	1 Best price	2 Very good
friend, etc)	producers	2 Run out of own seed	
3 Bought from local	8 From own storage	3 Best seed quality	
trader or agro-dealers	9 Other,	4 Can buy on credit	
4 Provided by NGOs	specify……	5 Other, specify	
		……..	

4.2.5 What are the major constraints in purchasing seed, please rank the first two important (*do not read out the reasons assign the farmers' answers to the given categories)*

(a) Lack of information about recommended variety --------- (e) High seed price ---------

(b). Non-availability of seed of required variety --------- (f) Low seed quality
----
(c). Need to travel long distances --------- (g) Others (specify)
…… ---------
(d) Credit facility not available ---------

4.4 Utilization of sorghum and finger millet from the 2009/2010 planting season (please use three rows per crop variety to add all consumption specifications;
if information cannot be given per crop variety it should be given per crop.

Name of crop variety	2. Harvest **(bags)** (Table 3.2)	3. Amount **sold** (**bags)**	4. Saved as seed **bags**	5. Amount **consumed** (bags)	Consumption specification, rank 3 **(Code A)**	8. Amount used for other purposes (bags)	Purpose **(Code B)**	Stalk is used **(0=no; 1=yes)**	*If yes:* Purpose **Code C**

4.5 Marketing of sorghum and finger millet

4.5.1 Please fill the following Table for marketing of sorghum and finger millet in the 2009/2010 season

Crop variety **Crop code**	Sold product **Code A**	Buyer **Code B**	Place of selling **Code C**	Mode of transport **Code D**	Transport costs/ transport **(TSh)**	Product grades **Code E**	*If no grade*: Product quality **Code F**	Amount sold in **unit of grain**	Tax free price/kg/grade or quality **(TSH)**

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

Code B
1 Consumer or other villager
2 Wachuuzi (assembler)
3 Middleman
4 Wa Dalali (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….

Codes E
1= White
2=Mixed

Codes F
1 Poor
2 Mediu
3 Good
4 Mixed
5 Other, specify…
…..

4.5.1 Continued. Please mark the month of harvest and the number of bags of sorghum and finger millet sold each month.

Month when most product was sold	Amount of product sold **(bags)**	Month when most product was sold *(tick)*	Amount of prod **(bags)**

(tick)		SG	FM			SG	FM
1. January				7. July			
2. February				8. August			
3. March				9. September			
4. April				10. October			
5. May				11. November			
6. June				12. December			

4.5.2 Please fill the following information for the t**wo most important** buyers for sorghum and finger millet from Table 4.5.1. *(If several answers apply to a question please separate the codes with ;)*

Buyer **(from Table 4.5.1)**	Crop **(1=sorghum; 2=finger millet; 3= both)**	Number of buyers dealt with **(99=many)**	Do you usually sell to the same buyer? **(0=no; 1=yes)**	Contract with buyer **(0=no; 1=yes)**	*If contract:* Content of contract? **Code A**	*If contract:* Length of contract **Code B**	*If contract:* Time of arrangement **Code C**

Codes A	**Code B**	**Code C**	**Code D**	**Code E**	**Code F**	**Code G**
1 Quantity to be delivered 2 Quality to be delivered 3 Timing of delivery 4 Input provision 5 Other, specify……..	0 Permanent 1 One season 2 Other, specify……	0 Before planting starts 1 Before harvesting starts 2 Other, specify……..	0 I wait until he passes the village 1 I contact him 2 He contacts me 3 I go to see him at the market 4 Other, specify……	1 Grain colour 2 Grain size 3 No stones 4 Other, specify……..	1 Delivery by own means of transport 2 Delivery through a group 3 Have to sell all harvest to the buyer 4 Other, specify……	1 Payment in advance 2 Payment on delivery 3 Payment after delivery 4 Other, specify……

4.5.3 Comparison of sorghum and finger millet buyers. [Please rank all traders from 1=Most important/best to 4=least important/worst. (*In case a farmer can only rank a limited number of traders or only one write 0 to the trader cells that cannot be ranked)*

	Villagers/ consumers	Wachuuzi (Rural assemblers)	Middlen
1. Who pays best prices for the grain delivered?			

2. Who has reliable weights/measures?			
3. Who pays timely for the grain delivered?			
4. Who is located nearest your farm?			
5. Who is stricter on grain quality requirements?			
6. Which marketing outlet do you prefer most?			

4.5.4 Which factors do you consider as most important when selling your sorgum and finger millet, please rank the first two (*do not read out the reasons. Assign the farmers' answers to the given categories).*

Sorghum		Finger millet
(a). Price (TSH/kg)	---------	(a). Price (TSH/kg)

(b). Kind of buyers (also farm gate)	---------	(b). Kind of market (also farm gate)

(c). Relation with buyer	---------	(c). Relation with buyer

(d). Market availability (access)	---------	(d). Market availability
(access) ---------		
(e). Others (specify)……..	---------	(e). Others
(specify)…… ---------		

4.5.5 What are the major constraints/limitations in selling sorghum/finger millet, please rank the first two (*do not read out the reasons. Assign the farmers' answers to the given categories).*

Sorghum		Finger millet
(a). Lack of information about buyer	---------	(a). Lack of information about
buyer preferences --------		
preferences		
(b). Lack of information about places	---------	(b). Lack of information
about places --------		
where to sell		where to sell
(c). Low price	---------	(c). Low price

(d). Need to travel long distances	---------	(d). Need to travel long distances
---------		
(e). Lack of information about prices	---------	(e). Lack of information about
prices ---------		
(f) Broker fix the price	---------	(f) Broker fix the price

(g). Others (specify)……..	---------	(g). Others (specify)……..

4.5.6 Do you mix different varieties of sorghum/finger millet during harvesting?

Sorghum 0 No 1Yes Finger millet 0 No 1Yes

4.5.7 Do you mix different varieties of sorghum/finger millet during storage/marketing?

Sorghum 0 No 1Yes Finger millet 0 No 1Yes

4.5.8 Are you aware of any collective action activities for sorghum/finger millet or other products? 0 No *(skip to 4.6)* 1 Yes

4.5.9 Did you ever sell **any of your crops** (also other than sorghum/finger millet) through collective marketing actions? 0 No, *skip to 4.5.10* 1 Yes, please fill the table below *(and skip to 4.6)*

Name of collective action	Collective action **Code A**	Crop	**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 ……

4.5.10 *If no in 4.5.9::* 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 ……..

4.6 Food security

4.6.1 How is the availability of sorghum and finger millet from your **own harvest** throughout the year? *(please start with the month of harvest, and tick months of harvest).*

Month	Sorghum		Finger millet		Pearl millet/bulrush millet		Mai	
	Harvest	Availability (**code B)**	Harvest	Availability **(code B)**	Harvest	Availability **(code B)**	Harvest	A
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 B		
0 None 1 Plenty 2 Enough 3 Shortage		

4.6.2 Where do you store sorghum and finger millet crop?

0 I do not store any *(skip to 4.6.7)* 1 At home 2 In private storage facility *(skip to 4.6.8)*
3 At home and in private storage facility 4 Other, please specify…… ……..... *(skip to 4.6.7)*

4.6.3 *If 1 (at home) in 4.6.2:* Why did you not store some of your produce in a specialized storage facility? Please
give the two most important reasons?

1 Too expensive 2 Too little harvest 3 No need because of own storage facilities 4 Too far away

5 No private facilities available 6 Other, please specify……

4.6.4 How do you store sorghum and finger millet produce at home?

1 Bags 2 Mud pots 5 Airtight drums 6 Other, specify……..…..

4.6.5 Do you undertake any action to avoid damage when storing the crop produce?

0 No *(skip to 4.6.7)* 1 Yes

4.6.6 What kind of action do you undertake to avoid damage when storing the crop produce? Please specify the
action according to the specific kind of storage and give costs for the actions, e.g. chemicals.

Storage..... Action ……..
Costs ……..

Storage..... Action ……..
Costs ……..

Storage..... Action ……..
Costs ……..

4.6.7 Do you use private storage facilities **for any crop** (not only for sorghum and finger millet)?

0 No, *skip to 4.6.10* 1 Yes

4.6.8 If yes, please fill the Table below

Name of storage facility	Location of storage facility **Code A**	Distance to storage facility **(km)**	Mean of transport **Code B**	No. of transports/ season	Costs of transport/ time **(TSH)**	Maximum storage quantity **(bags)**	Costs of storage **(TSh per kg/month)**

Code A	**Code B**	
0 Village 1 Neighboring village 2 Next town 3 Other, specify	1. Hired truck 2. Donkey/horse cart 3. Back load 4. Other, specify	

4.6.10 Would you be interested to store sorghum and finger millet produce in private storage facilities?

1 Yes 0 No, please give two reasons why not

1 too expensive 2 sell the harvest immediately because of cash needs

3 too little harvest 4 have own storage facilities

5 other

5.0 Access to information and participation in technology transfer

5.1 Do you have access to a government extension officer? 0 No 1 Yes

5.2 *If yes in 5.1:* How many times **per year** do you consult the extension officer?
……

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

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

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……..

5.4 Have you ever participated in technology evaluation or transfer activities during the last 2 years?

0 No (*skip to 6.0)* 1 Yes

5.5 *If yes in 5.4:* Please fill the following Table.

Participated activity	How many times did you participate in the last two years?		**Code A**
CODE A			
	2008/2009	**2009/10**	1 Own plot PVS 2 On-farm trials/demonstrations 3. Farmer Field days 4. Farmer Training Centre 5. Learning from Lead Farmers 6. Other (specify)……

6.0 Livestock, farm and non-farm assets

6.1 Livestock production activities.

Animal type	**No. of animals 12 month ago**	**Value in TSh/animal 12 month**	**Animal type**	**No. of animals 12 month ago**	**Valu TSh/a 12 mon**

		ago			
Cattle			**Goats**		
Indigenous milking cows			Milking goats		
Chotara			Non-milking goats		
Kwakisasa			Mature male goats		
Other non milking cows (mature)			Young goats		
Trained oxen for ploughing			**Sheep**		
Bulls			Mature female sheep		
Heifers			Mature male sheep		
Calves			Young sheep (ram and lamb)		
Other livestock			**Other livestock**		
Mature trained donkeys			Chickens		
Young donkeys			Bee hives		

6.2 Livestock maintenance costs *(Please record for the last 12 month,units need to be same for own and purchased items! If not you need to know how much of the unit given under own source is the unit given under purchased quantiy (1 bundle = 0.5 kg).A farmer should give the price/unit of product. If s/he is not able to do so please ask for the total costs.*

Description	Total quantity per year	Unit	Total quantity from own source	Unit	Total quantity bought	Unit	Per unit price **(TSh)**	Tota **(T**
1.Crop residue								

2.Green fodder								
3.Dry fodder (hay)								
4.Concentrates								
5.Veterinary services								
6.AI services								
7.Herds boy (animal tending)								
Other costs, specify								
8.								
9.								

Asset name	Number	Total value **(TSH)**	Walling material for the building **Code A**	Roofing material for the building **Code B**	Type of house is tembe **(0=no; 1=yes)**	
1. Homestead						
2. Other building						
3. Satellite dish						
4. Gas oven						
5. Sofa						
6. Chairs						
7. Tables						
8. Shelf/wardrobe						
9. Bed						
10. Carpet/matt						
11. Other furniture						

6.3 Please fill the following Table for household items

Codes A
1 Bricks (stone/mud)
2 Stone
3 Mud
4 Unburned bricks
5 Other, specify……..…

Codes B
1 Grass thatch
2 Iron sheet
3 Tiles
4 Other, specify……

6.4 Please fill the following Table for household farm assets that you currently own:

6.5 Credit access and social assets

6.5.1 Did you **try** to obtain **any credit** in the last 12 months?

0 No 1 Yes *(skip to 6.5.4)*

6.5.4 *If yes in 6.5.1*: Did you get the credit? 0 No 1 Yes *(skip to 6.5.6)*

6.5.5 *If no in 6.5.4:* Why did you not get the credit? Please give the two most important reasons.

1. ……
   ……

2. ……
   …….

6.5.7 *If yes in 6.5.6*: 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**	
		Quantity	Unit

Code A	Code A	**Code B**
1 NGOs	5 Farmers/traders	1 Investment in agriculture
2 Banks	6. SACCOs	2 In vestment in non-agriculture
3 Saving sacas	7. Family/friends	3. Consumption
4 Village money lenders	8. Other (specify)……..	4. Other (specify)……..

6.5.8 Membership to farmer organizations/clubs

Type of Association, Coop , Group, club or Local Admin household has been or is a member **Code A**	HH member who is a member **Code B**	Association or club functions **Code C, rank 2**	**Year** joined	**Entry fee (TSH)**	Annual subscription fee **(TSH)**	Number of attended meetings/ year	Still a member now **(0=no; 1=yes)**	If not a member now then **year** stopped being member

Code A
1 SACOs
2 Producer marketing group
3 Village administration
4 Farmers' group
5Youth club
6 Faith-based organization
7 Saving and credit group
8 Farmer field school
9 Other, specify …….

Code B
1 Household head
2 Spouse
3 Son/daughter
4 Parent
5 Son/daughter in-law
7 Other relative

Code C
1 Produce/livestock marketing
2 Input access/marketing
3 Seed production
4 Farmer research group
5 Savings and credit
6 Tree planting and nurseries
7 Soil & water conservation
8 Input credit
9 Local administration
10 Other, specify……

Codes D
1 Resigned for personal reasons
2 Resigned because the organiz
3 Finished his/her term
4 Was deposed for some reason
5 Unable to pay annual subscrip
6 Other, specify……

7.0 IMPORTANT CONSUMPTION EXPENSES IN THE last 12 months
[Here, wife and/or person involved in purchases should be the principal respondent/s]

7.1 Weekly expenditure data Please ask for the expenditure of all household members in the last seven days for all items in the tables and fill zero for no expenditures

Item	Expenditure in TSh/week
1. Tobacco, cigarettes	
2. Newspapers or magazines	
3. Fares for busses, taxis, etc.	
4. Other, specify …….	
5. Other, specify …….	

How many [MEALS/SNACKS] were eaten by household members outside of the home during the past 7 days? (Including meals in restaurants, other people´s houses and those eaten in social community kitchens, school feeding programs etc.)

MEALS/SNACKS	Number	Total value in **TS**
Breakfast		
Lunch		
Dinner		
Snacks/beverages		

7.2 Non-food expenditure

Has your household bought, spent money on or received gifts of any of these items during the past 12 months?
Please exclude from your answer any item purchased for processing or resale in a household enterprise.

Item	How much in TSH did your household spend on this item during the past 12 months?	Did you receive any of these items as a gift during the past 12 months? **0 =no; 1=yes**	*If yes*, What is the value in TSH of all the item that you received as a gift during the past 12 months?
Personal care items (soap, shampoo, toothpaste, etc.)			
Cosmetics			
Women's clothing			

Men's clothing			
Children's clothing			
Women's footwear			
Men's footwear			
Children's footwear			
Cloth and sewing supplies			
Blankets			
Tailoring expenses			
Shoe shine			
Personal services (haircuts, shaving, manicures, etc.)			
Books (e.g. novel , newspaper, magazine, tabloid. Excluding textbooks)			
Postal expenses, telegrams, etc.			
Entertainment (cinema, cassette/ VCD rentals, cultural and sporting events, etc.)			
Item	How much in TSH did your household spend on this item during the past 12 months?	Did you receive any of these items as a gift during the past 12 months? **0 =no; 1=yes**	*If yes*, What is the value in TSH of all the item that you received as a gift during the past 12 months?
Household cleaning articles (soap, washing powder, bleach, broom, toilet supplies, etc.)			
Kitchen supplies (napkins, matches, bags, etc.)			
Electrical items (light bulbs, cords, plugs, batteries, etc.)			
Repairs and maintenance of household articles (e.g. nails,			

hammer, cutlass, scicors)			
Household linens (sheets, blankets, towels, etc.)			
Small kitchen appliances (blender, mixer, etc.)			
Dishes (crockery, cutlery, glassware, etc.)			
Kitchen utensils (pots, pans, buckets, tools, etc.)			
Small electrical items (radio, walkman, watch, clock, etc.)			
Sports and hobby equipment			
Musical instruments			
Vehicle repair, maintenance, parts and licenses (do not include gasoline)			
Building, repair and maintenance of the house			
Guard/security			
Rent for the house			
Electricity			
Water			
Telephone (mobile+landline)			
Rent for other buildings			
Insurance (auto, property)			
Health insurance			
Other costs for health/medicine			
Regular worship			
Excursion, holiday (including travel and lodging)			
Charity, donations			

Tax (Income tax, Land tax, Housing and property taxes)			
Church contributions			
Deposits to savings accounts			
Legal or notary services (e.g. ID Card, liscence etc.)			
Marriages, births and other ceremonies			
Female/ male dowry/ brideprice/ groomprice			
School fees and supplies			
Funeral expenses			
Remittances			
Lendings to another person			

7.3 Food expenditure, please fill the following table for the consumption of the whole household for the last 12 months

Expense Item	How many month in the last 12 month did you buy this item?	Frequency of purchase per month (e.g. 2 times/month)	What is the average quantity bought per month?		What is the average price for this item per unit?	*If previous cannot be answered:* How much did you spent for this item per month?	Total value of item received as gift in the last 12 month
			Quant	Unit	**TSH**	**TSH**	**TSH**
Cereals and Pulses							
Mtama							
Ulezi							
Pearl millet							

Wheat							
Mchele							
Mahindi							
Mbaasi							
Mataage							
Karanga							
Dengu							
Kunde							
Njegere							
Ufuta							
Other, specify …….							
Horticultural crops							
Viazi							
Viazi vitamu							
Beetroot							
Mhogo							
Maboga							
Sukumawiki							
Nyanga							
Vitungu							
Cabbigi							
Carrots							
Pilipili hoho							
Other, specify							

Other items							
1. Chumvi							
2. Sukari							
3. Pilipili							
4. Pilipili kichaa							

Expense Item	How many month in the last 12 month did you buy this item?	Frequency of purchase per month (e.g. 2 times/month)	What is the average quantity bought per month?		What is the average price for this item per unit?	*If previous cannot be answered:* How much did you spent for this item per month?	Total value of item received as gift in the last 12 month
Other items contd.			Quant.	Unit	**TSH**	**TSH**	**TSH**
5. Tangawizi							
6. Vitungu saumu							
7. Pilipili yaunga							
9. Mafuta aliset							
10. Mafuta yakupikia							
Other,							

specify							
Animal origin foods							
Nyama ya ngombe							
Nyama ya kandoo							
Nyama ya goat							
Nkuku							
Samaki							
Nyama nyiingine							
Maziwa							
Siagi							
Jibini							
Mayai							
Other, specify							
Fruits							
Ndisi							
Papai							
Machungwa							
Mayembe							
Parachichi							
Mapera							
Other,							

specify							
Processed food							
1. Biskouti/kek i							
2. Chips							
3. Mkate							
4. Chapati/pan cake							
Other, specify							

Expense Item	How many monthsin the last 12 month did you buy this item?	Frequency of purchase per month (e.g. 2 times/month)	What is the average quantity bought per month?		What is the average price for this item per unit?	*If previous cannot be answered:* How much did you spent for this item per month?	Total value of item received as gift in the last 12 month
Other items contd.			Quant.	Unit	**TSH**	**TSH**	**TSH**
Beverages							
Kahawa							
Majani ya chai							
Vinyawaji baridi							
Bia							
Pombe ya kienyeji							
Other, specify ……..							
Cooking equipment							
1. Kuni							
2. Mkaa							
3. Mafuta ya taa							
4.							

Mishumaa							
Other, specify							

8.0 Decision making in the household

8.1 Please fill the following table about the ownership and decision making in your household *(this Table need to be answered by the woman, the male head of household should not be present when filling the Table)*

Resources	Ownership **0=male; 1=female; 2=both**	Decision making **0=male; 1=female; 2=both**		
1. ASSETS:		Buying	Selling	Utilization/ undertaking th activity
Land				
Livestock				
Credit				
Farm equipment				
Household equipment				
Investment (money)				
Other, specify				
2. INPUTS:				
Seeds				
Fertilizers				
Pesticides				
Own labor				
Hired labor				
Others (specify)				
3. OUTPUTS:				
Crop produce				
Storage				
Sale quantity				
Marketing				
Fodder				
4. POST HARVEST				
Threshing				
Seed cleaning and purification				
Milling				
Other processing activities……				
Marketing				
Other post harvest activities……				
5. OTHERS:				

Household maintenance				
Education of children				
Children's marriage				
Migration				
Cash income from farm activities				
Cash income from off-farm activities				
Others				

Appendix 2: Checklist for informal survey

1.0 Names of respondents (a group comprises of adopters, non-adopters and other key informants in each surveyed village)

Name	Adopted new sorghum variety (Yes/NO)

1.2 Ward……

1.3 Village…….

SECTION A: To be filled by adopters only after splitting the group into adopters and non- adopters.

2**.0 Variety preference (Matrix ranking**)

IMPROVED VARIETIES	**Attribute 1**	**Attribute 2**	**Attribute 3**	**Attribute 4**	**Attribute 5**	**Total score**	**Rank**
i. Pato							
ii.Tegemeo							
iii. Macia							
iv. Hakika							
v. Wahi							
vi. Wagita							
vii…….							
viii…….							
ix……							
x…….							
Local varieties							
Total score							
Rank							

3.0 Major constraints limiting the *extent* of adoption for improved sorghum varieties. (To be answered by adopters separately) The rank will depend on the frequency a constraint has been noted.

CONSTRAINTS	**RANK**	**HOW IT LIMITS ADOPTION**
1.		
2.		
3.		
4.		

4.0 A: ASSESSMENT OF FAMILY LIVING CONDITION AFFECTED BY ADOPTION OF IMPROVED SORGHUM VARIETIES IN 2009/2010 SEASON

(a) Does availability of improved sorghum varieties important to you? (Yes/No)

(b) Do you consider (a) above is a major need to improve your livelihood? (Yes/No)

(c) Whether yes or no in (b) above, list other things which need to be changed in sorghum production in order to improve your livelihood.

……
……
……
……

4.0 B: ASSESSMENT OF FAMILY LIVING CONDITION AFFECTED BY ADOPTION OF IMPROVED SORGHUM VARIETIES.

What are the five important changes/ benefits from adoption of sorghum variety if any? (To be filled by each adopter separately)

Welfare/wealth variables	**Compare average years before adoption and after adoption**	**Is change directly due to adoption**	**Give other reasons for the change**
1.			
2.			
3.			
4.			
5.			

SECTION B: To be filled by non-adopters only.

5. Would you be interested in adopting improved varieties for sorghum? (Yes/No)

6. If yes, what are your 5 major constraints?

i……..

ii…….

iii……

iv……

v……

7. If no, why are you not interested?

…….

……

……

……...

8. What would need to change so that you would become interested?

i……

ii……

iii……..

iv……..

9. For each of the constraint you have mentioned above, what you see as solutions to overcome that constraint.

i…….

ii……

iii……..

iv……..

v……..

THANK YOU ALL FOR YOUR COOPERATION

Appendix 3: Conversion factors for Tropical Livestock Units (TLU)

Source: ILCA (1990)

Livestock categories	**Conversion factor**
Cattle	0.7
Donkey	0.5
Pig	0.3
Goat	0.1
Sheep	0.1
Chicken	0.01
Duck	0.01