LIVESTOCK RELATED FACTORS AND FARMERS’ CHOICE OF MAIZE CULTIVARS IN TANZANIA

BY

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ABSTRACT

Research was undertaken to determine livestock related factors that influence smallholder farmers' choice of maize cultivars in Hai and Moshi rural Districts. The study employed On-farm mother-baby trial, informal and formal interviews. A total of 150 farm households - both participants and non-participant in mother baby trials were interviewed using structured questionnaire. 17 mother- baby trial participants were purposively selected based on their willingness to participate, access to irrigation water and ability to allocate land for the trial. The mother trial in each site consisted of 12 different improved maize varieties: SITUKA1; KILIMA ST; PAN67; SC627; SC 403; LONGE 6H; LISHE H1; LISHE H2; LISHEK1; SITUKA M1; PAN 6549 and DK8031. Non-participants were randomly selected from village list of farm households. Data were collected in three stages: (i) Agronomic data recording (ii) field farmers' assessment and focus group discussions (iii) face to face structured interview. Data analysis focused on agronomic performance, descriptive statistics, multinomial logit and logit regression methods. Agronomic results indicated no significant differences for grain yield, biomass yield, plant height, and ears per plant for all the varieties in all locations. However, SC 627 revealed a slightly better performance in terms of grain and biomass yields, suggesting high potential for both food and livestock feed. The most important criteria among farmers in selecting maize varieties were yield, drought tolerance, early maturity, pest resistance, marketability, stover biomass and milling quality. Econometric analyses results indicated that attributes for grain characteristics, education level, livestock number owned, farm size and market related aspects are important variables in influencing maize cultivars choice by farmers. The study concluded that PAN 67 and DK 8031 were likely to be chosen for household food while SC627 and LISHE H1 were likely to be selected for marketing (for commercialized households) and livestock feed. The most important attributes considered by farmers for selection of maize varieties were drought tolerance, disease resistance, early maturity and milling quality. The study recommends maize breeders incorporate attributes which are valued most by farmers in the crop-livestock farming system.

DECLARATION

I SONDA, GEORGE declare that this dissertation, entitled “Livestock related factors and farmers’ choice of maize cultivars in Tanzania” is a result of my own work and that it has not been submitted either wholly or in part to this or any other university, for the award of any degree.

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The above declaration is confirmed by

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(Supervisor)

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DEDICATION

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LIST OF ABBREVIATIONS AND SYMBOLS

CIMMYT	= International Maize and Wheat Improvement Center
CV	= Coefficient of Variation
DAP	= Diammonium phosphate
EPP	= Ear per plant
FAO	= Food and Agriculture of the United Nations
FGD	= Focus Group Discussions
FMFI	= Farmer Managed Farmer Implemented
FYM	= Farm Yard Manure
GDP	= Gross Domestic Product
GoT	= Government of Tanzania
GTZ	= Germany Agency for Technical cooperation
HH	= Household
HYV	= High Yielding Variety
Kg	= Kilogram
LSD	= Least Significant Difference
LU	= Livestock Unit
MAX	= Maximum
MIN	= Minimum
MNL	= Multinomial Logit
N	= Nitrogen
NGO	= Non Governmental Organization
NMRP	= National Maize Research Programme
OLS	= Ordinary Least Square
OPV	= Open Pollinated Variety

PAME	= Participatory Assessment Monitoring and Evaluation
PAR	= Participatory Action Research
PIP	= Participatory Integrated Policy
PPB	= Participatory Plant Breeding
PR	= Participatory Research
PRA	= Participatory Rural Appraisal
PVS	= Participatory Variety Selection
RMRI	= Researcher Managed Researcher Implemented
RRA	= Rapid Rural Appraisal
SPSS	= Statistical package for social scientists
Std	= Standard Deviation
TShs	= Tanzania Shillings (Currency)
URT	= United Republic of Tanzania

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Maize is an important food staple in Tanzania (Doss *et al*. 2003). Approximately, 46% of the total maize grain output in Tanzania is contributed by the production from Southern Highlands, 17% from Lake Zone and 11% from Northern Zone (Limbu, 2000). Increased use of improved maize varieties in production has been in the public eye for a long time. The initiation of the National Maize Research Program (NMRP) as a means of coordinating maize research in Tanzania, way back in the 1970s though maize research started in 1960s is an early example of closer attention of food security and livelihood improvement in practice. Some years later many improved open pollinated (OPV) and hybrid maize varieties were released and are still widely used by farmers (Nkonya *et al.* 1997; Doss *et al.* 2003).

Studies by (Nkonya *et al.* 1998; Limbu 2000) show that maize farmers in Tanzania grow both local and improved varieties. Identification of pure varieties is difficult due to individual producer choice and recycling behavior. Several scholars (Byerlee and Eicher 1997; Nkonya *et al.* 1997, 1998; Thorne *et al.* 2002; Doss *et al*. 2003, 2006) cite Eastern Africa –Tanzania is no exception as an area of low adoption rates of improved technologies and that traditional maize varieties are still common in Tanzania.

Similarly, Heisey and Mwangi (1993) have argued that the importance of factors affecting technology uptake and/or choice differs between locations. Cash limitations, lack of awareness of the technology or its benefits are some of the barriers to technology uptake (Nkonya *et al.* 1997; Doss *et al.* 2003; Doss, 2006). Thorne *et al*. (2002) observed that farmers rejected short stemmed maize varieties in the past because it could not provide fodder for livestock and that where benefits are realizable uptake of the technology has been good. Other findings (Nkonya *et al.* 1997, 1998; Doss *et al.* 2003) have reported that many technologies- especially on maize varieties have not been adopted. This has raised concerns that have necessitated continued development of new varieties with perceived benefits by farmers to enhance uptake.

Nevertheless, it is evident that over the years, productivity of maize like other food crops and livestock (an integral part of agriculture in Tanzania) has not been encouraging. The yield of maize has remained constant at 1.25 tonnes per hectare below the recommended average rate of 2.25 tonnes per hectare for the past 10 years (Myaka *et al.* 2003; URT, 2006 b). In the wet season milk production reach up to 4 405 109 litres per day and during dry season as a result of poor or lack of feed decreases to 2 455 408 litres per day (about 56% of the production of the wet season) (URT, 2006a).

The macro economic trade and sector analysis trend for livestock have shown that demand for meat and milk has almost doubled over the past two decades in the East Africa region (Delgado, 1999). For example, milk consumption increased from 1.5 million metric tonnes in 1975 to 3.2 million metric tonnes in 1995, while meat consumption rose from 0.5 million metric tonnes to 0.9 million metric tonnes in the same period (Delgado, 1999). A similar trend has been observed in Tanzania where milk consumption rose from 664 600 metric tonnes in 2000 to 777 000 metric tonnes in 2002 and that of meat from 334 100 metric tonnes to 361 400 metric tonnes in the same period (URT, 2005).

However, in spite of the growing demand for milk and meat in the region and in Tanzania particularly, livestock productivity is constrained by feed and fodder shortages (Thorne *et al.* 2002; Myaka *et al.* 2003; Romney *et al.* 2003).

In Tanzania, pastoralist management systems are also coming under increasing pressure from competition for land from crop-based sedentary agriculture and human population growth (URT, 2006c) leading to food and feed shortages, as a result demand for alternatives such as food-feed crops –maize is one example has increased (Mduruma and Blummel, 2004). Focusing on the attributes of a range of maize varieties preferred by farmers in the crop-livestock production system is likely to generate useful information to plant breeders, seed input dealers and policy makers about why one variety is preferred than another.

Therefore, targeting maize improvement to better meet the needs of crop-livestock producers through the development of new varieties that have desirable food and fodder characteristics is likely to reduce the current food-feed constraints.

1.1.1 Maize as food and feed in Tanzania

In Tanzania, maize is the most important cereal crop grown for human food. In some areas, where feed resources are scarce, maize stover (the non-grain portion of the maize plant) is used as livestock feed. The annual per capita consumption of maize for Tanzania is 112.5 kg and contributes about 60% of dietary calories for human food (URT, 1996, 2006 b).

Participatory rural appraisal studies have also shown increasing demand for the use of maize stover as livestock feed (Thorne *et al.,* 2002; Lyimo *et al.* 2006) and about 4 million tonnes of maize stover and maize cobs are produced annually (Urio and Kategile, 1987). Maize products and byproducts are estimated to provide about 30% of annual feed resources for livestock in Tanzania (Shirima 1994), cited by Thorne *et al.* (2002). In 1981, maize was considered the leading crop in providing crop residues that could be utilized as a livestock feed (Urio and Kategile, 1987). The importance of dry maize stover in the diet of livestock in the farming system where feed resources are scarce, is approximately 40% where as green stover is used only after thinning, leaf stripping, chopping plant tops or the entire green plants after immature cob has been removed for roasting (Lyimo *et al.* 2006). Maize bran is used primarily to supplement forage based rations and only 5% of maize grain is used in commercially produced non ruminant feeds (Thorne *et al.* 2002).

1.1.2 Problem statement and justification

Reduced land areas under common grazing coupled with increasing human population has resulted into diminishing food and fodder supply from this source in Tanzania and Eastern Africa at large (URT, 2006 c; Thorne *et al.* 2002). Demand for food- feed crops is thus increasing to cope with the existing situation (Mduruma and Blummel, 2004).

In Tanzania, particularly in the Northern Zone regions of Arusha, Manyara and Kilimanjaro, smallholder farmers are using maize stover as the source of feed for livestock after grain harvesting (Lyimo *et al*. 2006). However, it is not known which factors influence cultivars choice in the crop-livestock farming system. Also, it is not known what cultivar attributes have greater importance to farmers. Until now, maize improvement in Tanzania has focused on increasing grain yield (Moshi *et al*. 1997; Tolera *et al*. 1999), nutritive values and suitability of crop residues as livestock feed (Luoga and Urio, 1985; Urio and Kategile, 1987; Tolera *et al.* 1999; Thorne *et al*. 2002) with little attention on other aspects such as producer choice preference or behavior in the overall context of the multiple roles maize can play in the broader agro pastoral systems. Adoption rates has remained low 6% and 12 % for hybrid and improved maize varieties respectively (Doss *et al.* 2003; Myaka *et al.* 2003; Nkonya *et al.* 1997). The low rate of adoption is one of the indications of dissatisfaction of utility farmers realized from these varieties.

This present study investigates the factors which influence choice of maize cultivars in a crop-livestock farming system using a preference based approach. The study will provide an input to maize breeders to be able to develop preferred maize cultivars that satisfies the needs of smallholder farmers under crop-livestock farming systems. It is also important for seed input dealers, to understand the demand for the preferred maize varieties before stocking maize seeds for distribution. Further, the study is necessary to provide an understanding of farm level, institutional and policy bottlenecks to technology uptake.

1.2 Objectives of the Study

1.2.1 Overall objective

The overall objective of this study was to determine factors that influence smallholder farmers' choice of maize cultivars in a crop-livestock farming system.

1.2.2 Specific objectives

1. To examine the socio-economic characteristics of crop and livestock producers in Hai and Moshi rural Districts, Northern Tanzania.
2. To identify non-monetary and monetary factors that influence smallholder farmers choice of maize cultivars in crop- livestock farming system
3. To determine farmer preferred or valued attribute(s) of maize cultivars in the crop –livestock farming system

1.3 Hypotheses

i. $H_0 =$ There are no significant differences of socio economic characteristics among farmers in the two districts under study.

ii. $H_0 =$ Number of livestock owned and presence of fodder traits as well as sales of crop (grain and stover) do not influence farmers choices of maize cultivars

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Review of Agricultural Technologies Consumer Choice studies

A growing body of literature (Nkonya *et al.* 1997, 1998; Kaliba *et al.* 2000; Thorne *et al.* 2002; Doss *et al.* 2003, 2006) exists on the topics related to technology preferences and/or adoption. Many producer technology adoption studies are related to individual farmer choices as influenced by factors that can be categorized into: farm and farmer's characteristics; technology characteristics and farming objectives (Adesina *et al*. 1992; Misra *et al.* 1993). The need to account for the preferences and choice of consumers (smallholder farmers) in crop improvement research has adequately been documented using the classical adoption approaches. Whilst the approaches to modeling adoption tend to assume separability between household production and consumption decisions (Feder and Umali, 1993). In this study, choice decisions are modeled as composed of an extensive margin decision about the set of more than two available maize cultivars, accounting for the commodity characteristics- both uniquely and in relation to available alternatives in a crop-livestock farming system context.

Economists (Smale *et al.* 1994; Adesina and Baidu-Forson, 1995; Baidu-Forson *et al.* 1997; Hintze *et al.* 2003; Edmeades *et al.* 2004, 2007; Mafuru, 2007) investigating consumers demand have also accumulated considerable evidence showing that consumers generally have subjective perception for characteristics of products and their demand for products is significantly affected by their perceptions of product attributes. For example, Mafuru (2007) using logistic regression model in studying consumer perception of sorghum variety attribute in Tanzania, found that colour and taste of sorghum *ugali* were very important criteria to evaluate the quality of *ugali*. De Groote and Kimenju (2007) using semi double bound logistic model in their study on consumer preferences for colour and nutritional quality maize in Kenya identified that consumer preferences are influenced by socio economic and cultural background –particularly income, education, gender and ethnic group. Similarly, Baidu-Forson *et al*. (1997) using the choice probability model of ordered probit to evaluate adoption decisions of farmers on modern ground nut varieties in Niger identified leaf spot resistance, improved pod yields and short crop cycle as important attributes in influencing adoption where as grain colour was not important.

In an extensive case study by Nkonya *et al*. (1997) conducted in Northern Tanzania to identify factors affecting adoption of improved maize seeds and fertilisers revealed that traditional technology is still common, perhaps because of cash limitation, and that maize grain yield variability did not matter in influencing maize seed adoption decision.

Benin *et al.* (2004) examined the factors affecting the diversity of cereal crops on farms where they concluded that adoption of modern maize varieties had no impact on the diversity in maize varieties grown on household. As a matter of fact, consumers of technology (farmers) behave in a way such that are not willing to give up a commodity chosen as a result of enough information and long term experience hence suggesting that modern varieties just add attributes that augment the set found in farmers varieties rather than replacing them. A similar argument by Doss (2006) is that farmers do not simply decide whether or not to permanently prefer and adopt an improved variety, but instead they make a series of decisions: whether or not to try planting an improved variety, how much land to allocate to the improved variety, whether or not to continue to grow it, and whether to try a different improved variety. It is appreciated that adoption decision behaviour differs across socio economic groups and over time (Feder *et al*. 1985; Heisey and Mwngi, 1993). Consistent with this fact, Michelle and Meinzen-Dick (2002) have emphasized the importance of livelihood strategies especially asset base and both perceived and actual vulnerability context in shaping people's choice. Other scholars, Lyangyintuo and Mungoma (2005) have established empirical evidence suggesting non linear relationship between wealth and choice decisions of agricultural technologies. Households on lower wealth behave differently from those of higher level.

While Adesina and Zinnah (1992) describe the consumer behaviour that perceptions of technology specific characteristics significantly condition technology uptake decision. The common conclusion to all these case studies center on consumer choice behaviour. It is acknowledged that individuals who are rational behave such that they maximize utility. The decision made is driven by the intrinsic analysis/or pay off analysis of a complete list of goods based on relevant information as, when, where and under what circumstances the goods would become available (Varian, 1999). These case studies therefore serve as the starting point to understand the livestock related factors on farmers' choice of maize cultivars.

This review have identified that most studies on adoption and/or consumer choices (Adesina *et al.* 1995; Baidu-Forson, 1997; Peng *et al.* 2005; De Groote and Kimenju, 2007; Mafuru, 2007) have applied dichotomous models which assumes a discrete choice response of yes or no, rather than the multiple choice scenario. In essence consumers are not bounded or restricted when making choice. Indeed they strive to seek for other alternative that they can afford to maximize utility when they respond in the factors of choices subject to constraint under varying circumstances (Varian, 1999; Nicholson, 2002). The deficiency of empirical economic studies on this area of consumer choice justified further investigation using a combination of new approach. The new approach include participatory on farm research in addition to both dichotomous and an extension of the dichotomous choice model (multiple choice econometric models)

The multiple choice models are distinct from the dichotomous (0 or 1) choice models in that for multiple choice problems there is a single decision among three or more alternatives (Greene, 1993; Maddala, 1983; Grifths *et al.* 1993).

Participatory on-farm trials are also usually regarded as central to participatory research. According to Morton *et al.* (2002) the importance and aim of farmer participatory research at technological level is to understand the main characteristics and dynamics of the farming experiences derived from indigenous knowledge and formal science. Franzel and Coe (2002) also note the importance of participatory on farm trials that it can generate information from many different environments at low cost.

Sthapit *et al.* (2002) describe participatory research in the context of participatory plant breeding (PPB) that it involves three essential components: (i) one parent is locally adapted cultivars (ii) selection is decentralized in the target environment and (iii) farmer participate in the plant breeding process.

2.2 Methodological Approaches to Consumer Choice studies

2.2.1 Choice models

In analysing choice problems that consumer faces, three types of probabilistic models: (i) linear probabilistic model (ii) probit model and (iii) logit model have commonly been used in the literature (Maddala, 1983; Greene, 1993; Griffths *et al*. 1993; Ichino, 2003). In situation where the number of choices is limited to two values, the linear probabilistic, probit and logit models are used (Griffths *et al*. 1993; Ichino, 2003). However, the linear probabilistic model has the disadvantage that the estimated probability value of prediction can fall outside the interval 0-1, this may not produce true probabilities (Maddala, 1983; Griffths *et al*. 1993; Ichino, 2003; Ndunguru, 2007) . To avoid the problem of out- of- range probabilities in the linear probabilistic model, non-linear probabilistic- logit and probit models which fall between the 0-1 intervals are used for at least two reasons. First probit and logit models transform the distribution of the attribute variables **x** into a probability density function that guarantee non- violation of 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; Griffths *et al*. 1993; Ichino, 2003; Ndunguru, 2007).

Probit and logit model are linear in the latent (unobservable) variable $y*$, hence generally defined as:

$y^* = \beta x + u_i$ ……………………………………………………………………..1

Where;

x is a vector of explanatory variables,

u_i = random error, β is the coefficient of x.

y^* is unobservable, latent variable.

Empirically, we observe a dummy variable D =1 $\forall$ $y^* > 0$, and D = 0 for $\forall$ $y^* < 0$.

To capture the choice of the decision maker confronted with more than two alternatives as in this case of multi-maize varieties, a combination of both binary logistic and multiple choice models are used.

The motivation behind the use of binary logistic choice model is that it can assess the impact of each choice alternative made, explicitly accounting for specific variety characteristics on whether a farmer choose or does not choose a variety. The multiple choice model is also able to measure the probability that the decision maker will choose each alternative. A commonly used multiple choice model is the multinomial logit (MNL) which is an extension of the binary logit model. In the MNL, the probability associated with the i^{th} individual choice of the j^{th} option is assumed to follow an underlying logistic distribution (the mathematical formulation for MNL and Logit models are presented in the proceeding methodology section 3.2.7).

Both the multinomial logit and logit models have been widely used to examine the characteristics associated with adoption and/or choice problems. For example, Mafuru (2007) used logit regression to study consumer preference of *ugali* prepared from sorghum varieties. Caffey and Kazmierezak (1994) used MNL to examine the characteristics associated with the adoption behaviour in the Louisiana Aquaculture system. Hintze *et al.* (2003) also employed a combination of logit and MNL to study variety characteristics and maize adoption in Honduras. Both of these studies were successful in explaining individuals' choice and/or adoption.

Given that little is known about the relationship between producers (crop-livestock farmers) and the choice behavior of maize cultivars, a combination of two sets of econometric analyses models (logit and MNL models) and participatory approach is preferred in this study.

The subsequent section presents reviews of participatory approaches used by many other scholars.

2.2.2 Participatory approaches

2.2.2.1 Meaning of participation

Participation, as an approach to development, began in the first instance, as an approach intended to subvert development orthodoxy (Chambers, 1994). This and later developments of participation, were the logical direction to take with respect to so many failed, wasted and damaging top-down projects and programmes.

Similarly, other institutions define participation in a broader context. For example GTZ understands participation as a process which concerns the relationships between different stakeholders in a community, policy level and service delivering institutions (Lema and Kapange, 2004).

Participation became known as being synonymous with democracy, equity and popular success. Participation has now been wholly taken on board by a number of both political and technology development institutions. Participation lends a completely different perspective to the traditional development approach. It is a challenge and an affront to traditional, top down, bureaucracy-led development. It is evident that for projects or programmes to be sustainable, the beneficiaries must assume not only more control but full control (Campbell and Sallagram, 2000; Neiland *et al.* 2005).

2.2.2.2 Typology of participatory approaches

The literature surrounding participation in both research and development contain a wide diversity of approaches and of methods. These move away from the transfer of technology approaches of the past, towards approaches which focus on the generation of knowledge and innovation of technologies through collaborative approaches. In the agricultural sector these have been referred to as 'farmer first' approaches (Chambers, 1989). The following are some examples of participatory approaches as adopted from Campbell and Salagrama (2000).

Participatory Action Research (PAR), under this the social group is helped to formulate a critical analysis of its own situation: its problems, weaknesses, needs, strengths, and resources. By identifying and consolidating the knowledge and skills which they already possess, poor women and men can use these as tools for their own empowerment. Historically, PAR reflects a much more stand-alone approach to participation, building on the capacities of the disempowered to make their own changes.

Rapid Rural Appraisal (RRA) is not a participatory approach; however, it did provide the foundation for many of the methods used in participatory approaches. RRA enables outsiders to understand rural conditions quickly. It combines methods from various disciplines to yield relevant data. The key principles in RRA are that it is a progressive and rapid learning process where triangulation (cross-checking data by multiple methods) is often used to quickly validate or refute findings, and it is a multidisciplinary learning process where a range of disciplines, local informants, and knowledge are brought together. RRA methods have been mainly applied in agricultural development (Kirway *et al.* 2003).

Participatory Rural Appraisal (PRA) grew out of RRA but the community members are much more actively involved in the generation and analysis of information. PRA is generally a continuing participatory process, unlike RRA which is more a one-off process. PRA supports the direct participation of communities, with rural people themselves becoming the main investigators and analysts. Rural people set the priorities, determine needs, select and train community workers, collect, document, analyze data, plan and implement solutions based on their findings. Actions stemming from this research tend to serve the local community. Outsiders are there to facilitate the process but do not direct it. PRA has been adapted with many scholars (e.g. Loader and Amartya, 1999) to extend the research method base in rice variety choice; for incorporation into the analysis of agricultural technologies (Coe, 2002; De Groote *et al.* 2002; Rutto *et al.* 2006).

Participatory Assessment, Monitoring and Evaluation (PAME) is an approach which is based on the premise that beneficiaries of interventions monitor and evaluate these interventions *de facto* either by adopting changes or discontinuing them as soon as external inputs are withdrawn. This is people-led and gender is explicitly incorporated as a perspective on development. IDS (1998) and Ezemenari *et al.* (1999) also add that PAME require involvement of all project/programme actors including implementers, policy makers and beneficiary to decide together in how progress or success should be measured.

Participatory and Integrated Policy (PIP) this was developed within the fisheries sector from recognition that different policy objectives can conflict and that taking a sectoral approach to policy formulation and implementation has the inherent flaw of increasing this potential for conflict. It is also acknowledged that those whose lives are going to be affected by policy processes should be involved in those processes and be linked to national policy frameworks. PIP aims to involve all key stakeholders in the policy process and to integrate these processes across sector and between administrative levels from the community, through local and national, to the international level.

Participatory Research (PR) is an approach to research which aims to involve community members in the research process to varying degrees. In many instances the community acts as an agent of the external researcher or may collaborate in some aspects of the research such as data collection or analysis.

A more developed view of PR is where the community has control of the research process. There are close links between PR and indigenous knowledge. Several studies (Chambers, 1994; Morton *et al.* 2002; Neiland *et al.* 2005) have described the importance of PR towards overcoming the previously failed projects or programmes which did not involve participation of stakeholders.

In the following discussion, the PR, more specifically the mother baby approach is discussed.

2.3 Mother- Baby Concept

Mother –Baby concept is one of the participatory research (PR) approach involving an on farm trial establishment and management with farmers. It is a way of evaluating new technologies in the fields by exposing such technology to farmers and provides a means for farmers to participate in technology selection.

It is a novel trial design method that was developed by Agronomist of a regional soil fertility network in Southern Africa and adopted to enhance farmer participatory involvement in conventional on-farm research. The method allows farmers and researchers to test the best bet technologies or new cultivars (De Meyer and Bänziger, 1999; Kwazira, 2006). Snapp (2002) also adds on the goal of mother-baby trial approach that is to facilitate communication across different approaches to experimentation and information flow among the partners.

The mother baby design as described by De Meyer and Bänziger (1999) consists of two types of trials: (i) Researcher managed mother trial: A trial design replicated within-site to test under researcher management a range of technologies and research hypotheses. This trial is either located on a research station or on-farm, e.g., at a central location in the village. (ii) Farmer managed baby trial: A number of satellite trials, where each trial is one replicate, using large plots under farmer management and farm resources. Each trial compares one to four technologies (usually a subset of those tested in the mother trial, where the sub-set to test can be chosen by the farmer or researcher) with farmers' technologies or cropping systems. Researchers indicate recommended management for technologies, and then monitor actual farmer practice and document farmer perceptions and preferences or choice.

Researchers test complex questions at a central mother trial (such as variety response to inputs) while farmers gain experience with a subset of technologies and their perceptions are systematically monitored in a rigorous, planned process, right along with biological performance of the technologies. Farmer participation in the design of baby trials can vary from limited to high, depending on the objectives of the research.

This linked process of mother/baby trials provides quantitative feedback to researchers, improving the design of future technologies. For maize cultivars evaluation farmers are exposed with different 12 maize varieties in the Mother trial and 4 varieties in the baby trials (a sub set of those in the mother trial) to evaluate their choices as influenced by livestock related factors particularly fodder (maize stover) and other factors as perceived beneficial in the crop-livestock system.

The approach increases the rigor of the experimental assessment process, as researchers have confidence that the survey and rating data on farmer preferences is based on real life experience with the technologies. (e.g. better definition of variety or cropping system niches that need filling).This also creates opportunities for communication and interaction between all stakeholders represented by farmers, researchers /breeders, extension services and seed companies.

2.3.1 Current studies applied mother-baby trial concept

Mother Baby trials have widely been used in Sub Saharan Africa particularly in Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Zambia, Zimbabwe, Ethiopia and Tanzania for over five years and are now recognized as an essential component of variety evaluation and promotion.

Abebe *et al.* (2005) used mother and baby trial methodology in the context of participatory selection of drought tolerant maize varieties in Ethiopia. The study concluded that farmer's preferences in some cases coincide with breeders' selection.

Similarly, De Groote *et al.* (2002) employed participatory breeding approach in identifying farmers' preferences for new maize varieties in Eastern Africa. Using numbers of techniques (participatory methods in maize breeding), which included classical on station breeding trials, mother and baby trials, farmer evaluation and PRA. The study was able to identify poor correlation between farmers and breeders evaluations, because the main classical breeding tool-the breeder's index did not seem to represent farmers' preferences.

In Malawi (Chamango, 2001) used farmer participatory approach by employing mother baby on farm trials with legumes for soil fertility improvement, led to the identification of potential legumes intensification best bet system that smallholder farmers could adopt for their maize production. The best bet was developed using field days and Focus Group Discussions (FGDs) conducted with farmers to rank the technologies tested in the mother baby trials. Similarly, (Mwale *et al.* 2006) evaluated drought and low Nitrogen tolerant maize varieties with farmers in Lilongwe. Other studies used similar approaches include those of (Hlophe, 2006) in Swaziland to evaluate maize varieties (hybrid and open pollinated varieties) for yield potentials and farmers preferences; Matowo *et al.* (2006) to evaluate tolerance of maize to drought and low N stress in Tanzania under farmers' conditions and preference. Atlin *et al.* (2002) studied sources of variations in participatory variety selection trial (PVS) with rain fed rice using mother-baby model. The results concluded that participatory PVS trials produce repeatable estimates of rain fed rice cultivar means. The repeatability of grain yield estimates from farmer managed trial was not markedly lower than for on station trials.

All these studies applied the classical PRA methodology to assess preferences from farmers involved in the trial. The method seemed to be successful in highlighting farmers' preferences and criteria used in prioritizing technologies or important traits to them.

However, the use of PRA approach in assessing farmers' preferences for technologies or cultivars traits in a group discussion is a crude method and may impose problems on reaching consensus where there is not necessarily agreement among farmers since there may be high variations in preference score because farmers choose for different reasons and have different socio- economic background.

On the other hand the PRA method is also weak in explaining the relative balance (trade offs) between the technology or traits and other factors influencing choices in the overall farming system perspective. Coe (2002) argues that analysis of data from participatory trial can and should use a combination of exploratory/descriptive methods and formal statistical modeling.

In the next chapter, study methodology specifically, on farm trial and field farmer evaluation (participatory approaches) are presented, as well as the theoretical and empirical estimation models are developed.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Areas

The study was undertaken from two districts in Kilimanjaro region. The two districts are Moshi rural and Hai which are agro ecologically distinct. Two villages from each District were selected to represent the study areas. Location of the study villages are shown in Figure 1 below.

3.1.1 Moshi rural district

Moshi rural district is one of the six Districts in Kilimanjaro region. It is situated in North Eastern Tanzania bordering Kenya to the North, Hai District to the West, Mwanga District and Arusha region to the South and Rombo District to the East. It lies between latitude 2 3^{o} - 3^{o} 50 E and longitude 37^{o} - 38^{o} 5 at an altitude of 762-5 895 meters above sea level (asl). It covers an area of 1 713 square kilometers.

Agro ecologically, the District is divided into four Zones namely: Mountain Zone with 1 830-5 895m asl and more than 2 000 mm of rainfall per year; Upper zone having 1 525-1 829m asl with between 1 200-2 000 mm of rainfall per year; Middle zone 915-1 525m asl with 900-1 200 mm rainfall per year; Lower zone 762-914 elevation with 400-900 mm rainfall per year.

The major crops grown include coffee, sunflower, maize, banana, paddy, beans, sorghum millet and groundnut. The average yield of maize is approximately 2.5 tonnes per hectare. The major livestock are the local cattle, goat, sheep and chicken.

The lower zone is important for animal feed supply especially to the middle and upper zones. Feed is supplied in the form of natural pastures or crop residuals which are cut and transported. The District is also connected to the tarmac, gravel and earth roads network. Other infrastructures include irrigation schemes, agro processing plants, warehouses market services for various commodities or agricultural input suppliers.

3.1.2 Hai district

Hai District is one of the six Districts in Kilimanjaro Region. It is located on the slopes of Mount Kilimanjaro in the Northeast Tanzania. The District has a total area of 2 169 square kilometers, out of which 1 000 square kilometers is used for crop production, 570 square kilometers for grazing livestock, 310 forest reserve and 289 square kilometers is occupied by water and rocks. The District is divided into 3 main agro ecological zones namely: lowland; midland and highland zones. The District has a bimodal type of rainfall with annual amount ranging from 350-2 000 mm. Long rains normally occur in March to June, where as short rains start in late September and lasts from end of December.

The major crops grown include maize, beans, vegetables, banana and coffee in the midland zone. Livestock include, goats, sheep, pigs, chicken, indigenous cattle and improved dairy cattle. Animals are fed with banana leaves and crop residues from maize and beans and, in the low land zone, cattle are grazed in the communal grazing land by the Maasai who practice extensive livestock keeping adopting transhumance pastoral pattern. The District is also connected to the tarmac and gravel roads network covering 539.7 kilometers. Other infrastructures in the District include electricity services, warehouses, and water schemes for irrigation services, market services, agro processors, mobile phone networks and agricultural input suppliers.

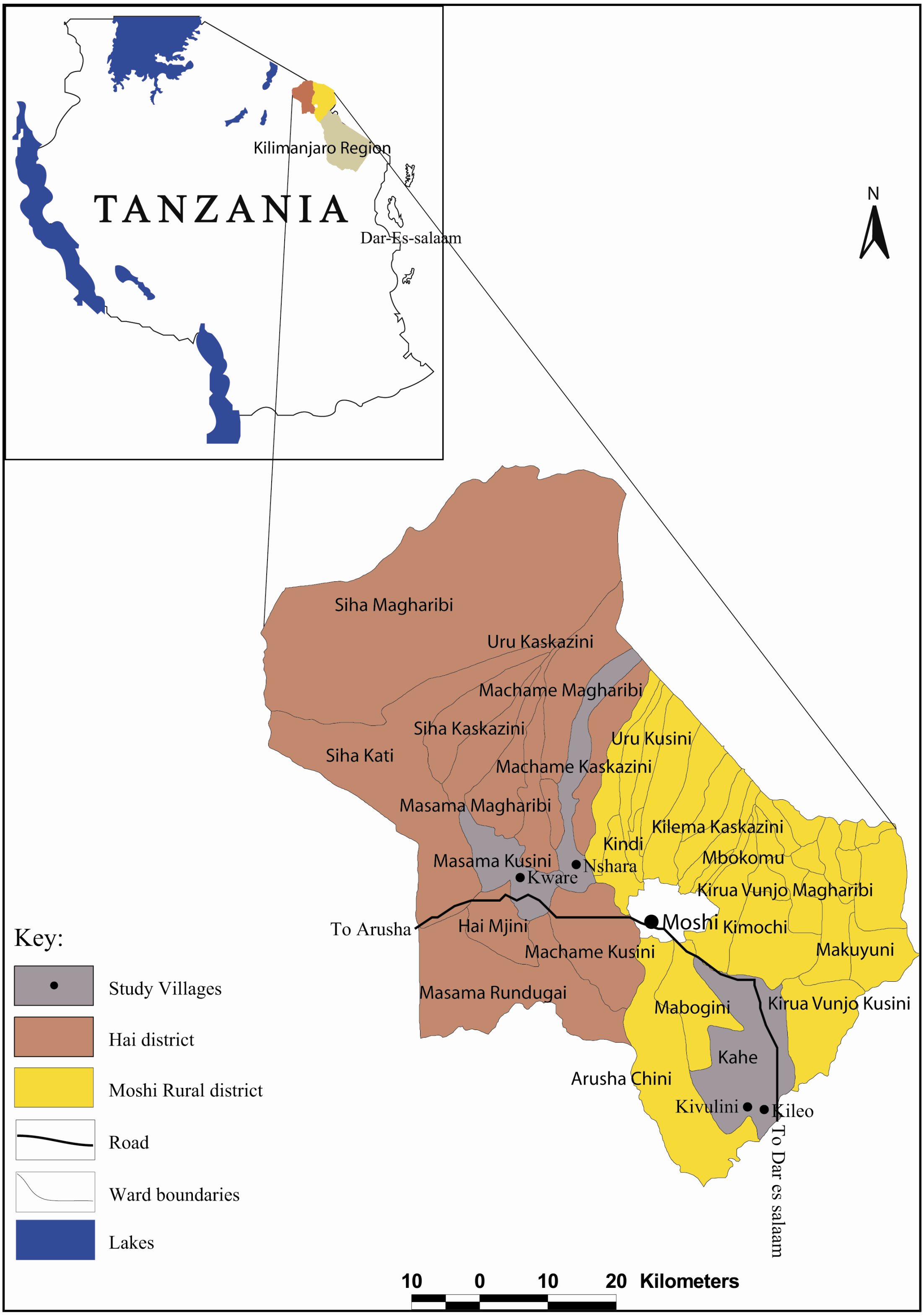

Figure 1: Map showing location of study villages

3.2 Research Approach

The research was designed such that data were collected in three stages. i) on-farm trials, ii) farmer field evaluation of the trials, iii) formal structured survey

3.2.1 On-farm trial

The study employed mother-baby experimental design. Experimental data was recorded from on farm mother trial using a prepared data sheet. Material and method for mother trial design is presented in Appendix 1.

A total sample of 17 farm households (3 for mother trials and 14 for baby trials management) were purposively selected for experimentation. The selection was based on the farmers' willingness to participate, possession of enough land and ability to conduct trial as well as accessibility of water for irrigation during short rains season.

3.2.2 Farmers' field evaluation

The second stage involved farmers' field assessment and focus group discussions (FGDs) using checklist (Appendix.3). Farmer field evaluation was conducted for the maize varieties established in the mother trials. The objective was to document farmers' maize variety selection criteria and preferences. Focus group discussions were conducted to capture farmers' perception on the multiple roles of maize in a crop-livestock farming context. A sample of 50 farmers (17 from Kware, 17 Nshara, and 16 Kivulini sites where mother trial established)- most of them having participated on the baby trial management during the season and representative to the area were invited to participate in the farmers' field evaluations and FGDs. Farmers used absolute ranking, pair wise and matrix ranking technique to give the general evaluation score of the varieties preferences basing on their criteria (the evaluation scores are presented in appendices 7, 8 and 9 respectively). The criteria were ranked and top ones were used. Each criterion was scored on a scale of 1 to 5 (1= not important/or very poor, 2 = poor, 3 = average, 4 = good, 5 = very important/very good) for each variety. The evaluation was conducted at harvest time assisted by research and extension staff.

3.2.3 Formal survey

The third stage involved formal cross sectional survey using a structured questionnaire (Appendix.2). The survey was conducted during the 2007/08 short rains growing season from crop -livestock farm households. The sample domain was selected to represent crop- livestock farmers in Hai and Moshi rural districts drawn from two villages in each District. Initially 60 farm households selected proportionately per village to make a total sample of 240 households was considered. However, two criteria were considered important before interview exercise was conducted in each village. First, was willingness of the respondent to be interviewed. Second, typical representative farmers in the crop and livestock production system. Based on these criteria thus the total sample of farmers who were willing for the survey remained 150 households for interview.

The total sample of 150 farm households (64 from Kware, 40, Nshara, 24, Kivulini and 22 Kileo) were interviewed using structured questionnaire. The 150 sampled farmers included 17 farmers that participated in mother –baby on farm trials. The 133 farmers (Non-participants in the mother baby trials) were randomly sampled using ballot papers drawn from a village list of farm households.

3.2.4 Sampling frame

The research focused on small holder farmers in a crop-livestock farming system as a unit of analysis. The target population was male headed and/or female headed farm households from all the two districts which are Hai and Moshi rural in Kilimanjaro region.

3.2.5 Sampling procedure and sample size

A multi stage area sampling technique was used where by two Districts namely Hai and Moshi rural which are agro ecologically distinct were purposively selected as the first stage.

From each district two villages were also purposively sampled as the second stage. The selection criteria for both districts and villages were based on high livestock density and the importance of maize crop for food or cash, importance of crop residues particularly maize stover for livestock feed and the availability of irrigation water during short rains season.

The third-final stage delt with choosing sample households. In the case of mother and baby trial, participants were purposively selected. Non-participants in the mother baby trials- 133 were randomly sampled using simple random sampling technique by applying ballot papers drawn from a population in each village under study. The entire sample population was assigned numbers which were then drawn to select the respondent from each village list of farm households identified at village government offices.

3.2.6 Data collection method

Information used in this study was derived mainly from primary data sources collected from on farm mother trials and farm households' survey. Data were collected in three stages: (i) mother trial data were recorded at an interval of every month from planting to harvesting using a prepared agronomic data sheet (Appendix 4) (ii) farmers assessment and focus group discussions collected information on farmers' preferences and perception of maize verities' importance in the crop-livestock context. Data were collected using checklists (Appendix 3) and (iii) information to help empirical analysis of factors influencing farmers' choice was collected through individual administered interview using a structured questionnaire containing both closed and open ended questions (Appendix 2). Detailed data types collected and data transformation to suit analysis is presented in Appendix 5.

3.2.7 Analytical framework

The conceptual approach to study the livestock related factors on farmers choice of maize cultivars is based on consumer preferences, which is centered in consumer theory. In consumer theory, demand functions are derived from considering a model of preference maximizing behavior coupled with underlying economic constraint and or decision making for the set of options that maximize utility (Varian, 1999; Nicholson, 2002; Dwivedi, 2004). The fact that individuals are considering more than one choice and keeping track of both the characteristics of individual and the characteristics of the different choice alternatives, this permits the analysis of farmer preferences using two separate sets of econometric analyses namely, multinomial logit (MNL) and logit models.

i) Multinomial logit model

Multinomial logit model allows for analysis of different individual characteristics confronted with multiple choices (Maddala, 1983; Greene, 1993). It estimates the probability of individual *i* choosing an activity *j* or particular maize variety in this case, given a set of explanatory variables.

The MNL is developed on the axiom of utility maximization. It assumes that if an individual makes choice *j* from a complete list of consumption bundle then, U*ij* is maximum among the *jth* option. The statistical model is driven by the probability that choice *j* is made. Based on the theory of consumer behavior, it is postulated that individual will choose a particular option (maize variety) that offers the greatest utility. An individual *i* faced with the decision to choose from among alternatives, the preference is constructed using utility function as formulated by Greene (1993);

$U_{ij} = \beta' z_i + \varepsilon_{ij}$ --2

Where;

U_{ij} is the utility that individual *ith derive* from choosing j^{th} option

z_i is a vector of individual characteristics

β is the parameter to be estimated and ε_{ij} is the error term.

The underlying assumption is that individual chooses option *j* if and only if the utility derived from it is greater than that for all other options.

The decision in making choice for option *j* with maximum utility for all other alternatives can be summarized as;

$$U_{ij} > U_{ik} = U_{ij}(z_{ij}) + \quad e_{ij} > U_{ik}(z_{ij}) + \varepsilon_{ik} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Rearanging equation (3) is formulated as ;

$$U_{ij}(z_{ij}) - U_{ik}(z_{ij}) > \varepsilon_{ik} - e_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

In a more general formulation, equation (4) can be expressed as;

$$U_{ij} = \beta_o + \beta_1 z_{1i} + ...\beta_n z_{ni} + e_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

In which case $z_{1i} \ldots\ldots z_{ni}$ are the transformation of the characteristics of individuals.

Equation (5) can be generalised as;

$$U_{ij} = z_{ij}\beta + e_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

This can be tranformed into an inequality reflecting the choice of individual *i* as;

$$\beta(z_{ij} - z_{ik}) > n_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

Where $n_i = \varepsilon_{ik} - e_{ij}$ from equation (2) above.

Assuming a normal distribution in n_i, the probability of choosing option j is represented by a cummulative normal probability density function. To simplify the econometric analysis in relation to the sample size, the study uses the logistic distribution function with linear logistic regression because of the well behaved statistical properties (Ndunguru, 2007).

It is postulated that if an individual *i* prefer *j* to *k* option and other alternatives in such this case of multiple choice, then the resulting probablity that individual will choose option *j* can be written as;

$$P_{ij} = \Pr(z_{ij}\beta + e_{ij} > z_{ik}\beta + \varepsilon_{ik}) \ldots\ldots 8$$

This probability can be given as the utility of the prefered option *j* weighted by the total utilty of the alternatives and therefore being represented as;

$$\text{Prob}\,(Y = j\,) = e^{\beta z_{ij}} \Big/ \sum_j e^{\beta z_{ij}} \ldots\ldots 9$$

Equation (9) is the multinomial logit model representing choice problem with multiple alternatives.

In its linear form for easy estimation, equation (9) is represented as;

$$P_{ij} = \beta_o + \beta_i Z_{ij} + \varepsilon_i \ldots\ldots 10$$

Where;

P_{ij} is the dependent variable given by individual's preference of the different maize variety chosen

Z_{ij} is the vector of explanatory variables

β_o is a constant term

β_i is a parameter to be estimated

ε_i is the error term

ii) Logit model

Since utility depends on the aspects specific to individual as well as to the choices (options) this motivate the use of logit model. Logit model allow to asses the impact (marginal effect) of variety characteristics on whether or not individual chooses a particular maize variety.

The fundamental assumption is based on utility maximization, U (M*ji*, A*ji*) (Griffiths, 1993; Lyangintuo and Mekuria, 2005) which ranks the preference of the *ith* individual for the *jth* variety (j=1). Thus the utility derived from the variety chosen depends on M, which is a vector of individual specific characteristics and A, which is a vector of the attributes associated with the variety.

Although the utility function is unobserved the relationship between utility derived from the *jth* variety is postulated to be a function of the vector of observed individual and variety specific characteristics and a disturbance term normally distributed. The mathematical representation is formalized as;

$$U_{ij} = \alpha_j F_i(M_i, A_i) + \varepsilon_{ji} \quad \text{...}11$$

Since the utilities U_{ij} are random, the *ith* individual will select the alternative *j*= 1 if $U_{1i} > U_{2i}$.

The probability that Yi = 1 is a function of independent variables defined by the following relationship;

$$P_i = \Pr(Y = 1) = \Pr(U_{1i} > U_{2i})$$

$$= \Pr[\alpha_i F_i (M_i, A_i) + \varepsilon_{1i} > \alpha_2 F_i (M_i, A_i) + \varepsilon_{2I}$$

$$= \Pr[\varepsilon_{1i} - \varepsilon_{2i} > F_i (M_i, A_i)(\alpha_2 - \alpha_1]$$

$$= \Pr(u_i > -F_i (M_i, A_i)\beta)$$

$$= F_i (X_i \beta) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 12$$

Where;

Pr is the probability function that an individual will choose a certain variety

Xi is the n x k matrix of explanatory variables

β is a k x 1 vector of parameters to be estimated

F (.) is the cumulative density function (distribution) of logistic random variable and is given by the following as formulated by Griffiths, (1993);

$$P_i = F(X_i \beta)$$

$$P_i = F(X_i \beta) = 1 \big/ 1 + e^{-x\beta} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 13$$

Equation (13) is the logit model representing the probability that an individual will either choose or do not choose a variety depending on the utilities attached.

The above logit probability model can be written as;

$$\log\left(p_i \big/ 1 - p_i \right) = \beta_o + \sum \beta_i X_{ji} + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 14$$

Where the dependent variable represents a log-odds ratio and is a linear function of the explanatory variables as defined above.

The linear specification of the logit model (equations 13 and/or 14) for empirical estimation is represented as;

$$P_i = Y_i = \beta_i X_i + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 15$$

Where;

$Y_i = 1$ is the probability that an individual chooses a variety, otherwise 0

X_i is a vector of explanatory variable

β_i are parameters to be estimated

ε_i is the error term

The parameters coefficients of both multinomial logit and logit models are not interpred in the same way as coefficients estimated using ordinary least square (OLS), they are odds ratio. The odds ratio is the exponential of the coefficient that explains the effects on odds rather than the probability. It is interpreted that for a one unit change in the independent variable , the odds are expected to change by a factor of exp β other things are equal. The exponential of a positive number is greater than one and of a negative is less than one. Thus if the exponential coefficient is greater than one implies increased odds of choosing j option and exponentioal coefficient between zero and one , odds decreases.

3.3 Empirical Model Specification and Data Processing

3.3.1 Descriptive data analysis

Basically, collected data were carefully cleaned to detect errors and omission and thereafter coded prior to data entry and analysis.

To address objective1 descriptive statistics (frequencies, means and cross tabulation) were used to describe the socio economic characteristics of producers. Hypothesis underlying this objective was subjected to non-parametric statistics (Chi-Square statistic) to test the significant differences between farmers' socio economic characteristics such as gender, livestock feeding management, use of farm income and non farm income for livestock management, institution support for crop and livestock management for the two study districts. Data were analysed using SPSS soft ware for windows version 12.

3.3.2 Empirical model specification for MNL and logit regression analyses

To estimate factors that influence cultivars choice and the relative importance of individual cultivars attributes preferred by farmers in the crop- livestock farming system (objectives 2 and 3) a multinomial logit and logit regression analyses were performed using STATA software for windows version 9.

Equation (10) for the MNL can be represented in its reduced form for empirical estimation as;

PREF=f(GENDER, AGE, EDUC, LIVNUMBER, FAMSIZE,MAIZSALE) 11

Where,PREF = is the dependent variable defined by variety preference (J=1,2…5).

Similarly, equation (15) for the logit model is empirically specified as;

VARCHOICE= f(ATRIBGRAIN, ATRIBSTOV, GENDER, AGE, EDUC, LIVNUMBER, FAMSIZE, HHSTAT, MAIZSALE)

Where,

VARCHOICE= is the dependent variable defined as 1 if the variety is chosen, 0 = otherwise,

Table 1 and 2 give definitions for the variables used to estimate both MNL and Logit regressions respectively.

Table 1: Definitions of variables used in the MNL regression analysis

Variable	Description
PREF	selection of maize variety over another for all possible choices: 1,2,3….5
GENDER	Sex of the respondent-Dummy variable: 1= Male; 0 = Female
AGE	Age of respondent. Continous variable (years)
EDUC	Education level of respondent. 1= literate/formal education; 0 = otherwise
LIVNUMBER	Livestock number owned: index in which livestock numbers are aggregated using the following weighting factors: cattle = 0.8 , goat = 0.6, sheep = 0.6
FAMSIZE	Total farm size (land) owned- acres. Continous variable
MAIZESALE	Market participation: 1 if the respondent sells maize grain; 0 = otherwise.

Table2: Definitions of variables used in the logit regression analysis

Variable	Description
VARCHOICE	Choice of the prefered maize variety =1, otherwise 0
ATRIBGRAIN	Index of farmer appreciation of a combination of variety attributes for grain characteristics aggregated using score weighting as: 9

	lowest; 18 cut off point ; 27 highest. The higher the index the higher the appreciation.
ATRIBSTOV	Index of farmer appreciation of a combination of variety attributes for stover characteristics aggregated using score weighting as: 9 lowest; 18 cut off point ; 27 highest. The higher the index the higher the appreciation.
GENDER	Sex of the respondent-Dummy variable: 1= Male; 0 = Female
AGE	Age of respondent. Continous variable (years)
EDUC	Education level of respondent: 1 literate/formal education; 0 = otherwise
HHSTAT	Household status of respondent: 1= Household head, 0 = otherwise
LIVNUMBER	Livestock number owned: index in which livestock numbers are aggregated using the following weighting factors: cattle 0.8, goat = 0.6, sheep = 0.6
FAMSIZE	Total farm size (land) owned- acres. Continous variable
MAIZESALE	Market participation: 1= if the respondent sells maize grain; 0 = otherwise.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Farmers' Socio –Economic Characteristics

Farmers' socio- economic characteristics are important variables that bear essential attributes in shaping individual decision making. The various socio-economic variables are included in this study to describe, on average the farm household asset base and vulnerability context which reflect the behaviour in choice decision making. As Smale *et al.* (1994) argue technology choice vary with the socio demographic characteristics of farm household when the decision maker's goal is to secure returns large enough to cover subsistence. Tables 3 and 4 present descriptive statistics for various socio economic variables (household and farm characteristics) included in this study.

4.1.1 Age structure

The results indicated great variations across the household farm families surveyed. The age of head of households ranged from 21 to 76 years old with a mode of 45 years and a standard deviation of 12.0 (Table 3).

These results suggest that many respondents were at the active and energetic age group which is important for economic activities performance.

4.1.2 Household size

The variable family member size here in referred to all members (number of people) dwelling and eating in the same pot for each household interviewed. The results indicated similarities on the average number of people per household for all age groups category in the sample surveyed.

The average number of people was about 6.5 with a maximum of 13 and std of 2.5. (Table 3). The implication of these results can be drawn to reflect the labour supply and food security within the household, consequently models the choice behaviour.

Table 3: Distribution of mean for household characteristics (N=150)

Variable	Responses	Mean	Std	Min	Max
Age	148	44.6	12.0	21	76
Number of people per HH	133	6.5	2.5	1	13

4.1.3 Farm size

Many households owned land through customary inheritance (63.3%). Other households obtained land both through renting and customary inheritance (15.8%). However, some household did not own agricultural land, they grown crops on a rented land (16.5%) or given free land by fellow farmers (4.3%) (Table 4).

The average farm size of respondents was about 2.36 acres with a std of 2.08 (Table 5) indicating a narrow dispersion of land size distribution in the sample surveyed.

These findings suggest that most farm households had on average small land holdings which have an implication on technology choices.

It is acknowledged that large farm size provides greater rooms for farmers to choose and allocate various alternative technologies- depending on the farming objectives.

Of the crops grown, on average maize was allocated about 1.6 acres which is about 0.59 (59 %) of the total average land a farmer grows different crops. This data confirm the importance of maize crop in the crop- livestock farming system. Other crops including sunflower, beans, coffee and banana were cultivated on average of 1.16 acres which is 0.42 (42%) of the proportionate land grown different crops (Table 5).

Table 4: Percent proportion of land resource ownership by households

Land resource ownership	Percent response
Customary inheritance	63.3 (88)
Rented	16.5 (23)
Both rented and customary inheritance	15.8 (22)

Given free land	4.3 (6)
No response	7.3 (11)

Notes: ( ) Contains number of respondents. N= 150

4.1.4 Average livestock herd size

The variable livestock keeping indicated that almost all farmers kept livestock which included cattle (improved or local breed) as well as sheep and goats and chicken.

The average livestock head size for improved cattle breed was 1.58 and sheep and goats 5.99. The average herd sizes for improved cattle as well as sheep and goats per households did not greatly vary across the households surveyed (Table 5).

There was a slight variation in the number of local cattle breed kept which averaged to 2.85 heads with a std of 4.3. The maximum herd size for local cattle breed reached 20 heads. The minimum herd size indicated some households did not own cattle (improved or local) and sheep and goats (Table5).

Table 5: Distribution of mean for farm characteristics (N= 150)

Variable	Responses	Mean	STD	Min	Max
Farm size (acres)	150	2.36	2.00	0	18
Land for maize (acres)	150	1.60	1.30	0	10
Other crops land (acres)	150	1.16	0.90	0	5
Improved cattle herd size	104	1.58	1.70	0	8
Local cattle herd size	104	2.85	4.30	0	20
Sheep and Goat herd size	104	5.99	6.70	0	46
Maize sells price (Tsh/kg	104	214	75.00	100	450
Stover sells price (Tsh/ton)	19	12 000	7 301	4 000	25 000
Cattle sells price (Tsh/head)	64	201 562	76 266	80 000	400 000
Sheep/Goat s price Tsh/head	53	26 038	11 867	12 000	75 000
FYM sells price(Tsh/ton)	4	6 250	2 500	5 000	10 000
Milk sells price (Tsh/lt)	46	274.35	71.90	150	150

4.1.5 Crop and livestock output marketing prices

The results also show variations (wider dispersion) from the mean for especially the output selling price variable. The average maize selling prices in absolute term as reported by respondents were about 214 Tshs per kg with a std of 75 while maize stover 12 000 Tshs per tonne with std 7 301; cattle 201 562 Tshs per head with std 76 266 and sheep and goats 26 037 Tshs per head with std 11 867, farm yard manure (FYM) 6 250 Tshs per tonnes with a std 2 500 and milk 274 Tshs per liter with a std of 71 (Table 5). These variations are perhaps due to among other factors, market information asymmetries most farmers experience. Scarborough and Kydd (1992) note that there is a degree of market failure due to lack of information. Based on the std the results further suggest that farmers face different output marketing prices within similar localities at least by now hence these variables are important in shaping the decision making of farmers to choose different maize varieties in question.

4.2 Farming System and Enterprises Management perspective

Byerlee and Collinson (1980) define farming system as the total of production and consumption decision of farm household including the choice of the crop, livestock and off farm enterprises and food consumed. Shaner *et al.* (1982) as cited by Kirway *et al.* (2003) describe the farming system as the unique and reasonably arrangement of farming enterprises that the household manage according to well defined practices in response to physical, biological and socio economic environments and in accordance with the household’s goal, preferences and resources.

Table 6 presents main farming systems characteristics particularly those related to maize and livestock management. The different enterprises in the farming system interact in receiving resources and delivering output, hence important in shaping the choice decision behavior of farm households in the crop- livestock farming system.

Table 6: Farming system characteristics

	Percent proportion of responses per District					
Variables	**Sample size (N)**	**Response**	**Hai**	**Moshi**	**Chi-sq value**	**p-value**
Livestock keeping	150	147	87 (103)	77 (44)	1.096	0.295
Livestock feeding mgt:	150	119			34.33	0.000**
• Zero graze			66 (60)	13.8 (4)		
• Extensive			13.3 (12)	65.5 (19)		
• Zero and ext			20 (18)	20.7 (6)		
Use of cash for feed purchase	150	121	74.7 (68)	20.7 (6)	28.44	0.000**
Livestock feed type purchased:	150	115			34.97	0.000**
• Wheat bran			11.6 (10)	0		
• Sunflower cake			10.5 (9)	0		
• Cotton seed cake			20.9 (18)	0		
• Maize stover			17.4 (15)	3.4 (1)		
• Maize bran			14 (12)	13.8 (4)		
• Stover and grass			3.5 (3)	3.4 (1)		
• None			22 (19)	79 (23)		
Output marketing	150					
• Maize sells		149	78 (82)	57.8 (26)	6.99	0.008**
• Maize stover sells		45	19.2 (19)	13.3 (6)	0.7	0.39
• Cattle sells		101	68.4 (54)	77.3 (17)	0.65	0.41
• Sheep and goats		92	63.8 (44)	60.9 (14)	0.06	0.8
• Milk sells		83	64.8 (46)	41.7 (5)	2.31	0.128
Maize varieties grown:	150	128			11.509	0.242
• Situka1			3.3 (3)	2.7 (1)		
• Kilima ST			4.4 (4)	13.5 (5)		
• Pan 67			17.6 (16)	18.9 (7)		
• SC627			12.1 (11)	13.5 (5)		
• SC403			12.1 (11)	2.7 (1)		
• Lishe H1			6.6 (6)	0.0		
• Lishe H2			1.1 (1)	0.0		
			5.5 (5)	0.0		

• LisheK1	9.9 (9)	10.8 (4)
• Pan 6549		
• DK8031	27.5 (25)	37.8(14)

Notes: ( ) contain number of respondents. Levels of significance **P <1%; *P <5%

Using the cross tabulation tool to compare and describe the socio economic characteristics/variables making up the farming system perspective for the two study districts, results indicated significant differences for the most selected variables. The variables livestock feeding management, use of cash for feed purchase, livestock feed type purchased and outputs marketing all were significant at less than 1 % level of significance ($P < 0.000$) (Table 6).

The null hypothesis that there is no significant difference of socio economic characteristics/variables (Livestock feeding management; Use of cash for livestock feed purchase; Livestock feed type purchased and Output marketing particularly, maize grains, stover, live cattle, sheep and goats and milk) among farm households in the two districts was therefore rejected in favour of alternative hypothesis using the Chi-square statistic test.

4.2.1 Livestock keeping.

Assessment of the livestock feeding management in the two districts showed statistical significant difference at less than 1% level. The results further indicate that Hai District practiced more zero grazing (66%) where as Moshi rural District common land grazing/ extensive grazing systems (65.5%) (Table 6). A possible explanation on this is that moshi rural district farmers have enough natural pastures available all year round as opposed to Hai district farmers where natural grass pasture is available during February to August (Table 9).

The variable type of livestock purchased for livestock feeding was also significant at less than 1% level of significant. About 74.7% of farmers in Hai District use farm and non –farm income sources to purchase different types of livestock feeds. The feeds mostly purchased include wheat bran, sunflower seed cake, cotton seed cake which is fed mostly to dairy cows. Other feeds purchased are maize stover, maize bran as well as natural and/or improved pasture as opposed to their counterparts in Moshi rural District who do not purchase livestock feed (79%) because they have enough natural grass pastures for common grazing land (Table 9).

4.2.2 Maize varieties grown

The variables maize varieties grown was not statistical significant difference for the two districts (Table 6). These results suggest similarity in the farming behaviour for these farmers. The plausible explanation on this is the fact that both these districts have access to development institutional support- largely offered by the government (Table 7). This could have an influence in the kind of services supported in the districts.

The most grown maize varieties include DK 8031 (27.5 %) for Hai and (37.8%) for Moshi rural, PAN 67 (17.6 %) and (18.9%) for Hai and Moshi rural respectively. Other varieties are PAN 6549 (9.9%) for Hai and (10.8%) for Moshi rural district and SC 627 (12.1%) for Hai and 13.5% for Moshi rural district (Table 6). The reasoning on this is probably long time farming experience of farmers for growing these varieties.

4.2.3 Institutional support

The variable institution support and type of institution rendering support on crop and livestock production for the two district results indicate significant difference at less than 1% and 5% levels of significant respectively (Table 7).

Both government institutions (GoT) and non- governmental organizations (NGO) offer different services towards crop and livestock development in a varying degree for the districts. About 71.4% of respondents appreciated government services and 28.6% non governmental organizations in Hai District. In Moshi rural District, 100% of services were offered by mainly government.

Limited Institutional service support especially by the NGO in Moshi rural District is probably the negativity of cooperation observed during the survey for many farmers in the area. Many farmers in the sample felt participation in research or any community based development activity is wastage of time. They tended to ask for incentive payment (cash payment) to participate in any research or community based development activity as way of compensating their time would be devoted for that particular activity (Table 7).

Table 7: Institutional support (N = 150)

		Percent proportion of responses per District			
Variables	**Response**	**Hai**	Moshi	**Chi-sq value**	**p-value**
Institution support	138	54.4 (56)	28.9 (13)	8.17	0.004**
Type of institution:					0.028*
• Government (GoT)		71.4 (40)	100 (13)		
• Non government(NGO)		28.6 (16)	0		

Notes: ( ) Contain number of respondents. Levels of significance **P <1%; *P <5%

4.3 Biophysical Results

The mother baby trials were conducted on three locations namely Kware, Nshara and Kivulini villages. Each mother trial site consisted of 12 improved maize varieties namely, SITUKA1; KILIMA ST; PAN67; SC627; SC 403; LONGE 6H; LISHE H1; LISHE H2; LISHEK1; SITUKA M1; PAN 6549 and DK8031.

Biophysical results for the 12 maize varieties performance are presented in Table 8. The results show that no statistical differences were observed for grain yield, biomass yield, plant height, and number of ears per plant in all the locations. When the treatments with and without fertilizers were compared, the results indicated that treatments with fertilizer (Nitrogen) had a pronounced yield difference at Nshara and Kivulini villages. While the mean yield differences due to planting with DAP fertilizer were 2.56 tonnes/ha and 1.88 tonnes/ha for Nshara and Kivulini respectively when compared to the treatment without DAP fertilizer (Appendix 6).

A careful examination of the results across sites (Table 8), grain yield indicated a slight difference ranging from a maximum of 6.51 tonnes/ha and a minimum of 4.53 tonnes/ha with SC 627 variety having the highest grain yield and SC 403 having the lowest grain yield.

Biomass yield differed across sites with SC627 having the highest (5.53 tonnes/ha) and Lishe K1 the lowest (2.88 tonnes/ha).

In the results of across sites analysis (Table 8), average ranks are the most important indicators of variety performance across locations. The basis of ranking is the mean yields performance of different varieties arranged in ascending order. The variety with the lowest average rank is the variety that has the best performance at the largest number of sites. The high rank of SC 627 in grain yield and biomass suggest that the variety has high potential for both gain (food) and livestock feed. When the two traits grain yield and biomass are combined and ranks averaged then the order of importance of the varieties become SC 627, LISHE H1, LONGE 6H, KILIMA, PAN 67, PAN6549 and DK 8031 for the first seven varieties. The lowest performers when the two traits are considered were SC403, LISHE K1 and SITUKA 1 (Table 8).

Other parameters- plant height and ear per plant were also statistically non significant (ns) across sites.

These results in general have shown better performing varieties e.g. SC 627 under farmers' environmental conditions across sites and this means the variety can be suitable in the crop- livestock farming system.

Table 8: Biophysical results for the three mother trials across sites

Variety	Grain yield (t/ha) and rank	Average rank for grain yield and biomass	Plant height (cm)	EPP (number)	Biomass yield (t/ha) and rank
SITUKA 1	5.29(8)	9	158.89	2.36	3.27(10)
KILIMA	5.39(7)	5	168.33	0.89	3.79(3)
PAN67	5.92(4)	4.5	161.67	1.08	3.73(5)
SC 627	6.51(1)	1	170.0	1.02	5.53(1)
SC 403	4.53(12)	11.5	156.32	0.95	2.88(11)
LONG 6H	6.11(2)	3.5	172.78	2.22	3.73(5)
LISHE H1	5.98(3)	2.5	165.56	0.94	4.27(2)
LISHE H2	5.29(8)	8.5	162.78	0.73	3.44(9)
LISHE K1	4.58(11)	11	152.78	2.99	2.88(11)
SITUKA M1	5.45(5)	6.5	158.89	1.01	3.43(8)
PAN 6549	5.45(5)	6	157.78	1.27	3.47(7)
DK 8031	4.87(10)	7	160.56	0.82	3.78(4)
MEAN	**5.45**	**-**	**162.17**	**1.35**	**3.68**
LSD	**NS**	**-**	**NS**	**NS**	**NS**
CV	**40.61**	**-**	**17.69**	**222.17**	**45.58**
MIN	**4.53**	**-**	**152.78**	**0.73**	**2.88**
MAX	**6.51**	**-**	**172.78**	**2.99**	**5.53**

Notes: ( ) Contain rank; EPP = Ear per plant

4.4 Farmers' Maize Variety Evaluations

Farmer's maize variety evaluation involved participation of farmers in assessing utilization, qualities of the different maize varieties and preference ranking. The evaluation was also used to identify maize variety selection criteria used by farmers with respect to the role maize play in the mixed crop- livestock farming system.

4.4.1 Different utilization of maize varieties

Evaluation results on maize utilization showed that the most important uses of maize in order of importance ranked in absolute term are grain for food, sales for cash (income), livestock feed (depending on village, grain for poultry, dry stover and green leaves top chopped after cobbing stage and/or uprooted during thinning for livestock, bran for livestock feed, maize stalks for mulching, cobs for fuel (after threshing) in Hai district. In Moshi rural utilization of maize varieties follow more or less similar pattern. Grain for food is ranked first, followed by livestock feed where livestock are fed on situ during natural grass shortages, sales for cash, crop residues incorporated in the soil as soil organic matter, cobs for fuel, grain as raw material for local brew preparation and fencing material (Table 9).

Table 9: Different utilization of maize varieties absolute ranking

District	Maize utilization	Absolute rank
Hai	Grain for food	1
	Local brew preparation	7
	Cobs for fuel wood	4
	Livestock feed (dry and green stover, grain)	3
	Crop residue for soil organic matter	5
	Grain sales for a cash (income)	2
	Fencing material	6
Moshi rural	Grain for food	1
	Local brew preparation	6
	Cobs for fuel wood	5
	Livestock feed (dry and green stover, grain)	2
	Crop residue for soil organic matter	4
	Grain sales for a cash (income)	3
	Fencing material	7

4.4.2 Criteria used by farmers to choose preferred maize variety

Farmers were asked to list the criteria they use to select preferred maize varieties. They also provided qualitative information on what they disliked about varieties.

The most important criteria used were yield, drought tolerance, early maturity, pest resistance (both field and storage), marketability, biomass and poundability (milling quality).

Respondents then observed the varieties in the field, before assessing them. They were asked to rank them pair-wise, and the 8 top varieties were then scored on the different criteria mentioned above, on a scale of 1 (poor/ not important) to 5 (very important).

The assessment results (Table 10) indicated that four maize varieties scored highest (>4.5 on average) based on farmers criteria. These varieties include Lishe H1, SC 403, SC 627, and Longe 6H across the sites. The most valued maize cultivars attributes that scored high on average (> 4.3) were drought tolerance, disease resistance, early maturity and poundability. Grain yield and stover biomass with average attribute scores of 4.1 and 3.8 respectively were less important (Table 10). The plausible explanation for this is that because farmers are risk averse but would like to maximize utility by avoiding heavy farm input investment due to uncertainties in production, they would prefer varieties which are drought tolerant, resistant to diseases and early maturing to ensure attainment of their multiple objectives in farming that include household food security.

Table 10: Scores for the criteria used by farmers to select maize variety

Variety	Drought tolerance	Disease	Yield	Market	Early maturity	Biomass	Milling Quality	Overall Average Variety score
LISHEH1	5.0	5.0	5.0	5.0	5.0	5.0	5.0	**5.0**
SC 403	5.0	5.0	4.0	4.0	5.0	5.0	5.0	**4.7**
SC 627	4.0	5.0	5.0	5.0	4.0	5.0	5.0	**4.7**
LONGE6H	4.3	4.7	5.0	4.7	4.3	4.0	5.0	**4.6**
LISHEK1	4.5	4.5	3.5	4.5	5.0	3.5	5.0	**4.4**
SITUKA1	5.0	5.0	3.0	4.0	5.0	3.0	5.0	**4.3**
SITUKAM1	4.0	5.0	4.0	5.0	4.0	3.0	5.0	**4.3**
PAN 67	4.5	4.0	4.0	4.0	4.5	4.0	4.5	**4.2**
KILIMAST	3.0	4.0	5.0	4.0	5.0	3.0	5.0	**4.1**
LISHEH2	4.0	4.7	4.0	4.0	4.3	4.0	4.0	**4.1**
DK 8031	4.7	3.7	3.7	3.3	3.7	3.0	2.0	**3.4**
Overall Average Attribute score	**4.4**	**4.6**	**4.1**	**4.3**	**4.6**	**3.8**	**4.6**	**-**

Scale 1-5, where 1= not important and 5 very important

Although grain yield and stover biomass were given low scores, their importance was evident when farmers mentioned the negative attributes. The negative attributes included low biomass yield and /or leaves which fall down after grain harvest because farmers preferred varieties with high biomass and leaves that stay green and

do not fall down for sometime after harvest. Other disliked attributes were non tolerant to drought, long duration to maturity, susceptible to diseases/pests, low yield, poor marketability and poor poundability/milling quality in that order of importance.
Another reasoning could be the domination of some farmers who driven the group during the scoring exercise.

4.5 Utilization of Maize Stover as Livestock Feed

The commonly livestock feed resources available in the area include: natural grass ; improved/ planted grass pastures; Banana stem; crop residues- maize, bean, and rice stover as well as supplementary feeds- Cotton seed cake, molasses, wheat and maize bran normally fed to dairy cows.
Focus group discussions on the position and utilization of maize stover as livestock feed when compared in relative terms with other available livestock feeds was observed that natural grass ranked (in absolute ranking) first across the sites (Table 11).

Table 11: Different livestock feeds resources preference ranking

District	Feed type	Preference rank	Seasonal availability (Months)
Hai	Natural grass	1	February to August
	Improved grass pasture(setaria, Guatemala)	5	All year round
	Maize rstover (green leaves 15% and dry stover 85%	2	April to September
	Banana stem	3	December to February
	Bean stover	6	May to September
	Supplementary feeds (csc, molasses, wheat and maize bran)	4	All year round
Moshi rural	Natural grass	1	All year round
	Maize stover fed in situ (15% and 85% as soil organic matter	3	September to February
	Bean stover	2	May to September
	Rice stover	4	February to June

However, natural grass pasture and other feed resources availability differed across sites. In Hai District for example natural grass for livestock feed was available during the months of February to August where as in Moshi rural District it was available all year round.

Maize stover ranked second followed by banana stem and supplementary feeds (cotton seed cake, molasses, wheat and maize bran) which ranked third and fourth respectively in Hai District. In Moshi rural District, bean stover ranked second, followed by maize stover and rice stover for the first four important livestock feed resources in the area (Table 11).

Overall the feed utilized was a function of feed availability because feeds were available at different time period (seasons) during the year. Preference ranking of the importance of the livestock feed resources followed similar availability pattern (Table 8). This preference behavior conform to the axiom of consumer preference which underlies that a consumer choose from a complete set of goods based on analysis of relevant information- what, when and under what conditions the goods are available (Varian, 1999). In this case, farmers chose first the natural grass pastures followed by the easily available alternatives that include the maize stover or bean stover in time of feed shortage.

4.6 Factors influencing Maize Variety Choice

Factors influencing maize varieties choice were estimated to determine how farmers behave in making decision for multi- maize varieties choice in a crop-livestock farming system. 12 improved maize varieties were assessed.

Screening on the maize varieties mostly chosen it was observed that only PAN 67 (22.4%), SC627 (19.7%), LISHE H1 (9.2%), PAN 6549 (17.1%) and DK8031 (31.6%) (Table 6) were the most frequently grown varieties by farmers in the sample. The varieties were grown either in one season allocated on small (land) plots or alternate seasons. No households were familiar with all 12 varieties. After removing observations with missing relevant data, only a sample of 78 households remained for the econometrics analyses.

The multinomial logit (MNL) and logit regressions were separately estimated across the study sites for the frequently grown maize varieties chosen by farmers.

i) Multinomial logit estimates

A number of explanatory variables were included in the MNL model in order to determine the farmers' preferences, examine the effects of explanatory variables on the likelihood of choosing maize variety from a number of alternative maize cultivars. The null hypothesis that number of livestock owned does not explain farmers' choice of varieties was also tested. The summary statistics for the MNL model are presented in Table 12.

The log-likelihood ratio test indicates that the amount of variation explained by the model is significantly different from zero at less than 5% significant level (Chi-square probability = 0.022). On the basis of these results the null hypothesis was rejected in favour of the alternative and concludes that the numbers of livestock owned do affect the choice behavior of farmers. This implies that the model can be used to explain the variation in preferences for smallholder farmers in the sample on the selected maize variables. DK 8031 maize variety is automatically selected as the reference choice category by the analysis (Table 12).

Table 12: Estimated results of multinomial logit regression- (DK8031 is a reference choice category)

Variable	PAN 67		SC 627		LISHE H1		PAN6549	
	Coefficient	**Z-value**	**Coefficient**	**Z-value**	**Coefficient**	**Z-value**	**Coefficient**	**Z-value**
GENDER	0.0327(0.862)	0.04	-022(0.8)	-0.28	-0.407(1.1)	-0.37	-0.76 (0.85)	-0.89
AGE	0.002(0.002)	0.78	-0.06(0.04)	-1.56	-0.006(0.018)	-0.34	-0.01(0.037)	-0.28
EDUC	21.108(1.21)	17.52*	2.11(1.3)	1.6	1.12(1.4)	0.8	21.2(1.8)	11.75*
LIVNUMBER	-0.29(0.15)	-1.96**	-0.015(0.1)	-0.14	0.069(0.154)	0.45	-0.09(0.11)	-0.83
FAMSIZE	0.647(0.33)	1.96**	-0.03(0.36)	-0.11	0.318(0.4)	0.18	0.67(0.35)	1.93**
MAIZSALE	-1.412(0.87)	-1.62	1.11(1.11)	1	20.5(2.225)	9.22*	-0.99(0.96)	-1.03
Constant	-20.7	-	-0.12(2.15)	-0.06	20.984	-	-20.98	-

Notes: ( ) contain standard error. Level of significance * P < 1%; ** P < 5%
Number of observations = 76
Log likelihood = -96.017
Chi-square value = 39.89
Chi- square probability = 0.022
PseudoR2=0.172

Including the monetary factors such as prices of maize, maize stover, livestock and livestock products in regression as explanatory variables introduced severe multicollinearity, and were dropped from the final regression estimation.

The variable **GENDER** estimated coefficients were negative and not significant for SC 627; LISHE H1 and PAN 6549 varieties. Although not significant, the negative estimated coefficients related to gender for the varieties choices imply that female farmers are more likely than men to choose the varieties in question. A possible reasoning on this is that family food and livestock feed care responsibility are assumed by women. However, the estimated coefficient was positive and not significant for PAN 67 suggesting that men have higher probability of choosing this variety than women.

The variable **AGE** estimated coefficients bear no significant relationship to all maize varieties choice. Although not significant, a careful examination of this variable estimated coefficients sign indicate negative relationship for SC 627, LISHE H1 and PAN 6549 varieties and positive for PAN67. The negative sign on the estimated coefficients suggest that young farmers are likely to choose these varieties while older farmers are likely to choose PAN67. Conceived explanation on this is that young farmers are less risk averse and can dare testing new technology. Another reasoning may be that older farmers have well prior knowledge, accessibility and long time experience in growing PAN 67 as compared to other varieties. This argument is supported by other scholars, Varian (1999) and Hella, (2003) who argue that individuals are able to choose among alternatives through analysis of relevant information, trial and error learning and sometime long experience in similar environment as well as form of biased cultural transmission and truism.

The variable education level **(EDUC)** estimated coefficients was positive and significant for PAN67 and PAN 6549 at less than 1% level of significant suggesting that literate (educated) farmers were more likely than the illiterate/ or with no formal level of education to choose these varieties. The plausible explanation for this is the fact that education does influence information processing. The belief is that education gives farmers the ability to perceive, interpret and respond to new information much faster, therefore a higher level of education is expected to positively relate to the usefulness of analysis of information in decision making.

The estimated coefficients for livestock number owned (**LIVNUMBER)** was negative and significant for only PAN 67 at less than 5% level of significant. These results suggest that households (farmers) with less numbers of livestock are more likely to choose PAN 67 than DK 8031. A conceivable explanation on this is that older farmers were likely to choose this variety as opposed to the younger one in the variable age. This can be linked to the fact that older farmers have experience in farming, perhaps human capital enhances the asset base and so was the group having at least some livestock as opposed to the younger ones who were probably yet to stabilize.

The variable farm size in acres (**FAMSIZE)** estimated coefficients were positive and significant for PAN 67 and PAN 6549 at less than 5% significant level. The results suggest that increasing the farm size, the probability of choosing PAN 67 to DK 8031 and PAN 6549 to DK 8031 is expected to increase. Large farm sizes provide greater benefits and opportunity for farmers to allocate alternative technology options.

The estimated coefficients for the market related variable (market participation) on grain sells (MAIZESALE) were positive and significant for LISHE H1 at less than 1% level of significant respectively. It was negative and not significant for PAN 67 and PAN 6549. The negative coefficient results suggest that PAN 67 and PAN 6749 relative to DK 8031 were less likely to be chosen for marketing, where as the positive sign for LISHE H1 and SC627 suggest high probability of marketing relative to DK 8031. This is expected because these varieties were described by farmers as having heavy weight, large grains that little amount of it fills up the selling measurement unit if at all kg was used for marketing. Another possible explanation is that LISHE H1 and SC627 have the best milling quality attributes (Table 10) preferred by both household consumers and at the markets.

Based on the MNL results, it is observed that literate farmers with basic formal education and those with larger farms are more likely to select one of the two maize varieties PAN 67 and/or PAN 6549 over DK 8031 and household with fewer number of livestock are more likely to choose PAN 67 than DK 8031. Interestingly, households participating in marketing of maize grains are more likely to choose LISHE H1 and/or SC 627 than DK 8031 because of their better marketability and milling quality attributes (Table 10).

ii) Binary logit estimates

Binary logit model was estimated to isolate the impact of variety characteristics on the varieties choice/or demand. Farmers were grouped as preferred (1) if they choose the variety and (0) otherwise/or they do not choose the variety. Five separate logit regression analyses for each of the five varieties (PAN67; SC627; LISHE H1; PAN6549 and DK831) were estimated and only representative characteristics of regressors (independent) variables were included in any given regression to avoid effect of inducing multicollinearity between the variables specified.

Out of five logit regression analyses for the five varieties, only three (PAN67; SC627 and DK8031) were able to explain the impact of variety choices for the variables specified and the other two logit regressions for LISHE H1 and PAN 6549 were unable to produce significant results for the overall model fitness due to few farmers (9.2% and 17.1% respectively) in the sample who chose these varieties, hence were dropped in the final analysis. Also some of the parameter estimates indicated statistically non significant for similar reason of sample composition and size of few farmers made the variety choice. The estimates correspond to contribution of specific attribute for each variety chosen. Major summary statistics results for the logit regressions are presented in Table 13.

	PAN 67			SC 627			DK 8031		
	Coefficient	Z value	Δ probability	Coefficient	Z value	Δ probability	Coefficient	Z value	Δ probability
ATRIBGRAIN	0.233(0.25)	0.93	0.03	-0.027(0.15)	-0.18	-0.00	0.23(0.26)	0.89	0.044
ATRIBSTOV	-0.008(0.22)	-0.04	-0.00	-	-	-	-0.32(0.24)	-1.33	-0.06
GENDER	0.17(0.74)	0.24	0.02	-1.42(1.29)	-1.1	-0.039	0.89(0.75)	1.19	0.15
AGE	0.003(0.002)	1.59	0.00	-0.08(0.04)	-1.95**	-0.00	0.00(0.00)	0.25	0.00
LIVNUMBER	-0.3(0.13)	-2.24**	-0.045	0.09(0.1)	0.94	0.00	0.16(0.085)	1.90**	0.03
FAMSIZE	0.22(0.20)	1.1	0.033	-0.35(0.30)	-1.17	-0.00	-0.48(0.29)	-1.61	-0.091
MAIZSALE	-1.47(0.7)	-2.09**	-0.27	2.64(1.34)	1.97**	0.032	0.92(0.84)	1.09	0.152
EDUC	-	-	-	_	-	-	-1.93(1.05)	-1.84**	0.44
HHSTAT	-	-	-	-	-	-	-	-	-
Constant	-5.018459	-1.63	-	0.8466	0.25	-	1.68477	0.56	-
N	78			80			70		
Log likelihood	-35.53			-31.74			-35.07		
Pseudo R^2	0.156			0.177			0.179		
LR Chi^2	13.21			13.73			15.38		
Prob Chi^2	0.067			0.056			0.052		
Predicted Prob	0.181			0.020			0.256		

Table 13: Logit regression estimates of maize varieties choice

Notes: ( ) Contain standard error. Level of significance *P<1%; **P< 5%

The log likelihood ratio tests for the estimated logit regressions showed that the variations explained by the model are statistically significantly different from zero at less than 10 % for PAN 67 (Chi- square probability = 0.067), less than 5% for SC 627 and DK 8031 (Chi-square probability = 0.056 and 0.052) respectively, indicating the existence of useful information for the estimated regressions.

The estimated coefficients for the variable attribute for grain characteristics (ATRIBGRAIN) was positive and non significant for PAN67 and DK 8031 variety choices while negative and non significant for SC627. The positive signs indicate that although not significant there is high likelihood that these varieties are chosen of. For each of maize variety attribute for grain characteristics increase, the probability of choosing PAN67 increases by 3.4% while DK 8031 increases by 4.4 %. The negative sign for estimated coefficient of attribute for grain characteristics (ATRIBGRAIN) for SC627 maize variety choice indicates less likelihood for farmers to choose this variety although the probability decreases by non significant impact (0%).

The estimated coefficients for the attribute for stover characteristics (ATRIBSTOV) is negative and non significant for PAN67 and DK 8031 maize varieties implying less likelihood choice of these varieties for stover characteristics preference. However, PAN67 the probability decreased with no impact (0%) than DK8031 which the probability change of decrease showed high impact about 6.1%. This is expected because DK8031 was described by farmers during focus group discussions as a variety with stover which fall down and do not stay green for some time after harvest because farmers preferred maize varieties with leaves/stover which stay green for some time after harvest and that do not fall.

The estimated coefficients for GENDER was positive and statistically non significant for PAN67 and DK8031 in explaining the variety choices. Inspite of being statistically non significant, the variable has a positive relationship, implying that being a male the probability of choosing PAN67 increases by 2.5% and by 15.4% for DK 8031. Not surprisingly, the coefficient for GENDER is negative and non significant for SC 627 indicating that women are likely than men to choose this variety. These results depict that being a male, the probability of choosing SC 627 decreases by 3.9%.

The coefficient of AGE was positive and statistically not significant for PAN 67 and DK 8031 indicating that old farmers are likely to choose these varieties. Although not significant, these results indicate that for a unit increase in age of a farmer, the probability of choosing these varieties increases by a non significant impact (0%). Similarly, the coefficient was negative and not significant for SC 627 implying that younger farmers are likely to choose this variety. Surprisingly, for a unit increase in age the probability of choosing SC627 also decreases by non significant impact (0%). The possible explanation of these findings is that old and younger farmers have their preference of maize varieties depending on their objectives and experience of farming. Most technology development efforts tend to assume homogeneity in the farming population particularly with socio economic variables. Hence, these findings underscore to take into account the need to have specific technology for the different groups of farmers in the population depending on their choices.

The coefficient for LIVNUMBER was negative and statistically significant for PAN67 at less than 5% confidence level of significant, while positive and statistically significant for DK8031 and non significant for SC 627. The negative sign indicates that farmers with fewer numbers of livestock are likely to choose PAN 67. For each additional livestock increase, the probability of choosing PAN 67 decreases by 4.5 %, *ceteris paribus.* Interestingly, the coefficients were positive for SC 627 and DK 8031 suggesting that increase in livestock number increases the probability of choosing these varieties, the probability increase by 3 % for DK 8031 and no impact for SC 627 (0%).

The estimated coefficient for FAMSIZE was found to be positive and non significant for PAN 67, negative and non significant for SC627 and DK8031. For each acre of additional land farmed by a farmer, the probability of choosing PAN 67 increases by 3.4%, while that of choosing SC 627 has no decrease impact (0 %) and DK 8031 decreases by 9.16 %.

The coefficient for MAIZSALE was negative and statistically significant at less than 10 % confidence level of significant, and positive and non significant for SC 627 and DK 8031 respectively. The negative sign for maize sale on PAN 67 indicates less likelihood of selling this maize variety. Being a farmer who sells maize, the probability of choosing PAN 67 for marketing decreases by 27.5 % , while the probability of selling increases by 3.24 % and 15.2 % for SC627 and DK 8031 respectively other things are equal.

The estimated coefficient for the household status (HHSTAT) was positive and non significant for SC 627 implying that being the head of household, the probability of choosing SC627 maize variety increases by 2.24 %. The possible reasoning on this is that household head are the main decision maker at the household.

The estimated coefficient for the formal education level (EDUC) was negative and statistically significant at less than 5% level of significant for DK 8031 suggesting that less educated farmers were likely to choose this variety. These results imply that for a unit increase in formal education the probability of choosing DK 8031 decreases by 44.2 %. This is expected because DK 8031 was described by farmers as the variety that is high yielding but with very light grains which are unsuitable for household consumption except for marketing since they could sell using containers as measurement units not considering weight. The implication on this is therefore that educated (informed) farmers are less likely to choose this variety if the measurement unit for marketing is kg.

Most important, the predicted overall probabilities of choosing these varieties were found to be 18.1 % for PAN 67, 2 % for SC 627 and 25.6 % for DK8031. It is worth to note here that the biophysical data (Table 8) indicated that SC 627 ranked first for grain yield of 6.51 tonnes per hectare and biomass yield of 5.53 tonnes per hectare. This is an indication that grain yield and biomass yield are not important factors influencing the probability of a variety to be chosen by farmers. This is expected because farmers chosen varieties valuing most production and consumption attributes (Table 10), particularly early maturing, resistant to field and storage pests, drought tolerant, grain and stover biomass yields and milling quality. SC627 was perceived by farmers as being late maturing and less tolerant to drought (Table 10). These findings complement the study by Smale *et al.* (1994) who note that farmers behave in response to avoid risk. The decision making goals are expressed in terms of a targeted level of random variable (output, income or subsistence- safety first behaviour). These results therefore underscore the importance of participatory technology development in order to include the needs and wants of consumers.

CHAPTER FIVE

5.0 CONCLUSSION AND RECOMMENDATIONS

5.1 Conclusion

The study concludes that farmers preference do not always coincide with breeders selection/or biophysical performance of varieties because farmers choose different varieties for different purposes. For example maize varieties which showed better biophysical performance in terms of grain yield and biomass yield (e.g. SC627) had low probability of being chosen by farmers.

PAN 67 and DK 8031 are more likely to be chosen by farmers for food and livestock feed while SC627 and LISHE H1 for marketing.

The main attributes that farmers valued most in selecting the preferred varieties include drought tolerance, disease resistance, early maturity, marketability and poundability/milling quality. In line with farmers valued attributes it is important to note that maize varieties which were perceived lacking the preferred attributes -especially drought tolerance and early maturity were not chosen first for food and livestock feed. This implies that farmers preferred maize varieties that meet the goal of food and livestock feed first in the crop livestock farming system. The yield attributes were considered next after food- feed first fulfillment, this is why biophysical performance/or breeders selection do not coincide with those of farmers.

The factors that influence the maize varieties choice in the crop –livestock farming system are education level of farmers, livestock number, farm size, as well as food (grain) and livestock feed attributes (biomass). Other factors include market participation on maize grain sells.

5.2 Recommendations

The study recommends the following;

Technical Recommendation (s)

1. The study recommends that maize breeders incorporate attributes such as drought tolerance, pests and diseases resistance, early maturity and milling quality in their breeding programmes which are valued most by farmers.

Institutional and Policy Recommendations

2. A forum where seed input dealers, farmers, researchers and extension services provider be designed to influence stock the identified varieties likely to be chosen to target these consumers (farmers).

3. Policy support in land ownership merit attention, because large farm size influenced variety choice. In terms of equity this implies the need to help those with smaller farm size. This could be done through development of strategies that could help farmers increase productivity per unit area over the growing season. Such strategies include improvement of irrigation schemes and agronomic principles adherence as well as use of inputs in production.

4. Education which positively influences variety choice for farmers is crucial. This can be imparted through training and creating awareness (educative) campaign for maize varieties technologies so that farmers are informed on the types and accessibility of the available maize varieties. This could be achieved through

seminars, experts' face to face contact with farmers, radio broad cast and leaflets distribution.

Recommendation for research

5. The study recommends a similar study for another two subsequent seasons to establish enough evidence of farmers' choice behaviour and biophysical data variability on the maize cultivars in a crop-livestock farming system. The fact that this study draws conclusion basing on only one season data may not be relied to draw conclusive recommendations.

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Appendices

Appendix 1: Material and method for Mother – baby trials

1. Materials in each mother trial

i. String
ii. Yellow trial with seed envelopes to be conducted under farmers condition
iii. Green trial with seed envelopes to be conducted under recommended input conditions

iv. Labels for each plot

v. Fertilizers calculated at the rate to apply

vi. Full instruction to the host farmer taking care of the trial

2. Materials in each baby trial

i. Labeled envelopes containing each 400 seeds

ii. Coloured tags with the variety names

iii. Simple instructions on management

3. Mother and baby trial Design

Mother and baby experimental design was adopted because is cost effective on –farm verification methodology. It allows farmers and researchers to test best-bet technologies or new varieties (De Meyer and Bänziger, 1999; Snapp, 2002; Abebe *et al*. 2005).

3. 1 Mother trial Design

Three on farm mother trials, one at each village: Kware and Nshara villages in Hai District and Kivulini village in Moshi rural District were designed and established. For each on farm mother trial, a host farmer was identified to establish the field trial which was Researcher Managed Researcher Implemented (RMRI).

The mother trial in each site consisted of 12 different improved maize varieties namely SITUKA1; KILIMA ST; PAN67; SC627; SC 403; LONGE 6H; LISHE H1; LISHE H2; LISHEK1; SITUKA M1; PAN 6549 and DK8031 which were established in a two trials layout-one managed using recommended fertilizer-Diammonium phosphate-(DAP) (referred to as green trial) at planting, at a rate of 22.5 kg N/ha and top dressed with Urea at a rate of 57.5 kg N/ha) and the other no fertilizer added at planting (referred to as yellow trial), top dressed with 57.5 kg N/ha to simulate farmer’s condition. A spacing of 5.0 m row length , 0.8 row width was used in each plot and 2 row per plot with 2 numbers of plant per hill giving a plant population of 50,000 plants per hectare.

Each mother trial was situated at the centre of the village to allow other farmers surrounding the trial access and compare the performance of cultivars under RMRI with those from their baby trials (FMFI).

3. 2. Baby trial Design

Baby trials were located around mother trials at each site. Each baby trial involved 12 farmers at Kware, 3 at Nshara and 7 at Kivulini villages and each farmer was allocated 4 varieties of the mother trial which, at a given site forms an alpha lattice design with each farmer constituting an incomplete block. Due to water shortages and rodents attack, 1 farmer dropped out at Kware, 2 at Nshara and 5 at Kivulini villages. A total of 14 baby trial managers persevered.

Baby trials were managed entirely by farmers themselves (Farmer Managed Farmer Implemented (FMFI), using their own husbandry practices, with little help from the researchers, except provision of seed and plot lay-out.

Appendix 2. Questionnaire for Formal structured interview of farmers

SECTION I: Background information and resource management

A. General characteristics

1. Date of interview ____

2. Respondent’s address (tick appropriately in the table below)

District: 1= Hai [ ] 2= Moshi rural

Village: 1 = Kware [ ] 2= Nshara 3= Kileo [ ] 4 = Kivulini

3. Respondent’s name____

4. Position in the household

1= Head of the household [ ]

2= Otherwise [ ]

5. Respondent’s age [_____________] years

6. Gender of respondent

1= Male [ ]

2= Female [ ]

7. Distance of household from major urban center [___________________] km

8. Years stayed in this address [_________] year

B. Household socio economics characteristics information

9. Family size

1= Children <10 years [_____________]

2= Members between (10-18) years who can work on the farm [__________]

3=Adult >18years [_____________]

4=Old (dependants) >60 years [_____________]

10. Education level of respondent

1= None [ ]

2= Primary 7 [ ]

3= Primary drop out [ ]

4= Secondary [ ]

5= Secondary drop out [ ]

6= post secondary [ ]

11. Main occupation of respondent

1= Farming ONLY Crops [ ]

2= Both Crops & Livestock production [ ]

3= Formal employment [ ]

4= Others [ ]

12. Marital status of respondent

1= Married [ ]

2= Single [ ]

3=Widowed [ ]

4= Others (specify) [ ]

***C.* Resource ownership information and management**

a) Livestock resource ownership and management

13. Do you keep livestock?

1= Yes [ ] 2= No [ ]

14. If yes mention type and breed as 1= exotic 2= local by filling in the box [ ] and number owned in the empty space__________ below in the table

Type of livestock eg.	# and Breed	Total Number
Cattle	______________________[ ] ______________________[ ]	
Goat	______________________[ ] ______________________[ ]	
Sheep	______________________[ ] ______________________[ ]	
Pig	______________________[ ] ______________________[ ]	
Donkey	______________________[ ]	

	________________________[ ]	
Others	________________________[ ] ________________________[ ]	

15. Indicate the feeding management system practice for your livestock

1= Common grazing land [ ] 2= Zero grazing [ ]

3= Both 1&2 [ ] 4 Others [ ]

16. Do you use cash income (both farm based and non farm based) to buy livestock feed?

1= Yes [ ] 2 = No [ ]

17 If yes (in 16 above) what type of feed do you buy

Feed type	Cost (Tshs) per unit
____	[ ]
____	[ ]
____	[ ]

18. If no (in 16 above) why?

Give reasons____

b) Land resources, farm assets and crop production

19. Do you own land?

1= Yes [ ] 2= No [ ]

20. If yes (in Q 19 above) how did your land obtained

1= rented [ ] 2= inherited [ ]

3 =both rented and own occupied. [ ] 4 = Others [ ]

21. Indicate the total land owned [__________________] acres

22. Indicate proportionate land use allocation for your farming activities (crops and livestock)

Farming activity (total land use)	Allocated land (acres)
1 .__________________________	[ ]
2.__________________________	[ ]
3.__________________________	[ ]
4.__________________________	[ ]

23. Indicate the average yields for maize and other major crops grown per land area (farm size) allocated

Type of crops grown	Intensity (acres)	Average yield
1________________________	[_______] acres	[________] Unit measure
2________________________	[_______] acres	[________] Unit measure
3__________________________	[________] acres	[________] Unit measure
4________________________	[________] acres	[________] Unit measure
5.________________________	[________] acres	[________] Unit measure

c) Commodity marketing and Institutional policy support information

24. Do you sell the following maize crop produce?

1) Maize grain 1= Yes [ ] 2= No [ ]
2) Maize stover 1= Yes [ ] 2= No [ ]

25. Do you sell the following livestock and livestock products?

1) Cattle 1= Yes [ ] 2= No [ ]
2) Goat /Sheep 1= Yes [ ] 2= No [ ]
3) Milk 1= Yes [ ] 2= No [ ]
4) Meat (Beef) 1= Yes [ ] 2= No [ ]
5) Farm Yard Manure (FYM) 1= Yes [ ] 2= No [ ]

26. Indicate the market place, distances from selling point to the urban center and selling prices for both crops (maize grain, stover) and livestock and livestock products mentioned in Q 24 &25 above

Commodity	Market place	Distance (km)	Sells price (Tshs)/unit
1. Maize grain	______________	_____________	______________
2. Maize stover	_______________	_____________	______________
3. Cattle	_______________	_____________	______________
4. Goat/Sheep	________________	_____________	______________
5. Milk	_______________	_____________	_______________
6. Meat	________________	_____________	_______________
7. FYM	________________	______________	_______________
8. Others (specify)	________________	______________	_______________

27. Do you receive any kind of support (like credit services, extension advises, technology) from NGOs, Government or any Institution to facilitate your crop and or livestock production and marketing?

1= Yes [ ] 2 = No [ ]

28. If yes, mention the Institute, type of commodity (crop/livestock) and services supported.

Institute	Type of commodity	Support services
1.______________	______________________	_____________________________
2.________________	______________________	_____________________________

3.________________ ________________________ ____________________________

4.________________ ______________________ ____________________________

SECTION II: Maize cultivars evaluation.

D. Maize cultivars attribute (traits) information as perceived by farmers.

In this section you will now assess the cultivars attribute(s) depending on your preferences and how you have so far observed the performance of various cultivars on farm.

29. Are you participating in maize trial for fodder traits evaluation project?

1= Yes [ ] 2= No [ ]

30. If yes (in 29 above) mention the maize varieties you are assessing indicating whether 1= improved 2= Local

1.________________________________[ ] 2.__________________________ [ ]
3.________________________________[ ] 4.__________________________[ ]
5.________________________________[ ] 6.__________________________[ ]
7.________________________________[ ] 8.__________________________[ ]
9_________________________________[ ] 10.__________________________[ ]
11.________________________________[ ] 12.__________________________[ ]

31. For the varieties mentioned in **Q30** above, please rank them according to your preferences in ascending order starting with the most preferred to the least preferred for: (a) preference for grain (b) preference for stover (c) preferred both for food and feed [A rank of 12, numbers the highest rank which implies least preferred variety]

a) Preferred varieties for Grain (food)

	Variety	Rank
i.	Situka1__________________________________	[ ]
ii.	Kilima ST ________________________________	[ ]
iii.	PAN 67 _________________________________	[ ]

iv. SC627________________________________ [ ]
v. SC403_____________________________ [ ]
vi. Longe 6H______________________________ [ ]
vii. Lishe H1______________________________ [ ]
viii. LisheH2______________________________ [ ]
ix. LisheK1______________________________ [ ]
x. Situka M1_____________________________ [ ]
xi. PAN 6549_____________________________ [ ]
xii. DK8031_____________________________ [ ]

b) Preferred varieties for stover

Variety	Rank
xiii. Situka1_______________________________	[ ]
xiv. Kilima ST _____________________________	[ ]
xv. PAN 67 ______________________________	[ ]
xvi. SC627_________________________________	[ ]
xvii. SC403_____________________________	[ ]
xviii. Longe 6H______________________________	[ ]
xix. Lishe H1______________________________	[ ]
xx. LisheH2______________________________	[ ]
xxi. LisheK1______________________________	[ ]
xxii. Situka M1_____________________________	[ ]
xxiii. PAN 6549_____________________________	[ ]
xxiv. DK8031_____________________________	[ ]

c) Preferred varieties for both food and stover

Variety	Rank
xxv. Situka1_______________________________	[ ]
xxvi. Kilima ST _____________________________	[ ]
xxvii. PAN 67 ______________________________	[ ]
xxviii. SC627_________________________________	[ ]

xxix.	SC403______________________________	[ ]
xxx.	Longe 6H_______________________________	[ ]
xxxi.	Lishe H1_______________________________	[ ]
xxxii.	LisheH2_______________________________	[ ]
xxxiii.	LisheK1_______________________________	[ ]
xxxiv.	Situka M1______________________________	[ ]
xxxv.	PAN 6549______________________________	[ ]
xxxvi.	DK8031______________________________	[ ]

32. Does shrinking (reduced) common resources affect the choice of maize varieties?

1 = Yes [ ] 2 = No [ ]

33. **Total varietal attributes Utility assessment**.

For each of the varieties ranked (in **Q31 a, b & c** above), rate the factors (attribute) against the level (value) that you attach to that particular attribute. The identified rating attributes or factors for each varieties are**: Grain yield; Stover biomas; Maturity period; Drought tolerance; Diseases resistance; Pest resistance; Seed availability; Seed input price ;Output marketability.** Circle the rating levels for each factor with respect to the cells below**.**

Var1 Kilima ST ,

1. Grain yield	*High*	*Medium*	*Low*
2.Stover Biomass,	*High*	*Medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*Medium*	*Low*
5.Pest resistance,	*High*	*Medium*	*Low*
6.Diseases resistance,	*High*	*Medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficult*
8.Seed input price,	*High*	*Medium*	*Affordable*
9.Output market	*easily marketed*	*Average*	*Difficulty*

Var2.PAN 67

1. Grain yield	*High*	*Medium*	*Low*
2.Stover Biomass,	*High*	*Medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*Medium*	*Low*
5.Pest resistance,	*High*	*Medium*	*Low*
6.Diseases resistance,	*High*	*Medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficult*
8.Seed input price,	*High*	*Medium*	*Affordable*
9.Output market	*easily marketed*	*Average*	*Difficulty*

Var3.SC627

1. Grain yield	*High*	*Medium*	*Low*
2.Stover Biomass,	*High*	*Medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*Medium*	*Low*
5.Pest resistance,	*High*	*Medium*	*Low*
6.Diseases resistance,	*High*	*Medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficult*

8.Seed input price,	*High*	*Medium*	*Afforda ble*
9.Output market	*easily marketed*	*Average*	*Difficu*

var4. SC403

1. Grain yield	*High*	*Medium*	*Low*
2.Stover Biomass,	*High*	*Medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*Medium*	*Low*
5.Pest resistance,	*High*	*Medium*	*Low*
6.Diseases resistance,	*High*	*Medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficul t*
8.Seed input price,	*High*	*Medium*	*Afforda ble*
9.Output market	*easily marketed*	*Average*	*Difficul ty*

Var5.Longe 6H

1. Grain yield	*High*	*Medium*	*Low*
2.Stover Biomass,	*High*	*Medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*Medium*	*Low*
5.Pest resistance,	*High*	*Medium*	*Low*
6.Diseases resistance,	*High*	*Medium*	*Low*
7.Seed availability,	*easily available*	*available*	*diffic ult*
8.Seed input price,	*High*	*Medium*	*Affor dable*
9.Output market	*easily marketed*	*Average*	*Diffic ulty*

Var6.Lishe H1

1. Grain yield	*High*	*Medium*	*Low*
2.Stover Biomass,	*High*	*Medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*Medium*	*Low*
5.Pest resistance,	*High*	*Medium*	*Low*
6.Diseases resistance,	*High*	*Medium*	*Low*
7.Seed availability,	*easily available*	*available*	*diffic ult*
8.Seed input price,	*High*	*medium*	*Affor dable*
9.Output market	*easily marketed*	*average*	*Diffic ulty*

Var7.LisheH2

1. Grain yield	*High*	*medium*	*Low*
2.Stover Biomass,	*High*	*medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*medium*	*Low*
5.Pest resistance,	*High*	*medium*	*Low*
6.Diseases resistance,	*High*	*medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficult*
8.Seed input price,	*High*	*medium*	*Affordable*
9.Output market	*easily marketed*	*average*	*Difficulty*

Var8.LisheK1

1. Grain yield	*High*	*medium*	*Low*
2.Stover Biomass,	*High*	*medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*medium*	*Low*
5.Pest resistance,	*High*	*medium*	*Low*
6.Diseases resistance,	*High*	*medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficult*
8.Seed input price,	*High*	*medium*	*Affordable*
9.Output market	*easily marketed*	*average*	*Difficulty*

Var 9.Situka M1

1. Grain yield	*High*	*medium*	*Low*
2.Stover Biomass,	*High*	*medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*medium*	*Low*
5.Pest resistance,	*High*	*medium*	*Low*
6.Diseases resistance,	*High*	*medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficult*
8.Seed input price,	*High*	*medium*	*Affordable*
9.Output market	*easily marketed*	*average*	*Difficulty*

Var10. PAN 6549

1. Grain yield	*High*	*medium*	*Low*
2.Stover Biomass,	*High*	*medium*	*Low*

3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*medium*	*Low*
5.Pest resistance,	*High*	*medium*	*Low*
6.Diseases resistance,	*High*	*medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficu lt*
8.Seed input price,	*High*	*medium*	*Afford able*
9.Output market	*easily marketed*	*average*	*Difficu lty*

Var 11.DK8031

1. Grain yield	*High*	*medium*	*Low*
2.Stover Biomass,	*High*	*medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*medium*	*Low*
5.Pest resistance,	*High*	*medium*	*Low*
6.Diseases resistance,	*High*	*medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficu lt*
8.Seed input price,	*High*	*medium*	*Afford able*
9.Output market	*easily marketed*	*average*	*Difficu lty*

Var12.Situka1

1. Grain yield	*High*	*medium*	*Low*
2.Stover Biomass,	*High*	*medium*	*Low*
3. Maturity period,	*Early*	*Average*	*Late*
4.Drought tolerance,	*High*	*medium*	*Low*
5.Pest resistance,	*High*	*medium*	*Low*
6.Diseases resistance,	*High*	*medium*	*Low*
7.Seed availability,	*easily available*	*available*	*difficu lt*
8.Seed input price,	*High*	*medium*	*Afford able*
9.Output market	*easily marketed*	*average*	*Difficu lty*

God Bless you & Thank you for your good cooperation and time-ASANTE SANA

Appendix 3. Checklist for Field Farmer Assessment and FGD

1. **Socio- Cultural and Socio –Economic Dimensions of Maize Grain and Maize Stover Preferences**

A. Maize production, management and utilization

1) What are the major crops grown in this area
2) What are the maize varieties you normally grow
3) Indicate the agronomic and general practices used for maize growing

- Fertilizer or FYM applications and rates
- Pesticides/weeding and frequencies
- Other practices

4) Why are local varieties still popular for both grain and stover?

5) Why many new varieties not grown? –Is it due to inherent variety characteristics or input-output marketing?

6) List the traits (attributes) that you prefer for a maize variety to posses

7) Rank the most attribute (traits) you prefer in ascending order and why do you assign that rank

8) For the varieties grown, rank the most preferred and indicate why you assign that rank

9) Do you receive support for maize production from external sources (credit-formal/informal, associations, extension, NGO, religious, policy) - mention the institute and support rendered by indicating or ranking its importance- Do any institution influence variety choice

10) indicate the maize utilization/ importance – as food/feed/cash (Give the proportion of how much goes for food/ feed or sold)

11) Differentiate preferences for and utilization of green maize and dry stover

12) Give suggestions on ways of improving maize varieties to suit your wants and needs.

2. Farming system perspectives

B. Maize grain and maize stover dynamics

13) Do maize grain and stover characteristics affect choice of livestock feed

14) What types or livestock are kept- indicate the breeds and proportion abundance in the village

15) How do you normally feed your livestock- common grazing/zero grazing/ both

16) When are the critical periods for livestock feed requirements?

17) Does the time for stover harvest affect the choice of maize varieties?

18) List types of livestock feed (both concentrates and fodder) do you normally use for your livestock feeding (proportional and seasonal importance of the feed type and why.

19) Indicate the timing calendar- when and why particular feed (concentrate /fodder) is used

20) What are the constraints of maize utilization as food and livestock feed- particularly the stover.

21) List by score orders the livestock production constraints (proportion pilling or likert scale

22). what are the tradeoffs (relative balance) of crops and livestock production and whether this affect choice of livestock feed?

C. Maize grain and maize stover marketing and institutional support

23) List the type of livestock feed resources purchased and or sold –(give the criteria of unit measure –volume vs weight)

24) Indicate the prices and marketing channel for livestock feed resources purchased and sold

25) Indicate the characteristics of maize grain for marketing

26) List the characteristics of maize stover suitable for your livestock feed and why.

Appendix 4. Mother trial Data collection sheet

MOTHER BABY
Mother (Green)

Planting date ____________

Plot area (m2) ____________

Mother Trial

Site ____________________________________

Rep	Bloc	Plot	Entry	Pedigree	Flowering		Height		Lodging		Num.	Num.	Field	Grain	Grain	Scores	Biomass	wt	dwt
					male	female	plant	ear	root	shoot	plants	ears	weight	weight	moist.				
1	1	1	11	PAN 6549															
1	1	2	9	LISHE-K1															
1	1	3	3	PAN 67															
1	1	4	7	LISHE - H1															
1	2	5	8	LISHE - H2															
1	2	6	1	SITUKA – 1															
1	2	7	10	SITUKA - M1															
1	2	8	2	KILIMA															
1	3	9	4	SC 627															
1	3	10	5	SC 403															
1	3	11	6	LONG 6H															
1	3	12	12	DK 8031															
2	4	13	9	LISHE-K1															
2	4	14	12	DK 8031															
2	4	15	1	SITUKA – 1															
2	4	16	5	SC 403															
2	5	17	11	PAN 6549															
2	5	18	4	SC 627															
2	5	19	7	LISHE - H1															
2	5	20	8	LISHE - H2															
2	6	21	2	KILIMA															
2	6	22	10	SITUKA - M1															

2	6	23	6	LONG 6H															
2	6	24	3	PAN 67															
3	7	25	5	SC 403															
3	7	26	4	SC 627															
3	7	27	2	KILIMA															
3	7	28	9	LISHE-K1															
3	8	29	3	PAN 67															
3	8	30	12	DK 8031															
3	8	31	7	LISHE - H1															
3	8	32	8	LISHE - H2															
3	9	33	10	SITUKA - M1															
3	9	34	1	SITUKA – 1															
3	9	35	11	PAN 6549															

Appendix 5. Data types, Cleaning and Transformation

1. Data types and Source

The study utilized mainly primary data obtained from smallholder farmers. Biophysical data included grain yield, biomass yield, plant height, ear per plant, pests and diseases score which were recorded for the periods from planting to harvesting stage.

Farmers' assessment data were uses of maize, criteria used to select varieties and rankings of variety and attributes preferences.

Focus group discussions dwelled on the topics of the position of maize stover as perceived by farmers as sources of livestock feed relative to other available feeds, feeds availability by season, and management.

During the interview, demographic characteristics of farmers such as age, gender, education levels, marital status and position of the respondent at the household data, were collected.

Other information were resources ownership like farm size, livestock numbers, use of farm and non farm income sources for livestock management, preference ranking of varieties for attributes for grain, stover and institution information such as proximity to the urban center from the household, crop sales, including maize grain and stover, livestock sales, prices of maize grain, stover, farm yard manure (FYM) and livestock and livestock products particularly milk and meat products.

2. Data Cleaning and Transformation

Before embarking into analysis all collected information were carefully cleaned to remove irrelevant data and/or outliers as well as computational conversions of some variables to allow them fit with the analysis /estimation method used.

Information on variety attributes assessment were modified basing on the three score points (1= lowest; 2= medium and 3= highest) into an index of farmer appreciation of a combination of all 9 variety characteristics (grain yield, sover yield, maturity period, drought tolerant, pest resistance, disease resistance, seed availability, seed price, and output marketing) for grain and stover attributes, aggregated using score weighting as: 9 lowest; 18 cut off point ; 27 highest. The higher the index the higher the appreciation.

Livestock number variable was also converted into livestock unit (LU). The LU for cattle usually of average size weight 250 kg in the area was 0.8; sheep and goats 0.2. Cattle, sheep and goat were multiplied with their respective index and summed up to obtain a livestock number variable (Pagot, 1992).

Appendix 6. Individual Site Results of Mother Trials (Green and Yellow)

	COMBINED ANALYS		AVEG RANK	NSHARA GN	NSHARA YL	KIVULINI GN	KIVULINI YL	KWARE GN	KWARE YL			
Variety	GY	RANK	GY+BIO	GY	GY	GY	GY	GY	GY	Plt height	EPP	Biomass(Rank)
SITUKA 1	5.29	8	9	7.27	4.93	5.03	3.34	6.7	6.84	158.89	2.36	3.27(10)
KILIMA	5.39	7	5	7.03	4.28	4.8	2.94	5.58	6.51	168.33	0.89	3.79(3)
PAN67	5.92	4	4.5	9.33	2.74	6.43	2.35	6.61	6.64	161.67	1.08	3.73(5)
SC 627	6.51	1	1	9.27	5.39	6.53	3.73	8.84	5.7	170	1.02	5.53(1)
SC 403	4.53	12	11.5	5.7	5.15	3.37	2.3	5.49	5.88	156.32	0.95	2.88(11)
LONG 6H	6.11	2	3.5	8.6	4.74	6.23	3.75	7.13	6.86	172.78	2.22	3.73(5)
LISHE H1	5.98	3	2.5	7.53	5.73	5.87	2.89	7.65	6.18	165.56	0.94	4.27(2)
LISHE H2	5.29	8	8.5	5.77	3.54	5.23	3.72	7.74	7	162.78	0.73	3.44(9)
LISHE K1	4.58	11	11	5.8	2.21	4.9	2.85	5.71	4.01	152.78	2.99	2.88(11)
SITUKA M1	5.45	5	6.5	5.7	5.75	5.03	3.78	7.31	5.95	158.89	1.01	3.43(8)
PAN 6539	5.45	5	6	6.2	5.34	3.37	2.77	7.08	7.03	157.78	1.27	3.47(7)
DK 8031	4.87	10	7	6.3	4	3.17	3.01	6.74	5.77	160.56	0.82	3.78(4)
MEAN	**5.45**			**7.04**	**4.48**	**5**	**3.12**	**6.88**	**6.2**	**162.17**	**1.35**	**3.68**
LSD	**NS**			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV	**40.61**			**32.93**	**35.42**	**23.63**	**20.47**	**21.53**	**22.22**	**17.69**	**222.17**	**45.58**
MIN	**4.53**			**5.7**	**2.21**	**3.17**	**2.3**	**5.49**	**4.01**	**152.78**	**0.73**	**2.88**
MAX	**6.51**			**9.33**	**5.75**	**6.53**	**3.78**	**8.84**	**7.03**	**172.78**	**2.99**	**5.53**

Notes: GN = Green (with fertilizer); YL = Yellow (without fertilizer), BIO=Biomass yield; GY=Grain yield; EPP= Ear per plant ( ) =contains rank

Appendix 7: Absolute ranking for maize varieties preference evaluation

Kware village

No	Variety	Rank
1	Situka 1	11
2	Kilima ST	12
3	PAN 67	6
4	SC 627	1
5	SC 403	7
6	Longe 6H	5
7	Lshe H1	2
8	Lishe H2	4
9	Lishe K1	10
10	Situka M1	8
11	PAN 6549	9
12	DK 8031	3

Kivulini and Kileo village

No	Variety	Rank
1	Situka 1	10
2	Kilima ST	8
3	PAN 67	7
4	SC 627	11
5	SC 403	12
6	Longe 6H	2
7	Lshe H1	1
8	Lishe H2	5
9	Lishe K1	3
10	Situka M1	6
11	PAN 6549	9

12	DK 8031	4

Nshara village

1	**Variety**	**Rank**
1	Situka 1	5
2	Kilima ST	9
3	PAN 67	11
4	SC 627	6
5	SC 403	1
6	Longe 6H	7
7	Lshe H1	2
8	Lishe H2	8
9	Lishe K1	3
10	Situka M1	10
11	PAN 6549	12
12	DK 8031	4

Appendix 8: Pair wise ranking for maize variety evaluation

Kware village

	Lishe H1	SC 627	DK 8031	Lishe H2	Longe 6H	PAN 67	SC 403	Situka M1	Total	Rank
Lishe H1	XXXX	SC 627	L H1	L H1	L H1	L H1	L H1	L H1	6	2
SC 627		XXXX	SC 627	SC 627	SC 627	SC 627	SC 627	SC 627	7	1
DK 8031			XXXX	L H2	L 6H	DK 8031	SC 403	DK 8031	2	5
Lishe H2				XXXX	L 6H	L H2	SC 403	L H2	2	5
Longe 6H					XXXX	L 6H	L 6H	L 6H	4	3
PAN 67						XXX	PAN 67	PAN 67	2	5
SC 403							XXX	SC 403	3	4
Situka M1								XXX	0	6

Kivulini and Kileo

	Lishe H1	Longe 6H	Lishe K1	DK 8031	Lishe H2	Situka M1	PAN 67	Kilima ST	Total	Rank
Lishe H1	XXX	L H1	L H1	L H1	L H1	L H1	L H1	L H1	7	1
Longe 6H		XXXX	L K1	L 6H	L 6H	L 6H	L 6H	L 6H	5	2
Lishe K1			XXXX	L K1	L H2	L K1	L K1	L K1	4	3
DK 8031				XXXX	L H2	Sit M1	DK 8031	DK 8031	2	5
Lishe H2					XXX	L H2	L H2	L H2	4	3
Situka M1						XXX	Sit M1	Sit M1	3	4
PAN 67							XXX	Kili ST	0	7
Kilima ST								XXX	1	6

Nshara village

	Situka 1	SC 403	SC 627	Lishe K1	Lishe H1	Lishe H2	Longe 6H	DK 8031	Total	Rank
Situka 1	XXXX	403	627	L K1	L H1	L H2	L 6H	L H1	**0**	**6**
SC 403		XXXX	403	403	L H1	403	403	403	6	2
SC627			XXXX	627	L H1	627	627	627	5	3
Lishe K1				XXXX	L H1	L H2	LK1	LK1	3	4
Lishe H1					XXXX	L H1	L H1	L H1	7	1
Lishe H2						XXX	L 6H	L H2	3	4
Longe 6H							XXX	L 6H	3	4
DK 8031								XXX	1	5

Appendix 9: Matrix ranking of different maize varieties

Kware village

	Maize varieties								**Total**	**Rank**
	Situka1	**SC 403**	**SC 627**	**PAN 67**	**Lishe H1**	**Lishe H2**	**Longe 6H**	**DK 8031**		
Drought tolerance	5	5	4	5	5	4	4	5	37	1
Disease/pest tolerance	5	5	5	4	5	5	5	3	37	1
High yield	3	4	5	3	5	4	5	4	33	4
Easiness to market	4	4	5	4	5	4	5	3	34	3
Early maturity	5	5	4	5	5	4	4	4	36	2
High biomass	3	5	5	4	5	4	4	3	33	4
Good poundability	5	5	5	5	5	4	5	2	36	2
Total	28	33	33	30	35	29	32	23		
Rank	6	2	2	4	1	5	3	7		

Key for scores: 1- Poor; 2- Satisfactory; 3- Average; 4 – Good; and 5 – Excellent

Kivulini and Kileo village

	Maize varieties								Total	Rank
	SitukaM1	**Lishe K1**	**Kilima ST**	**PAN 67**	**Lishe H1**	**Lishe H2**	**Longe 6H**	**DK 8031**		
High yield	4	4	3	4	5	4	5	4	33	3
Drought tolerance	5	5	4	4	5	4	4	5	36	1
Disease/pest tolerance	4	4	5	5	5	4	5	3	35	2
Early maturity	5	5	4	4	5	4	4	4	35	2
Easiness to market	4	5	5	4	5	5	5	3	36	1
High biomass	3	3	3	4	5	4	4	3	29	4
Good poundability	5	5	5	4	5	4	5	2	35	2
Total	30	31	29	29	35	30	32	24		
Rank	4	3	5	5	1	4	2	6		

Key for scores: 1- Poor; 2- Satisfactory; 3- Average; 4 – Good; and 5 - Excellent

Nshara village

	Maize varieties								Tota l	Ran k
	Lishe H1	SC 627	DK 803 1	Lishe H2	Long e 6H	Lish e K1	SC 403	Situk a 1		
Drought tolerance	5	4	5	4	4	5	5	5	37	1
Disease/pest tolerance	5	5	3	5	5	4	5	5	37	1
High yield	5	5	4	4	5	3	4	3	33	4
Easiness to market	5	5	3	4	5	4	4	4	34	3
Early maturity	5	4	4	4	4	5	5	5	36	2
High biomass	5	5	3	4	4	4	5	3	33	4
Good poundability	5	5	2	4	5	5	5	5	36	2
Total	35	33	23	29	32	30	33	28		
Rank	1	2	7	5	3	4	2	6		

Key for scores: 1- Poor; 2- Satisfactory; 3- Average; 4 – Good; and 5 - Excellent

Appendix 10: Outputs for MNL regresion results for variety choice

Multinomial logistic regression	Number of obs	=	76
	LR chi2 (24)	=	39.89
	Prob > chi2	=	0.0220
Log likelihood = -96.017057	Pseudo R2	=	0.1720

Pref	Coefficient	Std.Error	z	P>|z|	[95% Conf. Interval]	
PAN 67						
GENDER	0.033	0.862	0.04	0.97	-1.657	1.722
AGE	0.002	0.003	0.78	0.435	-0.003	0.008
LIVNUMBER	-0.295	0.15	-1.96	0.050**	-0.59	0
FAMSIZE	0.648	0.331	1.96	0.050**	-0.001	1.297
MAIZSALE	-1.412	0.871	-1.62	0.105	-3.12	0.295
EDUC	21.109	1.205	17.52	0.000*	18.747	23.471
CONSTANT	-20.704					
SC627						
GENDER	-0.227	0.801	-0.28	0.777	-1.798	1.344
AGE	-0.063	0.04	-1.56	0.119	-0.142	0.016
LIVNUMBER	-0.015	0.108	-0.14	0.886	-0.227	0.196
FAMSIZE	-0.039	0.365	-0.11	0.914	-0.755	0.676
MAIZSALE	1.117	1.119	1	0.318	-1.076	3.309
EDUC	2.113	1.312	1.61	0.107	-0.459	4.684
CONSTANT	-0.12	2.156	-0.06	0.956	-4.347	4.106

Pref	Coefficient	Std.Error	z	P>|z|	[95% Conf. Interval]

LISHE H1						
GENDER	-0.407	1.108	-0.37	0.713	-2.58	1.765
AGE	-0.006	0.018	-0.34	0.733	-0.042	0.03
LIVNUMBER	0.070	0.154	0.45	0.65	-0.232	0.372
FAMSIZE	0.318	0.409	0.78	0.436	-0.482	1.119
MAIZSALE	20.528	2.226	9.22	0.000 *	16.165	24.891
EDUC	1.122	1.407	0.8	0.425	-1.636	3.879
CONSTANT	-22.998					
PAN6549						
GENDER	-0.76	0.858	-0.89	0.376	-2.442	0.922
AGE	-0.011	0.037	-0.28	0.777	-0.083	0.062
LIVNUMBER	-0.098	0.118	-0.83	0.409	-0.33	0.134
FAMSIZE	0.676	0.35	1.93	0.053 **	-0.01	1.362
MAIZSALE	-0.992	0.967	-1.03	0.305	-2.888	0.904
EDUC	21.224	1.806	11.75	0.000 *	17.685	24.764
CONSTANT	-20.988					

(Pref==DK 8031 is the base outcome)

Appendix11: Outputs for Logit regressions for maize variety choice

Number of obs = 78

LR chi2 (7) = 13.21

Prob > chi2 = 0.0672

Log likelihood = -35.53116 Pseudo R2 = 0.1567

Pref	**Coefficient**	**Std.Error**	**z**	**P>|z|**	**[95% Conf. Interval]**	
PAN67						
ATRIBGRAIN	0.233	0.250	0.930	0.351	-0.257	0.724
ATRIBSTOV	-0.009	0.227	-0.040	0.968	-0.454	0.436
GENDER	0.175	0.743	0.240	0.814	-1.282	1.632
AGE	0.004	0.002	1.590	0.111	-0.001	0.009
LIVNUMBER	-0.303	0.135	-2.240	0.025**	-0.568	-0.037
FAMSIZE	0.227	0.206	1.100	0.270	-0.177	0.632
MAIZSALE	-1.479	0.707	-2.090	0.036 **	-2.865	-0.094
CONSTANT	-5.018	3.080	-1.630	0.103	-11.056	1.019

Marginal effects after logit

y = Pr(PAN 67) (predict)

= 0 .18175275

Variable	dy/dx	Std. Error	z	P>|z|	[95% C.I.	]	X
ATRIBGRAIN	0.035	0.037	0.940	0.349	-0.038	0.107	22.141
ATRIBSTOV	-0.001	0.034	-0.040	0.968	-0.068	0.065	22.154
GENDER*	0.025	0.105	0.240	0.808	-0.180	0.231	0.705
AGE	0.001	0.000	1.610	0.108	0.000	0.001	69.385
LIVNUMBER	-0.045	0.018	-2.500	0.012**	-0.080	0.010	4.064
FAMSIZE	0.034	0.030	1.110	0.265	-0.026	0.093	2.359
MAIZSALE	-0.275	0.149	-1.850	0.065**	-0.567	0.017	0.782

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Number of obs = 80; LR chi2(7) = 13.73

Prob > chi2 = 0.0562

Log likelihood = -31.741687; Pseudo R2 = 0.1778

SC627	Coefficient	Std.Error	z	P>|z|	[95% Conf. Interval]	
ATRIBGRAIN	-0.027	0.153	-0.180	0.858	-0.328	0.273
HHSTAT	1.400	1.366	1.030	0.305	-1.277	4.078
GENDER	-1.425	1.297	-1.100	0.272	-3.967	1.117
AGE	-0.084	0.043	-1.950	0.051	-0.168	0.000
LIVNUMBER	0.099	0.105	0.940	0.346	-0.107	0.305
FAMSIZE	-0.358	0.306	-1.170	0.243	-0.959	0.243
MAIZSALE	2.643	1.342	1.970	0.049	0.013	5.273
CONSTANT	0.847	3.371	0.250	0.802	-5.760	7.453

Marginal effects after logit; y = Pr(SC 627) (predict)= 0.02026035

Variable	dy/dx	Std. Error	z	P>|z|	[95% C.I.]	X

ATRIBGRAIN	-0.001	0.003	-0.170	0.866	-0.007	0.006	22.150
HHSTAT*	0.022	0.027	0.820	0.414	-0.031	0.076	0.713
GENDER*	-0.040	0.058	-0.680	0.496	-0.154	0.075	0.700
AGE	-0.002	0.001	-1.380	0.167	-0.004	0.001	68.713
LIVNUMBER	0.002	0.003	0.740	0.458	-0.003	0.007	4.025
FAMSIZE	-0.007	0.011	-0.660	0.507	-0.028	0.014	2.350
MAIZSALE*	0.032	0.035	0.930	0.350	-0.036	0.100	0.788

(*) dy/dx is for discrete change of dummy variable from 0 to 1,**note**: atribstov dropped due to collinearity

Number of obs = 70; LR chi2(8) = 15.38

Prob > chi2 = 0.0522; Log likelihood = -35.072129; Pseudo R2 = 0.1798

DK8031	**Coefficient**	**Std.Error**	**z**	**P>|z|**	**[95% Conf. Interval]**	
ATRIBGRAIN	0.233	0.261	0.890	0.371	-0.278	0.745
ATRIBSTOV	-0.321	0.241	-1.330	0.183	-0.793	0.151
EDUC	-1.937	1.051	-1.840	0.065**	-3.997	0.124
GENDER	0.893	0.752	1.190	0.235	-0.581	2.366
AGE	0.000	0.002	0.250	0.803	-0.003	0.004
LIVNUMBER	0.162	0.085	1.900	0.058**	-0.006	0.330
FAMSIZE	-0.480	0.298	-1.610	0.107	-1.064	0.104
MAIZSALE	0.922	0.847	1.090	0.276	-0.738	2.581
CONSTANT	1.685	3.023	0.560	0.577	-4.239	7.609

Marginal effects after logit; y = Pr(DK 8031) (predict) = 0.25672336

Variable	**dy/dx**	**Std.**	**z**	**P>|z|**	**[95% C.I.]**	**X**

		Error					
ATRIBGRAIN	0.045	0.050	0.900	0.371	-0.053	0.142	21.957
ATRIBSTOV	-0.061	0.045	- 1.350	0.177	-0.150	0.028	22.029
EDUC*	-0.442	0.228	- 1.940	0.053**	-0.890	0.006	0.900
GENDER*	0.155	0.115	1.340	0.179	-0.071	0.381	0.700
AGE	0.000	0.000	0.250	0.803	-0.001	0.001	70.886
LIVNUMBER	0.031	0.016	1.940	0.053**	0.000	0.062	4.057
FAMSIZE	-0.092	0.054	- 1.690	0.091	-0.198	0.015	2.300
MAIZSALE*	0.153	0.118	1.290	0.196	-0.079	0.384	0.786

(*) dy/dx is for discrete change of dummy variable from 0 to 1