RESOURCE ALLOCATION DECISIONS AND CONSTRAINTS OF SMALLHOLDER FINGER MILLET FARMING IN TESO DISTRICT

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KM15/2834/10

Thesis Submitted to Graduate School in Partial Fulfillment of the Requirements for the award of Master of Science Degree in Agricultural Economics of Egerton University

Declaration

This thesis is my original work and has not been presented in this or any other institution for the award of any other Degree.

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Abstract

Increased agricultural productivity offers a potentially powerful tool for spearheading broad based income gains among Africa's poor. To increase agricultural productivity there should be a shift from subsistence farming to market oriented production by smallholder farmers. Smallholders will normally produce; consume part of what they have produced and market the surplus thus the non-separable nature of production and consumption decisions. With this in mind there is need to focus on crops that while providing households with food security, they still can supplement households' cash income. Finger millet is one such crop that holds an advantage over maize in its drought tolerance ability and current high market prices. This study documents the role finger millet plays in the Teso farming system of western Kenya, resource constraints to increasing area under finger millet and models alternative scenarios for expanding the area under finger millet while relaxing key constraints.

Trained enumerators who filled in structured questionnaires interviewed a total of 117 farmers. The study used a linear programming farm model. Descriptive statistics is used to describe the role of finger millet in western Kenya along with constraints that impede increase in area planted to the crop. The study finds out that the majority of household heads had no formal education or did not finish primary education, had no access to extension and grew finger millet primarily for food. On average farmers had 3.5 acres of which 0.9 acres is planted to finger millet. Yields average 227kgs/Acre of which 151 kg is the average consumption requirement. Despite 96.5% of the farmers alluding to availability of a ready market, 86.5%cannot increase production in the long rains due to limited land and labor. The LP farm model also predicts that with subsidized fertilizer, hybrid seeds, good management practices and organized producer groups then smallholders could potentially specialize in finger millet production.

Dedication

To the new generation of the Chebelyons…Bill and Adrian Chebelyon

Acknowledgement

The writing of this thesis has been one of the most significant academic challenges I have ever faced. Without the support, patience and guidance of the following people, this study would not have been completed:

Prof. Margaret Ngigi, who despite of her other numerous academic commitments acted as my supervisor. Her professionalism, wisdom and keen eye inspired and motivated me.
Dr. Wellington Mulinge, my second supervisor for his patience and efforts during fieldwork.
Dr. Alastair Orr and entire ICRISAT team for their financial and technical support from the inception of this study to where it is now.

Dr. Chrispus Oduori for his many thoughtful and experienced insights into the study area.

My friends and colleagues Buckson Mwangi and Robert Ogeto for their persistent reminders and constructive criticism.

John and Betty, my parents, for their encouragement and constant support.

Corazon, my wife for her love, care and time spent working on this thesis.

It is to them that I owe my deepest gratitude.

Acronyms and Abbreviations

SAT	Semi-Arid Tropics
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
FAO	Food and Agriculture Organization
WRD	World Development Report
GDP	Gross Domestic Product
LP	Linear Programming
KES	Kenya Shillings
FM	Finger Millet
LR	Long Rains
SR	Short Rains

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CHAPTER ONE
INTRODUCTION

1. Background Information

Increased agricultural productivity offers a potentially powerful tool for spearheading broad based income gains among Africa's poor (Diao *et al*, 2007, Schott, 2003, Mellor , 2001). Agricultural productivity drives pro-poor growth, benefiting landless laborers since an increase in production leads to high demand for labor and thus employment opportunities. This also reduces urban poverty by slowing migration to the urban areas. Apart from contributing directly towards raising rural living standards, growth in agriculture also stimulates productivity in other sectors such as food processing. This is due to increased supply of raw materials to the agri-food processing industries. The market players along the agricultural supply chain also stand to profit from increased productivity, thus the need for developing economies especially those dependent on agriculture to focus on agricultural productivity.

Agro-industries contribute to overall economic development, alongside changes in poverty rates among those whose livelihood is linked to the agri-food economy. Developing countries have witnessed an emergence of agro-industrial enterprises as part of broader processes of agribusiness development (Silva *et al.*, 2009). For agriculture based economies like Kenya, moving the core economic activities from the farm gate to the agro-industrial sector represents diversification and leads to high levels of productivity and income generation as well as non-farm employment in rural areas. Demand for food and agricultural products are changing in unprecedented ways. Thus, the prospects for continued growth in demand for value-added food and agricultural products constitute an incentive for increased attention to agro-industries development within the context of economic growth, food security and poverty-fighting strategies. Therefore, for agro-industries to be in operation there is need to focus agriculture towards market oriented production rather than just production for household consumption.

Agricultural commercialization involves the transition from subsistence farming to increased market-oriented production. Market-oriented production entails modernization of systems, which depends heavily on the intensification of production process. Jayne *et al* (1996) argue that commercial orientation of smallholder agriculture leads to a gradual decline in real food prices due to increased competition and lower costs in food marketing and processing. They further conclude that these changes improve welfare of smallholder farmers in two ways: for consumers the low food prices increases their purchasing power for food, while for producers a decline in food prices enables the reallocation of limited household incomes to high value non-food agribusiness sectors and more profitable non-farm enterprises.

The main forces that normally drive commercialization include an increased market for food (as is already the case in most developing countries) arising largely from population growth and demographic change; urbanization; the development of infrastructure and market institutions; the development of the non-farm sector and broader economy; rising land opportunity cost; and macroeconomic trade and sectorial policies affecting these forces (Pinglani and Rosegrant, 1995). In Malawi, the process of agricultural commercialization has generally led to an increase in per Capita household incomes (Peters, 1999). In Nigeria cassava commercialization largely driven by urban consumers' preference has led to an increase in per capita purchases by rural households of most food items.

Rural farm households desire a diverse consumption bundle, they either undertake production of all such goods or specialize in the production of those goods it holds a comparative advantage – consuming a portion and trading the surplus for other goods and services for which it holds no comparative advantage. In addition, farm household must have access to productive technologies and adequate private and public goods in order to produce a marketable surplus (Barret, 2008). Smallholder farmers in developing countries are associated with semi-subsistence production, operating rudimentary production technologies with limited assets and modest participation, if at all, in competitive and regionally integrated markets offering remunerative terms of trade.

Sharma *et al* (2002) highlights that there is an urgent need to focus on improving crops relevant to the smallholder farmers and poor consumers in the developing countries of the Semi-Arid Tropics (SAT). Despite the importance of these crops; including sorghum, millet, cassava and others indigenous to Africa, their research in has largely lagged behind because they suffer something of an image problem and there often tends to be a preference for maize as the premier crop (Taylor *et al.*, 2003).

Sorghum and millet are crucial to the world food economy because they contribute to household food security in many of the world's poorest, most food insecure regions. In the main production regions in Africa and Asia 95% of the millet crop is consumed as food. A large proportion of farm households aim simply to produce enough grain to meet household requirements- and many often fail to meet this limited goal. Only a small proportion of the harvest is traded, mostly on local food markets (ICRISAT and FAO 1996). Taylor *et al* (2003), describes millet (and sorghum) as the most drought-tolerant cereal grain crops that require little input during growth and with increasing world populations and decreasing water supplies, represent important crops for future human use.

Finger millet is an important food crop in Kenya, it fetches over double the price of sorghum and maize (Oduori, 2000). Its good storability makes it good for food security, while the high nutritional value is stimulating industrial interest. Finger millet farmers face numerous challenges among them; labor shortages, credit access, weeds infestation and pest and diseases. These constraints are further compounded by competition from other crops. Despite these challenges, finger millet is still widely used and valued and also has industrial potential.

In order to enhance and extend demand for finger millet for market orientation, there is need for a strategic shift to commercial production. Finger millet is produced in rural areas while commercial processors are usually based in larger urban centers for instance the processing industry for finger millet in Nairobi is the largest in the Eastern and Southern Africa region sourcing raw millet from rural Eastern Uganda and Western parts of Kenya. Demand for finger millet is high and its popularity is spreading all over Kenya and hence opening up a large market. High demand and availability of market notwithstanding, quantities traded in Kenya are still largely confined to cross-border transactions.

1.1 Problem statement

Despite high market demand for finger millet in Kenya, the supply for the Nairobi processing industry is met by Uganda and Tanzania. Several reasons have been given for the failure to develop an efficient supply chain within Kenya. These include growers' preference for maize as a source of food security, competition by other crops for scarce land, labor shortages, and competition from the market for local beer; there is uncertainty on the potential role of finger millet would play as a supplier of malt were the market for local beer be completely legalized and/or liberalized. Nonetheless, micro-studies on smallholder farm modeling and constraints to expanding production and marketing of finger millet in Kenya are scant.

1.2 Objectives

1.2.1 The broad objective

The General objective of this study was to enhance the livelihoods of smallholder farmers through augmented production of finger millet in Kenya.

1.2.2 The specific objectives

The specific objectives of this study are:

1. To examine the role finger millet plays in the smallholder farming systems in Western Kenya.
2. To determine resource constraints on expanding the area currently under finger millet.
3. To model alternative scenarios for expanding the area planted to finger millet, relaxing key constraints such as labour, land and other variable inputs.

1.3 Research Questions

1. What role does finger millet play in the Teso farming system?

2. What are the resources or other constraints restricting expansion of area currently planted to finger millet?

3. Can area under finger millet and yields be expanded if key constraints are relaxed?

1.4 Justification

Integrating traditional smallholder farmers into the exchange economy is important for stimulating growth, rural and overall economic development, food security and poverty alleviation (Omiti *et al.*,2006). With limited alternatives for earning cash income and no crop insurance, smallholder farmers largely depend on their own production for food, feed and fodder needs (Nagarajan and Smale, 2005). There is a surge in demand for millet for both food and nonfood uses since they are known to offer both nutritional and livelihood security for human beings and fodder security for diverse livestock populations in dry land regions. Due to its many uses finger millet fetches a high price in the market thus would be a source of income for many rural households. There is a high demand for finger millet by urban processors and for domestic consumption; this provides an incentive for expanding production of finger millet by farmers in western Kenya.

In light of all these, the study will attempt to document the constraints to expanding production and thus hope to address them ultimately, improving the incomes and food needs of the rural smallholder farmers. It is also expected that the findings of this study will aid in understanding impacts of policies and determine the size and magnitude of exogenous shocks on household-farm behavior, (say an increase in the price of finger millet or a subsidy in the price of seeds) on variables of interest, including production, consumption, marketed surplus and household resource use.

1.5 Limitations of the study

The study was conducted in Teso District of Western Kenya and not any other District in the region. The study also focused on smallholder farmers particularly those producing finger millet amongst other cereals. Being a production study, it only focused on that.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

2.2 Review of Past Studies

2.2.1 Agro-Processing and Poverty Alleviation

Poor rural areas in Africa are characterized by low total incomes for most people, with limited consumption and expenditures, a poorly developed monetary economy and markets (for agricultural inputs, outputs, and consumer goods and services) which are relatively thin and prone to large seasonal variability in demand and supply. Strong growth in the supply to large domestic agricultural markets could have significant impacts on overall economic growth and poverty alleviation, but the demand for staples is relatively price inelastic (Poulton *et al.*, 2006).

According to World development Report, WDR, (2008), strong synergies can exist between agribusiness, the performance of agriculture and poverty alleviation; this means that efficient agribusiness can spur agricultural growth and a strong link between agribusiness and smallholder farmers can reduce rural poverty levels. Within the manufacturing industry, the agro-processing sector occupies a significant position in overall turnover in developing economies. WDR (2008), points out that the agro-industry contributes a share of 61% to total manufacturing in agriculture based countries like Kenya, 42% in countries in transformation and 35% in urbanized developed countries.

Agricultural growth is the primary source of poverty reduction in most agriculture based economies like Kenya. Literature points out that the expansion of smallholder agriculture can lead to faster rate of poverty alleviation, by raising the incomes of rural cultivators and reducing food expenditure, and thus reducing income inequality; see Diao and Hazzel (2004), Bahram and Chitemi (2006), Anriquez and Stamoulis (2007).

Transition from agriculture to other sources of income presents a higher potential for poverty reduction. In this context many studies have suggested increase in productivity in agriculture that would allow movement of workers from agriculture to other sources of income and in particular industrialization are necessary for growth and poverty reduction (Gollin *et al.*, 2002). Since agro-industry is a very significant way of adding value to agricultural products, it offers an important way to transit towards industrialization, whereby countries industrialize based on competitive advantage in agri-food processing then increasingly move away from this source of competitive advantage by creating new sources that lead to industrial development, with a declining Gross Domestic Product (GDP) coming from agriculture.

2.2.2 The Case of Markets in Rural Agricultural Economies

Markets fail when the cost of a transaction through market exchange creates disutility greater than the utility gain that it produces, resulting in the market not being used for transaction. De Janvry *et al* (1991) point out that either a surrogate institution will emerge to allow the transaction to take place or the transaction will simply not exist. Generally, the market exists, but the gains by a particular household may be below or above cost, resulting in some households using the market while others do not. Market failure is therefore not commodity specific but household specific. When a market fails for a particular household, the corresponding commodity becomes a non-tradeable for that household (De Janvry*et al*., 1991).

There exists wide spread empirical evidence on market failures. Examples include the study by Goetz *et al.,* (1988) in southeastern Senegal where they found that 99% of peasant households assert that they prefer growing enough food for subsistence to relying on markets. Von Braun *et al.,* 1989) observe in Guatemala and Philippines that peasant households continue to grow their own food, and more so as income rises, instead of increasing production of cash crops which will provide higher returns to labour and land than the sale of a marketed surplus of food.

Waithaka *et al,* (2006) points out that although smallholder farming is a hard calling, there are farmers who are successful, those who grow a cash crop with a guaranteed market along with food staples. Many farmers are not always aware of the options available that would help them achieve their objectives and would benefit if they were exposed to different options. Even where farmers are aware of the potential benefits of alternative technology options, they are constrained by market failure and the heavy burden of providing for many people who depend solely on small farms. Overall, rural development strategies aimed at improving market access for both inputs and outputs and value addition are critical to improving income generation and therefore land and labour productivity in rural areas. Policy research on strategies that would enhance scaling up of successful innovations should be encouraged.

2.2.3 Agricultural Households' Goals

In his study in Eastern Kenya, Parton (1993) notes that the principal goals of the farm household include food security, dietary preference, and the education of children. The high priority given to food and food security goals were signified by the fact that subsistence food crops were accorded preference in order of planting, application of manure and were grown on the best land. In seasons of poor crop performance, farmers often sold livestock to meet family subsistence and cash needs. However, most farmers attempted to store enough grain for one season so that they did not have to sell livestock when a season's shortfall in crop production occurred. The long storage ability of finger millet coupled with its high tolerance to drought could make it a better crop for both subsistence and cash needs of a farm household.

2.2.4 Production trade-offs

Household level trade-offs between food and cash crops production occur when the households participation in a commercialized crop scheme enables it to acquire resources not otherwise available for use in other enterprises in the crop mix (Govereh *et al.,* 1999). In Zimbabwe, Mariga (1994), points out that private cotton marketing firms administered a credit line for inputs and equipment. The equipment package included ploughs that could be used in maize production and thus increasing farmers' profits. This highlights the potential non-separability between production technologies used in food crop production and the decision to grow selected cash crops and thus enabling farmers participate in associated markets.

Strasberg *et al.,* (1999), finds out that in Kenya, the presence of commercially viable cash crops such as groundnuts and cotton had positive spillover benefits for smallholder food production. This spillover benefits included increased adoption of fertilizer on food crops made possible by cash crop input delivery channels. Thus there is a general consensus that intensification of cash cropping promotes food crop production at the farm household level.

2.2.5 Constraints to Smallholder Agriculture

Salami *et al.*, (2010) noted that in East Africa sustained gains to agricultural productivity are threatened by land degradation, especially soil erosion and loss of fertility. The study concludes that clear land use and agricultural policies need to be developed to provide a framework for researchers, extension workers and smallholder farmers on environmentally sensitive practices. The lack of clarity of property rights and inequitable access to land exacerbate the land degradation constraint.

For investment, smallholder farmers rely on savings from their low incomes, this limits opportunities for expansion. Because of lack of collateral and credit history, most farmers are bypassed by banks and formal microcredit institutions. While more recently microfinance institutions have taken financial services to previously unbankable clients, they have so far largely failed to reach poorer rural areas and smallholder agricultural producers whose livelihoods are characterized by highly seasonal investments, risk and returns (Peacock *et al.*, 2004).

Smallholder farmers are normally constrained by access to inpit and output markets. The access to both markets is a key precondition for the transformation of the agricultural sector from subsistence to commercial oriented production. In the study by Salami *et al.*,(2010), in Kenya, Uganda and Tanzania, observed that all these countries are still grappling with marketing of both agricultural inputs and outputs, with markets not adequately equiped to serve the needs of the poor. Adeqaute storage facilities constitute another constraint to marketing and food security: In Afirca, large quantities of agricultural commodities produced by farmers tend to rot away unmarketed, while the smallholder farmers do not have the technology for timely consumption (Kamara *et al*., 2002).

2.2.6 Modelling Agricultural Household Resource Allocation Decisions

Individual farmers must repeatedly make decisions about what commodities to produce, by what method, in which season and in what quantities. Decisions are made subject to the prvailing farm physical and financial constraints, and often in the face of conciderable uncertainity about the planning period ahead. Uncertainity may arise in forecasted yeilds, costs and prices for the individual farm enterprises, in enterprise requirements for fixed resources, and in the total supplies of the fixed resources available. Traditionally farmers have relied on experience, intuition and comparison with othe neighbours to make their decisions. It is only with recent advances in mathematical programming that satisfactory procedures have been developed for whole farm planning in more complex situations.

Alexander Chayanov, working with survey data collected from peasant farms in late 19^{th} century and early 20^{th} century developed an economic model of the peasant family farm. The model was intended to identify the determinants of resource allocation in peasant households and the distribution of income among them. In this model the key features of the household economy was the interdependence between consumption and production and the absence of wages as a category of production cost. Chayanov argued that the demographic characteristics of the household largely determined the scale of production. This model was firmly based on neo-classical marginal utility analysis and has been found to be consistent with more rececent theoretical and empirical studies of peasant resource allocation concerning risk aversion, price response and the subsistence share in peasant production, (Chayanov, 1966).

Wallace and Moss (2001) used recursive strategic programming to analyse farmers’ decision making with conflicting goals. The study examined goal oriented farmers’behaviour within a dynamic modelling framework. The technique included a set of goals in a composite objective function refered to as achievement function and sought to minimize the deviations among the desired level of goals and the actual achievement. The study found out that short run profit could be traded for the attainment of other goals, such as avoidance of borrowings. The effects of the goal structures on farm profit were quite small, reflecting the fact that profit goal complimented the attainment of other goals. This simply means that in the short run, profits realised from farm produce sales could be used to purchase other goods not produced thus not affecting the households consumption goal instead complementing.

Tittonel *et al* (2007) using the inverse modelling technique analyzed trade-offs in resource and labour allocation in Western Kenya. The technique allowed for the analysis of trade-offs between different farmers' objectives and to compare resource allocation strategies to achieve them. The approach combined details on the underlying crop, maize, and soil bio-physical processes, and their feedbacks accounting for a farmer's likely goal (like increasing food production, reducing erosion) through optimization. The approach has an advantage over Multiple Goal Linear Programming which does not account for biophysical processes.

Generally, inverse modelling and linear programming have been used to model farm household decision making. Linear Programming model is an optimization that identifies a production plan that maximizes peasant net income under various policy instruments. Since this study does not wish to encompass any biophysical processes then it adopts a linear programming farm model. This choice is made on the basis that smallholder finger millet farmers form the population of this study. Smallholder finger millet farmers need to move towards market oriented production so as to achieve commercial levels. This means that they should aim at maximizing gross margins from finger millet which can then supplement their cash incomes while still ensuring food supply to the household.

Optimization is at the core of most modeling of decision-making. It is based on the observation that people, including subsistence farmers in the rural African Households, generally want to do the best for their families, they are also reasonably rational (Brown, 2000). Wanting the best and being reasonably rational, they are therefore best modeled as optimizers, constrained optimizers, given that resources are not infinite.

2.3 Theoretical Framework

The study proposes to use a concept founded on the theory of the farm household model developed by Singh, Squire, and Strauss (1986), and de Janvry, Fafchamps, and Sadoulet (1991) and Taylor and Adelman (2003).

Farmers continually make decisions concerning how they allocate their resources; this behavior is motivated by desire to maximize levels of satisfaction otherwise termed utility. Thus, to understand the manner in which farmers allocate their resources, knowledge is required of important motivational factors- goals, objectives and values- that are the focal points of their decision (Wallace 2002). Most studies that have modeled farmer decision-making have assumed a single objective of profit maximization as the motivation for decision-making. This is not always the case; farmers are normally motivated by multiple, often conflicting, goals of which profit maximization is only one (Wallace 2002). Thus, utility cannot be equated to profit because smallholder farm households simultaneously take into account consumption and production (Kruseman 1995). Therefore, in such situations the decision maker is usually seeking an optimal compromise among several objectives that could include increasing gross margins, reducing indebtness, avoiding risk, expanding the business, improving family living standard and achieving sufficient leisure time.

In their struggle to achieve these objectives, smallholder farmers are usually constrained by a number of factors normally by the full income of the household, total time allocated to farm production and leisure and a fixed production technology. The production technology combines purchased inputs and labor with physical characteristics of the farm, which are fixed in a single decision making period. Full income in a single decision making period is composed of the net farm earnings (profits) from crop production, of which some may be consumed on the farm and the surplus sold, and income that is 'exogenous' to the seasons' crop and variety choices, such as stocks carried over, remittances, pensions and other transfers from previous seasons.

At the core of this theory is the issue of separability –that is, whether the household's production, consumption and labor decisions are simultaneously or jointly determined (non-separable) or the decisions are recursive (separable). In the separable case, the household is a perfect neo-classical household, and farm decisions regarding inputs and outputs are taken first and the net income derived can be used to solve the consumption decisions. In developing economies like Kenya and marginal production environments, market failures exist. Market failure results in non-tradable outputs or factors of production (De Janvry *et al*.,1996). Realistically, households often face mixed markets, where both tradable and non-tradables exist (Taylor, 2003).In real life, households may face missing markets for some goods but not others, resulting in a mixture of tradable and non-tradeables at the household level. Markets for food may exist, with market determined prices, but the labor market may not as high labor transaction cost discourage hired labor use.

The sources of non separability include both aspects related to production decisions and those related to consumption decisions. Farmers in western Kenya face imperfect grain markets; In addition, they grow multiple crop varieties as an ex-ante risk strategy – either to mitigate production or price and income risk due to a certain kind or degree of market imperfections. Although it may not be profitable to grow finger millet for off- farm sale, a household may opt to grow a certain variety for food or fodder because of taste or food preference that are not easily substituted through market purchases. Farm households also face high transaction costs thus do not make transaction decisions based on market prices largely attributed to limited market access. Hence, households who produce finger millet may remain self-sufficient, consuming what they grow.

It is because of these reasons (high transaction costs, market imperfections and price and income risk) that smallholder farmers face multiple trade-offs when deciding on the allocation of their available financial, labor and nutrient resources to competing production activities within their farms. Such trade-offs are reinforced by their limited access to production resources and poor development of factor markets. This concept of trade-offs is fundamental to economics and originates from the fact that resources are scarce. Consequently to obtain more of one scarce good, an individual must give up some amount of another scarce good.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

3.2 Research Design

The study used both primary and secondary data. Primary data were collected in March to April 2012 through a farm household survey. This was during land preparation in anticipation of the long rains for agricultural year 2012-2013. The collection of this primary data was guided by a structured questionnaire, which was informed by emerging themes from key informant interviews that were conducted in the study area before data collection began and were pretested and administered by trained enumerators. Secondary data were obtained from desktop review of various literature sources. Analysis was done using EXCEL® and SPSS.

3.3 Target Population

Teso District is in Western Kenya and lies between latitudes 0^0 .29' and 0^0 .32' north and longitudes 34^0 .01' and 34^0. 07' east and has an area of 559 kilometers square. Most parts of the District receive between 1270 and 1790 millimeters mean annual rainfall; suitable for both food and cash crops. The economy of the district is agricultural based with 68% of the population involved in one form of agricultural production or the other. Teso District has four administrative divisions namely; Amagoro, Angurai, Amukura and Chakol. The table below summarizes selected demographic indicators for the district.

Demographic Variable	Quantifier
Total Population	**197,395**
Total number of households	38,258
Number of males	95,631
Number of females	101,764
Female/Male sex ratio	100:94
Number of youthful population (15-25 years)	43,776
Labor force (15-64 years)	95,065
Dependency ratio	100:108
Population growth rate	2.8%
Income from Agriculture	65%
Income from rural self employed	18%

Table 1: Demographic Indicators of Teso District

Source: District Statistics Office, 2001

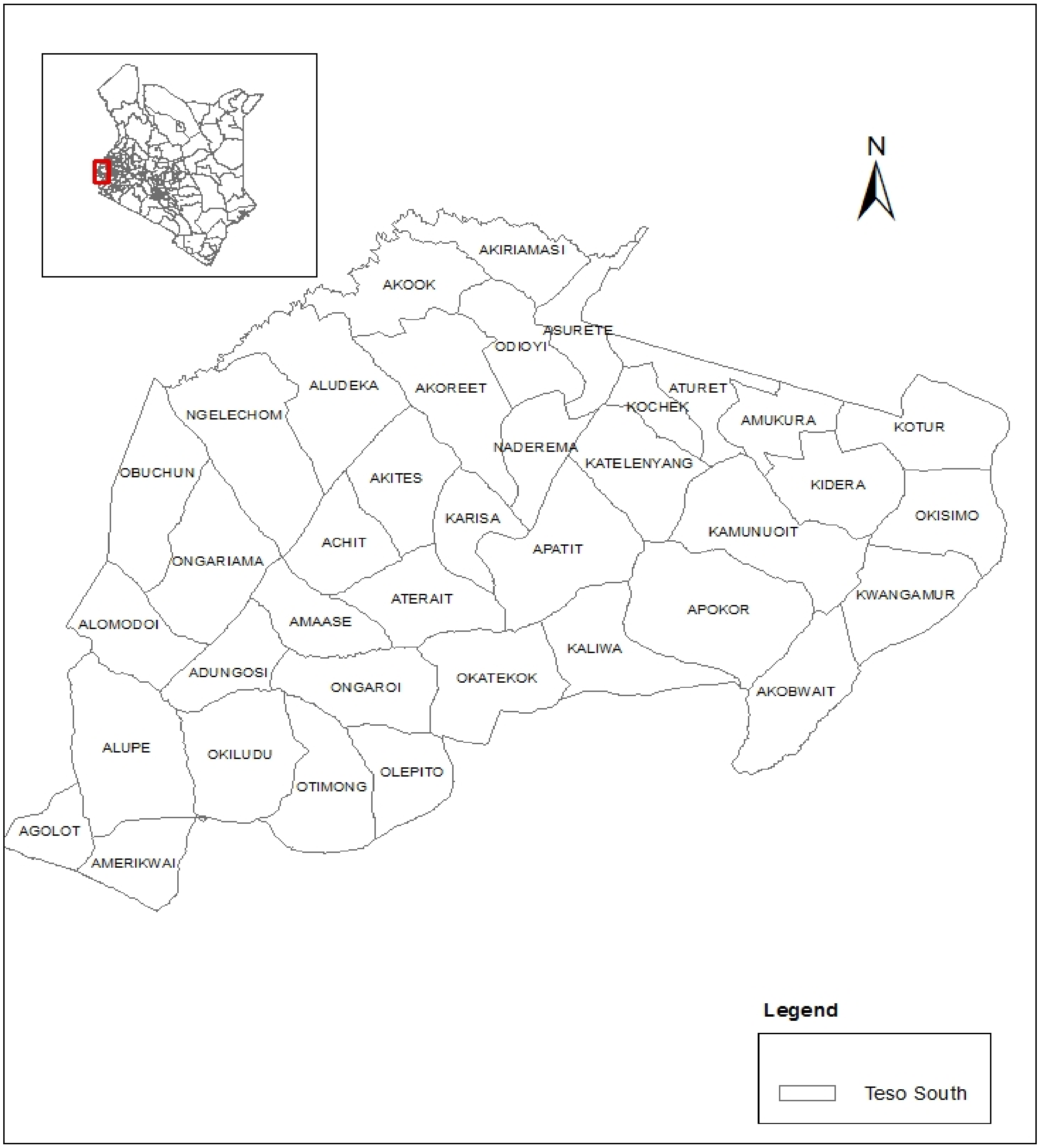


Figure 1 Map of study site

3.4 Sampling and Design Procedure

The study surveyed finger millet farmers in Teso District which was purposively chosen. This is because the district is predominantly a finger millet producing area. Salasya *et al.,* (2009), reports that 84.3% of farmers grew finger millet in Teso District. They further found out that 54.3% of respondents in Teso were registered in organized farmers' groups. Amukura Division was selected at random and a sampling frame obtained from the Divisional Agricultural Office. This sampling frame consisted of farming households in the division. A random sample to select 2 locations was done and Apegei and Asinge locations were selected. From the two locations a random sample of 117 households was drawn as per the explanation below. When a selected household did not grow finger millet the previous year/season then it was replaced by the closest household that did. Since it is anticipated that about 85% of farmers in the region grow finger millet then Kothari (2004) sample size determination technique will be used;

$$n= \frac{(z^2) . (p)(q)}{(e)^2}$$

Where n= the desired sample size,

z = the value of the selected alpha level (α= 0.05)

p=the estimate of the proportion of finger millet farmers in the district(85%)

q = 1-p

e = the acceptable margin of error (6.5%= 0.065).

$$n= \frac{(1.96)^2 (0.85)(0.15)}{(0.065^2)} = 115.92 \approx 116$$

3.6 Data Analysis Methods

3.6.1 Descriptive Statistics

Various graphs and charts are used to illustrate proportions of farmers growing finger millet and the cereal crop diversity on their farms and also constraints on expanding production. Farm household socioeconomic data and variables of data analysis are presented through means, standard deviations and percentage frequency distributions.

i. The linear programming farm model

For a given farm situation the linear programming model requires specification of

a) The alternative farm activities, their unit of measurement, their resource requirements and any specific constraints in their production.
b) The fixed resource constraint of the farm
c) The forecast activity returns net of variable costs, otherwise called gross margin

To formulate the problem mathematically we introduce the following notation:

Z = Total Gross Margin

X_j – the level of the j[th] farm activity, such as acreage under finger millet. Let n denote the number of possible activities; then j=1……….n.

c_j – the forecasted gross margin of a unit of the j[th] activity say shillings per acre

a_{ij}– the quantity of the i[th] resource (land, labour and working capital) required to produce one unit of the j[th] activity. Let m denote the number of resources; then i=1………m

b_i- the amount of the i[th] resource available (say acres of land or number of labourers)

With this notation, the model can thus be written as;

$$\max Z = \sum_{j=1}^{n} cj\ Xj$$

Such that

$$\sum_{j=1}^{n} aij\ Xj \leq bi, \quad all\ i = 1 \dots \dots \dots m$$

And

$$Xj \geq 0\ all\ j = 1 \dots \dots \dots \dots \dots n$$

Three crops can be grown each year; maize, finger millet and sorghum- each of which has specified labor requirements per hectare. Let: X_1 = maize X_2 = finger millet, X_3 = sorghum. For all the crops grown, female and male labor will be allocated, along with land. Being smallholder farmers who make production and consumption decisions simultaneously then gross margins will be maximized subject to consumption constraint. The different quality of labor (male, female) has been chosen discretely because the main crop in focus is finger millet. Female labor is always cited as critical for weeding and threshing of finger millet and thus the need to be included into the linear programming model.

Algebraically, the model can be formulated as

Max $Z = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3$

Subject to

$X_1 + X_2 + X_3 \leq b_1$…………………………………………… (1) Land constraint

$\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \leq b_2$ …………………………………… (2) Female labor constraint

$\mu_1 X_1 + \mu_2 X_2 + \mu_3 X_3 + \leq b_3$ …………………………….………… (3) Male labor constraint

$Ƶ_1 X_1 + Ƶ_2 X_2 + Ƶ_3 X_3 \geq b_4$ …………………..…………………… (4) HH consumption constraint

$X_1, X_2, X_3, \geq 0$

Where

b_1= Total land size

b_2= Total household female labor supply

b_3= Total household male labor supply

b_4= Maize and finger millet consumed by household and

α, β, μ, and Ƶ = are the parameters to be estimated

CHAPTER FOUR

DATA ANALYSIS, PRESENTATIONS AND INTERPRETATION OF FINDINGS

4.1 General Household Characteristics

Lloyd *et al*, 1993 suggested that the gender of the head of the household affects the manner in which household resources are utilized and disbursed within the household. Of the households studied 76.1% were headed by men while 23.9% were headed by women. When analyzed by farm size, 74.5% were male headed households in the land size category 0.5-2.5 acres while 64.9% and 93.1% in the subsequent land sizes as presented in the table.

Chi-Square test for association between gender and farm size indicates that there is a statistically significant association since p=0.027 which is less than 0.05, this means that men have significantly different sizes of land holdings compared to women.

Table 2: Gender of Household head across farm sizes

	0.5- 2.5 Acres		**2.6 - 4.5 Acres**		**4.6 Acres and above**	
Gender of HH Head	Male	Female	Male	Female	Male	Female
Percent	74.5	25.5	64.9	35.1	93.1	6.9
Chi Square Test	.027					
N of Valid cases	117					

Age of Household Head did not vary significantly across the farm sizes, neither did Household size. The average age of the household age was 47.9 years, however, the mean was 52.7 years for households with 4.6 acres and above compared to 45.7 years for those with 0.5 to 2.5 acres. The average household size was 5 members of which 3 contributed to farming activities.

Table 3: Average age of HH head and size of household across land sizes

			HH Head Age in Years	**HH Size**	**Number of HH members contributing to farm activities**
Farm Size (Acres)	0.5-2.5 Acres	(N=51)	45.67	5.06	3.65
	2.6-4.5 Acres	(N=37)	47.16	4.73	3
	4.6 + Acres	(N=29)	52.72	5.28	3.48
All	(N=117)		47.89	5.01	3.4
P value			0.137	0.482	0.185

Farmer organizations lead to active and effective farmer participation in value chains. Despite 91.5% of households interviewed being full time farmers only 29.1% were registered to a farmer organization and 40.2% had access to extension services. The low level of farmer association therefore means that farmers may not be provided with many services that are critical to their success in accessing markets.

4.2 Finger Millet Production

Majority, 65.8%, of households primarily grew finger millet for food while 34.2% for cash, thus finger millet is an important crop in their farming system. This gives further empirical evidence to the theory of the farm household model, that is, production and consumption decisions are non-separable thus these households will first produce food then sell the surplus to purchase what they cannot produce.

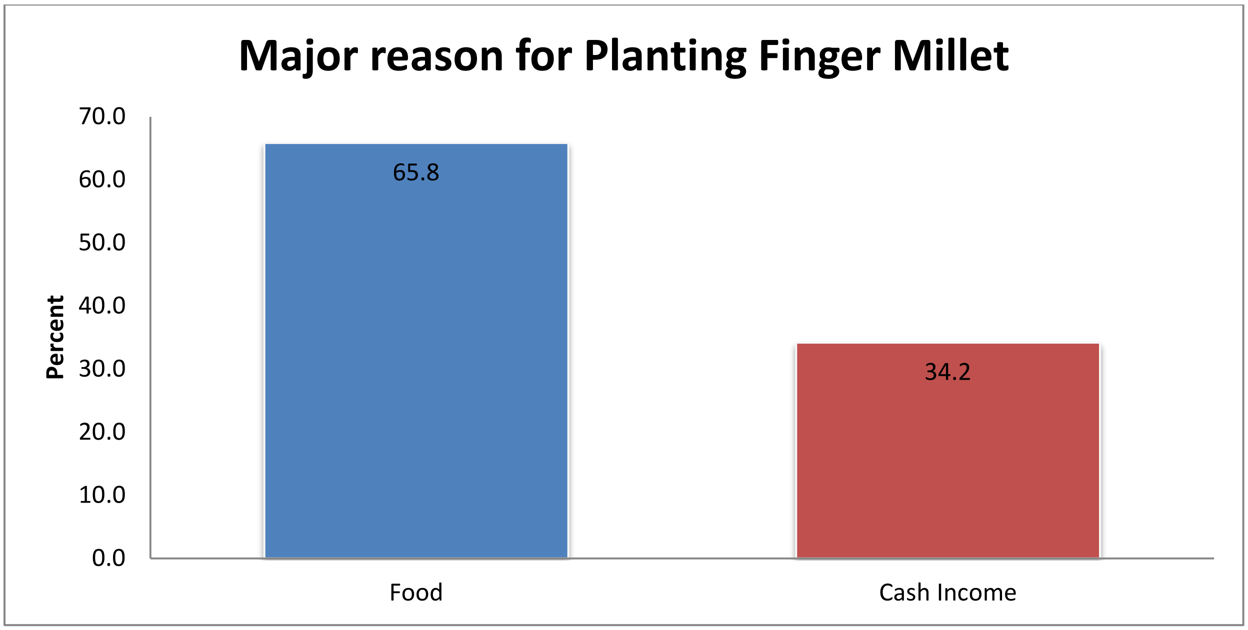


Figure 2: Major reason for growing finger millet

The study finds 73.5% of the respondents planted their finger millet in pure stands, only 10.3% planted in rows as opposed to 89.7% who broadcast. As a crop husbandry practice, broadcast sowing is likely to be a barrier to swift and effective weeding. Nyende *et al*, (2001) found out that row planting cost four times as much as row planting but resulted in reduced weeding and harvesting expenses, and greater production.

Land Size	N	% Planting in pure stands	% Row Planting	% with adequate storage	% with access to market information	% with access to ready markets
0.5-2.5	51	78.4	9.8	100	72.5	98
2.6-4.5	37	62.2	8.1	100	64.9	97.3
4.6 +	29	79.3	13.8	89.7	65.5	93.1
Total	117	73.5	10.3	97.4	68.4	96.5
Chi Square		3.582	0.591	9.343	0.731	1.377
P Value		0.167	0.744	0.009	0.694	0.502

Table 4: Planting characteristics and access to markets

As land size increased there was an increase in area planted to finger millet and also an increase in finger millet output. In the 0.5-2.5 acre land size they had a mean of 0.6 acres under finger millet and had an output of 2.16 bags (216Kgs) compared to farmers with 2.6-4.5 acres having 0.85acres under millet and producing an average of 2.47 bags and farmers with 4.6 acres and above having 1.46 acres under finger millet with an average output of 3.50 bags.

	Total Land Size			**Area Cultivated Finger Millet**			**Total Output Finger Millet**		
Farm Size	0.5-2.5 (N=51)	2.6-4.5(N=37)	4.6 and above(N=29)	0.5-2.5 (N=51)	2.6-4.5(N=37)	4.6 and above(N=29)	0.5-2.5 (N=51)	2.6-4.5(N=37)	4.6 and above(N=29)
Mean	1.67	3.52	7.02	0.60	0.85	1.46	2.16	2.47	3.50
Std. Deviation	0.52	0.51	3.56	0.27	0.39	0.78	1.39	1.63	2.58
Std. Error	0.07	0.08	0.66	0.03	0.06	0.14	0.19	0.26	0.48
Sig.			0			0			0.008

Table 5: Average land size, area planted to finger millet and output

One way ANOVA resulted in a statistically significant difference between farm size and area under finger millet and total output at 0.05 significance level.

4.3 Finger Millet Marketing

The table below summarizes the marketing channels used by the households in selling their finger millet:

	Middlemen	Village Brewer	Cereal Traders	Industrial Miller
0.5-2.5	58.8	13.7	27.5	0
2.6-4.5	45.9	13.5	40.5	0
4.6 and above	34.5	3.4	55.2	6.9

Table 6: Finger millet marketing across land size

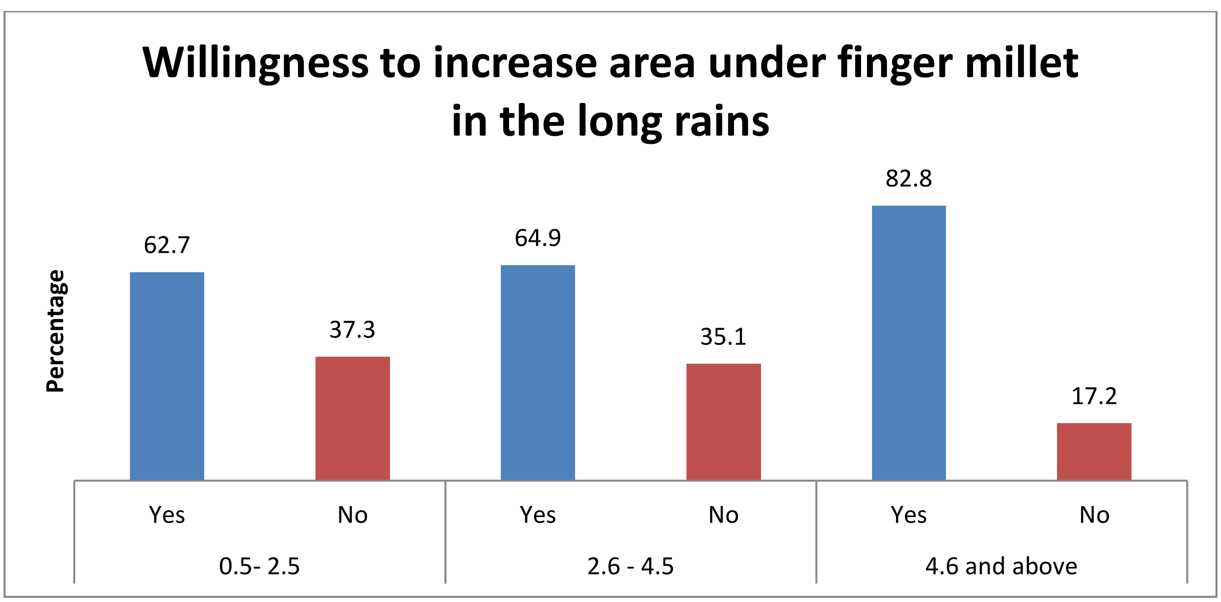
Of notable importance is the fact that as farm size increase then less farmers sells to middlemen and village brewers. There is an increase in number of farmers selling to cereal traders instead. A few farmers with 4.6 acres and above sold to industrial millers due to the fact that they had the bulk required by this market. Though illegal, the village brewer presents a good market for the farmers produce if liberalized.

4.4 Finger Millet Production Constraints

Salasya *et al*., (2008), state that main constraints for finger millet farming in western Kenya were that it is labor intensive, low soil fertility and low yielding varieties in order of importance. This study therefore did not focus on these constraints rather it did on constraints to expanding area planted to finger millet in both seasons (Long Rains and Short Rains).

Respondents were asked if they would consider increasing the area planted to finger millet in the short rains:

Figure 3: Willingness to increase area under FM in LR

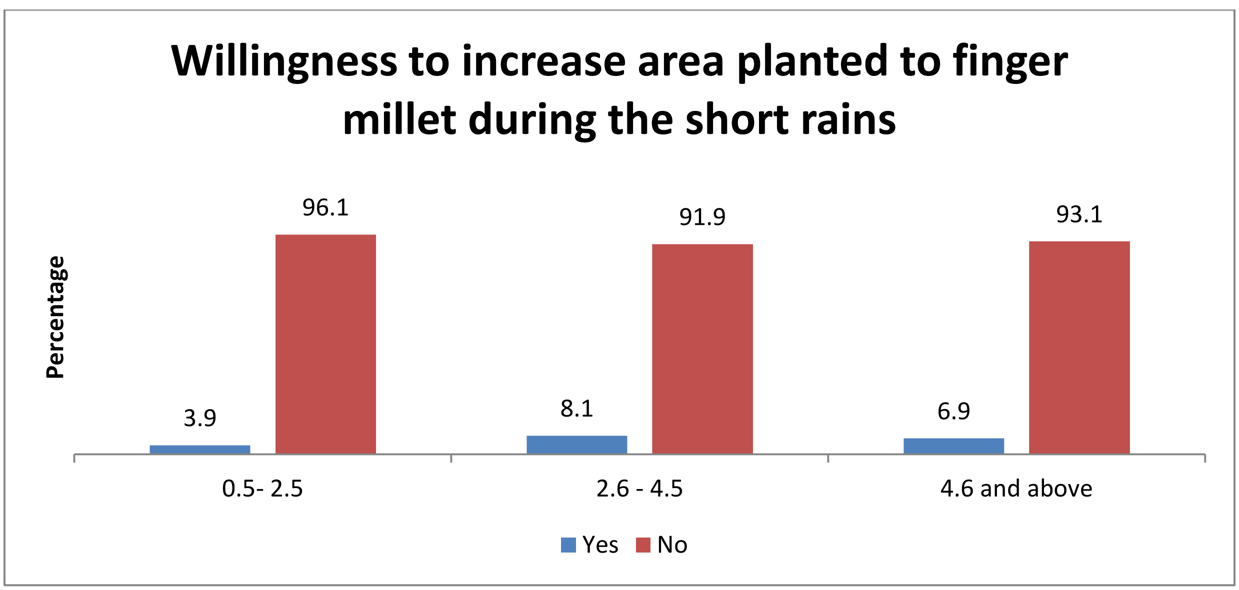


As evidenced in the graph, when land size is increased then more farmers were willing to increase the area planted to finger millet and vice versa. 82.8% of the farmers with 4.6 acres and above were willing to increase areas under finger millet compared to 62.7% with those having 0.5-2.5 acres and 64.9% of those with 2.6-4.5 acres.

All those farmers who answered no (meaning they would not increase area under finger millet in the short rains) were asked what constrained them to do so and the responses were varied across the various land sizes. Farmers with less than 2.5 acres had their most important constraint as limited land (78.9%), limited labor (10.5%) unreliable weather and lack of financing institutions (5.3% each). This was the case for farmers with 2.5-4.5 acres of land. Those farmers with more than 4.6 acres still attributed their most significant constraint to limited land. However, they had lack of financing institutions (33.3%) and low market prices (16.7%) as their second and third constraints respectively.

In the short rains farmers normally may opt not to plant since they fear the rain may not be sufficient to sustain the crop. From my study 94% of all farmers were not willing to increase area planted to finger millet during the short rains. 84.4% of those not willing to increase area under finger millet ranked unreliable weather as the major reason while 4.6% ranked soil fertility loss and 3.7% limited land as their major reasons.

Figure 4: Willingness to increase area planted to finger millet during the short rains



4.5 HH Income

Figure 5: Household income sources

Income source		% HH earning Income from these sources (N=117)	% HH who ranked it main income source (N=117)
Livestock	Dairy	7.69	2.56
	Beef	9.4	4.57
	Shoats	5.98	0.85
	Chicken	40.17	3.42
Crops	Maize	52.14	20.51
	Finger Millet	60.68	20.69
	Cassava	27.35	3.42
	Other Crops	19.66	1.71
Other Sources	Regular Salaried Employment with benefits	4.27	4.27
	Regular Salaried Employment without benefits	12.82	0.85
	Professional Services rendered	2.56	2.56
	Small and medium sized enterprises	9.48	4.35
	Casual Labour	22.22	13.68
	Remittances	3.42	1.71
	Other Income sources	1.71	0.86

Very few people collect all their income from any one source, hold their wealth in the form of any single asset or use their assets in just one activity. In this study, majority of households about 40% earned income from chicken as a livestock income source. For the crop income, 60.7% earned from finger millet, 52% from maize and 27% from Cassava. Maize and cassava formed the main source of income for 20.5% and 20.6% of the households respectively while casual labor was also a main source of income for 13.7% of the households. This income sources give evidence that Maize and Finger Millet remain very important sources of income for households in Teso District, indicating that these households mainly rely on farm income.

Casual labor is also a very important non-farm income source in the area. Farm households in developing countries allocate part of their labor to non-farm activities especially employment in the rural non-farm labor market (Reardon, 1997) and Finger millet farming households in Teso district are no exception as demonstrated by the results above.

4.6 Household Expenditure

Figure 6: Household Expenditure

Land Size	Observations	Mean	Std. Dev.	Min	Max
0.5-2.5 Acres	51	15584.08	17313.98	900	88000
2.6-4.5 Acres	37	24546.38	26916.6	3500	134000
4.6 + Acres	29	28203.93	26154.89	4200	85250
Total	117	21488.91	23392.23	900	134000

The figure gives the mean monetary expenditure of households across the various land sizes. The household will normally spend on food, education for their children, health services, among others. This table summarizes total household monetary expenditure and we can see that the mean varies across the land sizes from KES 15584 to KES28203 for those households having larger land sizes.

However, performing an ANOVA just to compare these means across the three land sizes we find that there is no significant difference as displayed below (*i.e. F<F Crit*):

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3472343835	2	1736171917	2.830712013	0.063123	3.075853
Within Groups	69920075830	114	613333998.5			
Total	73392419665	116				

4.5 LINEAR PROGRAMMING FARM MODEL

A smallholder farmer is selected at random from the middle group in the strata. The household produced three crops all in one season; finger millet, maize and sorghum. The household had six members, three adults (male household head, and two females) and three school going children. The three adults contributed to farming activities. The household allocated 1 acre to maize, 0.75 acres to finger millet and 0.25 acres to sorghum and still let part of their 3.5 acre land fallow for residence. After collecting gross margin data, maize had Kenya shillings 15000, finger millet 14200 and sorghum 900 for their respective allocated land. The crop budgets also indicated that finger millet requires 24 days of female labor and 8 days of male labor. Maize required 19 days of female labor and 10 days of male labor while sorghum 10 days of female labor and 4 days of male labor. It was estimated that the household had 100 man days available for labor of which men provided 30 days and females the rest.

Being both a producer and consumer of finger millet the household could not sell all its finger millet harvest instead consumed a part of it and sold the surplus. An acre of land planted to finger millet yielded 250 kilos and the household required 200 kilos to consume. The surplus was sold at Kenya shillings 50 per kilo. The household also required Kenya shillings 20000 for discretionary spending and this money was raised only through farming activities afore mentioned. The aim of the household was therefore to maximize revenue from their cropping activities so as to have money to spend on food items they did not produce.

Table 7*: LP Model Matrix Construct*

	Activities	Maize	Sorghum	FM	FM	FM		
Constraints/ Resource	Unit of Measure	Acre	Acre	Acre	Kg	Kg	RHS	Limit
Land	Acre	1	0.25	0.75			<=	3.5
Finger Millet Accounting Row	Kg			-250	1	1	<=	0
Finger Millet Consumption	Kg					-1	<=	-150
Female Labor	Days	19	10	24			<=	70
Male Labor	Days	10	4	8			<=	30
Gross Margin	KES	15000	900		50		>=	20000

Table 8: *LP Optimal Production for the farm*

	Activities	Maize	Sorghum	FM	FM	FM			
	Variables	2.27	0.63	0.6	0	150			
Constraints/ Resource	Unit of Measure	Acre	Acre	Acre	Kg	Kg			Limit
Land	Acre	1	1	1			3.5	<=	3.5
Finger Millet Accounting Row	Kg			-250	1	1	0	<=	0
Finger Millet Consumption	Kg					-1	-150	<=	-150
Female Labor	Days	19	10	24			63.8	<=	70
Male Labor	Days	10	4	8			30	<=	30
Gross Margin	KES	15000	8666		50		39488.47	>=	20000

The matrix yields a feasible solution outlined above. From the solution, it would be best if the household allocated 2.3 acres to maize, 0.6 to Sorghum and finger millet each. From this the household satisfy its consumption need and have 39,488 Kenya shillings for discretionary spending at the end of the season.

4.5.1 Sensitivity Analysis

Table 9: *Sensitivity Report*

Activity Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
Maize Area	2.27	0	15000	6665	583
Sorghum Area	0.63	0	8666	6334	1166
Finger Millet Area	0.6	0	0	388.67	1E+30
Finger Millet Production	0	-1.55	50	1.55	1E+30
Finger Millet Consumption	150	0	0	51.55	1E+30

Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
Gross Margin	39488.50	0	20000	19488.46	1E+30
Total Land	3.5	4443.33	3.5	1.55	0.38
FM Accounting	0	51.55	0	150	193.75
FM Consumption	-150	51.55	-150	150	193.75
Female Labor	63.8	0	70	1E+30	6.2
Male Labor	30	1055.67	30	3.8	13.6

The tables above summarize the sensitivity report for the household. The final value column gives the most feasible solution that the household can adopt so as to maximize end of season cash/gross margin. This therefore means the household is better off planting 2.3 acres to maize and 0.6 acres to finger millet and sorghum respectively and will still produce 150 kg of finger millet for its consumption.

If the household adopted the most feasible solution as yielded by the model then it would increase its gross margin to Kenya shillings 39,488.5 from KES 20,000. In this way there is no slack in male labor constraint but 6 days of female labor remains unused and therefore the female household member can reallocate these man days to other activities. All the land is also used and finger millet will be produced only for consumption and none for sale.

The shadow price column also called the dual price column indicates the magnitude in which the objective function will change with every additional increase/decrease per unit of the constraints. For this case, for every additional acre of land then the end year cash would increase by KES 4443, however, there is an allowable increase of 1.5 acres and decrease of 0.38 acres after which the model will have to be re-run. For every additional kilo of finger millet produced the household will increase their end of season cash by 51 KES. There is however a slack in the female labor constraint, since 6.2 days are not used and for male labor all days are used with a shadow price of KES 1055. This means that for every additional male labor unit then the cash available for discretionary spending at the end of season would increase by KES 1055, a clear indication that male involving themselves more in production activities would raise the household's income.

4.5.2 Model Calibration and Validation

Linear programming models are never considered as finished tools. Rather, they are always a work in progress, always capable of being improved with new information. However, before we use the model to help predict responses to changes in technology, infrastructure, prices, resource availability or policies, we need to validate it so as to assure the users that they do, in fact, adequately reflect conditions in the community being modeled.

4.5.4 Policy Analysis-Prediction

Since industrial demand for finger millet is not satiated currently then, millers are forced to import from neighboring Uganda. Nitrogen is a key factor in crop production that most often limits crop production (Shukla et al., 2004). Now suppose the country would like to increase its finger millet production and the best way to do that then farmers are to be availed with subsidized Nitrogenous fertilizer (at half the current cost, 1450 KES), which is to be applied at a rate of 20kg N per hectare, (Oduori, 1993) this will increase yield to 2 tons/ha or 830kg/ha. In addition to providing subsidized fertilizer, the government is willing to provide hybrid seeds for free. Due to the small farm sizes, the government also would like to organize farmers into producer groups. Farmer organizations have a potential to mitigate the effects of imperfect markets by enabling contractual links to input and output markets (Coulter et al., 1999) and by promoting economic coordination in liberalized markets (Rondot and Collion 1999) upon which market functions for smallholder farmers can be leveraged, this would currently fetch them KES 100/kg of finger millet. I estimate this policy would require 3 additional days of male labor and 1 for female labor.

To test this policy intervention, the LP model is constructed again to factor in the fertilizer subsidy and increased market price.

	Activities	FM (Fertilizer)	Maize	Sorghum	FM	FM	FM			
	Variables	2.727272727	0	0	0	2113.636364	150			
Constraints/ Resource	Unit of Measure	Acre	Acre	Acre	Acre	Kg	Kg			Limit
Land	Acre	1	1	1	1			2.727273	<=	3.5
Finger Millet Accounting Row	Kg	-830			-250	1	1	2.84E-14	<=	0
Finger Millet Consumption	Kg						-1	-150	<=	-150
Female Labor	Days	25	19	10	24			68.18182	<=	70
Male Labor	Days	11	10	4	8			30	<=	30
Gross Margin	KES		15000	8666		100		211363.6	>=	20000

Table 10: LP Matrix Solution when policy simulation is factored

The model predicts this time a complete specialization on finger millet specifically grown under N fertilizer, in this way all male labor is used and 68 days of female labor. 2.7 acres of land will also be allocated to finger millet. There will also be an increase in end of year cash/gross margin to 211,363 KES. With this cash the HH can now purchase other foods it cannot produce or its production is uneconomical.

It is however only safe to assume this as a true prediction only if:

1. Input acquisition comes at no extra cost, i.e. fertilizer/seeds availed where farmers do not have to pay transport cost and other transaction costs.
2. The farmer will adopt good management practices in addition to hybrid seeds and fertilizer so as to realize the quoted yield of 2 tons per hectare.
3. The household will be able to procure other staple foods like maize from the market.
4. A surge in supply of finger millet will not lead to a fall in prices.
5. Producer marketing groups will operate efficiently so as not to jeopardize the price.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Finger millet is the most important small millet grown in eastern and southern Africa and it serves as a subsistence and food security crop that is especially important for its nutritive and cultural value. As a consequence of the diversity of the roles of finger millet in society, there is growing market demand for the grain. Household income may be enhanced by sale of finger millet and income generated through trade as well as production.

Finger millet played an important role in the farming communities of Teso District as it was mostly grown for food then cash was the second major reason. A crop that provides both food and can be sold for cash represents smallholder households' important produce and finger millet was found to be one of them in this particular district.

As regards to constraints to expanding area under finger millet in the Long Rains, the most notable was limited then limited labour and few stated unreliable weather and lack of financing institutions. Those farmers with larger pieces of land still had limited land as their most important constraint however lack of financing institutions and low market prices appeared as their second and third constraints respectively. In the short rains, majority of farmers were not willing to increase area planted to finger millet due to unreliable weather and soil fertility loss.

Smallholder finger millet farmers relied on this crop for food and income, therefore, it is necessary for subsistence. From a typical smallholder farm that was modeled it was found to be feasible to produce a mix of all the crops, *ceteris paribus*. However, with a few interventions like group marketing, fertilizer application and row planting then the model predicts that it would be most feasible for the household to specialize in finger millet. This mix of interventions would enable the farmer earn from finger millet, save part for household consumption and sell surplus to the market in return purchasing goods he holds no comparative advantage.

Rachi, 1975 concludes that few crops respond as markedly to modest increments of fertilizer as finger millet do. And thus its commercialization would offer smallholder farmers a new lease of life, as they would earn more, high liquidity, for otherwise cash strapped farm firm.

5.2 RECOMMENDATIONS

With increased research input in finger millet production, processing and utilization, the crop holds a lot of potential in productivity, commerce and industry in Africa, this in mind, I would like to recommend that government provides subsidized fertilizer, seeds and develops efficient extension services to train farmers in good management practices. This from the analysis we find could encourage smallholder farmers to intensify their finger millet production towards commercialization.

Also of great importance is the formation of producer marketing groups/organizations which would offer improved market opportunities for small producers by bulking, storage, grading, sorting, and selling the produce directly to buyers at the upper end of the value chain.

More effort need to be put on plant breeding to ensure farmers receive hybrid seeds capable of producing high yielding crops that would give high returns per hectare. With higher returns, more farmers will be drawn into producing finger millet thus commercializing the enterprise.

There ought to be increased funding towards socio-economic studies as regards finger millet production so as to increase the current knowledge base, complemented by study of livelihood modeling using Linear Programming as very few people if none have done any farm modeling studies in the area.

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ANNEXE: HOUSEHOLD QUESTIONNAIRE

I. General Household Characteristics

Enumerator ID [………..]	**Date** (dd/mm/yy) [………………]	**Location** […………………………………………..]	**Village** […………………………………………….]
Name of household head	…………………………………………………………………………		
Name of respondent	…………………………………………………………………………		
Relationship of respondent to household head if not the HH head? 00=Head of HH [……………………..…….]			
Farm size [………..Acres]	**Area under finger millet** [………Acres]		
Distance from farm to nearest tarmac road […………Km]	**Distance to nearest major Input Market** […………Km]	**Distance to output market** […………Km]	

Number of cattle	**Crossbred**	**Local**	**Ownership of plough team**	**Farming level**
Milking Cows			1= Yes 2= No […………]	1= Full time 2= Part time […………]
Heifers				
Bulls				
Calves				
Total				

Is HH Head registered in an organized farmers group	**Does HH have access to extension services?**
1= Yes […………] 2= No	1= Yes […………] 2= No

II. Crop Land Allocation, Total Output Produced and Marketed

Crop	Cultivated Area (Acres)	Total Output		Total output consumed by HH		Total Output marketed		Value of marketed output (KShs)
	2011 season	Quantity	Unit 1=Bags 2= Kgs	Quantity	Unit 1=Bags 2= Kgs	Quantity	Unit 1=Bags 2= Kgs	
Maize/beans								
Finger Millet								
Sweet potatoes								
Sorghum								
Cassava								
Sugarcane								
Cowpeas								
Other Specify ………………								

III. Household consumption of own produced crops

Indicate the months in which HH consumes own production

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Maize/beans												
Finger millet												

IV. Finger millet production

1. When did you start planting finger millet? ………………………..

2. Why do you grow finger millet? (Rank Reasons by ticking)

Reason	**Rank**
Food	
Fodder	
Cash Income	
Other	

3. In which way do you plant finger millet? [...........]
   1= Pure stand
   2= Mixed crop
4. If mixed crop, then with which other crop? [...........]
   1= Maize
   2= Beans
   3= Sorghum
   4= Groundnuts
   5= Cassava
5. Which planting method do you use?
   1= Broadcast
   2= Row planting
6. If broadcast, then why not row planting?
   1=…………………………………………………..
   2=…………………………………………………..
   3=………………………………………………….. *(Rank the reasons)*
7. In which way do you store your finger millet harvest? [...........]
   1= Granary (traditional)
   2= Kitchen ceiling
   3= Modern Store
8. Is the storage adequate? [...........] And does it influence your decision to produce finger millet? [..........]
   1= Yes
   2= No
9. Is there a ready market for your finger millet produce? [...........]
   1= Yes
   2= No
10. Who is the major buyer?

Buyer	**Rank**
Local Brewer	
Village Miller	
Cereal Traders	
Industrial Miller	
Other (Specify) ……………….	

11. Does the HH have access to a threshing machine? [...........]

1= Yes

2= No

12. Source of Plough team? [...........]

1= Own

2= From a neighbor/ no fee

3= From a neighbor at a fee

4= Group owned plough team

13. Do you have access to market information as regards finger millet? [...........]

1= Yes

2= No

14. What is the most important source of market information? [...........]

1= TV 4= Extension Officers

2= Radio

3= Newspapers 5= Model farmers

15. Can you increase the area planted to finger millet in the long rains (LR)? [...........]

1= Yes

2= No

If no please rank the following constraints to increasing the area under finger millet in the long rains

16. Can you increase the area planted to finger millet in the short rains (SR)? [...........]

1= Yes

2= No

If no please rank the following constraints to increasing the area under finger millet in the short rains

Constraint	**Rank**	
	LR	**SR**
Limited labour		
Soil Fertility loss		
Low yielding varieties		
Unreliable weather		
Low market prices		
No markets		
High Input cost		
Limited land		
Limited access to extension		
Lack of financial institutions		
No seeds		

V. **Household Size and Composition** ***(Consider members currently residing and start with HH head)***

	Sex 1= Male 2= Female	Age in Years	Relation to HH Head 1=Head 2=Wife 3=Husband 4=Son 5=Daughter 6=Grandchild 7=Male relative 8=Female Relative 9=Other (Specify) …………………..	Primary occupation 1=Farmer 2=Salaried employee with benefits 3=Regular employee, no benefits 4=Professional 5=Informal business 6=Casual labourer 7=Student 8=Cannot work due to illness/ 9=Unemployed 10=Others (specify_______ 77=Don't know 88=N/A 99 =Refused	Contributes to farm activities 1=Yes 2= No	Number of months resident at the HH in last 12 months	Level of Education 1= No formal schooling 2= Nursery school 3= Primary 4= Unfinished secondary 5= Secondary completed 6 =Vocational Training 7= Pre-college/university courses/unfinished university 8= College/university completed 9= Other (specify)___________ 77= Don't know 88= N/A 99= No answer
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							

VI. Household Wealth Indicators

Material used for walls in the residential main house (majority of the walls) 01=Brick/cement 02=Mud/dirt 03=Straw matting/cardboard 04=Wood 05 =Other:__________________	**Material used for flooring in the residential main house** 01=Brick/cement 02=Mud/dirt/dung/sand 03=Tiles/carpet/parquet 04=Wooden planks 05 =Other:__________________	**Material used for roofing in the residential main house** 01=Brick/cement 02=Corrugated metal/plastic 03=Straw/grass/plastic sheets 04=Tiles 05=Tin cans 06 =Other:__________________
State of the dwelling 01=Completely dilapidated shack 02=Good condition 03=Needs major repairs 04=Under construction/repair	**How many rooms are in the house?**:_____ Room is a space with permanent division however frail (eg fabric). But a curtain that is opened and shut does mean separate rooms (Include bathroom and kitchen)	**Do you have access to a latrine/toilet**? 01 =Yes 02 =No
If Yes what type of toilet facilities do you use? 01=Bucket/newspaper/polythene 02=Flush toilet 03=Open space 04=Pit latrine 05= Other: ________	**During the DRY season, what is your primary source of water for HOUSEHOLD use?** 01= Public well 02=Private well 03=Informal piped water supply 04= Municipal water supply in house/compound 05=Municipal water supply in neighbor's house/compound 06=Public tap 07=Rainwater in tank 08=River/stream 09=Spring 10=Water truck 11= Other:_____________ 77 =Don't know 99 =No answer	**During the WET season(s), what is your primary source of water for HOUSEHOLD use?** 01= Public well 02=Private well 03=Informal piped water supply 04= Municipal water supply in house/compound 05=Municipal water supply in neighbor's house/compound 06=Public tap 07=Rainwater in tank 08=River/stream 09=Spring 10=Water truck 11= Other:_____________ 77 =Don't know 99 =No answer
What is the main source of fuel for cooking in this household? 01=Biogas 02=Bottled Gas (LPG) 03=Charcoal 04=Coal 05=Dung 06=Electricity 07=Firewood 08=Kerosene	**What is the main source of lighting in this household?** 01=Biogas 02=Kerosene 03=Mains electricity 04=Naked flame (candle, fire etc) 05=Solar power 06= Other:_________________ 77=Don't know 99= Refused	**What is the ownership of this house and the land on which located?** 01= House owned, land owned with title 02= House owned, land owned without title 03= House owned, land leased 04= House leased land leased 05= House leased land owned 06= House owned, land squatted 07= Other: _______________ 77=Don't know

VII. Household Income Sources

Please indicate if Household gets monetary income from the following sources		**1. Yes 2. No**	**Approximate proportion of total annual income:** **1. Less than 25%** **2. 25% - %50%** **3. 50% -75%** **4. More than 75%** **5. 100%**	**Approximate amount in Kenya Shillings**
Agriculture (livestock)	Dairy			
	Beef			
	Shoats			
	Chicken			
Agriculture (Crops)	Maize			
	Finger millet			
	Cassava			
	Other			
Regular Salaried employment (with benefits)				
Regular paid employment with no benefits				
Professional Services rendered (Doctor, consultant)				
Small and Medium Sized enterprise				
Casual Labouring				
Remittances				
Other …………………………………				
TOTAL				

VIII. Household Expenditure

Please make a classification of your expenditures over the last 12 MONTHS	**1= Yes** **2= No**	**Approximate proportion of total annual expenditure:** **6. Less than 25%** **7. 25% - %50%** **8. 50% -75%** **9. More than 75%** **10. 100%**	**Approximate amount in Kenya Shillings**
Food			
Shelter			
Education			
Loan repayment			
Clothes			
Health			
Family events			
Household utilities (Electricity, water)			
Domestic Helper			
Other ………………….			
Total Annual Expenditure			

CROP BUDGETS

FINGER MILLET: 0.75 Acres	Cost/Unit or Wage rate	No. of Units or Man Days or Kgs	Total Cost/Acre
Land Preparation			
Oxen Plough	600	3	1800
Fertilizers			
DAP	90	15	1350
CAN	70	15	1050
Male Labor			
Row Planting			0
Broadcasting	200	1	200
First weeding	200	8	1600
		9	
Female Labor			
Second weeding	200	5	1000
Thinning	200	4	800
Top Dressing	200	1	200
Harvesting	200	10	2000
Threshing	200	4	800
		24	
TOTAL			10800
YIELD (Kgs)			250
Market Price (KES)			100
Gross Income			25000
Gross Margin			**14200**

MAIZE: 1 Acre			
	Cost/Unit or Wage rate	No. of Units or Man Days	Total
Land Preparation			
Oxen Plough	600	3	1800
Seed	350	4.5	1575
Fertilizers			
DAP	90	20	1800
CAN	70	20	1400
Male Labor			
Row Planting	200	3	600
First Weeding	200	7	1400
Harvesting			
		10	
Female Labor			
Row Planting	200	2	400
First weeding	200	5	1000
Basal Fertilizer Application	200	1	200
Top Dressing	200	1	200
Harvesting	200	5	1000
Shelling	200	5	1000
		19	
TOTAL			12375
YIELD (Kgs)			630
Market Price (KES)			40
Gross Income(KES)			25200
Gross Margin (KES)			**12825**

SORGHUM: 0.25 Acres			
	Cost/Unit or Wage rate	No. of Units or Man Days	Total
Land Preparation			
Oxen Plough	600	0.5	300
Fertilizers			
DAP	90	2.5	225
CAN	70	2.5	175
Male Labor			
Row Planting			
First Weeding			
Harvesting			
Female Labor			
Row Planting	200	1	200
First weeding	300	2	600
Basal Fertilizer Application	200	1	200
Top Dressing	200	1	200
Harvesting	200	4	800
Shelling	200	1	200
		10	
TOTAL			2900
YIELD (Kgs)			60
Market Price (KES)			80
Gross Income(KES)			4800
Gross Margin (KES)			**1900**