ANALYSIS OF FACTORS INFLUENCING PRODUCTIVITY AND EXTENT OF SMALLHOLDER COMMERCIALIZATION OF GREEN GRAMS AND PIGEON PEAS IN MACHAKOS COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

I, John Mulwa Wambua declare that the thesis hereby submitted for the degree *Doctor of Philosophy* at the Egerton University is my own independent work and has not previously been submitted in any other University.

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Recommendation

This Thesis has been prepared under our supervision and is submitted with our approval as the supervisors:

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DEDICATION

I am dedicating this thesis to my beloved wife Irene, children Judith, Jacob and Joseph, son in-law Liya Mango and granddaughter Christina Tanu Liya as they contributed to my vision destiny of the family. The next dedication goes to the farmers and grain traders for struggling with imperfect markets to generate income for wealth creation and poverty reduction in rural areas.

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ABSTRACT

Small farmer commercialization was an indispensable pathway towards sustainable food security based on production specialization of food crops. The common staple food crops in Mwala and Yatta sub-counties which are the main semi-arid areas in Machakos County were green grams and pigeon peas. However, the factors affecting productivity and the resultant output for commercialization are not fully understood. The main objectives were therefore to assess the extent and determinants of the levels of commercialization, estimate the factors affecting productivity of green gram and pigeon pea, determine the effects of productivity and output retention on size of marketed surplus of green gram and pigeon production and assess the factors affecting market performance. A survey method was used during data collection where 364 households and 110 grain traders were sampled. Results shown by the descriptive statistics indicated that, the percentages of subsistence and commercial oriented households, focusing on green gram were 79.1% and 20.9%, respectively. The percentages of subsistence and commercial oriented households, focusing on pigeon pea production were 87.9% and 12.1%, respectively. The mean productivity of green gram in the subsistence, semi-commercial and fully commercial farms were 11.581, 104.474 and 204.439 kilograms per hectare, respectively. Pigeon pea mean productivity was 43.334, 48.25 and 13.708 kilograms per hectare in subsistence, semi-commercial and fully commercial farms. Marketed surplus of green gram was determined by the size of landholding (4.422***), yield of green gram (0.056***), retention for seed and given away (1.027**) and production systems in agro-ecological zones (43.613***). Significant increase in pigeon pea marketed surplus was due to household's retention for seed (2.064***) and market price of output (1.641***). In terms of market degree of competition, results showed that, few large traders of green gram, about 8.26 % accounted for 78.40% of the total volume purchased. Few large traders of pigeon pea, about 8.27 %, accounted for 72.13%. Therefore, this study concluded that, subsistence level dominated in green gram and pigeon pea production. This could have been influenced by low productivity of green gram and pigeon pea, low household marketed surplus and low market competition. Based on the results, various policy concerns were recommended for transforming subsistence-oriented production into market-oriented production focusing on green gram and pigeon pea food crops.

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ABBREVIATIONS AND ACRONYMS

ASDS	Agricultural Sector Development Strategy
ASTGS	Agricultural Sector Transformation and Growth Strategy
ERS	Economic Recovery Strategy for Wealth and Employment Creation
GDP	Gross Domestic Product
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
KALRO	Kenya Agricultural and Livestock Research Organization
KARI	Kenya Agricultural Research Institute
PRSP	Poverty Reduction Strategy Paper
RoK	Republic of Kenya
SRA	Strategy for Revitalizing Agriculture
TLU	Total Livestock Unit
USAID	United States Agency for International Development

CHAPTER ONE

INTRODUCTION

1.1 Background to the problem

The agricultural sector in Kenya is dominated by smallholder farmers. The importance of smallholders lies in the production of most of their own food, generation of their own incomes, and creation of large amounts of productive employment (Hazell, 2003; Nyikal, 2003; RoK, 2016). Smallholder farming contributes to reduction in rural poverty and food insecurity through food production and generation of incomes that underpin the livelihoods of vast numbers of poor people. In addition, they support rural non-farm economy, as well as assisting with in the reduction of rural-to-urban migration.

Although smallholder agriculture in Kenya is key and central to food security, it does not adequately address food insecurity since it neglects non-food needs of households and sources of income. The smallholder farmers in Kenya face various challenges. They have been known to be resource poor and therefore unwilling to increase production for sale (Nyikal, 2000). However, few smallholders have remained in subsistence agriculture while many have become semi-commercial through selling part of their meagre food output for cash requirement.

Although the sector is dominated by the smallholder farmers, its contribution remains linked and crucial to Kenya's overall economic growth and social development. According to RoK (2017), the sector is currently accounting to approximately 33 percent of the country's GDP. It employs more than 40 percent of the total population and about 70 percent of the rural population. An additional 27 percent is contributed to GDP through linkages to other sectors such as manufacturing, distribution and services. Despite an increased contribution to the GDP, the performance of the sector has, over the years, shown a declining trend, resulting into deterioration in the overall economic growth and per capita income.

In response to the poor performance of the overall economy over time, Kenya has been developing and implementing different economic strategies to enhance the National economy. The strategies have been part of the development and implementation of various policy frameworks, aimed at addressing problems of poverty in Kenya. Some of these National economic strategies for improving the overall GDP are such as *Poverty Reduction Strategy Paper* (PRSP) 2001-2004 (RoK, 2001), *Economic Recovery Strategy for Wealth and*

Employment Creation (ERS) 2003-2007 (RoK, 2003) and *Kenya Vision 2030* (2008-2030) (RoK, 2007). All the strategies emphasized agriculture as the main sector for poverty reduction and economic development. Based on that, agricultural strategies were developed and implemented in an effort to enhance its contribution to the GDP. The agricultural strategies covered issues such as improvement of farm productivity and linkages between farmers and markets. Some of these agricultural strategies are such as the *Strategy for Revitalizing Agriculture* (SRA) 2004-2014 (RoK, 2004), *Agricultural Sector Development Strategy* (ASDS) 2009-2020 (RoK, 2009) and the *Agricultural Sector Transformation and Growth Strategy* (ASTGS) 2019-2029 (RoK, 2016).

Moreover, in the mid-2000s, the Ministry of agriculture initiated the traditional high value crops program. This was in response to two main challenges: (i) weather patterns; and (ii) failure of domestic maize production to assure households, and the nation, of sufficient staple food to feed a growing population. The specific objectives of the initiative were to: improve farmers' access to seeds of traditional high-value-drought-tolerant crops, promote diversification in production and consumption of alternative cereal and non-cereal crops, improve farm households' food-sufficiency, improve farmers' income through generation of surplus output for sale, and reduce the gap between domestic food production and consumption in the country. This initiative was therefore to promote production and consumption of alternative cereal and non-cereal crops and enhance food security in Kenya. To achieve these objectives, the Ministry availed to farmers, seed varieties that were drought tolerant and adaptable to arid and semi-arid areas (ASALs). The main non-cereal crops distributed were green gram (*Vigna radiate* Wilczek.) and pigeon pea (*Cajanus cajan* (L.) Millsp). The production of green gram and pigeon pea commodities is largely found in warm and dry parts of eastern Kenya (Kimiti et al., 2009; Mergeai et al., 2001; Shiferaw et al., 2008; USAID, 2010). Smallholder farmers dominated in the production of green gram and pigeon pea in these areas. The production was for both food and income.

Commonly, the agricultural strategies were anchored in the belief that sustainable food security and income required a vibrant, commercial and modern agricultural sector that sustainably supports Kenya's economic development. To improve smallholder farmer's food-sufficiency and income through generation of surplus output for sale, agricultural commercialization remains central to policy issues. This is because, according to Jaleta et al. (2009) and Muriithi and Matz (2015), subsistence agriculture might not be a viable activity to ensure sustainable household food security and welfare in the long-run. Hence, commercializing smallholder agriculture is an

indispensable pathway towards economic growth and development. It has often been viewed as an avenue to improve household food security, economic growth and development of rural areas.

Smallholder commercialization involves household's transformation from subsistence to semi-subsistence and eventually, to a full commercial through increase in proportion of agricultural produce that is sold (Mathenge et al., 2010; Pender & Alemu, 2007). According to Kirui and Njiraini (2013), smallholder commercialization has a positive influence on use of purchased inputs and in the share of marketed output.

This study contributed towards literature on agricultural commercialization focusing on the factors for increasing the productivity and marketed surplus of staple food crops. Moreover, the study contributed to the development of conceptual framework for the analysis of smallholder commercialization. The study also contributed to the policy recommendations aimed at facilitating the process of transforming smallholder agriculture from subsistence system to a fully commercialized farming

1.2 The statement of the problem

Kenya's smallholdings are mainly subsistence farms. They are, however, known to be resource poor and therefore, operate below their potentials. It has however, not been known what makes smallholders move out of subsistence farming. The last decade has seen increasing interests in interventions that promote production of high-value-drought-tolerant crops in warm dry parts of Eastern Kenya. A number of policy intentions underlie these interventions. First, production of such crops, in substantial amounts, is likely to contribute to commercialization of farm household in ASALs. Second, increased marketed surplus from the crops would play a role in diversifying diets of Kenyan, whose main staple food is maize. The aim of this study was to assess the influence of production of the two crops on agricultural commercialization of the targeted households.

Kenya has adopted commercialization of smallholder agriculture as a strategy for its economic transformation. Prior studies on the agricultural commercialization among smallholders in Kenya have targeted newly introduced high-value cash crops, such as French beans. This is as opposed to traditional food crops. Furthermore, such studies concentrated more on external market factors. This is because most cash food crops target the export markets. The case of green gram and pigeon pea is different because these are food crops and the smallholders target the domestic

market. This study therefore was scheduled to fill this information gap by analyzing the factors influencing productivity and extent of smallholder commercialization of green gram and pigeon pea in Machakos County.

1.3 The objectives

1.3.1 The general objective

The main goal of the study was to contribute towards development of pathways for commercialization of pigeon peas and green grams in Machakos County

1.3.2 The specific objectives

The specific objectives of this study were therefore to:

(i) Assess the determinants and levels of commercialization of households green grams and pigeon peas in Machakos County;

(ii) Estimate the factors affecting productivity of green gram and pigeon pea among smallholder farmers in Machakos County

(iii) Determine the effects of productivity and output retention on size of marketed surplus of green gram and pigeon production among smallholder farmers in Machakos County;

(iv) Assess the factors affecting market performance in commercializing small farms focusing on green gram and pigeon production in semi-arid Machakos County

1.4 Research questions

What were the levels of commercialization of households and crop-specific green gram and pigeon pea and their determinants among smallholder farmers?

(i) How were the factors of production and commercialization levels influencing the extent of productivity of green gram and pigeon pea among smallholder farmers in Machakos County?

(ii) What were the effects of productivity and output retention on size of marketed production of green gram and pigeon pea crops among smallholder farmers in Machakos County;

(iii) Given the volume of marketed surplus, what was the degree of market concentration and the influence of factors of market share and trading on performance of channeled markets of green gram and pigeon pea production by smallholder farmers in semi-arid Machakos County?

1.5 Justification

Without addressing the two main questions on how subsistence-oriented production systems are transforming to influence household commercial levels and whether the rural grain traders had capacity for smallholder farmers to continue increasing marketed surplus, there will be lack of knowledge on how to commercialize farm household in semi-arid areas of Kenya. Moreover, farmers will remain at subsistence level, food insecure, poor and ultimately rural areas will continue being under-developed.

A commercialized farm household in Kenya is assumed to be producing a significant amount of surplus output. The household allocates a proportion of its resources to the enterprise and sells a considerable proportion of its output to targeted markets. Although cash crops dominate in a commercialized farm household in high rainfall areas, smallholder commercialization is not restricted only to these crops as green grams and pigeon peas crops grown in semi-arid areas are also frequently marketed to a considerable extent. During the transformation process and as households specialize, commodities traditionally considered as food crops may increasingly be marketed. If smallholders' food production systems increase commercialization, there would be more specialized production systems through reduction in the mixture of commodities (crop types) and increase in the cropping intensity. Increased smallholder commercialization would

lead to predominantly market source of inputs, such as use of improved seeds. The households would increase the total cropped land and household labor. There would be higher household productivity due to higher levels of commercialization. Higher productivity would lead to higher marketed surplus.

The capacity of rural markets to enable the smallholder farmers to continue increasing the marketed surplus of traditional food crops is important in understanding how to transform individual farms from subsistence to commercial level. The capacity would include offered opportunities and incentives for smallholders to participate in commercialization. Increasing marketed surplus of pigeon peas and green grams not only determines the income level of the producer, but it also ensures food security to the non-farming population. Furthermore increased household income would be realized through higher market price of the output. As a result higher market price, would offer better incentives in the form of higher income, which can achieve welfare gains for smallholder farmers through enhanced household nutrition and food security and productivity.

Therefore, information on the relationship between subsistence-oriented food crop systems and the household commercial levels and whether rural grain traders have capacity for smallholder farmers to continue increasing marketed surplus, would curtail the transform individual farms from subsistence to commercial in Machakos. .

1.6 The scope and limitations of the study

The traditional food production systems were green grams and pigeon peas. These are mainly grown for household subsistence as staple food crops. They are adaptable to semi-arid areas of Kenya. The area of study is administratively designated as Mwala and Yatta sub-counties in Machakos County, Kenya. The grain traders covered in the study were found in the registered marketplaces with defined one or two market days in a week.

Soliciting data from the smallholder farmers was difficult due to lack of seasonal farm records of inputs and outputs. Data collection from the grain traders was difficult because they were not free while offering data. This was because the traders could not understand the difference between research and the government taxation authority. The traders lacked full information in the data set variables. Grain traders in the registered marketplaces were few and therefore all the traders in a market were interviewed.

1.7 Operational definition of terms

Smallholder commercialization: Several definitions are adopted. According to this study, commercialization of smallholder production is a process involving a transformation from production for subsistence to production for the market (Sokoni, 2008). Smallholder commercialization include both market orientation and participation (Abafita et al., 2016). Following Ele et al. (2013), Gabre-Madhin et al. (2007) and Govereh et al. (1999), agricultural commercialization is the proportion of agricultural production that is marketed. The proportion is an index that measures the agricultural output sold by the household which is *sales - to - output ratio*. Additionally, the von Braun et al. (1994), suggested that commercialization indicated increased market transactions to capture the benefits from specialization.

Market concentration: It is the main element in market structure, reflects the degree of competition in the market and an important determinant factor of grain trader's performance. There are many indices developed to measure market concentration but the index used in this study is the Gini coefficient (Margetts, 2006). A higher concentration measure represents a higher level of lack of competition, which is few participants dominate the market (Wesman (2005).

Crop productivity: This is the quantity of output per hectare of green grams or pigeon peas food crops (kg ha^{-1}) according to Govereh and Jayne (2003).

Marketed surplus: Marketed surplus is defined in this study as that portion of output which actually enters the market (kilograms) after the farmer meets his family consumption and payment in kind. According to Grover et al. (2012) and Gupta and Arora (2000), marketed surplus is the amount left with the farmer after meeting his family consumption, payment in kind, gifts and on farm wastage.

Trader's performance: Traders' performance in this study is defined as a link between farmers and traders. Traders' performance enhances enhance farmers' crop production and market participation and is expected to lead to competition in the market. This study measured a trader's performance using purchases, sales and marketing margins according to Fafchamps and Minten 2002)

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CHAPTER TWO

LITERATURE REVIEW

This section contains a general review of literature on smallholder commercialization. The review covered relevant concepts from various sources within the study of commercialization of smallholder agriculture. The review was used to inform the conceptual framework which in turn was used as the roadmap to construct the research methodology and argue in the results and discussion sections.

2.1 Rural markets and smallholder commercialization

Rural markets play major roles in facilitating commercialization of smallholder farm households. They bring production inputs closer to the producer, while presenting exchange points for agricultural outputs (Sitko & Jayne, 2014). Though the markets are in remote areas, they increasingly serve as outlet points for commodities traditionally considered as food crops. However, farm households differ in the way they connect with the markets, and in the extent to which rural output markets offer economic opportunities (Arias et *al*., 2013). As a result, farm household are likely to vary in their levels of commercialization. Moreover, rural output markets may be volatile owing to small volumes of transactions (Barret, 2010). This may influence households' incentives to commercialize.

2.2 Agricultural commodities and the smallholder commercialization

The need for policy support in commercializing smallholder agriculture, as a strategy of facilitating economic growth and developed, is well recognized (Braun 1995 & Timmer 1997). However, whether to target traditional food crops or cash crops has been a subject of debate. The issue has been whether to focus on enhancing the productivity and marketability of staple food crops or to introduce high-value crops (Abdullah et al., 2017). Available literature suggested that, the basis of commercialization (Braun et al., 1994; Gabre-Madhin et al., 2007), and the decision should be guided by relative comparative advantage (Pingali & Rosegrant, 1995) and market signals (Jaleta et al., 2009; Pingali, 2001). Where traditional food crops offer the most feasible option, policy support should be directed at increasing productivity and marketed surplus (Jaleta et al., 2009).

2.3 Marketability of food crops

Food crops are major tradable commodities in the rural and urban markets. However marketability varies among commodities, measured by the use of an index computed as the proportion of amount marketed out of total production (Gabre-madhin et al., 2010; Gabremedhin & Jaleta, 2012; Quaye et al., 2009). Thus, for a given household, crops meant for market have values closer to 1, while those meant for consumption have values closer to 0. Abafita (2016) showed that, crop-specific marketability index can be used in the construction of the households' market orientation index (MOI).

2.4 Smallholder market-orientation and commercialization

Market-oriented smallholders focus on production of commodities that is marketable. Thus, they make production decision based on market signals (Gebremedhin & Jaleta, 2010). Essentially, thus entail three basic economic questions: what to produce, how to produce and how to market (Jaworski & Kohli, 1996). Relative importance of marketable crops in a household's production plan and crop mix has been used by Gebremedhin and Jaleta (2012) to define the smallholder market orientation. Underlying market orientation is a profit objective (Pingali & Rosegrant, 1995; Pingali, 2001). The degree of a farm-household's market orientation, and its competitive advantage, determines its commercialization (Fritz, 1996; Selnes, et al., 1996).

According to Abafita et al. (2016) indicated that, in the presence of market failure, production decisions are influenced by the household characteristics. Further, specific commodity that the household chooses to produce and sell, is jointly defined by production, consumption, and market transaction factors. Improvements in infrastructures alone cannot lead to adoption of high-yielding technologies (Ahmed et al., 2001; Goetz, 1992). Although, there has been a wide acceptance of the need to promote smallholders' market participation, the agreement on appropriate policies and strategies to promote the participation is limited.

Household market participation index (MPI) has been computed as the proportion of the value of crop sales to total value of crop produce (Braun et al., 1994). Further studies modelled the household market participation index as a function of household head characteristics, ownership of livestock, market access, access to institutional services (extension, credit and value of crop production (Gabremedhin & Jaleta, 2012). As noted by de Janvry and Sadoulet (2003), limitations to market participation by smallholder farmers are imposed by imperfections in input

and output markets, giving rise to high transaction costs and low level of smallholder commercialization.

2.5 The smallholder productivity and commercialization

Smallholders differ in access to production inputs. In turn, they also vary in farm productivity (Arias et al., 2013) and marketable surpluses (Alam & Afruz, 2002; Grover, 2012; Reddy, 2009; Rios et al., 2009). However, little research has looked at extent to which commercialization of smallholder farms and the farm productivity influence each other (Govereh & Jayne, 1999; Strasberg et al., 1999). However, Rios et al. (2009) tested two important hypotheses that: households that sell more farm-output have higher farm productivity, and households with higher farm productivity sell more farm-output.

2.6 Smallholder specialization and commercialization

A number of studies have shown that it is essential to address specialization of production in the analysis of the smallholder commercialization (Wickramasinghe & Weinberger, 2013). However, smallholder agricultural has been viewed as having limited opportunities for specialization and little potential to exploite economies. The view is based on small size of agricultural markets, seasonality, and tasks that are not amenable to specialization, as well as little possibility for the division of labour over cropping tasks (Yang et al., 2013). Unlike the manufacturing sector, the nature of the smallholder agriculture does not admit subdivisions of labour, nor a separation of one business from another.

Though, the smallholder agricultural sector has been viewed with limited opportunities for specialization, the literature recognizes specialization over tasks (Benjamin, 1995; Janvry et al., 1991; Kikuchi & Hayami, 1999; Roumasset et al., 1995; Roumasset & Lee, 2007; Schaffner, 2001) and specialization over cropping systems ranging from pure stands with cash or food crops to cash crops intercropped with food crops (Kurosaki, 2003). Specialization on the most profitable crops, given soil type, climate and weather conditions, is a possible economic option for the poor smallholder households to increase incomes.

Omamo (1998) looked at the relationship between specialization and the distance to the nearest road. The study findings showed that, as the distance to the nearest road shortens, the small-scale farmers tend to shift away from diversified cropping patterns in favour of cultivating only one crop. Other studies looked at the relationship between specialization and the distance to the

nearest road and supported the findings. For instance, Stifel et al. (2003) showed that in Madagascar, the concentration level of agricultural production in the least remote areas was around 1.5 times that of the most remote areas, suggesting that improved road access facilitated specialization in agricultural production. Gibson and Rozelle (2003) found that, in Papua New Guinea, each extra hour to reach the nearest road induces a 2.6 percent reduction in the number of agricultural activities. Also according to Yang and Ng (1993), specialization has been associated with comparative advantage. It has been shown that, producers would choose to specialize in an activity according to their comparative advantage and simply purchase other goods and services from the market, provided that transaction costs are sufficiently small.

According to Klasen et al. (2016), Lambin and Meyfroidt (2011) and Ruiz-Perez et al. (2004), household income is also influenced by the functioning of markets. With improved infrastructure, the transportation costs are low and farmers may shift their agricultural production from an autarky-based self-sufficient subsistence production to a more market-oriented specialized production, thus enhancing smallholder commercialization (Limao & Venables, 2001; Renkow et al., 2003).

2.7 The theoretical framework

A theoretical agricultural household model was used to analyze the agricultural households based on comparative advantage of smallholder commercialization. The model captures the relationships between the factors determining the level of farm production and farm inputs demand, factors governing consumption and labour supply and how the behaviour of the household as a producer affects its behaviour as a consumer and supplier of labour.

In an agricultural household, production and consumption activities take place within the same economic unit. For instance, some farm output is produced for sale and some is used for home consumption. According to Ellis (1993), Janvry et al. (1991) and Vance and Goeghegan (2004), non-separable household utility maximization model has been suggested as the most appropriate model to adopt while modelling agricultural commercialization in developing countries with pervasive market failures. The non-separable household utility maximization follows the standard consumer theory caveat to the existence of imperfect market information. According to Jaleta et al. (2009) and Kennedy (1994), the smallholder commercialization provides means to improve household food security, health and nutrition status through increased household income. Increased income allows the household to purchase a diversified mix of goods and

services, including food, health care, and better housing, among others, or increase the current market basket. Additionally, commercialization is assumed to increase the food intake of household members, through the income–food–consumption linkage, which could improve their nutritional and health status.

Following Goetz (1992), Janvry et al. (1991), Janvry and Sadoulet (1992), Key et al. (2000) and Skoufias (1994), for any production cycle, the household is assumed to maximize a utility function. We assumed *U* as household utility, which is the function of several consumable goods [consumption of own produce, purchased food and non-food products, leisure and some exogenous utility shifters (household characteristics)]. Household utility is maximised with respect to the constraints to commodities own produced, purchased food and non-food products, leisure and household characteristics. Therefore, farm households solve the following the constrained utility maximization problem:

$$\text{Max } U(X_{SFC}, X_{MFC}, X_L), \qquad (1)$$

Subject to three constraints

(i) Production: $Q = f(L, X)$

(ii) Time: $X_L + H = T$

(iii) Full income: $P_{SFC}(\underbrace{Q - X_{SFC}}_{\text{Marketed surplus}}) + w(\underbrace{H - L}_{\text{Marketed labour}})$

Where:

X_{SFC} = Staple food consumption

X_{MFC} = Market-purchased food and non-food consumption

X_L = Leisure

Q = Output of traditional food crops (green gram and pigeon pea)

L = Labour used in production (both household labor and hired labour)

X = Other input used

X_L = Leisure

H = Household labour

T = Total time available to the household

P_{MFC} = Price of market food consumption

P_{SFC} = Price of subsistence food consumption

w = Market wage rate

These three constraints can be combined into one full income constraint by substituting the production constraint into the full income constraint for Q and substituting the time constraint into the full income constraint yields a single constraint of the form:

$$\{P_{SFC}\, f(L, X)\} - P_x X - w^*L + w^*T = \pi + w^*T = P_{SFC}\, X_{SFC} + P_{MFC}\, X_{MFC} + w\, X_L$$

Farm profit (π) — Full value of time

Therefore: $P_{SFC}\, X_{SFC} + P_{MFC}\, X_{MFC} + w\, X_L = \pi + w^*T$ (2)

In equation (2):

$\pi = P_{SFC}Q(L, X) - P_X X - wL$ is a measure of farm profit.

$P_{SFC}\, X_{SFC} + P_{MFC}\, X_{MFC} + wX_L$ is a total household "expenditure" on three items; (i) the market-purchased commodity (X_{MFC}), the household's "purchase" of its own output (X_{SFC}), and the household's "purchase" of its own time in the form of leisure (X_L).

w*T is a full income which is the value of the stock of time owned by the household

Equations 1and 2 were the core of this study. In these equations, the household could choose the levels of consumption for the three commodities [staple food consumption (X_{SFC}), a market purchased food consumption and non-food (X_{MFC}) and leisure (X_L)] and the total labour into staple food crop production. When farm profits have been maximized through an appropriate choice of labor input, the value of full income is:

$P_{SFC}\, X_{SFC} + P_{MFC}\, X_{MFC} + wX_L = Y^*$

Maximizing utility subject to this new version of the constraint yields the following first-order conditions:

$\partial U/\partial X_{SFC} = \lambda P_{SFC}$ (3)

$\partial U/\partial X_{MFC} = \lambda P_{MFC}$

$\partial U/\partial X_L = \lambda w$

and

$P_{SFC}\, X_{SFC} + P_{MFC}\, X_{MFC} + w\, X_L = Y^*$

These are the standard conditions from consumer-demand theory. The solution to equation 3 yields standard demand curves of the form:

$X_i = Xi(P_{MFC}, P_{SFC}, w, Y^*)$ (4)

i = MFC, SFC, L.

From the theoretical analysis of the agricultural household, equation (2) showed a *profit effect* which was a one-way relation between production on the one hand and consumption and labor supply on the other hand.

2.8 The conceptual framework

The overall conceptual framework given in Figure 2.1 was based on the literature on smallholder commercialization (Abdullah et al., 2017; Braun, 1995; Govereh et al., 1999; Goletti, 2005; Jaleta, et al., 2009; Leavy & Poulton, 2007; Pingali & Rosegrant, 1995; Pingali, 1997; Timmer, 1997; Zhou, et al., 2013).

According to literature, agricultural commercialization has been defined in different ways. It can occur on both sides, either on output side with increased market surplus or input side with increased use of inputs. Agricultural commercialization has also been defined as the proportion of agricultural production that is marketed. Being a proportion of production marketed, commercialization can be measured along a continuum from zero (total subsistence-oriented production) to unity (100% of production is sold). Therefore, commercialization of agriculture involves a transition from subsistence-oriented to increasingly market-oriented patterns of production and input use. The transition is a change from subsistence type of production to market oriented with the aim of profit maximization.

The conceptual framework of the analysis is summarized in Figure 2.1, for the factors determining the commercial levels among smallholder farmers constructed based on the smallholder farm-market links. The conceptualized smallholder commercial levels were subsistence, semi-commercial and fully commercial (Figure 2.1). In the framework, the household commercial level was explained by production specialization (objective 1), productivity (objective 2) and marketed production (objective 3) and market performance (objective 4).

Well-functioning markets promote sales of farm products and induce farmers to specialize in production by reducing farm activities and concentrating on a few enterprises to increase

profitability per unit. It was expected that, specialization pushed for renewed approaches to farming by making the operations more efficient and increased individual commitment to commercial activities. In the conceptual framework, the link between farm and market was explained by the commercialization transition through production specialization. It was predicted that, specialization improved productivity, increased production and supply and in turn stimulated market participation.

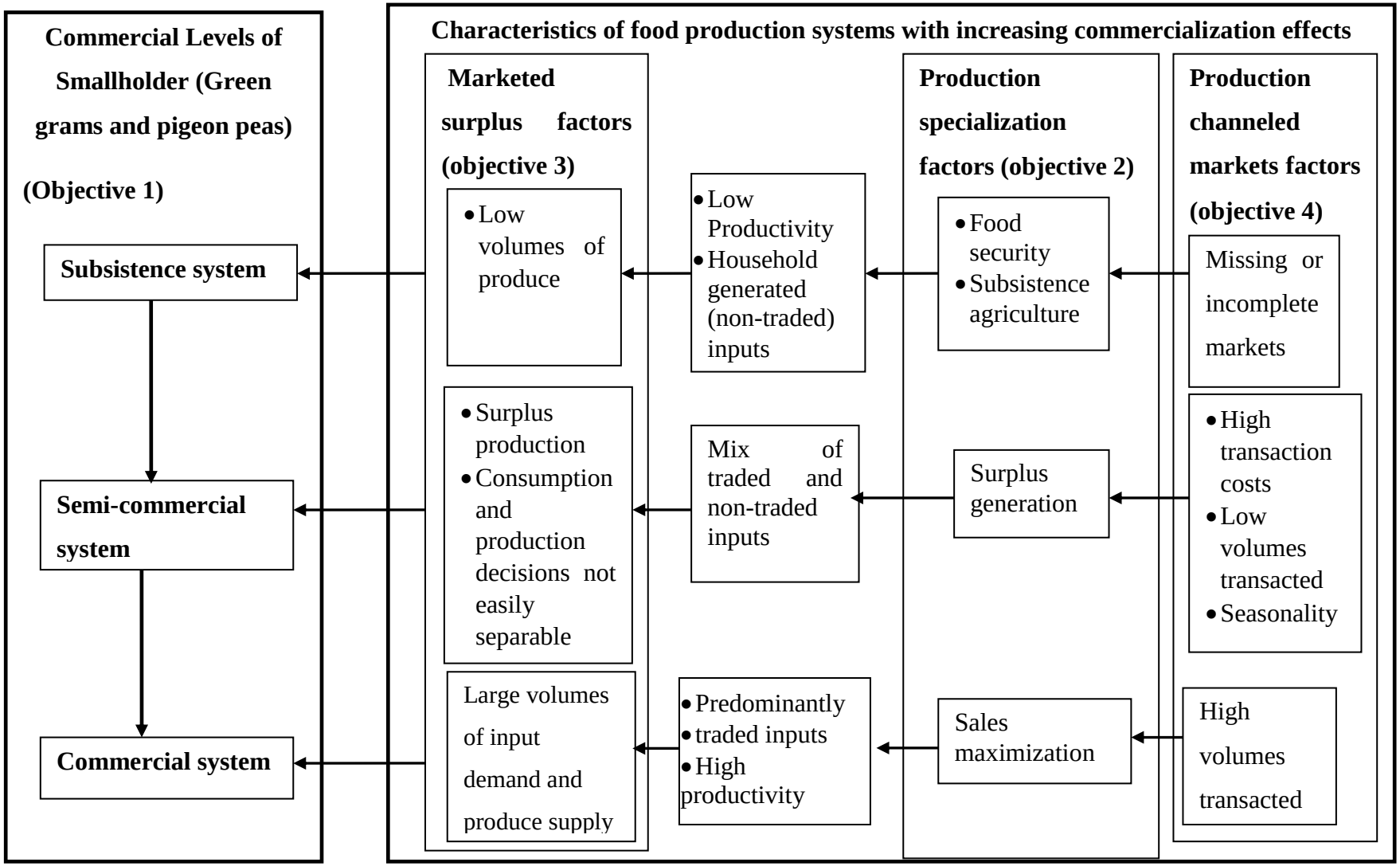

Figure 2.1

Conceptual Framework of the Analysis of the Factors Determining Households' Commercialization Levels

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CHAPTER THREE

METHODOLOGY

The methodology section covered the study area selection and description, study design, sampling designs and methods of data collection. Methods of data analysis are provided in the specific chapters.

3.1 Study sites selection and description

Mwala and Yatta sub-counties in Machakos County, were selected as the study sites due to agro-ecological zones suitable for the production of green gram and pigeon pea. These sub-counties lie in lower and drier areas of Machakos County. Mwala sub-county is located between longitudes 37° 20’ to 37° 50’ East and latitudes 1º 10’ to 1º 40’ South (Barron, 2004) while Yatta sub-county lies between the longitudes 37^0 20' and 37^0 55' East and between latitude 0^0 50' and 1^0 30' South (Munyao et al., 2013). The main agro-ecological zones (AEZs) are lower midland four (LM 4) and lower midland five (LM 5). These AEZs are more suitable for the production of green gram and pigeon pea crops than wetter areas. However, the magnitude of coverage of each type of AEZ in each sub-county vary. Agro-ecological zone lower midland four dominate in Mwala sub-county while agro-ecological zone lower midland five largely covers Yatta sub-county (Figure 3.1). Both AEZs have two rainfall seasons per year which are separated by a dry spell. According to Jaetzold et al. (2006) and RoK (2009), long rains begin in mid-March and end in May, while short rains start in mid-October and end in late November. Comparatively, long rains are less reliable than short rains in terms of seasonal success in crop production (Waweru et al., 2015).

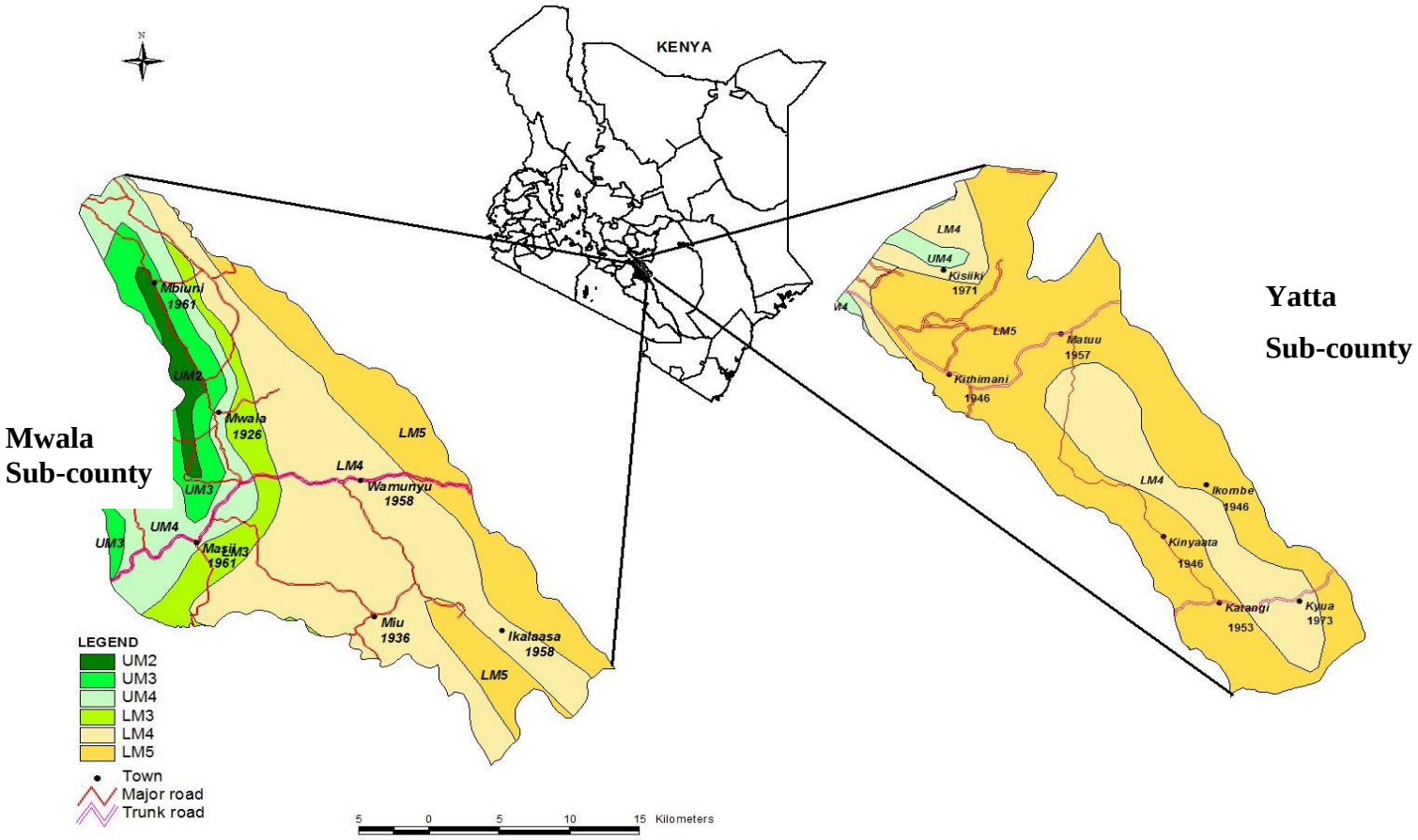

Figure 3.1

A Map of Kenya Showing Position of Mwala and Yatta Sub-Counties and their Respective Agro-Ecological Zones Lm 4 And Lm 5

Farmers in AEZs LM 4 and LM 5 mainly rely on rainfall, though unreliable for the production of crops. Due to the rain-fed agriculture, the crops production systems are dominated by food crops than cash crops. The main food crops grown are maize, beans, green gram, pigeon pea, cowpeas, sorghum and millets (Jaetzold et al., 2006; Mwangi et al., 2015; RoK, 2009). These crops are grown in both long and short rain seasons except pigeon pea. Pigeon pea is an annual crop and mainly planted during short rain season.

Despite the farmers' reliance on rain-fed agriculture, the production of crops depends on the potential and sizes of land in both sub-counties. Farms' sizes are becoming small due to high population densities. According to Frederick et al. (2000), RoK (2009) and Waweru et al. (2015), the population density is 160 and 152 persons per square kilometre in Mwala and Yatta sub-counties, respectively. This has led to the two sub-counties being dominated by smallholder farmers. Despite reliance on rain-fed agriculture and declining farm sizes, agriculture remains an important source of livelihood in the two sub-counties. For instance, in Yatta sub-county, agriculture is the most important sector, contributing to 70% of the household's income (Mburu et al., 2015; RoK, 2009) where about 40% of household's earnings are derived from crop sales and 30% from livestock. About 30% of the earnings are from off-farm activities including money sent from earnings by household members working away.

Market centres in Mwala and Yatta sub-counties were selected in order to evaluate their performance in commercializing small farms. According to Mutiso (2015), Mwangi et al. (2015) and Musyoka (2017), the markets are distributed in remote locations in each sub-county (Figure 4.2). Due to the remoteness of the markets, the transaction costs between small farmers and buyers can be substantive, prohibitive and therefore exchange would not take place (missing or market failure). Some of the transaction costs are due to transport and communication infrastructure which affect search and information costs. The main agricultural products traded in these remote markets are mainly food crops; maize, beans, green gram, pigeon pea, cowpeas, *dolichos lab lab*, sorghum and pearl millet.

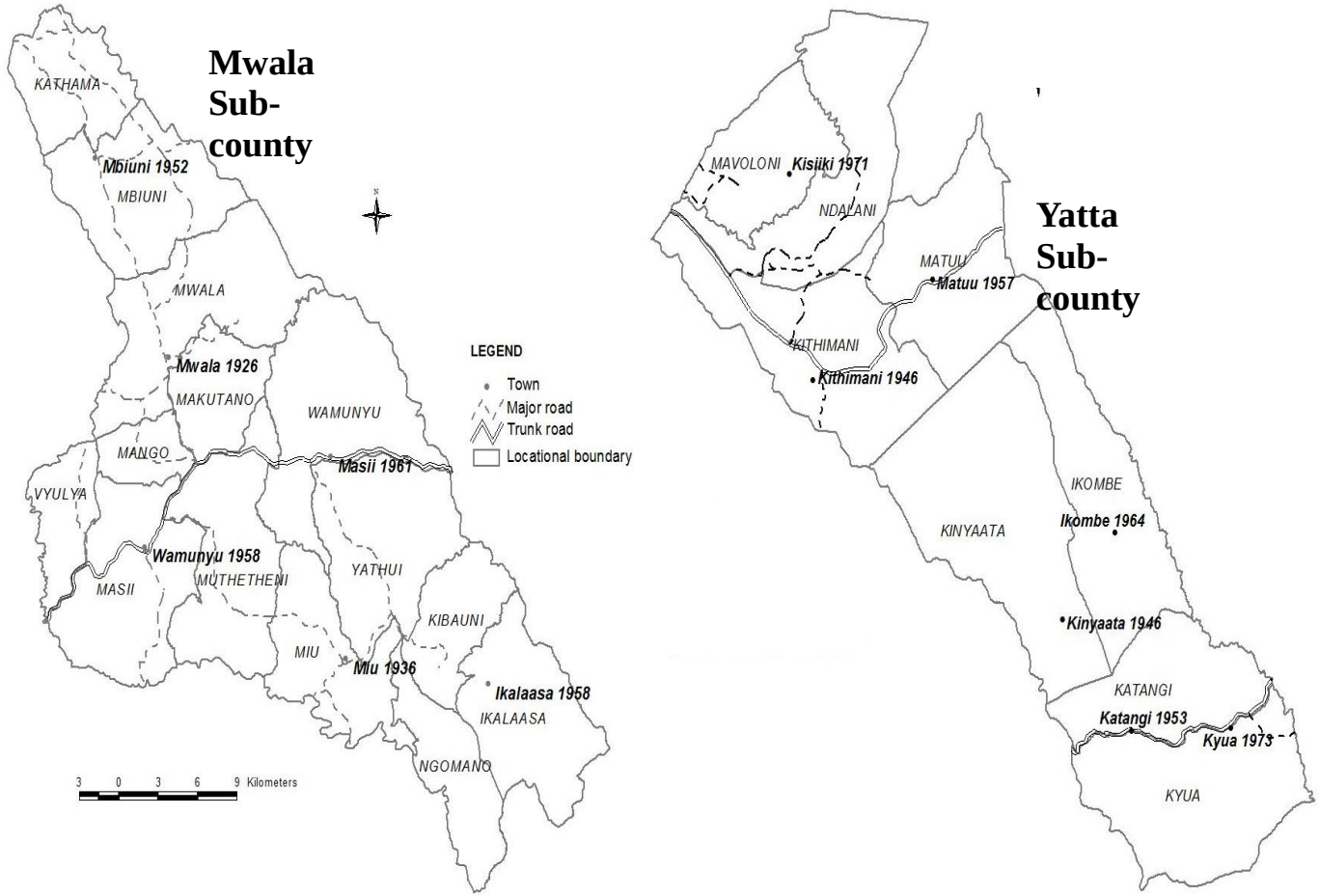

Figure 3.2

A Map of Yatta (left) and Mwala (right) Sub-Counties Showing the Respective Positions of the Designated Markets

3.2 Sampling procedure

This study used two samples during data collection. One sample was obtained from smallholder producers of green grams and pigeon peas. The other sample was obtained from the grain traders (market intermediaries). The sample of smallholder producers of green grams and pigeon peas was obtained using a three-stage sampling procedure. The first-stage involved purposive sampling of agro-ecological zones lower midland four (AEZ LM 4) and agro-ecological zones lower midland five (AEZ LM 5) in Mwala and Yatta sub-counties, respectively. The second-stage involved purposive sampling of locations where AEZ LM 4 and AEZ LM 5 dominated in Mwala sub-county and Yatta sub-counties, respectively. The selected locations with large coverage of AEZ LM 4 in Mwala sub-county were Ikalaasa, Kathama, Kyawango, Mango, Masii, Mbiuni, Miu, Muthetheni, Mwala, Wamunyu and Yathui. The selected locations with large coverage of AEZ LM 5 in Yatta sub-county were Kinyaata, Katangi, Ikombe, Kyua, Matuu and Ndalani. In each location, the number of households was calculated using equation 3.1. With the use of this equation, the determined sample size was 182 households in each sub-county. The total number of households interviewed in both sub-counties was 364.

$$CI = z * \sqrt{\left(\left(\frac{p(1-p)}{n}\right)\left(\frac{N-n}{N}\right)\right)}$$ ---------- Equation 3.1

Where:

CI is Confidence interval, expressed as decimal (0.04), Z-value of 1.96 for a 95% confidence interval found in the cumulative normal probability table. The value of *p* is the proportion of population of interest to be observed who grow green gram and pigeon pea and is taken to be 0.5 as a maximization rule. That is, when $p = 0.5$, the sample size *n* is maximized, N is the pooled population of farmers in the selected wards and n is the sample size.

In the third-stage, random sampling technique was used to select the households from the lists of households drawn from the locations. The sampling procedure for the producers of green grams and pigeon peas was summarized in Table 3.1.

Table 3.1

Summary of Sampling Procedure of Green Grams and Pigeon Peas Producers

Stages	Lists used	Sampling methods	Sample size			
			Mwala sub-county	Households	Yatta sub-county	Households
First-stage	AEZs	Purposive	AEZ LM 4		AEZ LM 5	
Second-stage	Locations	Purposive	6		11	
Third-stage	Households in each location	Random sample	Kinyaata	52	Ikalaasa	11
			Katangi	24	Kathama	10
			Ikombe	26	Kyawango	24
			Kyua	28	Mango	13
			Matuu	26	Masii	28
			Ndalani	26	Mbiuni	15
					Miu	13
					Muthetheni	13
					Mwala	15
					Wamunyu	28
					Yathui	12
	Total households in each sub-county			**182**		**182**

For the selection of grain traders, a three-stage sampling procedure was adopted. The first-stage was purposive method of sampling which involved compiling the lists of major marketplaces in Mwala and Yatta sub-counties. The major marketplaces were the designated marketplaces having one or two scheduled market days in a week. The number of marketplaces identified in Mwala and Yatta sub-counties were six and seven, respectively. The names of listed marketplaces in Mwala sub-county were Ikalaasa, Kalamba, Masii, Mbiuni, Mwala and Wamunyu. The names of listed marketplaces in Yatta sub-county were Ikombe, Katangi, Kinyaata, Kisiiki, Kithimani, Kyua and Matuu. The second-stage was purposive method of sampling which involved compiling the lists of grain traders in each identified marketplaces in Mwala and Yatta sub-counties. The numbers of grain traders in Mwala and Yatta sub-counties were 38 and 72, respectively. The third-stage was purposive sampling method which involved selection of grain traders among the population in each marketplace. Since the sizes of population of grain traders in all the marketplaces in Mwala and Yatta sub-counties were small, all the grain traders were included in the sample. The selected grain traders for the interview were 38 and 72 in Mwala and Yatta sub-counties, respectively. A total of 110 grain traders were selected. The sampling procedure for the grain traders was summarized in Table 3.2.

Table 3.2

Summary of Sampling Procedure of Grain Traders

Stage	List used	Sampling methods	Sample size			
			Mwala sub-county		Yatta sub-county	
			Marketplaces	Grain traders	Marketplaces	Grain traders
One-stage	Marketplaces	Purposive	6		7	
Two-stage	Grain traders	Purposive	Ikalaasa	6	Ikombe	9
			Masii	9	Katangi	7
			Mbiuni	3	Kinyaata	2
			Mwala	10	Kisiiki	8
			Wamunyu	10	Kithimani	11

		Kyua	5
		Matuu	30
Third-stage	**38**		**72**

3.3 Method of data collection

A cross-sectional survey method of data collection was used. The method facilitated data collection from farmers sampled to represent the larger population of green gram and pigeon pea producers and grain traders. This meant that, the data were collected in as short a time as was feasible. Interview method was used to collect data from household heads and grain traders in rural markets. Prior to the interview with the household heads and grain traders, two types of questionnaires were developed.

3.4 Methods of data analysis

Methods of statistical data analysis were descriptive and multiple regression models. However, the types of descriptive statistics and regression models varied as shown in the analysis in each study objective.

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CHAPTER FOUR

DETERMINANTS AND LEVELS OF COMMERCIALIZATION OF HOUSEHOLDS IN GREEN GRAMS AND PIGEON PEAS IN MACHAKOS COUNTY

Abstract

The production of green gram and pigeon pea by the smallholder farmers in Machakos County is mainly for food and cash. Farmers in this County, however, have remained food insecure and poor due to low farm income. Commercialization of green grams and pigeon peas is an indispensable pathway towards linking smallholder farmers in economic growth and development. The objective of this study was therefore to assess the levels of commercialization and their determinants among the smallholder farmers in green grams and pigeon peas production. Method of data collection was cross-sectional survey. Statistical analysis and ordered logit regression model were used. Results showed that, about 79.1% of the households had subsistence behaviours in green gram production. About 20.9% had commenced commercializing green gram production. The percentages of households with subsistence and commercialization behaviours of pigeon pea production were 87.9% and 12.1%, respectively. There were factors which determined commercialization at the household level, such as type of commodity (-0.626***), market price (0.040***) and use of improved seeds (0.867**). The factors which affected green gram commercialization level were agro-ecological condition (2.394***), total cropped land (0.118***), production market price (0.032***) and productivity (0.023***). The commercialization level of pigeon pea production was determined by total cropped land (-0.004*), family size (0.008**) and household labor size (0.021*). Therefore, it was concluded that, there were more households with subsistence than commercialization behaviours of green gram and pigeon pea production. However, the study established factors with potential of transforming households and crop-specific commercialization levels. Recommendations were drawn from the findings such as development and promotion of improved seeds through research and agricultural extension. At the farm levels specialization was recommended. A policy support in product prices was recommended.

4.1 Introduction

Smallholder production of green gram and pigeon pea have increasingly become important in Kenya (RoK, 2015). Between the year 2010 and 2014, production of green grams grew at an about 19 percent per annum. Production of pigeon pea increased by about 184 percent between the years 1996 and 2005 (FAOSTAT, 2017). During the same period, acreage under pigeon pea increased by about 28 percent. From the year 2010 to 2014, the country's total national annual production of pigeon peas oscillated between 103233.6 and 196324.2 MT at the net average increase of about 25 percent (RoK, 2015).

The main producing areas of green grams and pigeon pea are in eastern parts of Kenya (Kimiti et al., 2009; Mergeai et al., 2001; Mwang'ombe et al., undated; Shiferaw et al. 2008), accounting for over 90% of the country's total production of the two grain legumes (Kimiti et al., 2009; USAID, 2010). Machakos, Makueni, and Kitui are the leading producing counties accounting for about 33%, 25% and 22%, respectively of total national production.

Literature has shown that, in the long run, subsistence agriculture may fail to ensure sustainable household food security and welfare (Kurosaki, 2003; Pingali & Rosegrant, 1995; Pingali, 1997; Timmer, 1997), especially in semi-arid areas. According to Jaleta et al. (2009) and Nyikal (2000), commercial agriculture would probably be effective in addressing sustainable food security and welfare for subsistence farmers. Although small farmers mainly practice subsistence farming, many have been forced into the smallholder commercialization process, passively by having to sell part of their meagre food crops output to meet cash requirements (obligations) for the non-food needs of the households (Hazell, 2007; Nyikal, 2000; Nyikal, 2003; RoK, 1998), including purchases of diversified mix of goods and services (Kirimi et al., 2013).

Literature shows that, household commercialization index (HCI) has been used for assessing the level of a given farm household in the process of commercialization, comparisons of the households and identifying the determinants of the household commercialization (Braun et al., 1994; Ele et al., 2013; Gabre-Madhin et al., 2007; Govereh et al., 1999; Kirimi et al., 2013; Randolph, 1992; Strasberg et al., 1999). For instance, Kirimi at al. (2013) found that the proportions of marketed output (quantity sold/quantity produced) for chronically food poor households were different from the food non-poor households in the years 2000, 2004, 2007 and

2010 in Kenya. The HCI for chronically food poor households in the years 2000, 2004, 2007 and 2010 were 0.30, 0.25, 0.27 and 0.27, respectively. The HCI were 0.47, 0.41, 0.46 and 0.44 in the years 2000, 2004, 2007 and 2010 for food non-poor households, respectively. Mainly the low HCI was due to the households' food security farming which was characterized with small marketable surpluses.

Low HCI tends to constrain households to subsistence farming. This is because the households cannot raise adequate capital to support surplus production of commodities to supply the market. Besides, small marketable surpluses are associated with high market transaction costs. In the long run, subsistence agriculture may fail to ensure sustainable household food security and welfare (Kurosaki, 2003; Pingali & Rosegrant, 1995; Pingali, 1997; Timmer, 1997), especially in semi-arid areas.

Therefore, given that green gram and pigeon pea are well adapted to semi-arid areas and are produced in almost all the farms, it was the purpose of this study to: (i) what were the extent of commercialization of green grams and pigeon peas (ii) what were the factors affecting the extent of commercialization of green grams and pigeon peas

4.2 Methods of data analysis

Following Agwu et al. (2012) and Mohammed et al. (2016), the study conceptualized HCI as the proportion of total quantity of crop produced by hh_i in year j, that is sold by the household in that year.. The index, thus, measured the extent to which a household crop production was oriented towards the market (Agwu et al., 2012; Demeke & Haji, 2014; Ele et al., 2013; Govereh et al., 1999; Martey et al., 2012; Opondo et al., 2017; Paul et al., 1999).

These previous studies showed that, the index lay strictly between 0 and 100. A totally subsistence oriented household would show a value of zero while a totally marketed oriented household would indicate a value closer to 100. Therefore, the HCI was used in the study to determine the factors affecting household's commercial level based on the total and specific crop production. The HCI was used to determine both household and crop specific level of commercialization. Mathematically it is expressed as shown in Equation 4.1.

$$\mathbf{HCI} = \frac{\boldsymbol{Total\ Volume\ of\ Crop\ Production\ Sold}}{\boldsymbol{Total\ Volume\ of\ Crop\ Produced}} * \mathbf{100} - - - - - - - - \boldsymbol{Equation\ 4.1}$$

With the use of HCI during the analysis, households were ordered as subsistence farmers, semi-commercial farmers and full commercial farmers. According to Agwu et al. (2012), subsistence farmers had the range of percentage of output sold 0 – 30%. The percentages of outputs sold for the semi-commercial and full commercial farmers were 31% – 50% and 51% – 100%, respectively.

The statistical methods of data analysis were descriptive and ordered logistic regression model. Descriptive method was used to get the percentages of households in pure subsistence, semi-subsistence and full commercial and in agro-ecological zones LM 4 and LM 5. Ordered logistic regression model was used to analyze the factors affecting households' commercial levels. The statistical packages used in data analysis were IBM Statistical package for social science (SPSS) version 21 and STATA release 14. The choice of SPSS was due to the crosstabulation in descriptive statistics analysis. The cross-tabulation was on the levels and the agro-ecological zones LM 4 and LM 5 of the households. The choice of STATA statistical package was due to the ordered logit (ologit) regression model for categorical dependent variable with 3 categories (pure subsistence, semi-subsistence and full commercial). Ordered logit model was used to model the smallholder according to the probability of a level of household commercialization as shown in Equation 4.2.

Prob (y = i) = $\beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + u$ ---------- Equation **4.2.**

Where:

Prob (*y* = i) = Probability of outcome y; i = household's commercialization level (1=subsistence; 2= semi-commercial; 3=full commercial);

X_1 = Type of commodity

X_2 = Production agro-ecological condition (1=*AEZ LM 4; 0=AEZ LM 5*);

X_3 = Total cropped land (hectares);

X_4 = Household family size (persons);

X_5 = Household labour size (adult equivalent units).

Adults' equivalent units were computed using OECD equivalence scale. This assigns a value of 1 to the first household member, of 0.7 to each additional adult and of 0.5 to each child under 15 years (Burniaux et al., 1998).

X_6 = Type of produce storage *(granary = 1; living house=0)*;

X_7 = Mean market price per kilogram of green gram and pigeon pea produce (kes);

X_8 = Household use of improved seeds of green gram and pigeon pea *(yes=1; no=0)*;

X_9 = Total livestock holding per household (Total Livestock Unit).

Mitiku (2014), Mazengia (2016) and Storck et al. (1991) indicated the conversion factors for the livestock population numbers into Tropical Livestock Unit (TLU). The conversion factors are calf (0.25), heifer (0.75), young bull (0.34), cows and oxen (1.0), donkey (0.7), young sheep and goat (0.06), adult sheep and goats (0.13), chicken/poultry (0.013), young donkey (0.35) and adult donkey (0.70).

X_{10} = Cropping intensities of green gram and pigeon pea (proportions of areas).

Cropping intensity was calculated as the ratio of the area under green gram and pigeon pea crops for each season during the year to the cultivable area operated by the farmer. To measure the extent of green gram and pigeon pea cropping intensities, the proportions were worked out according to Biswas (2016) as shown in Equation 4.3.

$$P_i = \frac{A_i}{\sum_{i=1}^{n} A_i} \quad \text{..... Equation 4.3}$$

Where; Pi = proportion of i^{th} crop; A_i = area under ith crop (ha);

$\sum_{i=1}^{n} A_i = \text{total cropped land (ha)}$; i = 1, 2, 3..... n (number of crops);
X_{11} = Age of household head (years);

X_{12} = Household head years in school (years);

$\beta_1, \beta_2, \cdots, \beta_k$ = estimated coefficients of the function;

u = distributed random error in ordered logit.

Table 4.1

Hypothesized Effects of Explanatory Variables on Households' Commercialization Level

Variable Name	Variable description	Variable measurement	Expected sign
Dependent variable: 1=subsistence; 2= semi-commercial; 3=full commercial levels of households			
Explanatory Variables:			
Type of commodity	Green gram and pigeon pea subsistence crops	Dummy (1=green gram, 0=pigeon pea)	-
Agro-ecological condition	Production AEZs lower midland (LM) 4 and 5 (AEZs LM 4 and 5)	Dummy (1=AEZ LM 4, 0=AEZ LM 5)	±
Total cropped land	Household's cultivated land under, crops	Hectares	+
Family size	Household family size	Number	±
Household labor size	Household labour size	Adult equivalent units	+
Type of produce storage facility	Household ownership of storage for grains	Dummy (1=yes; 0=no)	+
Market price per kilogram	Average price per kilogram of output of green gram and pigeon pea sold	Kenya shillings	+
Use of improved seeds	Improved seeds of green gram and pigeon pea	Dummy (1=yes; 0=no)	+
Total livestock holding	Total livestock owned by household	TLU	+
Cropping intensity	Average proportion of the area under green gram and pigeon pea to total cultivated area	Proportion	+
Age	Age of household head	Number of years	-
Household head education	Household head years in school	Number of years	+

The probability of levels of green gram and pigeon pea crop-specific commercialization level was modelled as shown in Equation 4.4. The hypothesized effects of explanatory variables on crop specific levels were indicated in Table 4.2.

Prob (y = i) = $\beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + u$ ---------- Equation **4.4**

Prob (y = i) = Probability of outcome y; i = crop specific commercialization levels (1=subsistence; 2= semi-commercial; 3=full commercial);

X_1 = Household agro-ecological condition (1=*AEZ LM 4; 0=AEZ LM 5*);

X_2 = Household total cropped land (hectares);

X_3 = Household size (persons);

X_4 = Household labour size (adult equivalent units);

X_5 = Household have produce storage *(yes=1; no=0)*;

X_6 = Market price per kilogram of green grams and pigeon pea produce (kes);

X_7 = Household use of improved seeds of green gram and pigeon pea *(yes=1; no=0)*;

X_8 = Total livestock holding per household (Total Livestock Unit);

X_9 = Household cropping intensities of green grams and pigeon pea (proportions of areas);

X_{10} = Age of household head (years);

X_{11} = Household head years in school (years);

X_{12} = Productivity of green gram and pigeon pea (kg ha^{-1})

$\beta_1, \beta_2, \cdots, \beta_k$ = estimated coefficients of the function;

u = distributed random error in ordered logit

Table 4.2

Hypothesized Effects of Explanatory Variables on Levels of Commercialization of Crop-Specific Green Grams and Pigeon Peas

Variable Name	Variable description	Variable measurement	Expected sign
Dependent variable: 1=subsistence; 2= semi-commercial; 3=full commercial of levels of crop-specific green grams and pigeon peas.			
Explanatory variables:			
Household agro-ecological condition	Producer AEZs lower midland (LM) 4 and 5 (AEZs LM 4 and 5)	Dummy (1=AEZ LM 4, 0=AEZ LM 5)	±
Household total cropped land	Household's cultivated land under crops	Hectares	+
Household size	Household family size	Number	±
Household labour size	Household labour size	Adult equivalent units	+
Household have produce storage	Household ownership of storage for grains	Dummy (1=yes; 0=no,)	+
Market price per kilogram of green grams and pigeon pea produce	Price per kilogram of output of green gram and pigeon pea sold	Kenya shillings	+
Household use of improved seeds of green gram and pigeon pea	Improved seeds of green gram and pigeon pea	Dummy (1=yes; 0=no)	+
Total livestock holding per household	Total livestock owned by household	TLU	+
Household cropping intensities of green grams and pigeon pea	Proportion of the area under green gram and pigeon pea to total cultivated area	Proportion	+
Age	Age of household head	Number of years	-
Household head years in school	Household head years in school	Number of years	+
Crop productivity	Productivity of green gram and pigeon pea	Kilograms per hectare	+

4.3 Results and Discussion

4.3.1 Farmers' in levels of crop-specific and households' pooled commercialization of green grams and pigeon peas.

Figure 4.1 indicated the percentage of households in subsistence, semi-commercial and fully commercial levels of green grams and pigeon peas production. The percentage of farmers was based on the crop-specific and household commercialization levels and agro-ecological zones lower midland four (AEZ LM 4) and lower midland five (AEZ LM 5).

According to Figure 4.1, the percentage of farmers in subsistence level of green grams production was 95.6% and 71.4% in AEZ LM 4 and AEZ LM 5, respectively. Semi-commercial farmers of green grams were 1.1% and 9.3% in AEZ LM 4 and AEZ LM 5, respectively. In the level of fully commercial in green grams production, the percentage of farmers was 3.3% and 19.2%, respectively.

In pigeon peas production, the percentage of farmers in subsistence level was 80.2% and 85.7% in AEZ LM 4 and AEZ LM 5, respectively. The semi-commercial farmers were 7.7% and 6.6% in AEZ LM 4 and AEZ LM 5, respectively. In the fully commercial level of pigeon peas production, the percentage of farmers was 12.1% and 7.7% in AEZ LM 4 and AEZ LM 5, respectively.

The pooled results shown in Figure 4.1 indicated the percentage of farmers in specific-household commercialization levels based on total marketed production of green grams and pigeon peas. According to the results, the percentage of subsistence farmers were 77.5% and 62.6% in AEZ LM 4 and AEZ LM 5, respectively. The semi-commercial farmers in total green grams and pigeon peas production were 9.3% and 17.6% in AEZ LM 4 and AEZ LM 5, respectively. The percentage of farmers in fully commercialized farms was 13.2% and 19.8% in in AEZ LM 4 and AEZ LM 5, respectively.

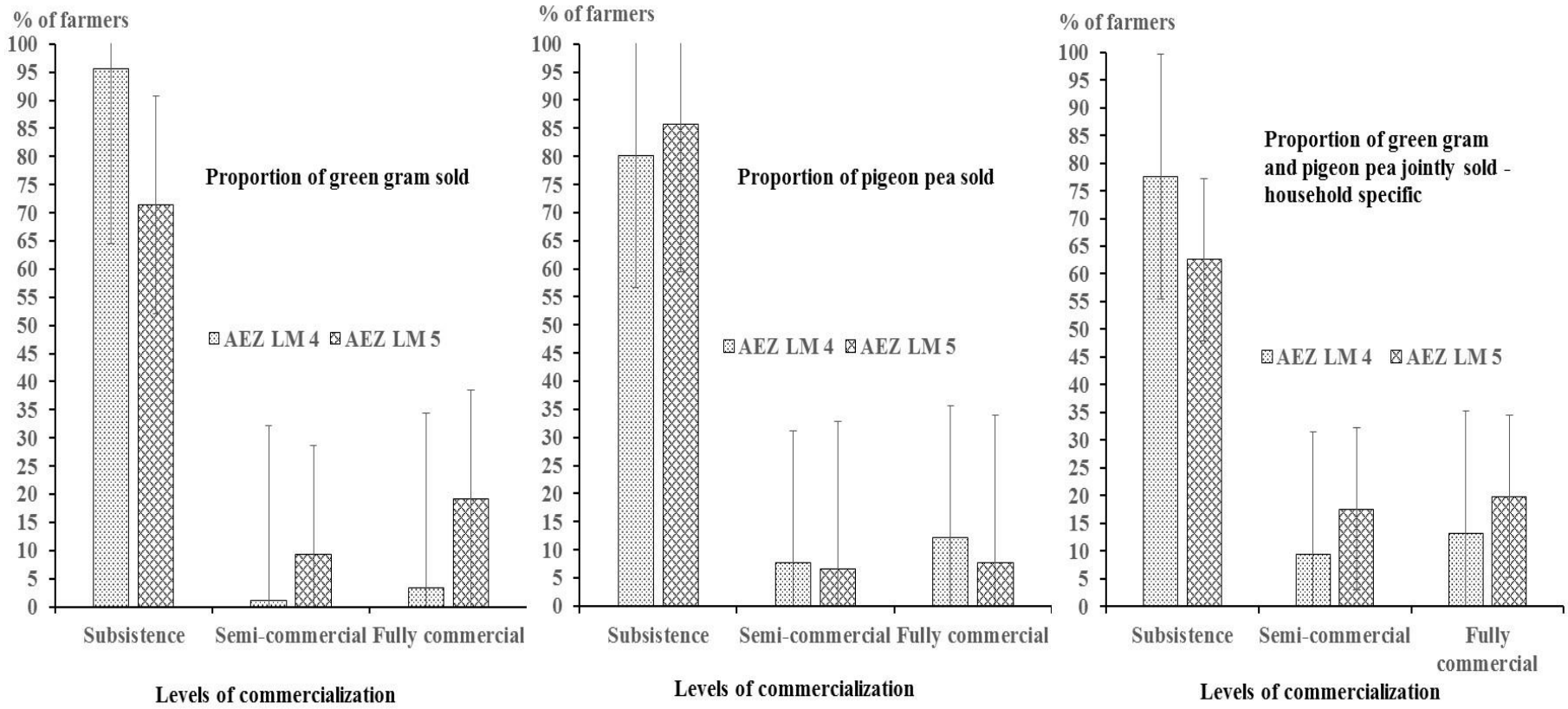

Figure 4.1

Percentages of Farmers in Commercialization Levels of Households and Crop-Specific Green Gram and Pigeon Pea

Similar findings were revealed in the literature by many authors. Torero (2011) revealed that most of African smallholders produce more staple food grains to meet firstly their own consumption and then put the rest on markets. Kimiti et al. (2009) indicated that, households in warm dry parts of eastern Kenya grow green gram for subsistence and markets. According to other studies green gram crop has become popular among smallholder farmers, especially in the climatically marginal areas (Machocho et al., undated; Poehlman, 1991; Purseglove, 2003). The main growing areas of pigeon pea crop in Kenya are Eastern, Coast, and Central provinces (Kimiti et al., 2009). The crop was produced for subsistence and for domestic and international markets (Mergeai et al., 2001). For the production of pigeon pea, more than 70% of pigeon pea dry grain produced in Kenya is traded for cash, while the bulk of green peas are consumed by the households as vegetable (Pambo, 2014). The dry grains of pigeon pea have mainly been utilized in coast province as well as local markets (Mwang'ombe et al., undated). Beyond local markets, the pigeon pea dry grains are exported as processed, unprocessed or as green pods (Ndambuki, 1991). Therefore, according to the literature, green gram and pigeon pea crops are normally grown to meet household food requirements. However, increased production would generate marketed surplus.

4.3.2 Factors influencing household commercialization level of pooled green gram and pigeon pea food crops

The factors affecting household's commercialization level were estimated using ordered logit based on maximum likelihood (ML) and results were shown in Table 4.3. The dependent variable in the model were three categories of household's commercialization as subsistence (low), semi-commercial (medium) and fully commercial (high). In the analysis, the model ordered the levels to capture the transformation process from subsistence to semi-commercial and fully commercial.

The analysis of variance (ANOVA) indicated that, the ordered logistic regression maximum likelihood was -306.999 when the model converged. The likelihood ratio (LR) chi-square of 135.83 was significant at p-value of 0.000. The model as a whole was statistically significant, as compared to the null or empty model with no predictors.

Table 4.3

Results of Ordered Logit Regression Model Estimation of the Factors Affecting Households' Commercialization Levels of Joint Green Gram and Pigeon Pea Commodities

Variables	**Ordered logit coefficient**	**Std. Error**	**z**	***p*>|*z*|**	**[95% Conf. Interval]**	
Dependent variable: Household commercial levels (1=subsistence; 2=semi-commercial; 3=full commercial)						
Independent variables:						
Type of commodity	-0.626***	0.243	-2.57	0.010	-1.103	-0.149
Agro-ecological condition	1.170***	0.259	4.52	0.000	0.663	1.677
Total cropped land	0.067***	0.025	2.73	0.006	0.019	0.116
Family size	-0.073	0.134	-0.54	0.586	-0.336	0.190
Household labor size	0.082	0.172	0.48	0.634	-0.256	0.420
Type of produce storage facility	-0.468*	0.240	-1.95	0.051	-0.938	0.002
Market price per kg	0.040***	0.005	7.75	0.000	0.030	0.051
Use of improved seeds	0.867**	0.380	2.28	0.023	0.122	1.611
Total livestock holding	0.043*	0.026	1.66	0.098	-.008	0.093
Cropping intensity	0.189*	0.108	1.75	0.079	-0.022	0.401
Age of household head	0.007	0.009	0.79	0.427	-0.011	0.025
Household head education	0.022	0.031	0.69	0.491	-0.040	0.083
Latent variable:						
/cut 1	7.281	1.414			4.510	10.05
/cut 2	7.870	1.420			5.087	10.65
Model summary:						
Maximum log likelihood	-306.999					
Prob > chi^2	0.000					
Pseudo R^2	0.181					

Note: ***, **, * Significance at 1, 5 and 10%, levels, respectively

Tropical Livestock Units (TLU) was used to convert all the types of livestock owned into one unit. The equivalents are: calf (0.25), heifer (0.75), young bull (0.34), cows and oxen (1.0),

donkey (0.7), sheep and young goats (0.06), sheep and goats adult (0.13), chicken/poultry (0.013), young donkey (0.35) and adult donkey (0.70) as indicated by Mitiku (2014), Mazengia (2016) and Storck et al. (1991).

Results shown in Table 4.3 indicated the regression coefficients, their standard errors, z-tests and their associated p-values, and the 95% confidence interval of the coefficients. The regression coefficients were in ordered log-odds (logit) scale.

Out of the twelve independent variables hypothesized to have influence on the levels of households in the commercialization process, eight variables were found to be statistically significant. The variables were type of crop ($p = 0.010$), agro-ecological zone ($p = 0.000$), owned total cropped land ($p = 0.006$), type of produce storage ($p = 0.051$), market price per kilogram of green gram and pigeon pea ($p = 0.000$), household's use of improved seeds of green grams and pigeon peas ($p = 0.023$), total livestock holding ($p = 0.098$) and cropping intensity of green gram and pigeon pea ($p = 0.079$). An addition of the household size variable was found non-significant ($p = 0.586$) though showing a negative relationship to the levels of commercialization. This meant, that the higher the household size, the lower the probability of being commercial. Other non-significance variables were household labor size ($p = 0.634$), age of household head ($p = 0.427$) and household head education ($p = 0.491$).

For the type of commodity, as farmers selected pigeon peas instead of green grams in the commercialization, there was a decrease of 0.626 in the log odds of being in a lower commercial level. Thus it will be easier to commercialize pigeon peas than green grams in Machakos County. According to Jaleta et al. (2009), the type of commodity in the process of smallholder commercialization was essential. .

Agro-ecological zone was a categorical variable where farmers were divided into two groups based on agro-ecological zone lower midland four (AEZ LM 4) and agro-ecological zone lower midland five (AEZ LM 5). The difference in commercialization levels between the category of farmers in AEZ LM 4 and AEZ LM 5 was 1.170 in the ordered log-odds scale, holding other variables constant in the model. Households in AEZ LM 5 were likely to be at higher levels (semi-commercial and full commercial) in the process of commercialization than the households in AEZ LM 4. According to the literature, agro climatic conditions were among the main factors affecting commercialization of agriculture at household level (Abdullah et al., 2017; Braun et al.,

1994; Jaleta et al., 2009; Olwande & Mathenge, 2012). Agro climatic conditions influenced smallholder commercialization by changing the conditions of supply for commodity.

The available area to the household was a continuous variable, measured in hectares. A one hectare increase in the available area to the household, was expected to change the household level by 0.067 units. Therefore, households with large available land were likely to be at higher levels in the process of commercialization than the households with less land. According to the literature, the available area to the household was among the several factors affecting commercialization of agriculture (Fredriksson et al., 2017; Olwande & Mathenge, 2012). Large areas owned by the smallholders influenced commercialization through the allocation of more land to the crops with market potential.

There were two levels on the variable ownership of produce storage. There were households without storage facility while others owned the facility. Results indicated strong association between households' levels and ownership of storage facility. As ownership of produce storage facility increased by one unit, the household level of commercialization was expected to decrease by 0.468. Therefore it showed that, ownership of produce storage did not influence higher levels of commercialization (semi-commercial and commercial). These findings contradict past studies which indicated that, significantly more subsistence farmers chose to have a storage facility than semi-subsistence and commercial to reduce their production risk (Riwthong et al., 2017).

There was a strong association between the levels of commercialization and market price. Household's level was expected to increase levels of commercialization by 0.040 due to one unit increase in market price per kilogram of green gram and pigeon pea. Therefore, higher levels in the smallholder commercialization would be influenced by increasing the market price of green gram and pigeon pea grain per kilogram. The subsistence households would change from subsistence to semi-subsistence to commercial, responding to the increase in the market price. The positive relationship between the market price and the levels of household commercialization could have been explained by an increase in the marketed surplus. Many studies in the literature showed that, farmers increased the amounts of marketed surplus due to increase in the market prices (Gashaw et al., 2015).

Due to the household use of improved seeds of green gram and pigeon pea, household level is expected to increase by 0.867. Therefore, households which use the improved seeds of green gram and pigeon pea are likely to be at higher levels in the smallholder commercialization. According to Gebremedhin and Jaleta (2010) and Pingali and Rosegrant (1995), sustainable commercialization of smallholders requires integration into the input markets, although most of the literature on smallholder commercialization deals only with the output side of commercialization. Sperling and McGuire (2010), indicated that, access to preferred seed with adaptability is a prerequisite for sustainable production. Increased crop yield and agricultural production is supported by the availability of seed (Abebe & Alemu, 2017). Therefore, with increased yield and production of crops, farmers were likely to be at higher levels in the smallholder commercialization).

The sign of the coefficient of total livestock unit (TLU) variable showed a positive relationship with commercial levels of households. Household level was expected to increase by 0.043 due to the total livestock units owned. As the total livestock unit (TLU) increased by a unit, the household level increased by 0.043 units. Results indicated that, households with higher TLU were likely to be at higher commercial levels while households with lower TLU were likely to be in subsistence level. Contrary to this finding was observed by Mitiku (2014) where, it was found that, livestock owned (TLU), reduced poverty, though not statistically significant. However, Mazengia (2016) was in agreement that an increase by a total livestock unit, increased household maize output market participation though not significant.

Cropping intensities of green gram and pigeon pea affected the levels of commercialization of households. Results depicted a positive and significant relationship between households' cropping intensities of green gram and pigeon pea and the households' commercial levels. As the cropping intensity of green gram and pigeon pea increased by a unit the household's commercial level increased by 0.189. This indicated that households with higher cropping intensities of green gram and pigeon pea were more likely to be at higher levels in the commercialization than households with lower intensities. The finding was consistent with the findings of Boughton et al. (2007), Mitiku (2014) and Olwande and Mathenge (2012) which explained the low commercial levels of households due to land shortage, leading to low cropping intensities which in turn led to limited generation of marketed surplus and therefore food self-sufficiency priority.

4.3.3 Factors influencing crop-specific green gram commercialization level

Table 4.4 shows the results of the ordered logit model estimation of the factors that determine green gram crop-specific commercialization level. The model had 12 variables. The iteration converged at the maximum log likelihood of -108.115. Results of the analysis of variance indicated a significant chi^2 at $p = 0.000$. The significant chi^2 statistic indicated a strong evidence that β_1 was not equal to zero. According to the results, the variables with significant coefficients were agro-ecological zones ($p = 0.000$), total cropped land ($p = 0.012$), market price per kilogram of green gram production ($p = 0.000$), education level of the household head ($p = 0.079$) and productivity of green gram ($p = 0.000$).

Table 4.4

Ordered Logit Regression Results of the Factors Affecting Green Gram Level of Commercialization

Variables	Coefficient	Std. Error	Z	p>|z|	[95% Conf. Interval]	
Dependent variable: Household commercial levels (1=subsistence; 2=semi-commercial; 3=fully commercial)						
Independent variables:						
Agro-ecological condition	2.394***	0.559	4.28	0.000	1.298	3.489
Total cropped land	0.118***	0.047	2.51	0.012	0.026	0.210
No. of family size	0.033	0.221	0.15	0.882	-0.400	0.466
Household labor size	-0.032	0.287	-0.11	0.912	-0.595	0.531
Owned produce storage	-0.492	0.422	-1.17	0.244	-1.320	0.335
Market price per kg	0.032***	0.008	3.91	0.000	0.016	0.049
Use of improved seeds	0.897	0.664	1.35	0.177	-0.404	2.197
Total livestock holding	0.008	0.081	0.10	0.917	-0.150	0.167
Cropping intensity	-0.148	0.289	-0.51	0.607	-0.714	0.417
Age of household head	-0.016	0.016	-0.99	0.320	-0.048	0.016
Household head education	-0.101*	0.058	-1.76	0.079	-0.214	0.012
Productivity of green gram	0.023***	0.004	6.23	0.000	0.016	0.030
Latent variable:						
/cut 1	12.722	2.899			7.038	18.405
/cut 2	13.682	2.927			7.944	19.419
Model summary:						
Maximum log likelihood	-108.115					
Prob > chi^2	0.000					
Pseudo R^2	0.496					

Note: ***, * Significance at 1%, 10% levels, respectively

Households in agro-ecological zones LM 5 were found in higher commercial level by 2.394 units along the ordered log odds than the households in agro-ecological zone lower midland four, keeping other factors unchanged. This could be explained by higher green gram production in

agro-ecological zone LM 5 than in agro-ecological zone LM 4. Total cropped land was positively related to the households' commercial levels. As the total cropped land increased by one hectare, households' commercial levels increased by 0.118 units along the ordered log odds. The positive relationship indicated that, farmers with large total cropped land were likely to be in higher levels in the process of smallholder commercialization.

Market price per kilogram of green gram was positively related to the households' commercial levels. A unit increase in the market price per kilogram, increased household's commercial level by 0.032 units it implies that farmers responded to the increase in the market prices of green grams by increasing sales. As productivity of green gram increased by one kilogram per hectare, household commercial level increased by 0.023 units. It was expected that, households with higher productivity sell more output and therefore the finding confirmed the study expectation. The finding also agreed with the study by Rios et al. (2009) which indicated that, higher household's sales led to higher agricultural productivity and higher agricultural productivity led to a higher volume of sales which was a two-way causality between commercialization and productivity.

Results from other studies have shown that, the two main ways for the commercialization to occur were either by increasing productivity and marketed surplus of the food crops or by focusing on cash crops (Kabiti et al., 2016; Kirimi et al., 2013; Osmani & Hossain 2015; Sharma & Wardhan 2015). Using the surplus production route ensured household food security while earning income for the producer. Other past studies on the two-way relationships indicated that, sales index significantly increased productivity at a high confidence level but at a low confidence level in Vietnam and Guatemala, respectively. According to Strasberg et al. (1999), there was an increase in fertilizer use and productivity for food crops due to household's agricultural commercialization in Kenya. Basically, commercialization provided a source of income for purchasing inputs, draft oxen and traction equipment that could promote food crop productivity.

The relationship between education level of the household head and commercial level showed a negative effect. As the level of education of the household head increased by one unit, the commercial level decreased significantly by 0.101 units. The decrease in the commercial level of household due to increase in the education level was contrary to the study expectation. It was expected that, as the household head acquired human capital, through formal schooling, there would be a likelihood of selling green gram production. The results were also contrary to the

findings by Edmeades (2006) and Rahut et al. (2010) which indicated that, as the level of education of the household head increased, farmers acquired human capital and therefore increased likelihood of selling the production. The inverse relationship between the increase in the level of education of the household head and the commercial level was an indicative of subsistence behavior. This could have been due to more exogenous income which reduced the likelihood of selling, as it provided an alternative source of income (rather than cash from green gram sales). Also, households' heads with high education might have lacked technical know-how in production.

4.3.4 Factors affecting the smallholder's pigeon pea crop specific level of commercialization

Table 4.5 showed the results of the ordered logit model estimation of the factors influencing pigeon pea level of commercialization. The model had 12 independent variables, but only three were significant: total cropped land, family size and household labour size.

Table 4.5

Results of Ordered Logit Regression Model Estimation Results of the Factors Affecting Pigeon Pea Crop-Specific Level of Commercialization

Variables	Ordered logit coefficient	Std. Error	z	p>|z|	[95% Conf. Interval]	
Dependent variable: Household commercial levels (1=subsistence; 2=semi-commercial; 3=fully commercial)						
Independent variables:						
Agro-ecological condition	-0.303	0.378	-0.80	0.424	-1.044	0.439
Total cropped land	-0.004*	0.054	-0.07	0.948	-0.109	0.102
No. of family size	0.008**	0.204	0.04	0.968	-0.392	0.409
Household labor size	0.021*	0.258	0.08	0.935	-0.484	0.526
Own produce storage	-0.822	0.366	-2.25	0.025	-1.539	-0.105
Market price per kg of pigeon pea	0.029	0.009	3.28	0.001	0.012	0.047
Use of improved seeds of pigeon pea	0.122	0.658	0.19	0.853	-1.167	1.412
Total livestock holding	0.052	0.039	1.31	0.191	-0.026	0.129
Pigeon pea cropping intensity	0.237	0.159	1.48	0.138	-0.076	0.549
Age of household head	0.017	0.013	1.25	0.210	-0.009	0.043
Household head education	0.072	0.047	1.53	0.126	-0.020	0.163
Pigeon pea productivity	-0.002	0.003	-0.88	0.381	-0.008	0.003
Latent variable cutpoints:						
/cut 1	2.355	1.845			-1.261	5.971
/cut 2	3.032	1.849			-0.591	6.656
Model summary:						
Maximum log likelihood	-143.157					
Prob > chi^2	0.0002					
Pseudo R^2	0.0774					

Note: **, * Significance at 5%, 10% levels, respectively

Results showed that, the full model was significantly different from the null model with no predicators at p = 0.0002 as indicated in the model summary. The significant overall model

meant that, there were predictors which explained the variations in the pigeon pea crop-specific commercialization levels. The maximum log likelihood was -143.157 where the model converged. According to the results, the predictors with significant coefficients were total cropped land, number of family size and household labor size.

According to the results, as the total cropped land increased by a hectare, there was a decrease of household commercial level by 0.004 units along the ordered log odds. The finding was contrary to the study prediction that, households with larger farms and more intensive pigeon pea production were more likely to participate as sellers in output market. The subsistence behaviour showed by the inverse relationship could have been due to lack of intensive production of pigeon pea and therefore low surplus. Also, farmers could have allocated small area to pigeon peas production.

The inverse relationship between the total cropped land as a determinant and the level of output commercialization though not significant was also established by Kabiti et al. (2016). Similarly, Mohammed et al. (2016), indicated that household commercialization level decreased due to the increase in total land holding.

Increased family size positively influenced the level of household commercialization. The extent of commercialization level significantly increased by 0.008 units due to one person increase in the household family size. This relationship was expected, since larger family size could potentially ensure adequate supply of family labor for higher pigeon pea crop production leading to surplus production. As the size of the household labour increased by a unit in adult equivalent, the commercialization level increased significantly by 0.021 units. The finding was consistent with Opondo et al. (2017), who found that, household family size positively affected the medium and high levels of cassava commercialization in Siaya County, Kenya.

4.4 Conclusion and Recommendations

Households in Mwala and Yatta sub counties in Machakos County grew green grams and pigeon peas mainly for both subsistence and markets. Household commercialization was the production transformation from subsistence, to semi-commercial to fully commercial levels. The extent of production transformation was based on total volume of crop sold and total volume of crop produced.

Based on results from descriptive statistics analysis, high percentages of households remained at subsistence level in the green gram and pigeon pea production. For green grams production, households in agro-ecological zone lower midland four (AEZ LM 4) contributed more to the subsistence production behaviour than households in agro-ecological zone lower midland five (AEZ LM 5). There was higher likelihood to transform green gram production to commercial in AEZ LM 5 than in AEZ LM 4. This was evidenced in higher percentages of households in semi-commercial and fully commercial in AEZ LM 5 than AEZ LM 4.

There was similar subsistence behaviour in pigeon pea production between households in AEZ LM 4 and AEZ LM 5. Also households in both AEZs contributed to the pigeon pea commercial production transformation. Efforts to influence pigeon pea crop specific commercialization would apply to both AEZs.

Ordered logit regression model analysis was used to estimate the factors affecting commercialization levels of households and green gram and pigeon pea production. The factors which contributed to the tendency of subsistence behaviour by reducing the levels of commercialization at the household level were the type of crop and the type of produce storage facility. For instance, green gram production showed higher likelihood of commercialization than pigeon peas. The type of produce storage facility in terms of capacity and structure reduced the commercialization level at the household.

The factors which were found with positive and significant effects on household commercialization level were production agro-ecological zone, total cropped land, commodity market price per kilogram, use of improved seeds, total livestock holding and cropping intensity. Besides understanding the factors which had negative and positive relationship with commercialization at household level, estimating commercialization index for green gram and pigeon peas was important since the tendency of household to sell could vary according to the type of major crop produced. For example, supply decision of farmers who produce many food crops which can be sold or consumed on the farm could not be similar.

The factors which influenced household tendency to sell more production of green gram crop-specific were agro-ecological zone, total cropped land, production market price per kilogram and productivity. Households with high level of education of household heads had tendency to decrease green gram crop specific level of commercialization. The factors which influenced households' tendency to increase sales of pigeon pea production were family size and household

labor size. In the pigeon pea production, households' subsistence behaviour was influenced by an increase in the total cropped land as indicated by the negative sign.

Some relevant technical, institutional policy recommendations were drawn from the findings of this study that could help to design appropriate intervention mechanisms to improve the smallholder commercialization and crop-specific green gram and pigeon pea in the study area. The fact that the type of crop reduced the household commercialization level, suggested the role of agricultural extension as an institution in promoting the commodities that could yield positive results towards improving commercialization of smallholder farmers of food crops. In this case promoting pigeon pea commodity instead of green gram in the process of smallholder commercialization could reduce commercialization level. Besides that, agro-ecological condition was shown as an important determinant of commercialization at household level.

It was therefore recommended that, specialization in production regions could increase household commercialization level. Farmers with large cropped land needed to increase cropping intensity of green gram and pigeon pea. Use of improved seeds was important in production and therefore, availability could increase household and crop-specific commercialization levels. Availability through variety development and extension was recommended. Government support in terms of distribution of improved seeds and market prices of green gram and pigeon pea. Livestock-crop integration was recommended through total livestock holding. Livestock support crop production through farm yard manure and draught.

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CHAPTER FIVE

FACTORS AFFECTING PRODUCTIVITY OF GREEN GRAM AND PIGEON PEA CROPS AMONG SMALLHOLDER FARMERS IN YATTA AND MWALA SUB-COUNTIES, MACHAKOS COUNTY

Abstract

Smallholder farmers in Yatta and Mwala sub- Counties grow green grams and pigeon peas for food and income. However, there has been limited research on factors affecting productivity of green gram and pigeon pea crops among smallholder farmers. The objective of this study was therefore to analyze factors and their extent in affecting the productivity of green grams and pigeon peas. Data were collected using cross-sectional survey method. Analysis was done using statistical analysis and multiple linear regression model with the help of IBM statistical package for the social sciences (SPSS), version 21. From the descriptive statistics it was found that, the mean productivity of green gram in the subsistence, semi-commercial and fully commercial farms were 11.581, 104.474 and 204.439 kilograms per hectare, respectively. Pigeon pea mean productivity was 43.334, 48.25 and 13.708 kilograms per hectare in subsistence, semi-commercial and fully commercial farms. Results of the multiple linear regression model showed that, the model with all the factors was significant at p = 0.000. The factors which showed positive and significant increase to the productivity of green gram were education level of household head (2.281**), use of improved seed (38.124**), green gram specialization index (15.240**), commercialization level (88.120***), ox-cart ownership (26.924**). The full model of pigeon pea productivity was significant at p = 0.003. The factors which significantly increased productivity of pigeon pea were gender of household head (0.017**) and use of improved seed (0.879*). The study therefore, concluded that, use of improved seeds could increase productivity of both green gram and pigeon pea food crops among other factors. Based on the findings it was recommended that, the government had to strengthen its effort in expanding agricultural extension services on the use of high yielding input varieties.

5.1 Introduction

Farmers commonly grow green gram and pigeon pea for subsistence and income. However, few studies have examined the relationships between production specialization, commercial and subsistence farming and productivity of green gram and pigeon pea. Given the commodity type for commercialization, there are issues on whether smallholder commercialization should focus on enhancing the productivity and marketability of staple food crops or on high-value crops (Abdullah et al., 2017; Jaleta et al., 2009).

According to Abdullah et al. (2017), smallholder specialization in traditional crops was preferred to high value crops. Some of the factors which influenced the type of commodity for commercialization process were technical know-how and attitude towards risk of smallholder, agro-ecological circumstances and socio-economic conditions under which the smallholders operated. Since the smallholders have been producing food crops for a long period, it was assumed that, they had technical know-how and experience in the production of these crops. Newly developed technologies on food crops could help in generating more production, more income for smallholders with lower risk than high value crops. On the other hand, with advanced modes of production and technologies on high value crops, there was more income generated for the farmers, though with at a higher risk than food crops.

Green gram (*V. radiata* L.) also known as mung bean has recently become popular among smallholder farmers and consumers in Kenya, especially in the climatically marginal and urban areas, respectively (Hargrave, 2007). Samant (2014) found that, the crop is one of the important short season grain legumes used in the conventional farming system in the tropical and temperate regions of the world.

In Kenya, green gram, has proved more successful in the drier areas of Machakos, Kitui, Tharaka-Nithi, and Makueni Counties, because of its seasonal earliness, (USAID, 2013). Among these Counties, Machakos County leads in green gram production. Malik et al. (2008) found that, green gram can be grown on a variety of soil and climatic conditions, as it is tolerant to drought. Grown under rainfed conditions, the greater green gram rooting depth helps to acquire stored water from various depths to improve stability in grain yield (Kumar & Sharma, 2009). Additionally, it is adapted to poor soils because it forms associations with mychorrhiza (Kasiamdari et al., 2002) and is a relay crop, hence plays an important role in environmental conservation and food security, respectively.

The agronomical importance of green gram is linked to its high protein content and other essential minerals, especially micronutrients (Patel et al., 2016). The crop serves as an alternative source of non-animal protein as was the case in some parts of East Africa during the outbreak of the Rift Valley Fever (Machocho et al., undated).

Looking at the green gram yields, significant amounts are realized in semi-arid regions of Kenya where the annual amount of rainfall is approximately 600–800 mm over two rainy seasons, but it can do with less, where two green gram crops are grown per year (Mogotsi, 2006). Although, the green gram withstands drought well, by curtailing the period of flowering and maturation, it is susceptible to water-logging, lowering the yields (RoK, 2003; URT, 2003; Swaminathan et al., 2012). Other constraints to the green gram yields are diseases, pest infestations, unsuitable varieties and inappropriate agronomic practices. Kimiti et al. (2009) found that, the range of the green gram yield was 30 - 416 $kgha^{-1}$. But the on-station research recommendations indicate that, the range of the potential yields is 300-1500 kg ha^{-1} (Karanja et al., 2006).

There are practices to enhance green gram yield, despite the yield constraining factors. These practices, entail the use of improved green gram varieties, industrial chemicals and fertilizers (Machocho et al., undated). However, the practices are expensive, pose health hazards and are environmentally undesirable. Besides, the chemicals are not popular among the resource poor farmers who are also the main producers and consumers of the legume. Looking at the legume-cereal intercropping systems, Sakala et al. (2000) found that, the intercropping of legume and cereal crops is a common practice of smallholder farmers throughout the tropics while in East Africa maize is commonly intercropped or rotated with grain legumes.

In Kenya, green gram is usually intercropped with maize, sorghum or millet. It is occasionally grown in pure stands or intercropped with other pulses. The usual practice here is to place 1–2 rows of green gram between rows of a cereal, or to plant green gram in the cereal row (Swaminathan et al., 2012). Farmers do not normally apply any inorganic fertilizer to a green gram crop, though it responds well to phosphorus. The crop uses residues from fertilizer applications to the main crops in the system. Nutrient removal per ton of seed harvested (dry weight) is 40–42 kg N, 3–5 kg P, 12–14 kg K, 1–1.5 kg Ca, 1.5–2 kg S and 1.5–2 kg Mg

Pigeon pea (*Cajanus cajan* (L.) Willsp.) is another important leguminous crop which provides multiple benefits to the rural poor in food security, maintenance of soil fertility through litter fall and nitrogen fixation, provision of fodder for livestock and fuel for small-scale farmers in

subsistence-agriculture (Egbe & Kalu, 2006; Kimiti, 2009; Shiferaw et al., 2008; Yeboah et al., 2004). The crop has ability to fix 41 to 250 kg N per hectare of atmospheric nitrogen through symbiotic association between the root nodules and a species of bacteria, *Rhizobia* (Kwame, 2003) and produce more N per unit area from biomass than many other legumes for the current growing crop and subsequent ones. The nitrogen fixation and phosphorous release is significant because most soils in semi-arid regions are deficient in nitrogen and phosphorus (Jones et al., 2002).

In Kenya, pigeon pea is the third most important food grain legume after bean (*Phaseolusvulgaris* L.) and cowpea (*Vigna unguiculata L.*). The crop is suitable in semi-arid agro-ecological zones and in cereal-legumes farming systems in Kenya (Kimiti, 2009). Predominantly it is mainly grown in the dry regions of the eastern province of Kenya (Mergeai et al., 2001). The main important pigeon pea producing districts in Kenya are Machakos, Makueni, Kitui, Mwingi and Mbeere which are located in the semi-arid eastern province of Kenya (Shiferaw et al., 2008). Among these districts, Machakos, accounts for about 33% of total national production; Makueni (25%) and Kitui (22%).

Due to the importance of the pigeon peas in Kenya, Kenyan Agricultural Research Institute (KARI), University of Nairobi (UoN) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), in recent years, developed and tested a number of short-, medium-, and long-duration improved varieties (Mergeai et al., 2001; Silim, 2001). The long-, medium-, and short, varieties take approximately 9, 6 and 4 months to maturity, respectively.

The result of development and testing of improved varieties was the release of two short-duration types called ICPL, 87091 (under the release name KARI Mbaazi 1) and Kat 60/8, and one long-duration type called ICEAP 00040 (under the release name KARI Mbaazi 2). These improved varieties are higher yielding and more resistant to Fusarium wilt. Additional lines at various stages of testing by ICRISAT and partners include ICEAP 00068, ICEAP 00554, ICEAP 00557 and ICP 6927, all for medium duration. The lines for long duration were ICEAP 00020 and ICEAP 00053. Attempts are also being made to adapt the improved varieties to broader environmental conditions through an ongoing breeding program.

Seed distribution systems of pigeon pea in the semi-arid lands of Kenya exist, which are formal and informal (Shiferaw et al., 2008). Regular seed supply and emergency/relief system are the formal seed supply systems. The informal seed supply system involves local grain stores,

neighbours, relatives and friends. The system adopted in providing farmers access to seed depends on the prevailing local circumstances. Most pigeon pea growing farmers source their seeds through this system and only turn to the formal system during emergency or hardship. Emergency seed relief interventions have been used to improve accessibility of farmers to seed especially, during drought, and in some cases to promote new improved varieties. Direct seed distribution, seed vouchers and fairs have been used to distribute seeds (Jones et al., 2002; Trip, 2000).

Several types of seed interventions have been adopted by Kenya Agricultural Research Institute (KARI) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), for instance producer marketing groups-PMGs and small seed packs to improve farmers' access to the pigeon pea improved seeds. However, despite the adoption of the seed interventions, by KARI and ICRISAT, the pigeon pea yielded less than 1 t ha^{-1} in the farmers' fields while the potential yield was about 5 t ha^{-1}. Mergeai et al. (2001), observed that, the grain yields obtained was low, between 300 to 500 $kg.ha^{-1}$ due to the farmers' non-use of improved varieties and complementary practices; and predominantly growing the late maturing pigeon pea genotypes that take up to 11 months to mature.

Access to improved seeds has been a major problem in all pigeon pea-growing areas due to the undeveloped seed markets (Tripp, 2000). Consequently farmers can maintain the productivity of new varieties for 3-5 years while using saved seed. Silim (2001) observed that, most of the local pigeon pea varieties grown by farmers belong to the long-duration group. These local varieties have lower yields than improved varieties under the normal conditions. The varieties were mostly intercropped with cereals (maize and sorghum) and other food legumes (beans, green gram and cowpea).

A large portion of the economic development literature is devoted to the factor differences in productivity. Some of the factors considered in the literature are gender (Githinji et al., 2011; Horrell & Krishnan, 2006; Njuki et al., 2006), education (Padhy & Jena, 2015), assets (Tatwangire, 2011; Zezza et al., 2008) and farm size (Chand et al., 2011; Masterson, 2007). Based on that, it was therefore, considered important to investigate the farmer differences in the factors related to the yields of green grams and pigeon peas in order to disseminate the knowledge to a wider community on how to improve the yields. The objective of this study was

therefore to analyze factors affecting the productivity of green gram and pigeon pea among smallholder farmers in Machakos County

5.2 Methods of data analysis

Data was analyzed using IBM statistical package for the social sciences, version 21. Statistical analysis was used to obtain descriptive results. frequencies were used to categorize households according to landholding sizes and production systems in agro-ecological zones lower midland 4 and lower midland 5 (AEZs LM 4 and LM 5). Categories of landholding sizes in hectares are; ≤ 0.80, 0.81 – 1.60, 1.61 – 2.40 and ≥ 2.41.

Types of tests used were one-way analysis of variance and multiple linear regression. *F-test* was used to compare the significance of the mean differences in the productivity of green gram and pigeon pea. Ordinary multiple linear regression model was used to assess the influence of smallholder commercialization level on household's productivity of green gram and pigeon pea. The empirical model 5.1 of household's productivity was developed and data fitted to analyze the effects of the explanatory variables. The hypothesized effects of the explanatory variables on the productivity of green gram and pigeon pea are shown in Table 5.1.

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 X_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + x_{10} + \beta_{11} x_{11} + \varepsilon \ldots\ldots$$ Equation 5.1

Where:

y_i = Household productivity of green gram or pigeon pea (*kg ha*$^{-1}$);

x_1 = Education (*years*);

x_2 = Gender (1=male; 0=female)

x_3 = Manure use (1=yes; 0=no);

x_4 = use of improved seed (1=yes; 0=no);

x_5 = Ox-cart ownership (1=yes; 0=no);

x_6 = Knapsack sprayer ownership (1=yes; 0=no);

x_7 = Livestock ownership (TLU);

x_8 = Total cropped area (ha);

x_9 = Specialization index (proportion of area);

x_{10} = Household commercialization level (1=subsistence, 2=sub-subsistence, 3=commercial);

x_{11} = Household's production systems in agro-ecological zones (1=*AEZ LM 4, 0=AEZ LM 5*);

ε = Disturbance term.

Table 5.1

Hypothesized Effects of Explanatory Variables on Productivity of Green Gram and Pigeon Pea

Variable Name	**Variable description**	**Variable measurement**	**Expected sign**
Dependent Variable: Productivity (kgs ha $^{-1}$)			
Independent Variables:			
Education	Educational status of the household head	Number of years in school	+
Gender	Gender of the household head	Dummy (1=male, 0=female)	±
Manure use	Application of farm yard manure in the food production systems	Dummy (1=yes,0=no)	-
Use of improved seed	Improved seeds of green gram and pigeon pea	Dummy (1=yes,0=no)	-
Ox-cart ownership	Household ownership of ox-cart asset	(1=yes,0=no)	-
Knapsack sprayer ownership	Household ownership of knapsack sprayer asset	Dummy (1=yes,0=no)	-
Livestock ownership	Total livestock owned by household	TLU	±
Total cropped area	Household total cultivated land under all crops	Hectares	+
Specialization index	Proportion of cultivated area under green gram and pigeon pea	Proportion of area	+
Household commercialization level	Household commercialization level	Dummy (1=subsistence, 2=sub-subsistence, 3=commercial)	+
Agro-ecological conditions	Household's production systems in agro-ecological zones	(1=AEZ LM 4, 0=AEZ LM 5)	±

5.3 Results and discussion

The objective was approached by; (i) comparing commercialization level with productivity levels of green gram and pigeon pea crops, (ii) evaluating the relationship between the farm size and productivity of green gram and pigeon pea (iii) determining productivity variations with the levels of specialization and commercialization among smallholder farmers.

5.3.1 Household commercialization levels and productivity of green gram and pigeon pea crops

Figure 5.1 showed mean productivity of green gram and pigeon pea crops of farmers in subsistence, semi-commercial and fully commercial levels. Results showed that, farmers in subsistence, semi-commercial and fully commercial levels had mean productivity of green gram of 11.581, 104.474 and 204.439 kilograms per hectare, respectively. For the subsistence, semi-commercial and fully commercial levels, the mean productivity of pigeon pea were 43.334, 48.25 and 13.708 kilograms per hectare, respectively.

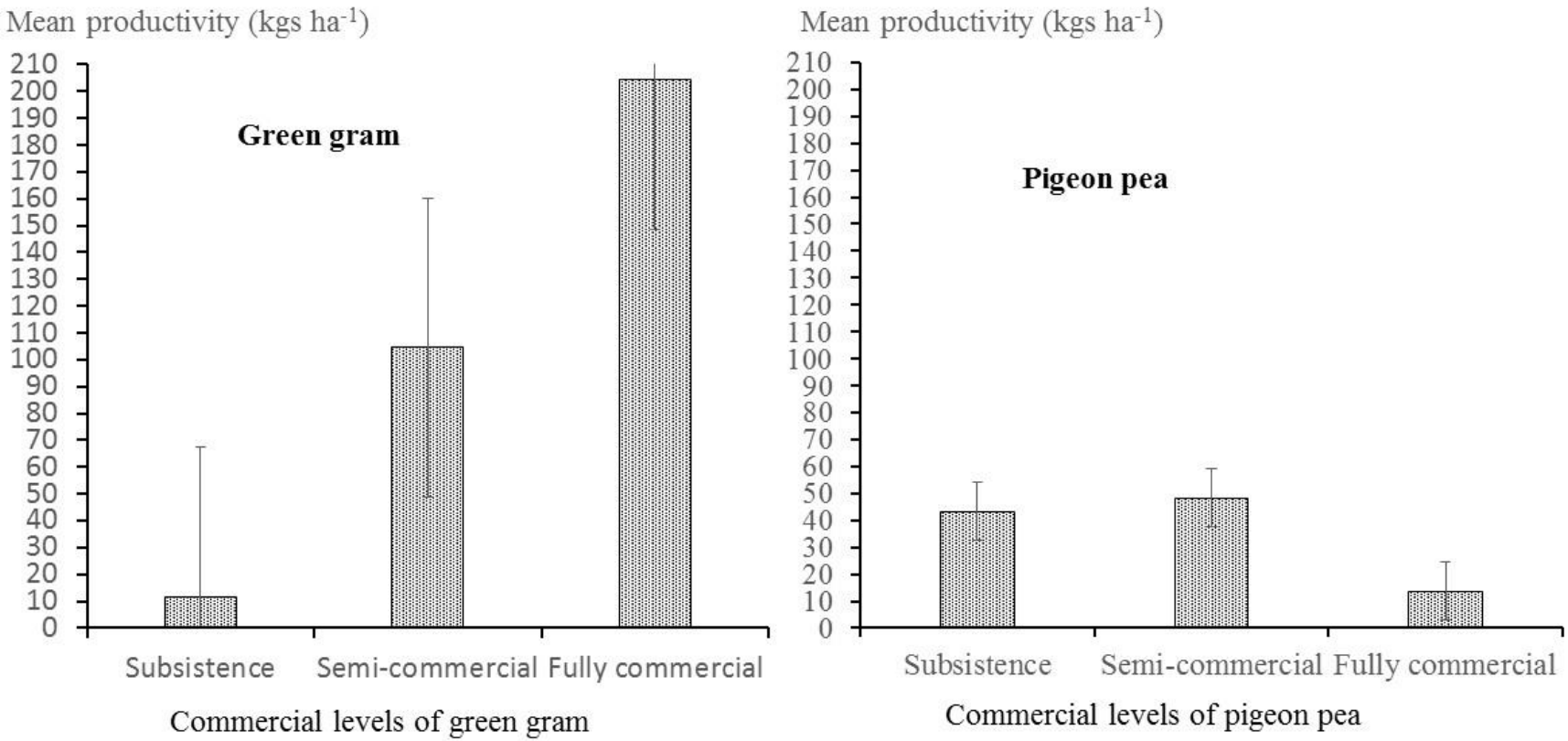

Figure 5.1

Levels of Productivity of Green Gram and Pigeon Pea in Commercialization Levels

The finding agreed with the study prediction that, households with higher commercialization levels, had the highest productivity. Higher commercialization level could generate more income for increased input use and productivity. Besides improved input use, commercialization could lead to specialization. The finding was in conformity with the past research findings, for instance, Ochieng et al. (2016) indicated that, crop commercialisation had both a direct effect on crop production and an indirect effect through input use (fertilizers and improved seed varieties). Strasberg et al. (1999) established that household agricultural commercialization, showed a significant and positive effect on food crop fertilizer use and productivity in Kenya. Li et al. (2017) and Wickramasinghe and Weinberger (2013) argued that, commercialisation encouraged better use of comparatively advantaged resources and therefore productivity changes.

Higher productivity in semi-commercial production of pigeon pea could be passively to sell part of their meagre food output for cash requirement. This finding agreed with research by Nyikal (2003) which argued that, although farmers were known to be supply responsive and were, therefore, expected to adopt commercial agriculture, many had continued in their semi-commercial and subsistence modes. According to RoK (1998), smallholders in Kenya produce most of their own food and also contribute the nation's total marketed output. Therefore, higher productivity of pigeon pea in semi-commercial households was to meet firstly their own consumption and then put the rest on markets for income.

5.3.2 Levels of productivity of green gram and pigeon pea according to households' farm sizes

Figure 5.2 showed the mean productivity of green gram and pigeon pea according to households' farm sizes. The mean productivity of green gram was 27.235, 45, 43.905 and 79.753 kilograms per hectare within the range of farm size of ≤ 0.80, $0.81 - 1.60$, $1.61 - 2.40$ and ≥ 2.41 hectares, respectively. Pigeon pea had the mean productivity of 23.474, 21.921, 64.946 and 67.790 kilograms per hectare within the same range of farm size respectively.

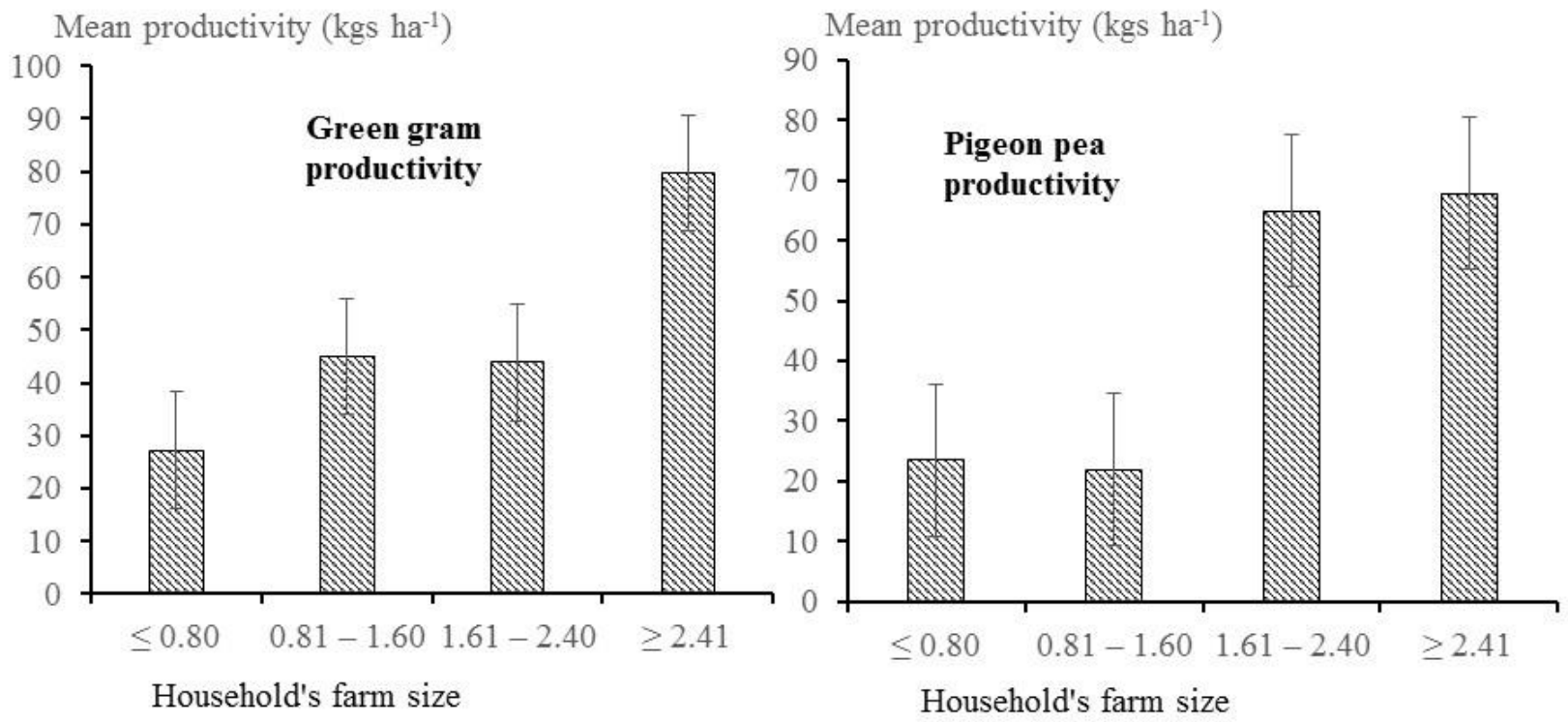

Figure 5.2

Mean Productivity of Green Gram and Pigeon Pea According to Households' Farm Sizes

According to results, larger farms had higher productivity than small farms in both green gram and pigeon pea crops. This can be explained by the differences in the input intensity levels by large farmers. According to Verschelde et al. (2011), incentives to use inputs varied with the production scale, which implied that, bigger farms used different technologies than small farms. Use of family labour also explained why larger farms had higher productivity than small farms. Collier and Dercon (2009) argued that, larger farms may exploit economies of scale. Other past research findings showed inverse relationship between productivity and farm size which indicated that, small farms were more productive than large farms (Chen et al., 2010; Mahmood et al., 2014; Verschelde et al., 2011).

5.3.3 Levels of productivity of green gram and pigeon pea according to production agro-ecological conditions

Figure 5.3 showed mean productivity of green gram and pigeon pea varied in production agro-ecological zone (AEZ) lower midland 4 (LM 4) and lower midland 5 (LM 5). Mean productivity of green gram in AEZ LM 4 and AEZ LM 5 was 19.9 and 173.67 kilograms per hectare, respectively. Pigeon pea had mean productivity of 109.26 and 34.01 kilograms per hectare, respectively.

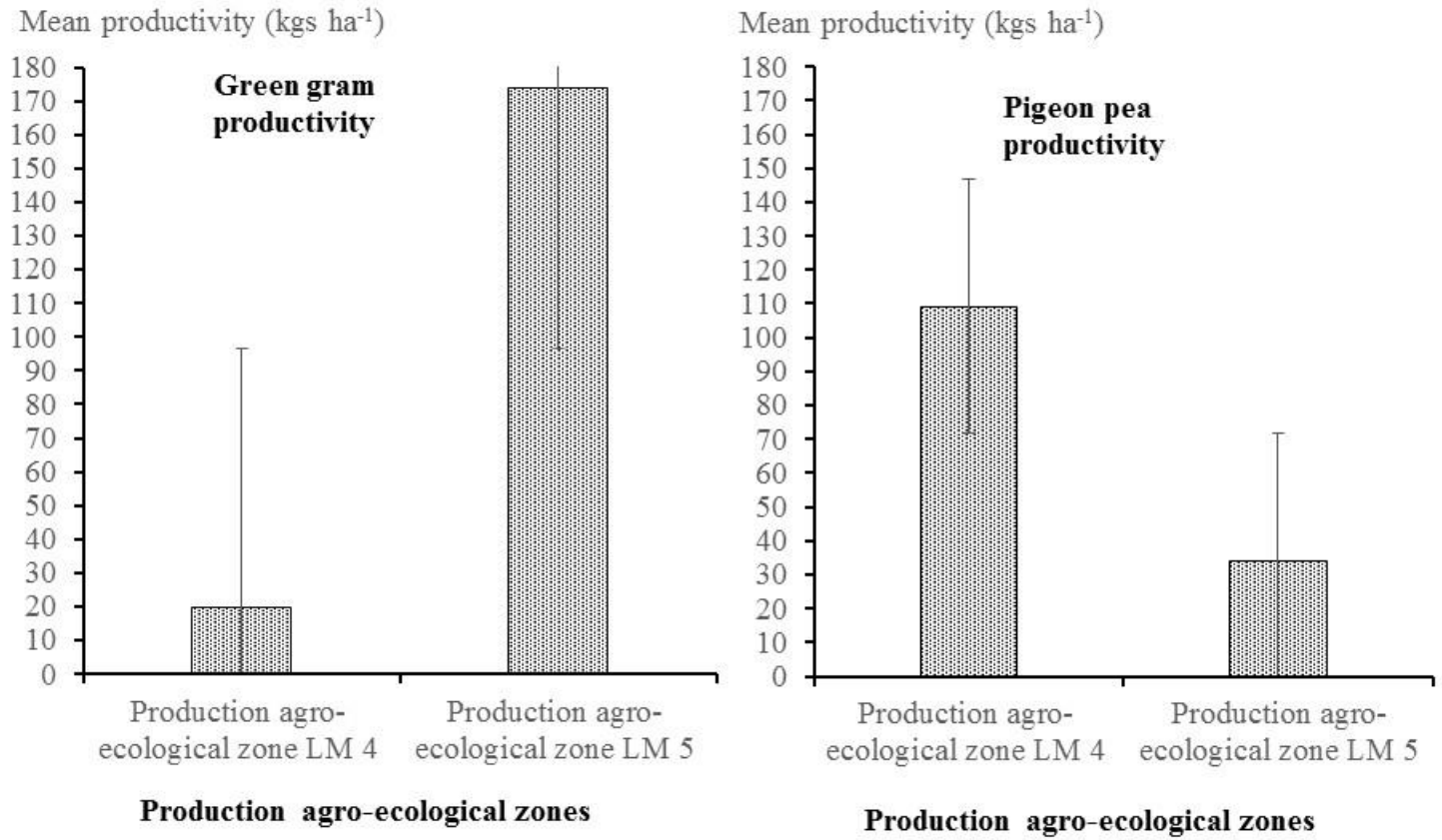

Figure 5.3

Mean Productivity of Green Gram and Pigeon Pea in Production Agro-Ecological Conditions

Results were contrary to the study prediction. It was expected that, the mean productivity of green gram and pigeon peas were similar in farms in AEZ LM 4 and AEZ LM 5. Although results agreed with the past research findings that green gram and pigeon pea, grow well in warm dry parts of eastern Kenya (Høgh-Jensen et al., 2007; Kimiti et al., 2009; Okoko et al., 2002), the productivity differed within the agro-ecological zones.

5.3.4 Factors affecting productivity of green gram

Multiple linear regression model was used in the analysis of the factors affecting productivity of green gram. The model had 11 explanatory variables. The overall regression model was significant, $F(11, 355) = 24.309$, $p = 0.000$ (Table 5.2). Results showed that the full model was different from the null model and a strong evidence that $\beta_1 = \beta_2 = ... = \beta_p = 0$.

Table 5.2

Results of Multiple Linear Regression Model of Factors Affecting Productivity of Green Gram (Kg Ha^{-1})

Variable	B	Std. Error	t-ratios	Sig.
Dependent Variable: Productivity of green gram				
Independent Variable:				
Constant	-143.096	45.006	-3.180	0.002
Gender of household head	-15.621	10.109	-1.545	0.123
Education level of household head	2.281**	1.142	1.998	0.047
Use of improved seed	38.124**	18.618	2.048	0.041
Cultivated farm size	0.936	1.365	0.685	0.494
Green gram specialization index	15.240**	7.526	2.025	0.044
Commercialization level	88.120***	7.106	12.400	0.000
Manure use	-11.869	9.633	-1.232	0.219
Knapsack sprayer	-11.035	10.989	-1.004	0.316
Ox-cart ownership	26.924**	13.114	2.053	0.041
Number of livestock (TLU)	1.794	1.407	1.275	0.203
Production agro-ecological condition	11.794	10.233	1.153	0.250
F-ratio	24.309			
Sig.	0.000			

***, ** indicated 1%, 5% significance levels.

Note: (*i*) Adults equivalent units were computed using OECD equivalence scale. A value of 1 to the first household member of 0.7, each additional adult of 0.5, to each child under 15 years (Burniaux et al., 1998).

(*ii*) Conversion factors of total livestock holding per household (Total Livestock Unit).

According to Moti and Gebremedhin (2010), Mitiku (2014) and Mazengia (2016), the conversion factors are calf (0.25), heifer (0.75), young bull (0.34), cows and oxen (1.0), donkey (0.7), young sheep and goat (0.06), adult sheep and goats (0.13), chicken/poultry (0.013), young donkey (0.35) and adult donkey (0.70).

The coefficients of the predictors of the yield of green gram were presented in Table 5.1. The significant predictors of the yield of green gram were education ($\beta = 2.281$, $p = 0.047$), use of improved seed ($\beta = 38.124$, $p = 0.041$), green gram crop intensity ($\beta = 15.240$, $p = 0.044$), household commercialization level ($\beta = 88.120$, $p = 0.000$), ox-cart ownership ($\beta = 26.924$, $p = 0.041$). Though the coefficient of gender predictor was nonsignificant, the direction agreed with the study expectation. It was expected that, household headed by male had higher productivity than the household headed by female. Result showed that, the yield of green gram was higher in households headed by males than households headed by females (Table 5.1), taking female as the appropriate reference category of the gender dummy variable. The finding supported numerous studies in the literature which looked at the role of women in African agriculture and accepted as an observed fact that female-headed households were less productive than male-headed households as measured by value of output per unit of land (FAO, 2011). Lower productivity in female-headed households had been attributed to both the lack of access to labour and draught animals (Holden et al., 2001), less secure tenure for women resulting in lower productivity (Alene et al., 2008) and lack of access to farming support in particular credit, extension, and input support, because of various forms of discrimination against women (Gĩthĩnji et al., 2011). Numerous studies in the literature also showed that, access to extension services was lower for women as compared with men (Ragasa, 2012; World Bank & IFPRI 2010). A number of studies have also pointed out the gap in credit, fertilizer and capital use and technological adoption between female and male-headed households (Deininger & Olinto, 2000; Ouma et al., 2006; Tiruneh et al., 2001; Wanjiku et al., 2007).

Education was positively related to the yield of green gram. A one year increase in school for the household head, the productivity of green gram increased by 2.281 kilograms (Table 5.1). The

finding agreed with the study expectation that, there was a positive relationship between the number of years of the household head and the productivity of green gram. In theory, education was expected to improve productivity in agriculture (Amare, 2010; Asadullah, 2005). Literature has shown that, a positive return to education arise because educated farmers are better managers, adopt more modern farm inputs and prefer risky (high-return) production technologies. According to Weir (1999), education may enhance farm productivity directly by improving the quality of labour, by increasing the ability to adjust to disequilibria, and through its effect upon the propensity to successfully adopt innovations. Education is thought to be most important to farm production in a rapidly changing technological or economic environment.

During the study, it was observed that, some farmers used improved while others used local green gram seed. The finding indicated that, farmers who were using improved seed of green gram increased productivity by 38.124 kilograms than the farmers found not using improved seed. The positive relationship agreed with the study expectation. Results also supported the work by Amare (2010) which indicated that, farmers found using improved seeds were likely to increase the crop productivity.

An increase in the cultivated farm size showed a positive relationship with the productivity of green gram. A one hectare increase in the cultivated land size increased the productivity of green gram by 0.936 kilograms, though not significant (Table 5.2). The positive relationship agreed with the study expectation. According to the literature, the result did not agree with findings from a large number of studies which investigated the inverse relationship (IR) hypothesis; that productivity of a farm increased with the decrease of land holding's size. During the years 1960s and 1970s, a large number of studies provided convincing evidence that crop productivity per unit of land declined with an increase in farm size. However, other published work have shown that, the inverse relationship has ceased to hold. A positive relationship between farm size and productivity has been attributed to higher application of fertilizer and other cash-intensive inputs on large farms although the inverse farm size-productivity relationship cannot be rejected at low levels of agricultural technology, but can be rejected at higher levels. It has been argued that the inverse relationship is neither a product of superior efficiency on the part of small farms nor is it due to better quality land on the small farms but arises from the desperate struggle for poor peasants for survival on below subsistence plots of land.

Green gram cropping intensity variable had a positive relationship with productivity. When a unit proportion of the area under green gram to the total cultivated area increased, the productivity increased by 15.240 kilograms. The finding agreed with the study prediction that cropping intensity impacted positively on productivity. Literature had shown that, the most common advantage of cropping intensity was to produce a greater productivity on a given piece of land by achieving more efficient use of the available growth resources that would otherwise not be utilized by each single crop grown alone (Lithourgidis, 2011). According to Yao and Liu (1998), cropping intensity has been used as an explanatory variable to the grain productivity.

Household commercialization level was positively related to the productivity of green gram. As commercialization level increased, the productivity of green gram increased by 88.120 kilograms. This result agreed with findings of some studies which showed that commercialization played a key role for the improvement of technical efficiency in a situation where subsistence agriculture was dominated by input market failures and credit constraints (Gebre-ab, 2006; Tirkaso, 2013). Other studies argued that being efficient and productive farmer, positively influenced the level of commercialization and hence supplies certain proportion of surplus output to the market after satisfying household demand (Govereh et al., 1999; Jaleta et al., 2009).

Manure use was a dummy variable and negatively related to the productivity of green gram, though not significant. Table 5.2 indicated that, farms with no manure application had lower productivity than farms where manure was used by 11.869 kilograms per hectare. The finding confirmed the study expectation that, use of manure increased crop yield. According to Li et al. (2001) and Zhang et al. (1998), adequate quantity and quality of manure explained the difference in output per unit of land area among farmers. Among all the farming practices, rational organic manure application was among the most important measures to bring about increase in grain yield (Fan et al., 2005a; Patil & Sheelavantar, 2006). Many farmers use manure because they are aware of its benefits, but the quantities are insufficient and of poor quality (Probert et al., 1995). However, the organic nutrients from manure are produced slowly due to slow decomposition because of the low rainfall, resulting to reduced plant growth. Other studies have shown that, with insufficient and poor quality organic manure application, soil water storage is low (Zougmoré et al., 2004). Therefore, with rational farmer organic manure application, water-use efficiency is promoted which is observed as the grain yield per unit of seasonal evapotranspiration, in kg ha^{-1} mm^{-1} (Adamtey et al., 2010; Hati et al., 2006; Patil &

Sheelavantar, 2006). Contrary argument on the relationship between manure application and water-use efficiency has been put by Affholder (1995). It has been argued that, application of manure raises a crop's water demand without substantially increasing the water supply of the soil. The soil dries faster at the end of the crop cycle where manure is applied than where there is no application.

The dummy variable ownership of knapsack sprayer was negatively related to the productivity of green gram though not significant. Results showed that, the productivity of green gram was higher in households owning knapsack sprayer than the households without knapsack sprayer. The finding agreed with the study expectation. Knapsack sprayer is an equipment used by farmers to enhance the pesticide usage and application for controlling different species of insect pests and diseases which attack the crops, causing substantial productivity losses (Nwaobiala & Ezeh, 2012).

The sign of the coefficient of ox-cart ownership dummy variable showed a positive relationship with productivity of green gram and the finding agreed with the study expectation. Ox-cart is in the household portfolio of productive assets and positively influences technical efficiency and therefore productivity. Farmers use ox-carts for the transportation of farm inputs and outputs to augment household labour. According to Kassali (2012), ox-carts were means of transportation to increase smallholder farmers productivity due to lack of own tractors or pickups.

The number of livestock ownership was essential in the productivity of green gram though not significant in the model. The finding agreed with the study expectation based on integrated crop-livestock farming systems framework. According to Ezeaku et al. (2015), integrated crop-livestock farming system offered opportunities to promote organic agriculture; and carryover of carbon and nutrients from one cropping season to the next.

Multiple regression model showed a positive relationship between agro-ecological condition and green gram productivity though the difference was not significant. The finding agreed with the study expectation that, there was no significant difference in productivity of green gram between the farms in AEZ LM 4 and the farms in AEZ LM 5. This finding supported past research by Swaminathan et al. (2012) which indicated that, green gram crop was a pan-tropical and was able to grow in adverse conditions. The productivity was influenced by a warm-season, mainly within a mean temperature range of 20–40°C, the optimum being 28–30°C.

5.3.5 Factors affecting productivity of pigeon pea

Table 5.2 showed results of multiple linear regression model analysis. The analysis of variance (ANOVA) for regression consisted calculations that provided information about levels of variability within the multiple linear regression model and formed a basis for tests of significance. In the ANOVA table for the productivity of pigeon pea the distribution was $F(11, 358)$, the F statistic was 2.656, and the probability of observing a value greater than or equal to 2.656 was $p = 0.003$. Therefore, at least one explanatory variable in the model, significantly influenced the productivity of pigeon pea at $F(11, 358) = 2.656$, $p = 0.003$. Out of eleven variables hypothesized and included in the multiple linear regression model, four showed significant influence on the productivity pigeon pea. The factors were gender ($\beta = 0.017$, $p = 0.067$), use of improved seed ($\beta = 0.879$, $p = 0.053$), cultivated farm size ($\beta = -0.174$, $p = 0.054$) and household's pigeon pea production agro-ecological condition ($\beta = -0.833$, $p = 0.000$).

Table 5.3

Results of Multiple Linear Regression Model of Factors Affecting Productivity of Pigeon Pea (Kg Ha^{-1})

Variable	Unstandardized Coefficients (β)	Std. Error	t-ratios	Sig.
Dependent Variable: Productivity of pigeon pea				
Independent Variables:				
Constant	5.751	1.115	5.157	0.000
Gender of household head	0.017**	0.249	0.067	0.067
Education of household head	-0.014	0.028	-0.493	0.623
Use of improved seed	0.879*	0.453	1.941	0.053
Cultivated farm size	-0.174*	0.090	-1.930	0.054
Pigeon pea cropping intensity	0.139	0.250	0.556	0.579
Commercialization level	-0.287	0.214	-1.340	0.181
Manure use	0.221	0.242	0.914	0.361
Knapsack sprayer ownership	0.160	0.269	0.596	0.552
Ox-cart ownership	-0.385	0.319	-1.208	0.228
Number of livestock (TLU)	-0.015	0.048	-0.312	0.755
Production agro-ecological condition	-0.833***	0.229	-3.646	0.000
F-ratio	2.656			
Sig.	0.003			

***, **, * indicated 1%, 5%, 10% significance levels.

Note: (*i*) Adults equivalent units were computed using OECD equivalence scale. A value of 1 to the first household member of 0.7, each additional adult of 0.5, to each child under 15 years (Burniaux et al., 1998).

(*ii*) Conversion factors of total livestock holding per household (Total Livestock Unit). According to Mazengia (2016), Mitiku (2014) and, storck et al. (1991), the conversion factors are calf (0.25), heifer (0.75), young bull (0.34), cows and oxen (1.0), donkey (0.7), young sheep and goat (0.06), adult sheep and goats (0.13), chicken/poultry (0.013), young donkey (0.35) and adult donkey (0.70).

According to Table 5.3, a male headed household increased productivity by 1.7%, significant at 5%. This confirmed the study prediction that farms managed by male had higher productivity than farms managed by female. Low productivity by female farmers was attributable to subsistence-oriented production where households prioritize food security more highly. Many studies in the literature have examined gender differences in agriculture and found gaps. For instance, gender differences in agricultural productivity (Okoye, 2008; Quisumbing, 1995 Okoye, 2008), gender differences in assets (FAO, 2011), gender and access to agricultural resources by smallholder farmers (Anaglo et al., 2014). Besides establishment of the gaps, however, there were studies which exceptionally demonstrated that female-headed households achieved the same or higher productivity than male-headed households. The vast majority of the literature on productivity of male and female farmers confirmed that, female were just as efficient as men and would achieve the same productivity if they had equal access to productive resources and services (Peterman et al., 2010; Quisumbing, 1996).

The coefficient for use of improved seeds was significant at 10 percent. A one kilogram use of improved seed increased productivity by 88 percent. According to Mergeai et al. (2001), there were three types of pigeon varieties classified into long (9 months), medium (6 months) and short (4 months) duration, developed and released in Kenya. Therefore, use of improved pigeon pea seed could be due to farmers' access to pigeon pea improved varieties.

There was an inverse relationship (IR) between the cultivated farm size and pigeon pea productivity. An increase of one acre planted decreases output by 17.4 percent The IR could have been due to low specialization and commercialization levels leading to low cropping intensity and use of purchased inputs.

Literature on inverse relationship is still inconclusive. According to Masterson (2007) and Mahmood et al. (2014), inverse relationship was more related to higher land use and cropping intensities, than due to differences in factor endowments in terms of soil, labour and managerial ability. Singh et al. (2002) argued that cropping intensity decreased as farm size increased and, therefore, concluded that small farms were more productive than larger farms.

5.4 Conclusion and Recommendations

According to results of descriptive statistics analysis, among the smallholder farmers, the mean productivity of green gram and pigeon pea crops were low compared to research potential. However, the mean productivity for both crops, varied based on smallholder farmers' commercialization levels, farm sizes and agro-ecological conditions. For instance farmers in fully commercialization and subsistence levels had the highest and lowest mean productivity of green gram, respectively. Pigeon pea mean productivity was highest in semi-commercial farms. Fully commercial farms had the lowest mean productivity. Based on the farm sizes, however, farmers with large farms had the highest mean productivity of green gram. Similarly for the case of pigeon pea, farmers with large farms had the highest mean productivity level. As farmers produced green gram and pigeon pea in different agro-ecological conditions, the mean productivity of both crop-specific varied. For instance, the productivity of green gram was higher in agro-ecological zone lower midland 5 (AEZ LM5) than agro-ecological zone lower midland 4 (AEZ LM 4). Pigeon pea mean productivity was higher in AEZ LM 4 than in AEZ LM 5.

According to results of the multiple linear regression model analysis, the smallholder farmer increase in the levels of education level of household head, use of improved seed, specialization index, household's commercialization level and ox-cart ownership, increased significantly green gram productivity. These factors improved the smallholder farmers' levels of productivity of green gram. There was no factor in the model which significantly reduced the productivity of green gram. The factors which were important to the smallholder farmers to increase productivity of pigeon pea were gender of household head and the use of improved seeds. Male headed households had higher pigeon pea productivity than female headed households. Farms where improved seeds were used had higher productivity than farms were there was use of non-improved seeds. As smallholder farmers grew pigeon pea, there were factors which significantly influenced the reduction of productivity such as cultivated farm size and production agro-ecological condition. Increase in farm size could have increased productivity of pigeon pea due to economies of scale and soil quality. As smallholder farmers grew pigeon pea in AEZ LM 4 and AEZ LM 5, the productivity in AEZ LM 5 was lower.

Based on the findings of this research study, therefore, the study recommended institutional and policy efforts to improve productivity of crop-specific green gram and pigeon pea. Extension agents were recommended to capacity build farmers on commercialization approaches for

transformation. For instance approaches to link smallholder farmers to input and output markets. Due to declining farm sizes in semi-arid areas in Machakos County, there was need for the extension agents to capacity build farmers on the use of technologies related to intensification farming. Also, capacity building farmers on the suitability of crops to agro-ecological zones which could affect productivity. In this case green gram was more productive in AEZ LM 5 while pigeon pea was more productive in AEZ LM 4. It was also recommended that, extension agents should teach farmers to use high yielding planting materials to enhance agricultural productivity in the area. Apart from using the extension agents to teach the farmers, the study also recommended a policy for the improvement of input delivery system aimed at making the inputs available at the right time and at affordable prices too. Policy efforts on the commercialization of green gram and pigeon pea food crops were recommended.

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CHAPTER SIX

EFFECTS OF PRODUCTIVITY ON MARKETED QUANTITY OF GREEN GRAMS AND PIGEON PEAS AMONG SMALLHOLDER FARMERS IN YATTA AND MWALA SUB-COUNTIES, MACHAKOS COUNTY

Abstract

The vast majority of households in Yatta and Mwala Sub-Counties depend on rain fed agriculture. Predominantly, the households produce for subsistence and rarely produce for the market. The objective of this study was therefore to determine the factors influencing household's marketed production of green grams and pigeon peas. Multiple linear regression model was used during data analysis. The analysis software was IBM statistical package for social science, version 21. Results indicated that, in all the farms, the factors which significantly influenced households' marketed production of green grams were size of farm (4.422***), yield of green grams (0.056***), retention for seed and given away (1.027**), households' access to output market information (-22.914*) and production systems in agro-ecological zones (43.613***). Farmers with the smallest farm size (≤ 0.80 hectares) significantly increased marketed production of green grams due to retention for seed and given away (0.75***) and (1.34**). For the farmers with large farm sizes (≥ 2.41 hectares), the marketed production of green gram was increased due to productivity (0.52***) and production agro-ecological condition (105.62**). The factors which significantly influenced household's marketed production of pigeon peas in all the farms were household's retention for seed and given away (2.064***) and market price of output (1.641***). For the farmers with the smallest farm sizes (≤ 0.80 hectares), the marketed production of pigeon peas was significantly increased due to retention for seed and given away (1.911*) and market price of output (0.904***). The factors which influenced farmers with large sizes of farms (≥ 2.41 hectares) to increase significantly marketed production of pigeon peas were retention for seed and given away (2.835***) and market price of output (2.414***). Based on the results, it was therefore concluded that, an increase in green grams productivity would increase household's marketed production, regardless of the farm size. The important factors influencing most of the farmers to increase significantly the marketed production of pigeon peas were retention for seed and given away and market price of output

6.1 Introduction

Green gram (Vigna radiate Wilczek) crop is tolerant to drought, with ability to give reasonable yields with as little as 650 mm of rainfall (Machocho et al., undated). Green gram grain provides an alternative household's source of non-animal protein. According to Kimiti et al. (2009), the main green gram growing areas in Kenya are in dry parts of Eastern province where the households use the output for both subsistence and income generation.

Pigeon pea (*Cajanus cajan* [L.] Millsp.) is a crop that can reduce hunger gap in many Sub-Saharan countries (Otieno et al., 2011). In Kenya, pigeon pea has various benefits which include good nutritional properties, ability to withstand dry conditions and declining soil fertility (Kimiti et al., 2009). Pigeon pea is one of the most important grain legumes in the semi-arid lands of Kenya. According to Than et al. (2007), Kenya is the second largest producer of pigeon pea after India. Semi-arid Eastern province of Kenya is the main producing area. The principal producing districts in Eastern province of Kenya are Machakos, Kitui, Makueni, Meru, Embu and Mbeere (Mergeai et al., 2001).

The generation of marketed produce and its transfer within agricultural sector and to non-agricultural sector is a crucial factor for achieving self-sustaining economic growth in most developing countries where agriculture remains to be the main stay of the economy (Gashaw et al., 2015). Marketed surplus has generally been defined in many studies as that portion of production which actually enters the market (Aslam et al., 2013). According to Gupta and Arora (2000), marketed surplus is the amount left with the farmer after meeting his family consumption, seed, payment in kind, gifts and on farm wastage. In non-market subsistence agriculture, the produce which is in excess of consumption can be distributed as gifts and in kind transfers with left over produce being available for sale in markets.

When a portion of the agricultural produce from the farmer is marketed, the farmer has participated in output agricultural markets and the smallholder commercialization has occurred (Kabiti et al., 2016; Osmani & Hossain, 2015; Pingali, 1997). Despite productivity increase, it has been found that increasing marketed surplus of food crops, increases smallholder commercialization instead of focusing on cash crops (Osmani & Hossain, 2015; Sharma & Wardhan, 2015). The route on surplus production of food crops ensures both household's food security and commercialization.

Askari and Cummings (2000) investigated variables influencing marketed surplus and the results discussion was divided along the lines of price and income effects and interactions between the two. The analysis on the marketed surplus by Svetlana (2006) found that, emphasis on variety attributes as determinants of the size of marketed surpluses disaggregated across varieties. The importance of the knowledge of the magnitude and sign of marketed surplus was highlighted by Medani (1997) among other studies, for the formulation of specific policies on agriculture and overall growth. For the expansion of the leading role played by agricultural sector in economic growth and poverty reduction in the developing countries, there is need for the smallholder farmers to increase their marketed produce (Gashaw et al., 2015). An increase in the marketed produce would help farmers to participate in high value markets and therefore increase their level of commercialization.

Despite, the behaviour of marketed surplus due to changes in prices, incomes and variety attributes, marketed surplus is determined by the interplay of different independent variables. Unless the pattern of behaviour of these variables is known or understood, any policy aimed at raising the size of the surplus may be ineffective. An understanding of the behaviour and factors affecting marketed surplus can be of major importance in the development of sound policies with respect to smallholder commercialization, imports and exports, national reserves and overall rural and national development objectives in Kenya.

Due to the scenario of green gram and pigeon pea and significance of marketed surplus, it is necessary therefore to analyze marketed produce of green gram and pigeon pea food crops across different size of holdings and factors affecting marketed produced. In view of the above, the study was undertaken to address the following objective: to evaluate the effects of productivity on marketed quantity of green grams and pigeon peas among smallholder farmers.

6.2 Methods of Data Analysis

IBM statistical package for social science, version 21 was used in data analysis. Frequencies in descriptive statistics were used to group households into categories according to landholding sizes. Landholding sizes were categorized according to quartiles. The ranges of the quartiles were; ≤ 0.80, $0.81 - 1.60$, $1.61 - 2.40$ and ≥ 2.41 hectares.

One-way analysis of variance was used to test whether households' categories are significantly different in the mean of green gram and pigeon pea marketed and retained. House retention of

green gram and pigeon pea is for consumption, seed and given away. Multiple linear regression was used to identify the factors influencing household's marketed produce of green gram and pigeon pea. Developed model for the household's marketed produce according to landholding size categories and overall farm sizes is shown in Equation 6.1. The hypothesized effects of the explanatory variables on the household marketed surplus of green gram and pigeon pea is shown in Table 6.1.

$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 X_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + \beta_{10} x_{10} + \varepsilon$ ----Equation **6.1**

Where:

y = household's marketed produce of green gram or pigeon pea (kgs);

β_0 = Constant;

β_i = regression coefficients;

x_1 = family size (adult equivalent);

x_2 = land holding sizes (ha);

x_3 = productivity of green gram or pigeon pea (kgs per hectare);

x_4 = retention for consumption (kgs);

x_5 = retention for seed and given away (kgs);

x_6 = storage facility (*1=yes; 0=no*);

x_7 = market information (*1=yes; 0=no*);

x_8 = distance of farm from main market (km);

x_9 = price of crop output (kes per kg);

x_{10} = production systems in agro-ecological zones (1=*AEZ LM 4; 0=AEZ LM 5*);

ε = disturbance term

Table 6.1

Hypothesized Effects of Explanatory Variables on Household's Marketed Production of Green Grams or Pigeon Peas (Kgs)

Variable Name	Variable description	Variable measurement	Expected sign
Dependent Variable: Marketed surplus			
Independent Variable:			
Family size	Household family size	Adult equivalent	-
Land holding sizes	Total land size owned by the household	Hectares	+
Productivity of green gram or pigeon pea	Yield per unit area	Kilograms per hectare	+
Retention for consumption	Household amount of produce retained for consumption	kilograms	-
Retention for seed and given away	Household amount of produce retained for seed and given away	kilogram	-
Storage facility	Household ownership of storage facility	Dummy (1=yes; 0=no,)	-
Market information	Access to market information	Dummy (1=yes; 0=no,)	-
Distance of farm from main market	Distance to output market	kilometre	-
Price of crop output	Price at which each unit of output was sold	Kenya shillings per kilogram	+
Production systems in agro-ecological zones	Regions of production suitable to green gram and pigeon pea	Dummy (1=AEZ LM 4; 0=AEZ LM 5)	±

6.3 Results and Discussion

6.3.1 Factors influencing households' marketed production of green grams

The multiple linear regression model was used to analyze the factors that influenced households' marketed production of green grams. Results shown in Table 6.2 indicated the analysis of variance (ANOVA) in green grams marketed production for different groups of farmers categorized by farm sizes. According to the categories of farmers, there were five regression models for estimating the coefficients of households' marketed production of green grams. The predictors of households' marketed production of green grams were size of family, size of landholding, yield of crop, family consumption, seed and given away, storage facility, access to market information, distance of farm from main market, price of crop output and production systems in agro-ecological zones (AEZs). Results of multiple linear regression model for each category of farmers was presented in Table 6.2.

Table 6.2

Results of Multiple Linear Regression Model on Household's Marketed Production (Kgs) of Green Grams

	Coefficients (β)				
	Households' marketed production models according to farm sizes				
	≤ 0.80	**0.81-1.60**	**1.61-2.40**	**≥ 2.41**	**All farms (overall)**
Dependent variable: Marketed production					
Independent variable (predictors):					
Constant	-88.05**	449.19***	143.84	-155.16	-39.47
Size of family	0.78	-4.20	2.96	2.902	1.56
Farm size	0.02	-48.33	-42.65	1.37	4.42***
Productivity of green gram	0.10***	0.07***	0.07*	0.52***	0.06***
Retention for consumption	-0.08	-0.02	0.24	0.05	-0.04
Retention for seed and given away	0.75***	2.55***	-0.69	-2.71	1.03**
Type of storage facility	-4.97	33.04**	-5.75	-80.99*	-14.58
Household access to output market information	-3.96	-3.10	-4.415	-46.49	-22.91*
Distance of farm from main market	-0.59	-2.05	1.81	-4.22	-1.55
Market price of output	1.34**	-6.95***	-1.78*	2.09	0.10
Production agro-ecological condition	8.46	4.47	35.24*	105.62**	43.61***
F (degrees of freedom)	(10, 105) 3.12	(10, 78) 6.24	(10, 63) 2.08	(10, 70) 3.25	(10, 353) 4.82
p values	0.002	0.000	0.040	0.002	0.000

* ** ***-significance at 1%, 5% & 10% probability level respectively

Note: (*i*) Adults equivalent units were computed using OECD equivalence scale. A value of 1 to the first household member of 0.7, each additional adult of 0.5, to each child under 15 years (Burniaux et al., 1998).

Results of the analysis of variance, shown in Table 6.2 indicated that, the multiple linear regression model explained the variance in the marketed production of green grams. In the landholding sizes of ≤ 0.80, 0.81 – 1.60, 1.61 – 2.40, ≥ 2.41 and overall, the multiple linear regression model analysis with all ten explanatory variables produced F(10, 105) = 3.120, p = 0.002, F(10, 78) = 6.241, p = 0.000, F(10, 63) = 2.078, p = 0.040, F(10, 70) = 3.247, p = 0.002 and F(10, 353) = 4.816, p = 0.000.

Results showed that, across all the farm sizes, households were not significantly different in the marketed production of green grams. Nevertheless, at the overall level, the coefficient was positively and highly significant (p = 0.000). In all the categories of landholding sizes and at overall level, households are positively and significantly different in the marketed produce of green gram due to yield levels. The households were significantly different at probability levels in different categories of landholding sizes as ≤ 0.80 (p = 0.001), 0.81 – 1.60 (p = 0.000), 1.61 – 2.40 (p = 0.096), ≥ 2.41(p = 0.008) and overall farm sizes (p = 0.004).

The categories of households due to farm sizes had significant differences in the amounts of marketed production of green grams due to the quantities of produce used as seed and given away were ≤ 0.80 (p = 0.009), 0.81 – 1.60 (p = 0.000) and overall landholding (p = 0.041). Not all the categories of households within landholding sizes were different in the amounts of marketed produce of green gram due to the ownership of storage facility, but significant differences were found among the households within the categories of the landholding sizes of 0.81 – 1.60 (p = 0.049) and ≥ 2.41 (p = 0.085).

Results showed that, due to access to market information, households within the categories of landholding sizes were not significantly different in the marketed produce of green gram, although the households in overall farm sizes were significantly different (p = 0.070). The households' categories which had significant differences in the marketed produce of green gram due to the market price are in ≤ 0.80 (p = 0.037), 0.81 – 1.60 (p = 0.001) and 1.61 – 2.40 (p = 0.096). Due to production systems in agro-ecological zones (AEZs) lower midland four LM 4) and lower midland five (LM 5), households were significantly different within landholding size

categories of 1.61 – 2.40 (p = 0.080), ≥ 2.41 (p = 0.045) and households in overall landholding size (p = 0.001).

In an overall regression model involving all the farms, the study findings agreed with the expectations. A one hectare increase in landholding size, there was an increase of 4.422 kilograms in the marketed surplus of green gram food crop. A number of studies in the literature reported that, in most cases there existed a strong linear, and in some cases a strong non-linear relationship between the quantity sold and farm size (Sharma & Wardhan, 2015). Kumar (1999) and Bhosale (2001) found similar results on the positive relationship between the area under the crop and the marketed produce. The relationship between the marketed produce and the area under crop was explained by Sashimatsung and Giribabu (2015) as due to the increase in the output of the crop where the farmer is left with more surpluses for marketing.

According to Lal et al. (1996), marketed surplus showed a positive relationship with farm size. Mishra and Nahatkar (1998) measured the marketed surplus of wheat and gram and concluded that, the scope for increasing the marketed surplus of wheat and gram appears to be mainly through planning further expansion of acreage. Positive relationship between size of holding and marketed surplus of paddy, wheat, jowar and arhar was reported by Nahatkar and Gautam (1999) who also found the reverse relationship for soybean and gram. An examination of marketed surplus of gram in different farm size groups was done by Khadase and Pawar (2000) and the results showed positive relationship between marketed surplus and size of holdings. Khadase and (2000) also looked at the relationship between marketed surplus of mung bean and size of holdings and the results show positive relationship.

Khadase and Pawar (2001) examined the marketed surplus of tur (pigeon peas), and the factors responsible for the increase or decrease in surplus and found a positive relationship between area under crop and marketed surplus. According to Khadase et al. (2001), total marketed a surplus of kharif jowar has a positive relationship with the size of holdings. A finding by Masoku et al. (2001) shows that, there is a positive and significant relationship between land size and market participation in the maize market.

Marketed surplus of red gram and identification of the factors influencing it was done by Amruta and Darji (2011) who reported that marketed surplus was positively and significantly related with cropped area in all the categories of farms studied. According to Singh et al. (2012), marketed surplus increases with the increase in the size of farms. Kumar (1999) examined the

determinants of marketed surplus across farm size groups and the results show that, all the categories of farmers which included the small and marginal farmers, fully participated in the market, but large farmers dominated in terms of share of marketed surplus. Past studies have also showed that, landholding sizes influenced positively marketed surplus of major food crops in different countries. This study provided an evidence to support the argument in the literature that, there was positive relationship between overall size of holding and marketed surplus and in this case green gram. This study suggested that, a farmer who had a large farm size would allocate more land for production of green gram, causing increase in the produce and therefore increased the marketed produce.

In all the categories of households there was a positive relationship between the yield and marketed surplus of green gram (Table 5.1). A one kilogram increase in the yield, increased the marketed produce by 0.099 kgs (≤ 0.80 ha.), 0.069 kgs (0.81 – 1.60 ha.), 0.068 kgs (1.61 – 2.40 ha.), 0.519 kgs (≥ 2.41 ha.) and 0.056 kgs (overall landholding). As expected, the yield of green gram was positively and significantly influenced the marketed produce in all the categories of households. According to Kumar et al. (2013), marketed surplus is influenced by the amount of produce of food grain crops. Further study by Kaur and Gupta (2017) reveals that, improvement in the crop yield increases the level of production which in turn increase the extent of marketed surplus. The higher the per acre yield, the greater the surplus of the farmer, so that the farmer is able to market a higher proportion of his output. The finding of this study therefore supports the argument that, as the household move from low to high yielding farming of green gram, there is an increase in marketed surplus regardless of the category of the landholding sizes.

High household's retention of the amount of green gram produce as seed and given away, significantly increases the amounts of marketed produce in the categories of landholdings sizes of ≤ 0.80 ha.(p = 0.009), 0.81 – 1.60 ha. (p = 0.000) and overall landholding (p = .041). Though not significant, the amounts of green gram used as seed and given away reduce the marketed produce in households in landholding size categories of 1.61 – 2.40 and ≥ 2.41 hectares. Result showed that, the influence of produce used as seed and given away on the marketed surplus is greater in households with landholding sizes of 0.81 – 1.60 hectares than households having ≤ 0.80 hectares. The finding is contrary to the expectation. The study expected that, the amount of marketed produce of green gram decreases with an increase in the amount of produce used as seed and given away, indicating negative relationship.

This study provided finding contrary to the findings suggested by the literature. According to Kumar et al. (2013), the higher the level of retention of produce for seed and giving away the smaller the marketed surplus. Most producers depend on own seed as seed market is not well developed for the smallholder production systems (Jabbar, 2010). Khadase and Pawar (2001) reported similar result which indicates that, the amount of produce used for in-kind wage payment and seed reduced the marketed surplus of Tur. It was not clear during the study why there is positive relationship between the amount of green gram produce used as seed and given away and marketed produce in the categories of landholding sizes of ≤ 0.80, 0.81 – 1.60 and overall landholding in hectares.

Results in Table 5.1 showed that, in the category of landholding size of 0.81 – 1.60 hectares, households with no storage facility significantly increased marketed produce of green gram more than households having storage facility (p = 0.049). The finding was contrary to the study expectation. Households in the category of landholding sizes of ≥ 2.41 hectares, showed significant decreasing relationship between the storage facility and the marketed produce of green gram (p = 0.085). The negative relationship indicated that, households with storage facility had more marketed produce than the households with no facility, all the households in the landholding category of ≥ 2.41 hectares. This relationship agreed with the prior expectation of the study. According to the literature, the study finding on more marketed produce by the households with no storage facility than the households having the facility is explained by the storage losses though the study did not quantify. Gill (2000) revealed that, in the form of theft and damages, storage function was a major culprit for food grain losses. According to Singh (2000), the post-harvest quantitative and qualitative losses occur due to the stored food grains because of physical factors such as temperature and moisture. The stored food grain losses are also due to the biological factors such as insects, micro-organisms, rodents, birds and mites. Chemical breakdown along with mechanical factors and pesticide use also cause storage losses of food grains. Additionally, it has been found that, conventional means of storage at the farm level cause about 10 per cent of the food grain losses. Therefore, the problems relating to the storage of food grains could explain higher marketed produce of green gram in the households with no storage facility than the households with the facility, hence positive relationship. According to Acharya et al. (2012) and Tura et al. (2016), larger farmers with better retention capacity, retain some of the marketed surplus in anticipation of fetching higher prices in future period. Therefore, households with better storage capacity have high marketed surplus when the

prices are high. In this study, higher marketed green gram in the households with storage facility than the households with no facility in landholding size category of ≥ 2.41 hectares is explained by the anticipation of fetching higher prices.

Households categorized by the landholding sizes have access or no access to output market information in the study area. This study reveals that access to market information is an insignificant factor in explaining the behaviour of marketed green gram in the categories of households in the study area. Results indicate that, without household's access to output market information, there is lower marketed green gram than households with access to information, though not significant. In overall landholding sizes, there is significant decrease in marketed green gram due to the household access to output market information (p = 0.070). The study expected that, none accessing households to output market information have lower marketed green gram than accessing households. Therefore, the finding concurs with the prior expectation. According to literature, households engaged in high commercial production levels are more active in accessing market information. With households' access to the information on output market, information regarding output prices is disseminated to producers (Kassa et al., 2017). It has been shown that, access to market information is an important factor in marketed surplus because farmers are presented with all the options which are available for them to choose from so as to get higher returns (Kabiti et al., 2016). Prior expectation of the study was that, as market price of green gram output increases, househods in different landholding size categories increase the marketed green gram. Results show that as market price of green gram output increase, households in landholding size category of ≤ 0.80 hectares significantly increase marketed green gram by 1.335 (p = 0.037). Negative relationship is found in landholding size categories of 0.81 – 1.60 and 1.61 – 2.40 hectares. As the market price of green gram increases, households in 0.81 – 1.60 and 1.61 – 2.40 landholding size categories significantly decrease marketed green gram by 6.949 (p = 0.001) and 1.784 (p = 0.096), respectively. The finding on the positively relationship supports prior expectations while the negative relationship contradicts.

In regard to the relationship between market price of output and marketed produce of various food crops, it has been shown in the literature that, the variables are positively as well as negatively related depending upon whether the consideration is short run or long run. It has been revealed that, farmers sell most of their produce when higher prices are given for a particular crop in order to earn profit (Kumar, 2013). According to Afruz (2002), even when prices are low, small farmers are large suppliers of agricultural crops during harvest time. The small farmers

supply the agricultural crops to meet their cash obligations. During off-season, on the other hand and when prices are high, the small farmers purchase the same crops to meet their consumption requirements. Due to small farmer sales during harvest time, purchases and therefore price variation, small farmers are worse off.

According to Afruz (2002), large farmers are relatively stronger in bargaining capacity with the market intermediaries than other landholding size groups of households and therefore receive the highest prices, leading to higher sales. The finding by Amruta and Darji (2011) reveals that, marketed surplus is positively and significantly related with current prices for sample as a whole. According to Pawar (1998) small and larger farmers for sorghum behave differently on surpluses. Irrespective of landholding size category, small farmers may sell surpluses to receive a cash income, whilst larger farmers may hold back surpluses until market prices for sorghum are high. Contrary finding is shown by Barman (2003) who analyzed the production and consumption variables influencing farm-level marketed surplus of winter rice and found that small farms were not price responsive, signifying the prevalence of distress sales. Therefore, the findings in this study support the positive and negative relationship between the market price and the marketed surplus. The increase in marketed green gram is explained by the bargaining capacity with the market intermediaries and holding back surpluses until market prices for green gram are high. The decrease of the marketed green gram is explained by the prevalence of distress sales where farmers' need for cash is immediate.

Production systems in agro ecological zones positively and significantly affects marketed green gram in landholding size categories of 1.61 – 2.40 (p = 0.080) and ≥ 2.41 (p = 0.045) hectares and overall sample landholding (p = 0.001). The findings agree with the expectation. Taking production systems in agro-ecological zone lower midland four as the appropriate reference category, this implies that for the farmers who are in agro-ecological zone lower midland four, their marketed green gram increases significantly by 35.235, 105.619 and 43.613 kilograms than farmers who are in agro-ecological zone lower midland five. Tura et al. (2016), looked at the relationship between agro-ecology, market participation and intensity of marketed surplus of teff producers and the finding shows that, the probability of market participation by smallholder farmers is positively and significantly affected by the agro-ecological zone. According to Alagh (2014), marketed surpluses differ by crop and season in the same region as well across regions. Therefore, seasonal variation in production systems in agro-ecological zones lower midland four

and lower midland five could explain the increase in the marketed green gram in production systems in agro-ecological zone lower midland four.

6.3.2 Factors influencing households' marketed production of pigeon peas

Results in Table 6.3 showed ten explanatory variables, which were hypothesized to be factors influencing household's marketed produce of pigeon pea in various landholding size categories and overall sample landholding. Results show that, the multiple regression model has worked in explaining the behaviour of marketed pigeon pea in households in landholding size categories and overall sample landholding. F-tests showed that, the model in landholding size categories was significant at $F(10, 105) = 3.892$, $p = 0.000$ ($\leq$ 0.80 ha.), $F(10, 78) = 24.334$, $p = 0.000$ (0.81 – 1.60 ha.), $F(10, 63) = 7.184$, $p = 0.000$, $F(10, 70) = 17.460$, $p = 0.000$ ($\geq$ 2.41 ha.) and $F(10, 353) = 32.845$, $p = 0.000$ (overall farm sizes)

Table 6.3

Results of Multiple Linear Regression Model on Household's Marketed Production (Kgs) of Pigeon Peas

	Coefficients (β)				
	Households' marketed production models according to farm sizes				
	≤ 0.80	**0.81-1.60**	**1.61-2.40**	**≥ 2.41**	**All farms (overall)**
Dependent variable: Marketed production					
Independent variables (predictors):					
Constant	-18.687	15.212**	-64.939	-34.685	-6.763
Size of family	0.737	-0.816	8.166*	-3.271	1.145
Farm size	35.732	-5.543	32.253	0.886	0.955
Productivity of pigeon pea	-0.001	-0.001	-0.031	0.006	0.002
Retention for consumption	0.069	0.311***	0.009	-0.179	-0.056
Retention for seed and given away	1.911*	-0.715***	1.010	2.835***	2.064***
Type of storage facility	-17.210*	-0.419	-6.730	-7.588	-6.299
Household access to output market information	14.103	-2.606	-12.851	17.907	3.443
Distance of farm from main market	-0.044	-0.118	-2.140	1.246	-0.395
Market price of output	0.904***	0.622***	2.212***	2.414***	1.641***
Production agro-ecological condition	-4.290	-2.450	-15.654	16.136	-1.574
F (degrees of freedom)	(10, 105) 3.892	(10, 78) 24.334	(10, 63) 7.184	(10, 70) 17.460	(10, 353) 32.845
Sig. (*p*)	0.000	0.000	0.000	0.000	0.000

* ** ***-significance at 1%, 5% and 10% probability level, respectively

Note: (*i*) Adults equivalent units were computed using OECD equivalence scale. A value of 1 to the first household member of 0.7, each additional adult of 0.5, to each child under 15 years (Burniaux et al., 1998).

The p-values of the t-test for each explanatory variable show that the size of family contributes significantly to the model in landholding size category of 1.61 – 2.40 hectares (p = 0.072). Family consumption contributes significantly to model in landholding size category of 0.81 – 1.60 hectares ($p = 0.000$). Significantly, there is contribution to the model by the household's use of pigeon pea produce for farm seed and also giving away in the landholding size categories of ≤ 0.80 ($p = 0.067$), 0.81 – 1.60 ($p = 0.002$), ≥ 2.41($p = 0.000$) and overall landholding sizes in hectares (p = 0.000). At the landholding size category of ≤ 0.80 hectares, storage facility contributed significantly to the model ($p = 0.064$). Market price of pigeon pea output was an important factor, contributing to the model in all landholding size categories and overall sample landholding as ≤ 0.80 ($p = 0.001$), 0.81 – 1.60 ($p = 0.000$), 1.61 – 2.40 ($p = 0.000$), ≥ 2.41 ($p = 0.000$) and overall sample landholding sizes ($p = 0.000$).

Family size was measured as adults equivalent units. Households with land sizes 1.61 – 2.40 hectares showed a significant increase in the marketed pigeon pea. In this category, an increase in the household size by one person, significantly increased marketed green gram by 8.166 8.166 kilograms. The finding was contrary to a *priori* expectation. It was expected that, as the size of family increases, the quantity of pigeon pea marketed produce decreased, irrespective of the size of landholding categories. This finding was inconsistent with the findings in the literature on the relationship between family size and marketed surplus. According to literature, an inverse relationship was observed between family sizes and marketed surplus (Borate et al., 2011; Kumar, 1999; Omiti & Mccullough, 2009; Pawar, 1998). It had been shown that, households with larger family sizes were less likely to participate in the output market as sellers and when they participated, they sold small quantities of output. It had been argued that, larger family sizes lowered marketed surplus than smaller family sizes. This was because in larger family sizes, there was higher quantity consumed and therefore less quantity available for sale. Another explanation was that, large family sizes increased the quantities needed for home consumption and therefore reducing the marketed surplus. On the other hand, there was less output due to labour-inefficiency in larger households, while the large households consumed higher proportion, leaving smaller and decreasing marketed surplus. This finding was inconsistent and consistent and with the findings of Alam and Afruz (2002) on the relationship between family

size and the marketed surplus of selected leading crops in Bangladesh. Alam and Afruz (2002) found inverse relationship between family size and marketed surplus of selected leading crops except wheat and mustard which showed positive relationship in Bangladesh. The finding was also in consistent with the findings of Gani and Adeoti (2011), who argued that, local farmers keep large family sizes to provide labour for agricultural purposes.

According to result in Table 5.2, household's retention for family consumption of pigeon pea produce was not found significantly influencing the changes in marketed produce of pigeon pea in overall farm sizes. Though the results are not significant in overall farm sizes, the household's retention of pigeon pea in landholding size category of 0.81 – 1.60 hectares was found increasing marketed pigeon pea significantly. In this category of landholding size, the household's retention of pigeon pea produce for consumption of one kilogram, significantly increases the marketed pigeon pea by 0.311 kilograms. The finding is contrary to a *priori* expectation of the study. The study expected inverse relationship between the quantities retained by the household for consumption and the marketed pigeon pea in the landholding size categories and overall farm sizes. According to the literature on marketed surplus studies, marketed surplus was increased when a household retained a smaller quantity of crop output than the actual retention for consumption (Tura et al., 2016). According to Edmeades (2006), variety attributes (consumption quality) of subsistence crops were found to be important factors, inducing households to retain varieties with better quality attributes for own consumption rather than for market sale. Analysis of the consumption patterns of pigeon pea in Kenya indicated that, in the total pigeon pea produced in the country, about 60% is dry grain while 40% was harvested and consumed at the farm or marketed as vegetable pigeon pea (Shiferaw et al., 2008). About two-thirds of the dry grain was marketed, while one-third was consumed at the farm. According to Mergeai et al. (2001) and Ronno (2000), most farm households consumed pigeon pea as green peas because of its taste and ease of cooking. The specific variety attributes of pigeon pea food commodity and low dry grain consumption could explain small quantity retention of pigeon pea output for household consumption and therefore increased marketed produce in landholding size category of 0.81 – 1.60 hectares.

The relationship between household's retention of pigeon pea produce for farm seed and given away and the marketed pigeon pea had negative and positive direction in different landholding size categories and the overall farms. The significant and negative relationship was found with the farmers in landholding size category of 0.81 – 1.60 hectares. In this category, as farmers

increased the retention of pigeon pea produce for seed and giving away by one kilogram, the marketed pigeon pea decreased significantly by 0.715 kilogram. The finding on the negative relationship agreed with the priori expectation of the study. The significant and positive relationship between household's retention of pigeon pea produce for seed and given away and marketed produce was found in landholding size categories of ≤ 0.80 and ≥ 2.41 hectares as well as in the overall landholding sizes. Households in landholding size category of ≤ 0.80 hectares increase significantly marketed pigeon pea by 1.911 kilograms due to one kilogram increase of retention of pigeon pea produce for seed and giving away. The category of households in landholding size of ≥ 2.41 hectares, significantly increased marketed pigeon pea by 2.835 kilogram when the households' retention of pigeon pea for seed and given away increased by one kilogram. Households in overall landholding sizes increased significantly marketed pigeon pea by 2.064 kilograms as their retention for seed and given away increased by one kilogram. Contrary to the study expectation was found in the positive relationships between the retention quantities of pigeon pea produce for seed and given away and marketed produce in households in landholding size categories of ≤ 0.80 and ≥ 2.41 hectares as well as in the overall landholding sizes. Literature indicated that, the higher the household's retention of food crop produce for seed and giving away, the smaller the marketed surplus (Alagh, 2014). The smaller marketed surplus was explained by the quantity actually retained by the household for seed and giving away from a given food crop in a given year. Household retention for both seed, given away and family consumption had been identified as the greatest single factor in the determination of marketed surplus. Therefore, the reduction in marketed pigeon pea in landholding size category of 0.81 – 1.60 hectares was explained by the increase in the retention for seed and given away. The positive influence of household's retention of food crop produce for seed and given away on marketed surplus could be explained by the variety attributes. According to Alagh (2014), household's retention for seed dependent on variety to be sown and area sown under particular crop. Therefore, the increase in the marketed pigeon pea in landholding size categories of ≤ 0.80, ≥ 2.41 and overall farm sizes could be explained by the types of pigeon pea varieties to be retained for seed and taken to the market. The area under pigeon pea changes across households and agro-ecological zones and therefore quantity of retention of seed.

Table 5.2 showed that, there was an inverse relationship between ownership of storage facility and marketed pigeon pea in all landholding size categories and overall farms. Results indicated that, the category of households with no storage facility had lower marketed pigeon pea than the

category with storage facility in all landholding size categories and the overall farms. Though, generally the results showed negative relationship in all the categories of landholding sizes and overall farms, significant differences among the households were found in landholding size category of ≤ 0.80 hectares. The general findings on inverse relationships in all landholding sizes and the overall farms agreed with the study expectation. In the literature on the marketed surplus, it had been argued that, farmers, especially larger ones with better retention capacity, retained some of the marketed surplus in anticipation of fetching higher prices in future period (Acharya et al., 2012). According to Kumar et al. (2013), there was a general impression that the bigger farmers hold on to their marketed surplus for a longer period than do small farmers. Contrary argument was put forward by Behrman (1966), which states that, larger farmers with respect to area under cultivation are likely to be more interested in cash by selling their produce in the market than keeping the produce at homes for consumption. In regard to small farmers, it has been argued that, the small farmers have longer span of spread of their sales than the bigger farmers. It was put forward on the crop pattern sales that, the smaller the farmer, the longer is the period over which sales are spread. Therefore, higher marketed pigeon in households with storage facility than the households without storage facility in all landholding size categories and overall farm sizes could be explained by the improved retention capacity and spread of sales.

Results in Table 5.2 showed that, marketed pigeon pea had positive relationship with the market price in all the landholding size categories and overall farm sizes. As the market price increased, households in landholding size categories of ≤ 0.80, 0.81 – 1.60, 1.61 – 2.40, ≥ 2.41 hectares and overall farm sizes increased significantly marketed pigeon pea by 0.904, 0.622, 2.212, 2.414 and 1.641kilograms. According to the results, lower quantities of marketed pigeon pea were found in categories of households with smaller landholding sizes than the categories of households with larger landholding sizes. The findings agreed with priori expectations of the study. One of the expectation was that, the categories of households with smaller landholding sizes had higher marketed pigeon pea than the categories of households with larger landholding sizes. The other expectation was that, an increase in market price per kilogram, increased marketed pigeon pea in all the households in the whole sample (overall farm sizes). The results on positive relationship between market price and household's marketed output of pigeon pea food crop in land holding size categories and overall farm sizes, supported earlier findings in the literature on marketed surplus of food crops. Adesiyan et al. (2012) found that an average price of paddy received by farmers, positively affected marketed surplus of the crop. An investigation by Sengupta (2010)

on the responsiveness of marketed surplus to price changes found that, of the factors determining marketed surplus, price was found to be a significant determinant and is an important factor in explaining the behavioural pattern of surplus among small and marginal farmers. According to Kumar et al. (2013), if higher prices are given for a particular crop, farmers sell most of their produce in order to earn profit and income which further determines their standard of living.

6.4 Conclusion and Recommendations

Based on the results, it was concluded that, the main factors which affected farmers in farm sizes to increase marketed production of green gram were the productivity of green gram, retention for seed and given away, market price and production agro-ecological conditions. Productivity could increase marketed production of green gram through more production in volume and therefore generating surplus for the market. Retention for seed could increase productivity since farmers could use the harvest as planting materials for about three seasons. Market price could explain increase in the marketed production of green gram through higher incentives and income. Farmers respond to higher market prices while supplying farm produce. Agro-ecological conditions determine the productivity of a crop, which in turn increases the volume of production. Farmers in agro-ecological zone lower midland five could increase marketed production of green gram more than farmers in agro-ecological zone lower midland four due to more production.

The factors which affected the marketed production of pigeon pea varied among farmers in farm size categories. For instance, farmers with farm sizes 0.81-1.60 hectares, showed increase in marketed production of pigeon pea due to retention for consumption. This could be explained by an increase in production of pigeon pea to generate surplus for income while sufficient for household consumption. Retention for seed increased marketed production of pigeon pea in most of the households in the farm sizes. Most of the households in farm sizes increased significantly marketed production of pigeon pea due to the increase in the market price.

For the smallholder to increase marketed production of green gram and pigeon pea, this study recommended various options based on the results. Some of these options were based on the efforts to transform subsistence production to market-oriented production. Some of the recommendations were production specialization, higher productivity, enhanced link to output market and policy support. Due to different farm sizes and the factors affecting marketed production of green gram and pigeon pea in each farm size, production specialization at farm

level would build and create comparative advantages and change in agricultural technologies in food-crop production, such as green gram and pigeon pea. The use of modern technologies such as farm inputs like seeds, fertilizer and other chemicals during production of green gram and pigeon pea could result in higher productivity and more production entering markets. Increasing marketed green gram and pigeon pea cannot be left to the smallholder farmer and market alone, but to promote specialization, increase productivity and reduce the costs of market exchange, government ought to help in creating enabling policy environments through investing in the development of rural markets, transportation and communication infrastructure, crop management, research and extension and provision of support services such as market information and extension services to rural households.

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CHAPTER SEVEN

ASSESSING THE FACTORS AFFECTING MARKET PERFORMANCE IN COMMERCIALIZING SMALL FARMS FOCUSING ON GREEN GRAM AND PIGEON PRODUCTION IN SEMI-ARID MACHAKOS COUNTY

Abstract

Low performance of grain traders in rural areas contributes to thin and less competitive markets, leading to low smallholder commercialization of green gram and pigeon pea. This study analyzed the market concentration and the factors influencing the grain trader's performance. Multistage sampling technique was employed to collect data from 110 traders, randomly selected in rural markets in Mwala (38) and Yatta (72) sub-counties, representing the production areas of pigeon pea and green gram, respectively. The methods of data analysis were descriptive and multiple linear regression. The market concentration indicated that, the markets were dominated by few large purchasers of green gram, about 8.26 % of traders accounting for 78.40 % of the total volume. Few large purchasers of pigeon pea, about 8.27 %, accounted for 72.13 %. Results of multiple linear regression model indicated that, the factors which showed the improvement in the trader's performance in the volume of purchase of green gram are the trader's contacts in distant markets beyond the sub-county (285.8838***), the trader's volume of pigeon pea purchases (0.5054047***), the trader's volume of cowpea purchases (0.278153***) and the trader's volume of beans purchases (0.5269458***). The factors which showed improvement in the trader's performance in the volume of purchase of pigeon pea are the annual working capital (0.002247***), and the trader's volume of green gram purchases (0.9504035***). The factors which showed improvement in the trader's performance by significantly reducing the retail-farm-gate margins in green gram trading was the buyers with only telephone orders (0.9127215***). Significantly, the retail-farm-gate margins in pigeon pea trading were reduced by the persons the trader could ask for a loan (0.5760093*) and the buyers with only telephone orders (0.437722*). Therefore, the study concluded that, due to high market concentration and the traders' use of social capital, the markets for green gram and pigeon pea are imperfect.

7.1 Introduction

The pre-reform period is rife in Kenya, similar to other countries in sub-Saharan Africa (SSA), with government interventions in markets and strict controls over the pricing and marketing of agricultural commodities (Nyairo, 2011). In this period, the government intervened directly in the acquisition and distribution of staple food grains and the regulation of grain traders' activities. According to Abbink et al. (2011), Govereh et al. (2010) and Jayne et al. (2010), there was market unpredictability created by state intervention, which was one of the primary obstacles limiting the improved performance of cereal markets. Since 1980s, agricultural sector in Kenya has undergone market reforms aimed at opening the sector to market forces to reduce or eliminate the existing bias against agriculture (Sitko & Jayne, 2014). The reforms brought withdrawal of the state from agricultural markets, legalization of private grain trade and the lifting of restrictions on inter-district transport of grains in Kenya. The withdrawal of state from agricultural markets forced farmers to sell their produce to private traders in rural markets.

According to Jayne et al. (2010), legalization of private grain trade and the lifting of restrictions on inter-district transport of grains as part of agricultural market reforms are measures in Kenya to assist the private sector enter grain marketing. The agricultural market reforms contributed directly to a significant increase in the number of small-scale, private grain traders (Barrett, 1997; Coulter & Golob, 1992; Dercon, 1993). Literature indicate that, the expansion of private grain trading is linked to low entry barriers, in terms of fixed and sunk costs. These low entry barriers allow individuals without significant capital or assets to easily enter into grain trading (Barrett, 1997; Coulter & Golob, 1992). Due to low barriers to entry, grain trading offers potential for strong poverty reduction to myriad rural people without the necessary land and capital to achieve levels of marketed surplus of cereal grains (Barrett, 1997; Dorward et al., 2004; Dorward & Morrision, 2000).

Although private traders perform a key role in linking rural producers to rural and urban consumers (Onu & Iliyasu, 2008; Shiferaw et al., 2008), the traders exploit farmers by offering prices that are below the cost of production due to lack of formal markets Sitko and Jayne (2014). Though private traders perform a key role in linking producers to markets, there is lack of connectivity due to remoteness (Navas et al., 2002; Orden et al., 2004; Torero, 2011). Due to lack of connectivity to more lucrative markets at provincial, national or global levels most of the smallholders practice either subsistence farming or operate largely in local markets (de Janvry et

al., 1991; Torero, 2011). Many local food markets are volatile due to low volumes transacted and their limited integration with regional or international markets (Arias et al., 2013). Due to low transacted volumes and limited integration with regional or international markets, investments remain low, incentives remain weak and low level of technology adoption and productivity by farmers. Further than that, without complementary investments important market players fail to undertake profitable investments, leading to failure in market coordination and encumbering market performance (Dorward et al., 2005; Kydd & Dorward, 2004; Poulton et al., 2006). Therefore, it was clear that the agricultural market reforms assumed the private sector could take over the grain trading institutions and enhance smallholder commercialization in Kenya. Despite the rising number of studies on agricultural market reforms in Kenya, most available research is biased heavily on a description of the state grain marketing system and its performance. Very little insight has been offered on the factors that influence the commodity pattern of entry of private traders into the market, especially in remote areas. Nor is it known whether private traders are able to undertake all the functions in grain marketing, the scale of their operations, their stocking behaviour and the structure of emerging private marketing system. In the absence of information on how private traders are likely to behave in the face of agricultural market reforms, farmers would remain without exploiting market opportunities. The objective of this study was therefore to assess the factors affecting market performance in commercializing small farms focusing on green gram and pigeon production in semi-arid Machakos County

7.2 Methods of data analysis

Data were analyzed using descriptive statistics and multiple linear regression. Descriptive statistics were done using IBM SPSS statistics, version 21. The descriptive statistics used were percentages, ratios, means and standard deviation and Gini coefficient. The multiple linear regression model was done using the Stata, version 14.

According to Cullis and van Koppen (2007), the method for calculating the Gini coefficient from ungrouped data, uses cumulative fraction of units (income earners, w_i) and the cumulative fraction of income (Z_i). In this case, the private traders replaces the recipients and the income is replaced by the purchase in the method. Taking into account all the above variables, the model is developed (Equation 7.1):

$$Gini\ Coefficient = 1 - \frac{\sum_{i=1}^{N}(z_i + z_{i-1})(w_i + w_{i-1})}{w_N \cdot z_N}$$ ---------- **Equation 7.1**

Where: *i* = 1, 2, 3, ---------N; N = Number of recipients.

Multiple regression model was used to contribute to the literature on the traders' production function, developed by Fafchamps and Minten (1999). The model illustrated the economic effect of physical capital, human capital and social capital on the functioning of traders' performance. The traders' production function is donated in Model 7.1.

$Q_i = F(K, H, S)$ ---------- **Model 7.1**

Where:

Q_i = a measure of performance of a trader (volume of transaction – purchase and sale, margin);

K = physical capital;

H = human capital;

S = social capital

Three multiple linear regression Equations were developed from model 7.1 to analyze the determinants of market performance. The Equations were 7.2, 7.3 and 7.4. The hypothesized effects were shown in Tables 7.1, 7.2 and 7.3, respectively.

$Q_P = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \beta_6x_6 - \beta_7x_7 - \beta_8x_8 - \beta_9x_9 - \beta_{10}x_{10} - \beta_{11}x_{11} + \beta_{12}x_{12} + \beta_{13}x_{13} + \beta_{14}x_{14} - \beta_{15}x_{15} + \beta_{16}x_{16} + \varepsilon$ ---------- **Equation 7.2**

Where:

Q_P = Trader's volume of purchase of green gram or pigeon pea (kgs);

β_0 = constant;

β_i = regression coefficients;

x_1 = age (*years*);

x_2 = gender (1=*male; 0=female*);

x_3 = experience (*years*);

x_4 = trader - broker association (*Number*);

x_5 = location (1=market centre; 0=outskirts of market);

x_6 = other occupation (*1=yes; 0=No*);

x_7 = green gram or pigeon pea purchases (*kilograms*);

x_8 = cowpeas purchases (*kilograms*);

x_9 = beans purchases (*kilograms*);

x_{10} = maize purchases (*kilograms*);

x_{11}= grain types (*Number*);

x_{12} = green gram or pigeon pea income share (*proportion*);

x_{13} = annual working capital (kes);

x_{14} = capacity of grain store (*90 kg-bags*);

x_{15} = purchasing distance (*kilometres*);

x_{16} = market region (1=surplus; 0=deficit region);

ε = disturbance term

$$Q_S = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 - \beta_7 x_7 - \beta_8 x_8 - \beta_9 x_9 - \beta_{10} x_{10} - \beta_{11} x_{11} + \beta_{12} x_{12} + \varepsilon$$ ---------- **Equation 7.3**

Where;

Q_S = Trader's volume of sale of green gram or pigeon pea (kgs);

β_0 = constant;

β_i = regression coefficients;

x_1 = purchasing brokers *(number)*;

x_2 = selling brokers *(number)*;

x_3 = persons the trader could ask for loan from *(number)*;

x_4 = markets in which the trader operates *(number)*;

x_5 = regular buyers in trader's market *(number)*;

x_6 = non-frequent local buyers in the trader's market *(number)*;

x_7 = regular distant buyers *(number)*;

x_8 = non-frequent distant buyers *(number)*;

x_9 = distant markets trader has contacts beyond the sub-county *(km)*;

x_{10} = business contacts by telephone *(number)*;

x_{11}= friends in grain trade *(number)*;

x_{12} = buyers with telephone orders only *(number).*

$Q_M = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 - \beta_7 x_7 - \beta_8 x_8 - \beta_9 x_9 - \beta_{10} x_{10} - \beta_{11} x_{11} + \beta_{12} x_{12} + \varepsilon$ ---------- **Equation 7.4**

Where;

Q_M = Trader's market margin in green gram and pigeon pea (kes);

β_0 = constant;

β_i = regression coefficients;

x_1 = purchasing brokers *(number)*;

x_2 = selling brokers *(number)*;

x_3 = persons the trader could ask for loan from *(number)*;

x_4 = markets in which the trader operates *(number)*;

x_5 = regular buyers in trader's market *(number)*;

x_6 = non-frequent buyers in the trader's market *(number)*;

x_7 = regular distant buyers *(number)*;

x_8 = non-frequent distant buyers *(number)*;

x_9 = distant markets trader has contacts beyond the sub-county *(km)*;

x_{10} = business contacts by telephone *(number)*;

x_{11}= friends in grain trade *(number)*;

x_{12} = buyers with only telephone orders *(number).*

Table 7.1

Hypothesized Effects of Explanatory Variables on Trader's Volume of Purchase of Green Grams or Pigeon Peas

Variable Name	Variable description	Variable measurement	Expected sign
Dependent Variable: Trader's volume of purchase of green gram or pigeon pea (kgs)			
Independent Variables:			
Age	Age of household head	Number of year	±
Gender	Gender of the household head	Dummy (1= male; 0= female)	+
Experience	Grain trader's trading experience	Number of years	+
Trader - broker association	Trader relationship with brokers	Number of purchasing brokers	+
Location	Location of the business in the marketplace	Dummy (1=market centre; 0=outskirts of market)	+
Other occupation	Other occupation from the grain trading	Dummy (1=yes; 0=No)	+
Green gram or pigeon pea purchases	Purchase of green gram or pigeon pea	Kilograms	-
Cowpeas purchases	Purchase of cowpea grains for the stock	Kilograms	-
Beans purchases	Purchase of beans grains for the stock	Kilograms	-
Maize purchases	Purchase of maize grains for the stock	Kilograms	-
Grain types	Types of grains in the trader's stock	Number	-
Green gram or pigeon pea income share	Share of income generated by selling green gram or pigeon pea to the total income	Proportion	+
Working capital	Average annual working capital	Kenya shillings	+
Store capacity	The grain storage capacity	Number (*90 kg-bags*)	+
Purchasing distance	Purchasing distance of grains	Kilometres	-
Market region	Region of production of green gram and pigeon pea	Dummy (1=surplus, 0=deficit region)	+

Table 7.2

Hypothesized Effects of Explanatory Variables on Trader's Volume of Sales of Green Grams or Pigeon Peas

Variable Name	Variable description	Variable measurement	Expected sign
Dependent Variable: Trader's volume of sale of green gram or pigeon pea (kgs)			
Independent Variables:			
Purchasing brokers	Brokers engaged in purchases of green gram and pigeon pea grains	Number	+
Selling brokers	Brokers engaged in sales of green gram and pigeon pea grains	Number	+
Persons the trader could ask for a loan from	Persons the trader could ask for a loan from	Number	+
Markets in which the trader operates	Trader's operating markets	Number	+
Regular buyers in trader's market	Trader's regular buyers within the same market	Number	+
Non-frequent local buyers in the trader's market	Trader's buyers within the same market but not frequent	Number	+
Regular distant buyers	Trader's distant and regular buyers	Number	+
Non-frequent distant buyers	Trader's distant and non-frequent buyers	Number	+
Distant markets trader has contacts beyond the sub-county	Distant markets beyond the sub-county that the trader has contacts	Kilometres	+
Business contacts by telephone	Trader's telephone business contacts	Number	+
Friends in grain trade	Trader's friends in grain trade	Number	+
Buyers with telephone orders only	Trader's buyers through telephone orders	Number	+

Table 7.3

Hypothesized Effects of Explanatory Variables on Trader's Market Margin in Green Grams and Pigeon Peas

Variable Name	Variable description	Variable measurement	Expected sign
Dependent Variable: Trader's market margin in green gram and pigeon pea (kes)			
Independent Variables:			
Purchasing brokers	Brokers engaged in purchases of green gram and pigeon pea grains	Number	+
Selling brokers	Brokers engaged in sales of green gram and pigeon pea grains	Number	+
Persons the trader could ask for a loan from	Persons the trader could ask for a loan from	Number	-
Markets in which the trader operates	Trader's operating markets	Number	±
Regular buyers in trader's market	Trader's regular buyers within the same market	Number	-
Non-frequent local buyers in the trader's market	Trader's buyers within the same market but not frequent	Number	-
Regular distant buyers	Trader's distant and regular buyers	Number	±
Non-frequent distant buyers	Trader's distant and non-frequent buyers	Number	±
Distant markets trader has contacts beyond the sub-county	Distant markets beyond the sub-county that the trader has contacts	Kilometres	±
Business contacts by telephone	Trader's telephone business contacts	Number	-
Friends in grain trade	Trader's friends in grain trade	Number	-
Buyers with telephone orders only	Trader's buyers through telephone orders	Number	-

7.3 Results and Discussion

7.3.1 Main characteristics of traders of green gram and pigeon pea

Figure 7.1 showed age categories and percentages of green gram and pigeon pea traders.. The percentages were for male and female traders. Below 40 years, the percentages of female traders (39.1%) were higher than male traders (24.6%). The percentages of male and female traders below 30 years were 9.1% and 10%, respectively. Between 31-40 years, the percentages of male and female traders were 15.5% and 29.1%, respectively. Above 41 years, the percentages of male traders (21.8%) were higher than the percentages of female traders (14.5%). Also, the percentages of male and female traders above 41 years (36.4%) were lower than the percentages below 40 years (63.6%).

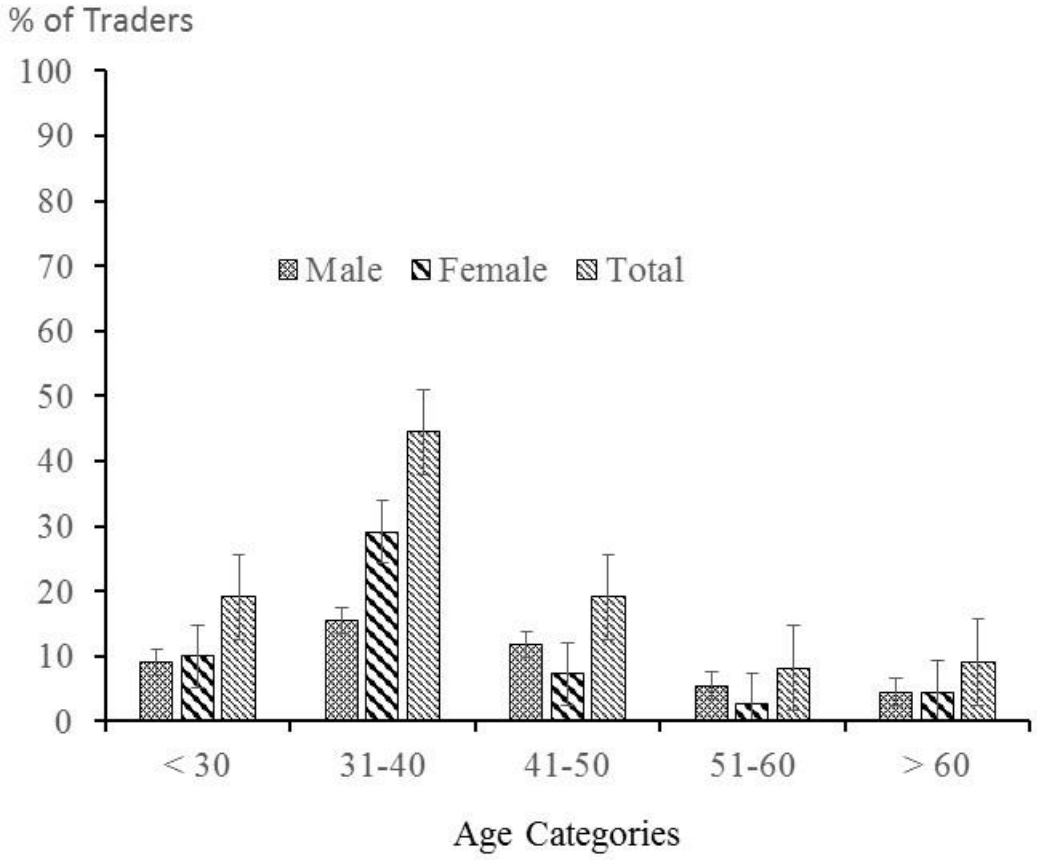


Figure 7.1

Percent Distribution of Private Traders by Age of Males and Females

Lower percentages of female traders, below 10% in age category less than 30 was contrary to the study expectation. However, higher percentages of male traders, above 24.6% in age category above 40 years agreed with the study expectation. This finding supports the literature on the types of food grain traders based on their age. According to Chakravarty and Van Ness (2001), Dessalegn et al. (1998) and Ngigi (2008), the traders are diverse in ages and distributed across categories. It has been noted that, the age distribution across the categories has significant implications to the operations of the markets due to the experience, management skills and access to capital by the traders (Amare, 2010; Chiwele et al., 1998; Ngigi, 2008).

According to Figure 7.1, among the traders who had entered the markets, 45.5 % were females while 54.5% were males. Pearson chi-square test was used to find out whether there was a relationship between the two categorical variables of gender. Result indicated that, the difference between the percentages of males and females grain traders in the grain market was not significant (χ (1) = 2.000, p = 0.157). An equal proportion of men and female grain traders in the market could be explained by the attractive margins due to market reforms.

Market reforms in Kenya enhanced entry of both men and females. Normally, grain traders in Mwala and Yatta combine a portfolio of commodities with high local demand for food in the same business. All the traders' firms were both retailing and wholesaling and therefore linked to both local and urban markets. The tendency was that men traders were more interested with urban markets while females are more likely to supply food to local households.

The finding was contrary to the study expectation that, among food grain traders, there are significant differences between the numbers of males and females. According to literature, females have more engaged in food trading than males in various African Countries. Literature show that, in African Countries, under agricultural market liberalization, women have entered food trading in large numbers (Aregu et al., undated; Baden, 1998). In West Africa, for instance Ghana and Guinea, women dominate private food trading, though a tiny but highly visible minority of wholesalers. Similarly, in Tanzania, women are found in low profit, small-scale food marketing, processing and selling their own produce to local markets, while men tend to buy up processed food in urban markets for sale elsewhere, often with large margins. In Zimbabwe, women dominate retail marketing of fresh produce bought from male wholesalers in central urban markets, to high density residential areas.

According to Figure 7.2, grain traders are different in terms of educational levels. Results reveal that, majority of the grain traders have college education level (58.2 %). About 0.9 % of the traders have no formal education. The percent of traders with primary education level is 21.8. The category of traders with secondary education level has the percent of 18.2 while those who have reached university education level comprised 0.9% percent.

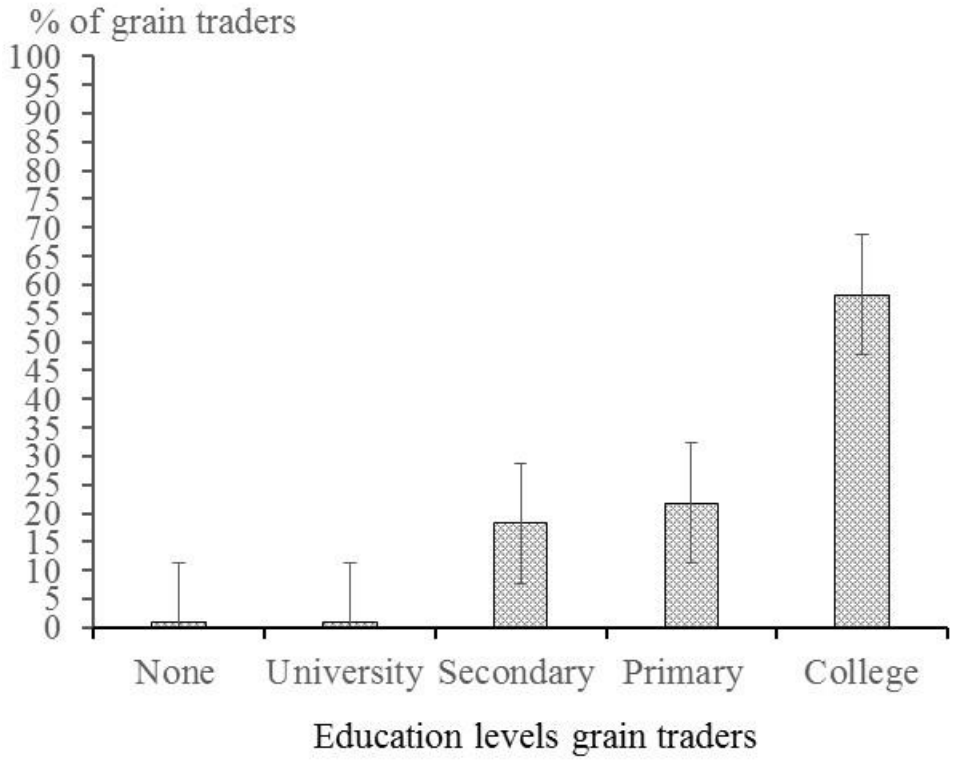


Figure 7.2

Percentages of Traders in Levels of Education

The finding supported the study expectation that, a number of traders have some basic education that will enable them to read market signals. The finding agrees with the literature on education characteristic of grain traders. According to Chiwele et al. (1998), grain traders who have acquired basic education have ability to read market signals. It has been indicated in literature that, the number of years of formal education is known to influence the behaviour, values, exposure and opportunities of individual trader (Durojaiye et al., 2014). Other studies in the literature indicate that, the more educated the individual trader is, the harder they work and the more profit earned.

Results shown in Figure 7.3 indicate the percentages of commodities purchased by the private trader. The percentages are based on the annual volume purchased of each commodity to the total volume of all commodities mainly purchased by the trader. The percentages of the common commodities among traders are; millets (0.1%), dolichos (0.2%), sorghum (1.7%), cowpeas (5.0 %), pigeon pea (8.0%), green gram (8.9 %), beans (12.2%) and maize (64.0%).

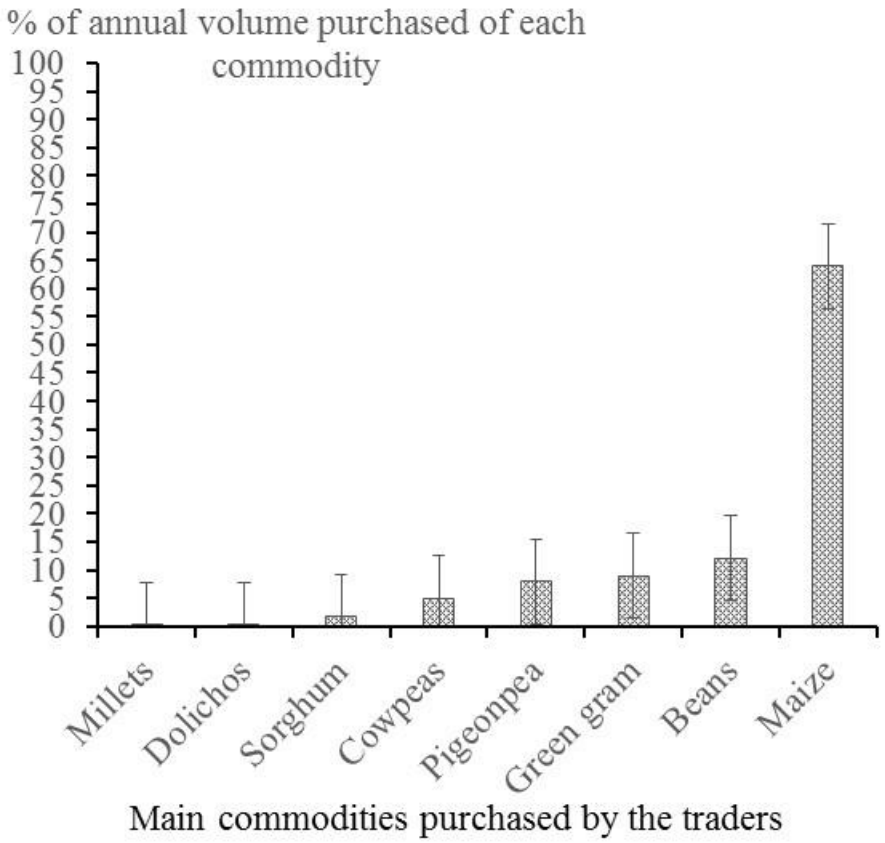


Figure 7.3

Percentage of Annual Volume of Each Community Purchased by the Traders

The finding supported the study expectation that green gram and pigeon pea were among the commodities traded in rural markets despite household consumption of the output. According to literature on trader buying behaviour studies in rural areas of developing countries, trading consists of firms which are limited in size, often located in remote places and are the cornerstones of the local economy (Tolbert et al., 1998). The trader purchase preference in food commodities has been explained by Sarkar et al. (2016). Some of the indicated factors that explain the purchase preference of rural traders are regular/frequent supply. Rural traders prefer

local suppliers and selling the commodities which offer them higher margins. Consumer demand for a product is a factor in purchase preference of rural traders, and rural traders prefer purchasing stocks that are of a higher perceived quality.

The commodities have different trader purchase preferences. For instance, it is likely that, maize and beans have the highest percentage of trader purchase preference due to the local demand from the rural households. The trader purchase preference on green gram and pigeon pea could be explained by the rural traders' preference on local suppliers and selling commodities which offer them higher margins.

Figure 7.4 shows the percentages of the categories of grain traders according to those who entered the market before, during and after market reforms. Results show that, about 2.7 % of the green gram and pigeon pea grain traders had entered the market before market reforms. In 1980s and 1990s, which is the market reform period, the percentage of the grain traders who entered the market was about 12.7. According to Figure 7.5, the category of the traders who entered the market in 2000s, has the percentage of 84.5.

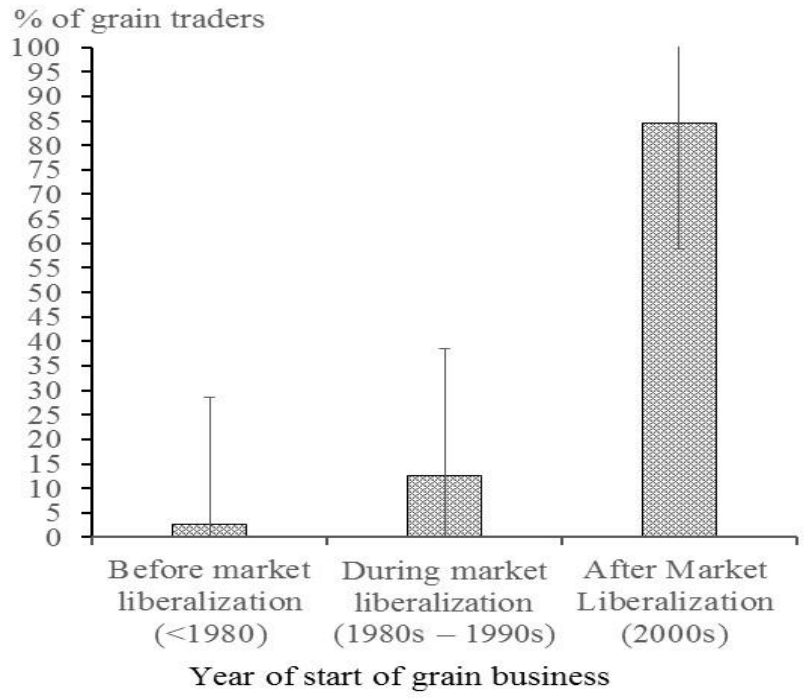


Figure 7.4

Percentages of Grain Traders in the Year of Starting Grain Trading

Higher percentage of the category of traders who entered the market in 2000s than those who entered the market before and during the reforms was in line with the study expectation that, as the market barriers reduce due to reforms, more grain traders participate in the market. The finding supported the argument in the literature on the increase of private sector market participation due to market reforms. According to Sitko and Jayne (2013), there is an evidence of an expansion in private grain trading due to the initiation of market reforms and the expansion has the beneficial effects on market integration and efficiency.

In many sub-Saharan countires, the market reforms involved the legalization of private grain trade and the lifting of restrictions on inter-district transportation of grains (Jayne & Jones, 1997), contributing significantly and directly to an increase in the number of small-scale private grain traders (Barrett, 1997; Coulter & Golob, 1992; Dercon, 1993). In the literature, the expansion of private grain trading, is explained by the low trader entry barriers, for instance fixed and sunk costs. Barrett (1997) and Coulter and Golob (1992) argued that, due to these low trader barriers, the individuals without significant capital or assets could easily enter into grain trading (Barrett, 1997; Coulter & Golob, 1992).

Furthermore, Barrett (1997), Dorward and Morrison (2000) and Dorward et al. (2004) argued that, due to low barriers to entry, grain trading offers strong poverty reduction potential for many rural people without necessary land and capital basically for producing marketed surplus levels of cereal grains. The rural poverty reduction is due to the expansion of off-farm income earning possibilities created by freeing up grain trading to private grain traders.

Therefore, the increase in private grain traders, including green gram and pigeon pea in the study area could be explained by low trader entry barriers and the expansion of off-farm income earning possibilities. Increase in the private grain traders implies that, there is increased private sector market participation. Increased private market participation enhances smallholder commercialization of green gram and pigeon pea.

7.3.2 Market concentration

Market concentration was defined in this study as a function of the number of traders and their respective shares of the total purchases. Figure 7.5 described the behaviour of traders in terms of degrees of competition in the grain business of green gram and pigeon pea. Results were presented using Lorenz curves. Results showed that, overall, the grain market for the green gram

was very concentrated with a Gini Coefficient of 0.866 (86.6%) with few traders. About 8.26% of traders, accounted for 78.40% of the volume of green gram grain purchased. About 1.58% of the volume of green gram purchased was accounted by 24.77% of traders. The trade for pigeon pea was relatively less concentrated with a Gini Coefficient of 0.796 (79.6%). About 8.27 % of pigeon pea traders, accounted for 72.13% of the volume of grain of pigeon pea purchased. Result showed that, about 1.134% of the volume of pigeon pea grain purchased, was accounted by approximately 17.431% of traders.

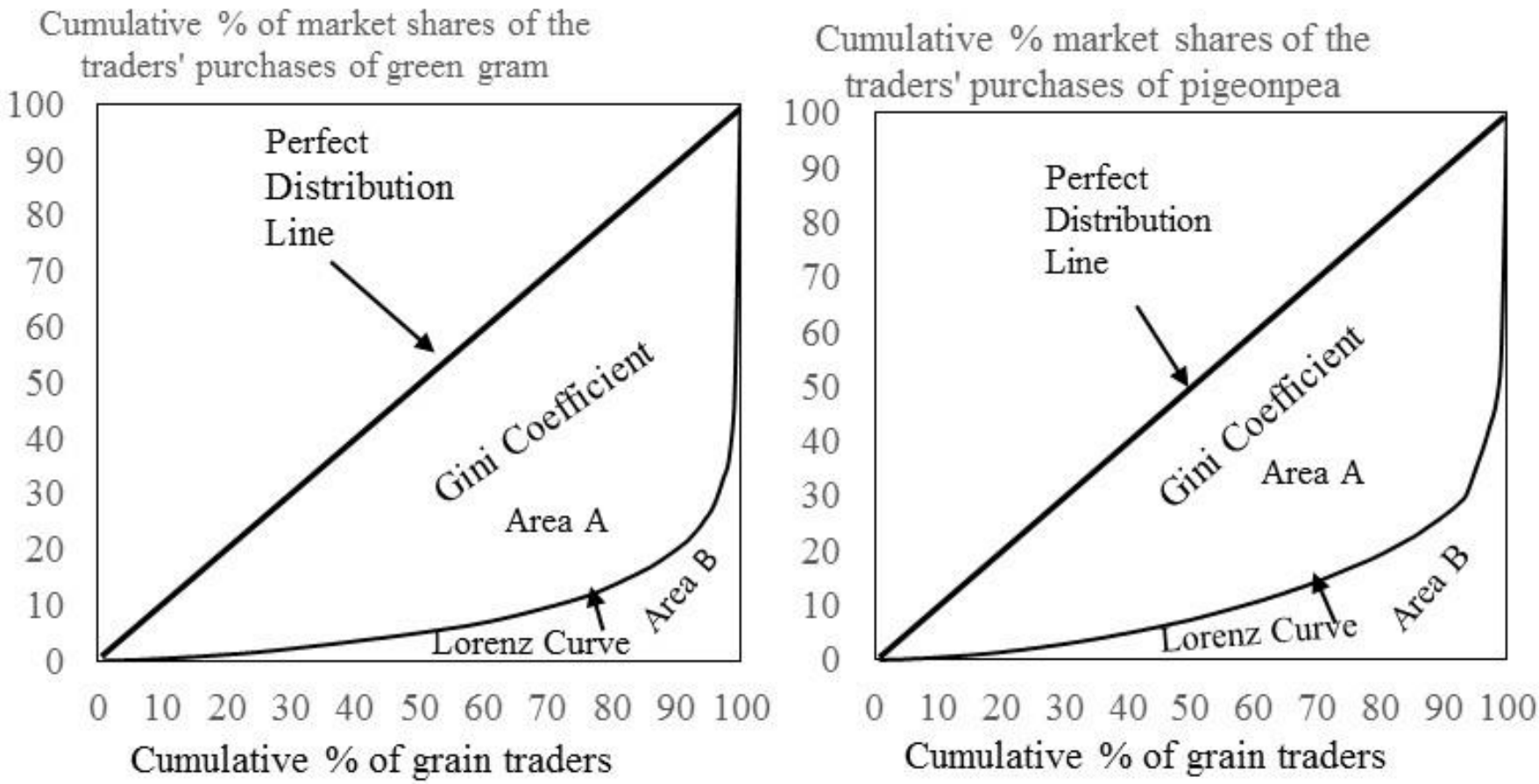


Figure 7.5

Lorenz Curves of Trader Purchases of Green Gram and Pigeon Pea Grain

These findings were in contrast with prior expectation that, in green gram and pigeon pea markets, there were many private grain traders participating, none of whom had a large market share for their decisions to affect market prices. A market dominated by many grain traders, having large share of the total volume purchased, reflects high level degree of competition.

According to Amare (2010), market concentration is measured using concentration ratio (Gini coefficient) which is the per cent of traded volume accounted for by a given number of participants. Market concentration is the key element in market structure and an important determinant of conduct and performance and hence the type of competition (Margetts, 2006). Furthermore, Margetts (2006) indicates two extremes in market structure models on the supply side as perfect competition and monopoly, with varying degrees of market control.

According to theory, perfect competition contains a large number of participants that no market control by any firm. Where the markets are dominated by one or few sellers or one or few purchasers, the nature is explained by the theory of "imperfect competition" (Todaro & Smith, 2003). According to Khols and Uhl (1985), the higher the concentration of sales of the industry, the higher the likelihood that the market would be imperfectly competitive.

Onu and Iliyasu (2008) noted that, competition is likely to be fierce in the presence of a large number of food grain traders. Due to fierce competition, the individual trader is therefore expected to be fairly efficient given the constraints faced. Furthermore, with fierce competition, Gini coefficient is fairly high, indicating the co-existence of a few very large traders and a large number of small traders. Other support to this study findings was by Wesman (2005), where it was pointed out that, as market concentration increased, competition decreased and chances of collusion and monopoly increased. Where a higher concentration measure represented a higher level of lack of competition, it was noted that, there were few participants dominating the market. According to Wesman (2005), the Gini coefficient value ranges from 0 to 1. Value of zero indicates perfect equality or uniform distribution of market shares and this is applicable with perfect competition and value of one means inequality in distribution implying imperfect competition.

7.3.3 Grain traders' market entry and exits

Figure 7.6 showed the mean number of grain trader entrants into and exits from the market. The mean number of traders who entered the market before the interviewed was 9. The mean market entrants which entered the market at the same time with the trader interviewed was 3. The mean number of traders who entered the market after the entry of the trader interviewed was 5.

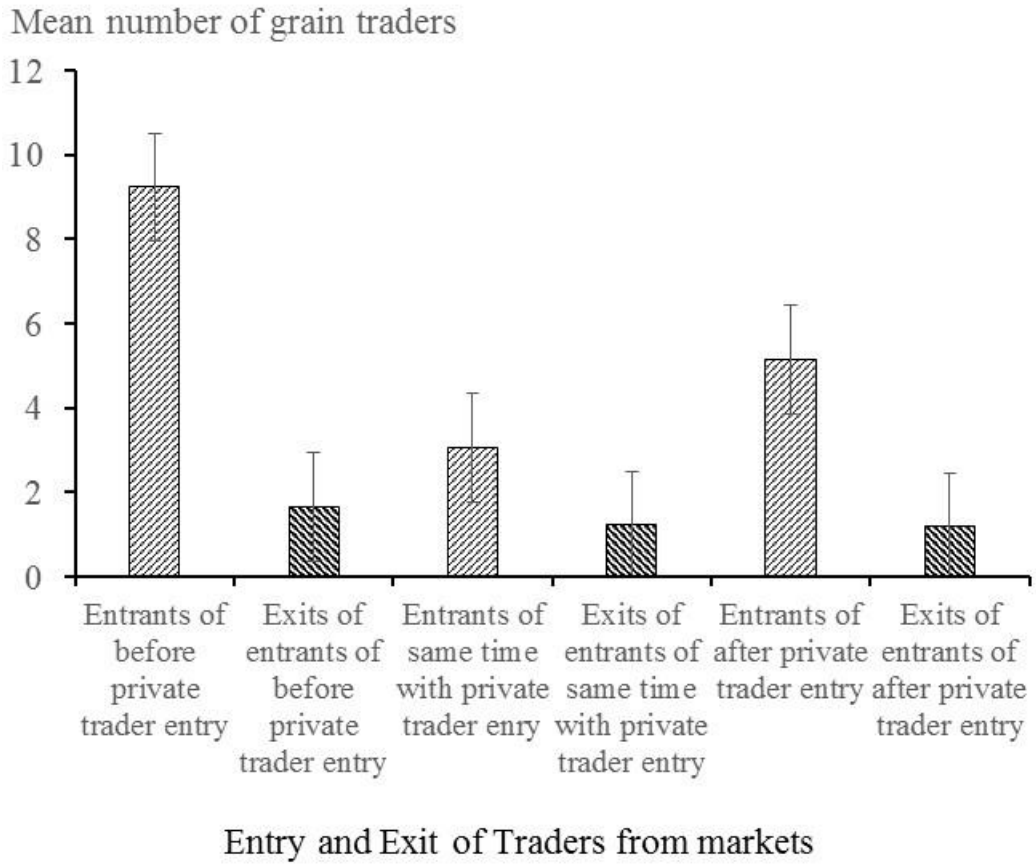


Figure 7.6

Market Entrants and Exits into and out of Grain Trading

According to the results in Figure 7.6, there were traders who entered the market before the entry of the trader interviewed but have exited, the traders who entered the market at the same time with the interviewed trader but had exited and the traders who entered the market after the entry of the interviewed trader but had exited from the market. The results showed that, the category of traders with the highest mean number of exits, entered the market before the entry of the interviewed trader (2). Both categories of traders who entered the market at the same time and

after entry of the interviewed trader had the same mean number of traders who exited the market (1).

Comparing the mean number of market entrants to the mean number of exits, the results generally show that, the number of traders entering in to the market are more than the number exiting from the market. This is important in facilitating the flow of products from the producers to the consumers. The finding on the behaviour of traders on market entry supported and contradicted the study expectation. The finding supports the study expectation because there would be a decrease in the mean number of grain traders entering the market at the same time and after the entry of grain traders interviewed due to high market barriers.

The finding contradict the study expectation because there would be an increase in the mean number of grain trader entering the market at the same time and after the entry of the traders interviewed if the barriers to entry are low. According to the literature on barriers to entry into the grain market, it has been shown that, if the barriers to entry are low, there would be new traders, entering easily into grain markets where they compete with established traders (Amare, 2010). Some of the major barriers to entry in to grain trade shown in the literature include lack of working capital, price, information and high competition among traders.

7.3.4 Grain traders' choices of market channels of green gram and pigeon pea production

Figure 7.7 indicated the percentages of traders in marketing chains of green gram and pigeon pea grains. While the overall marketing chains of green gram and pigeon pea systems were quite complex, the choices of traders were either categorized as short or long in terms of transfer of ownership from the producers to the consumers. The short marketing chains involved consumers in the rural areas while the long chains involved consumers in urban towns and export markets.

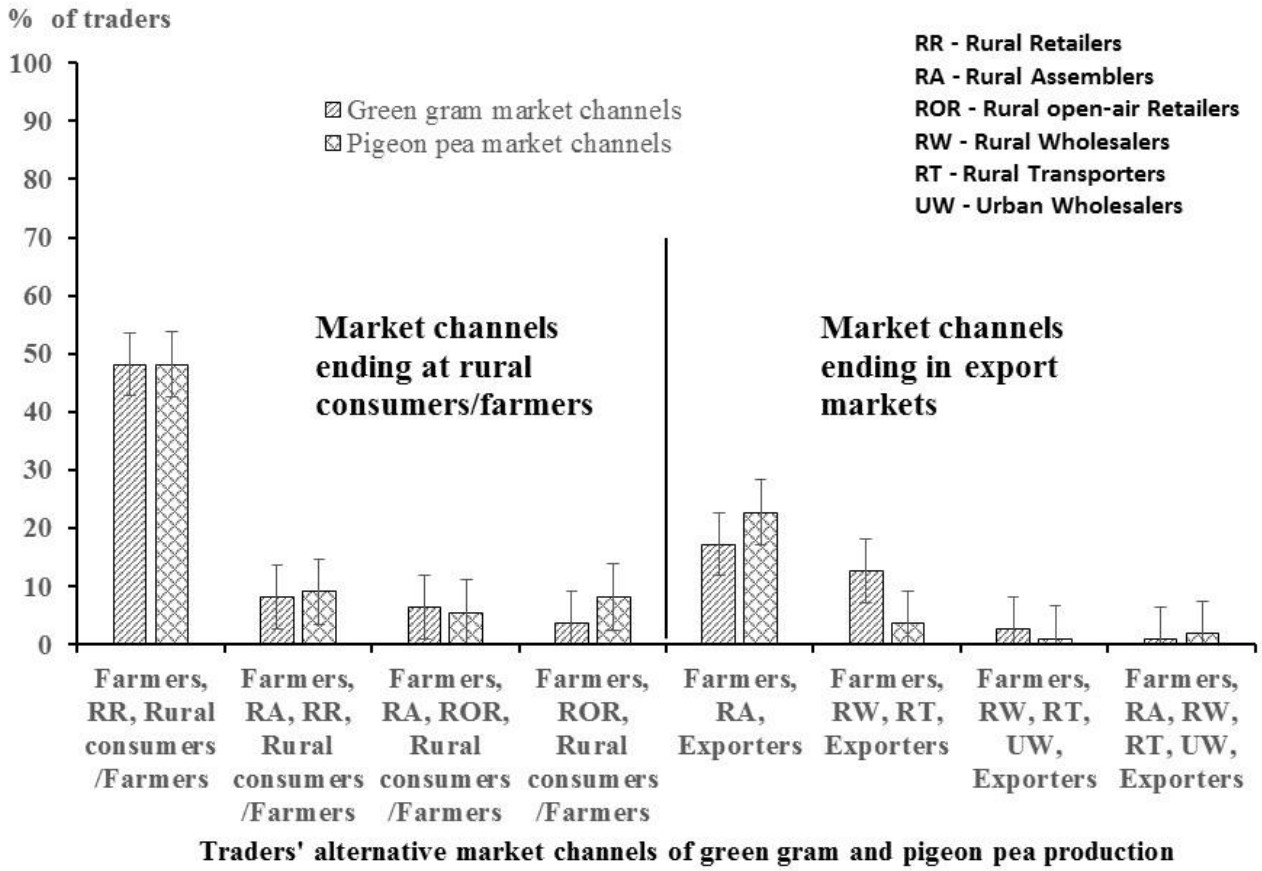


Figure 7.7

Percentages of Traders in Alternative Marketing Chains of Green Gram and Pigeon Pea Production

According to the results, about 66.4% of green gram traders had chosen the short marketing chain, where the consumers are in rural areas. The choice of export markets (long chain) for green gram was about 33.6% of traders. With the rural consumers, the highest percentage of traders (48.2%) was in the chain involving farmers, rural retailers and rural consumers, including farmers. The lowest percentage of traders (3.6%) was in the chain involving farmers, rural open-air retailers and rural consumers, including farmers.

Among the marketing chains of green gram to export markets, the highest percentage of traders (17.3%) was found in the chain involving farmers, rural assembly and exporters. The lowest percentage (0.9%) was found in the chain involving farmers, rural assemblers, rural wholesalers, rural transporters, urban wholesalers and exporters.

In the marketing chains of pigeon pea, about 70.9% of traders was found in the rural consumer chain while approximately 29.1% of traders was in the export market chain. Among the rural consumer pigeon pea chains, the highest percentage of traders (48.2%) was found in the chain involving farmers, rural retailers and rural consumers, including farmers. In the same consumer pigeon pea chains, the lowest percentage of traders (5.5%) was found in the chain involving farmers, rural assemblers, rural open-air retailers and rural consumers, including farmers.

In the export marketing chains, the highest percentage of traders (22.7%) was found involving farmers, rural assemblers and exporters. The export chain with the lowest percentage of traders (0.9%) involves farmers, rural wholesalers, rural transporters, urban wholesalers and exporters. The findings agreed with the study expectation that, the predominant choice of traders in marketing chains of green and pigeon is the rural consumer chain. This is supported by the argument that, rural traders are small in scale of grain stocking and have limited link to urban and international markets.

The literature on choice of marketing chain of food grains has shown similarities in the factors influencing farmers and traders. According to Kihoro et al. (2016), the factors influencing farmers' choice of marketing chains (rural assemblers or rural retailers) are total cost of production activities, cost per unit of green grams transported to the market, cooperative selling, green gram selling price per kilogram and access to marketing formation. According to Chirwa (2009), the reasons for preferring market channel depend on household and farmer characteristics, crop characteristics and market characteristics. Farmer characteristics include gender of the farmer, age of the farmer in years, education of the farmer, area under crop cultivation and cropping pattern. It is indicated that, the crop characteristics include the price of the crop and the commercialization index. The market characteristics include the market being close to the buyer, always selling to the buyer, buyer that offers best price and the buyer under contract.

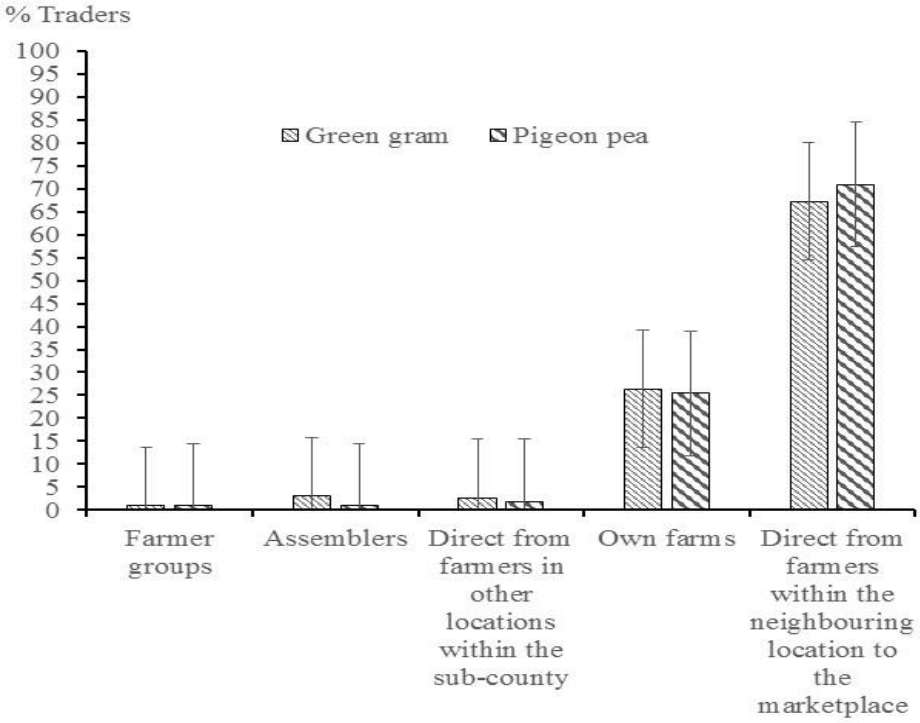
According to Sujarwo et al. (2014), the study of marketing channel choice on traders' level is rare. Sujarwo et al. (2014) argued that, many researchers have been focusing their studies on farmers' choice of marketing channels of different commodities. Nevertheless, food grain traders are important actors in the marketing chains in distributing grains from farmers to consumers. According to Chirwa (2009), Sujarwo et al. (2014) and Xaba and Masuku (2013), choice of

marketing channels by small traders is determined by trader characteristic, size of business, profitability aspect, information aspect, negotiation aspect, credit access and location.

The choice of rural consumer marketing chain by the traders of green gram and pigeon pea could be due to the trader characteristics, size of business and information aspect. The trader characteristics could include gender, age and education. The size of business probably is small scale with no organizational aspect. Access to information depends on the remoteness of traders in rural areas.

7.3.5 Grain traders' sources of green gram and pigeon pea grains

Figure 7.8 showed the percentages of traders based on their sources of green gram and pigeon pea grains. Results show that, the highest percentage of traders get green gram (67.3 %) and pigeon pea (70.9 %) directly from farmers within the neighbouring location to the marketplace. The lowest percentage of traders get green gram (0.9 %) and pigeon pea (0.9 %) from farmer groups. According to the findings, traders were obtaining grains of green gram (26.4 %) and pigeon pea (25.5 %) from own farms.



Traders sources of green gram and pigeon pea grains

Figure 7.8

Percentage of Traders in Sources of Green Gram and Pigeon Pea Grains

The highest percentage of traders sourced grains from farmers within the neighbouring location to the marketplace and was consistent with the study expectation. It was expected that, due to less market remoteness, more traders choose the neighbouring farmers while sourcing green gram and pigeon pea grains. Market remoteness includes distance proximity and information asymmetries. According to literature on private trader market participation, market access by farmers is another factor in explaining a trader's choice on source of grain. It has been shown that, farmers in isolated rural regions have limited marketing options (Sitko et al., 2014). Barrett (2008) and Osborne (2005) indicated that, output markets in more remote regions have failed to effectively develop, because traders have limited incentives to incur large fixed costs to enable them reach households in different areas, forcing households' inclination towards semi-subsistence production.

According to Endale (1993), market fragmentation causes lack of free movement of goods and services. The fragmented markets are largely disconnected from adjacent markets as opposed to integrated markets. Transaction cost has also been shown as a factor influencing the trader's choice on source of grain according to the literature. According to Gabre-Madhin (2001), each trader incurs the search time and search labor per transaction. This cost depends on the trader's ability to hire additional labor or to engage the family members in the search effort.

7.3.6 Grain traders' sale flows of green gram and pigeon pea grains to the buyers

Figure 7.9 indicated the percentages of private traders according to the sale flows. Results show that, the highest percentages of traders sell their grains of green gram (49.1 %) and pigeon pea (50.9 %) to the individual consumers within the market. Other important grain buyers are institutions within the County (hospitals/schools) with the percentages of traders of 31.8 and 30.6 for the green gram and pigeon pea, respectively. Results show that, traders are not selling green gram grain to the rural wholesalers within the county. The percentage of traders selling pigeon pea grain to the rural wholesalers within the county is low (1.9 %).

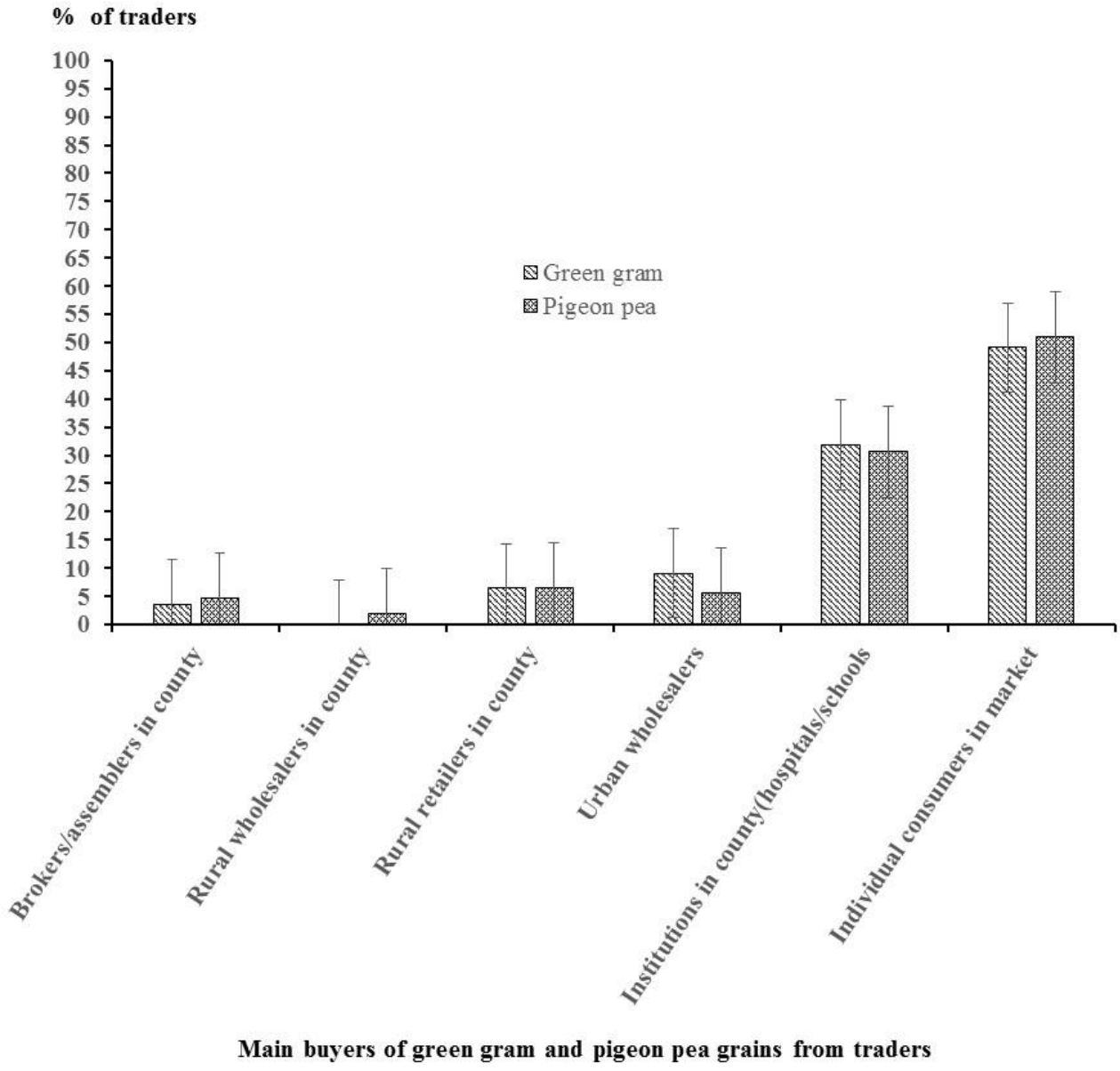


Figure 7.9

Percentage of Traders According to Buyers of Green Gram and Pigeon Pea Grains

Use of individual consumers within the markets by most of the traders of green gram and pigeon pea supported the study expectation. It was expected that, due to being small scale, the grain traders have their sales to the consumers within the same market. The finding supports the literature on private trader market participation. According to Chiwele et al. (1996), a significant level of participation by traders in food crops is explained by differences in the diversity of end-buyers of the different products. Research findings have shown, that there is significant spatial

market segmentation and high marketing costs in grain trading due to substantial fixed or sunk costs associated with grain wholesaling and transport (Barrett, 1997). It has also been shown that, in sub-Saharan Africa, pursuing output market policies by policy-makers have limited the capacity of private sector traders from participating in output markets (Abbink et al., 2011; Ellis & Manda, 2012; Jayne et al., 2006; Tschirley & Jayne, 2010). The trader's use of individual consumers within the market for selling green gram and pigeon pea could be explained by the spatial market segmentation, high marketing costs and limited capacity. These factors lead to low level private sector trader market participation in green gram and pigeon pea in regional, urban and international markets.

7.3.7 Grain traders and their marketing functions

Results in Figure 7.10 showed that, the highest percentage of traders had the task of selling grains directly to consumers through retail and micro-retail (46.4%). The percentages of traders in other performed marketing functions were assembling from traders (26.4%), production (21.8 %), export (1.8%), transport (1.8%), wholesale (0.9%) and quality verification and grading (0.9 %).

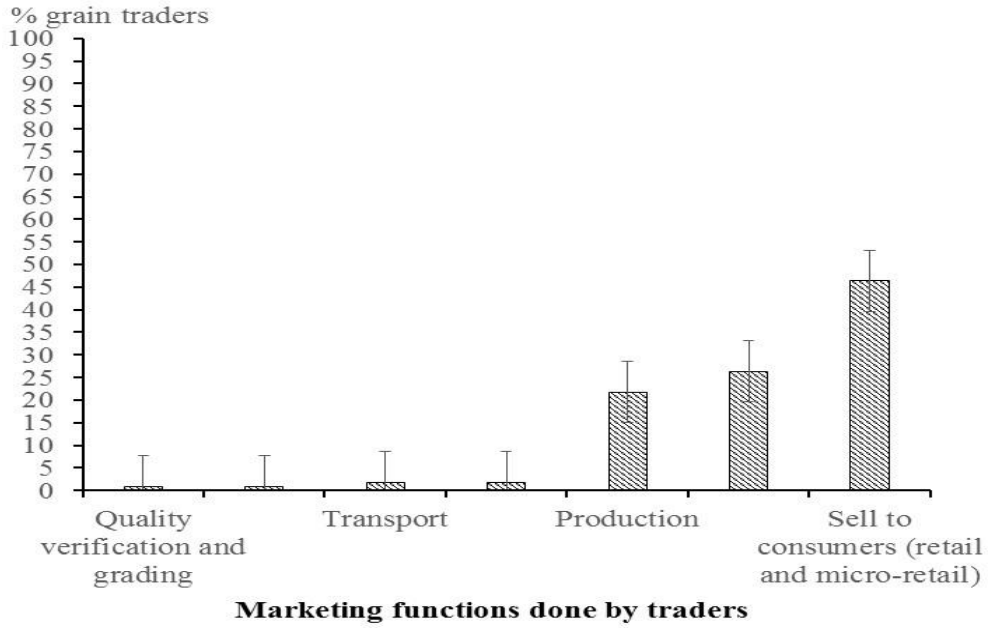


Figure 7.10

Percentage of Traders in Marketing Functions

Since the highest percentage of traders were found selling grains directly to consumers through retail and micro-retail, the finding supports the study expectation. Though the finding is consistent with the expectation, there are other functions undertaken by the green gram and pigeon pea traders. According to results, some of the grain traders of green gram and pigeon pea were directly undertaking production function. In the assembly function, the traders purchased grains from producers. The retail function involves selling grains to consumers. For the movement of grains, the traders were found undertaking transportation function. Though wholesale function had low percentage of traders, the function was undertaken to distribute green gram and pigeon pea to other local markets within the sub-county. The export function, though undertaken by low percentage of traders of green gram and pigeon pea is done to the international markets.

According to Onu and Iliyasu (2008), marketing costs per unit are generally functions of quantities handled by each individual trader, the distance travelled from the supplier, the number of intermediaries and the marketing tasks undertaken by the trader. Mainly the typical tasks are assembly, quality verification and grading, transport, storage, processing, retail and micro-retail. It has been indicated in the literature that, individual traders may undertake one or several tasks. According to Amare et al. (2010) and Branson and Norvel (1983), these costs are due to fundamental physical process or service required to give a product the form, time, place and possession utility to meet consumers' desire.

Figure 7.11 indicates that, the highest percentage of traders are not transporting their grains (54.5 %). Results show that, traders who transport their grains, mainly use public (23.6%), rented (10.9 %) and own vehicles (7.3%). Other traders use combinations of public and rented (1.8%) and public and own vehicle (1.8%) for transporting grains.

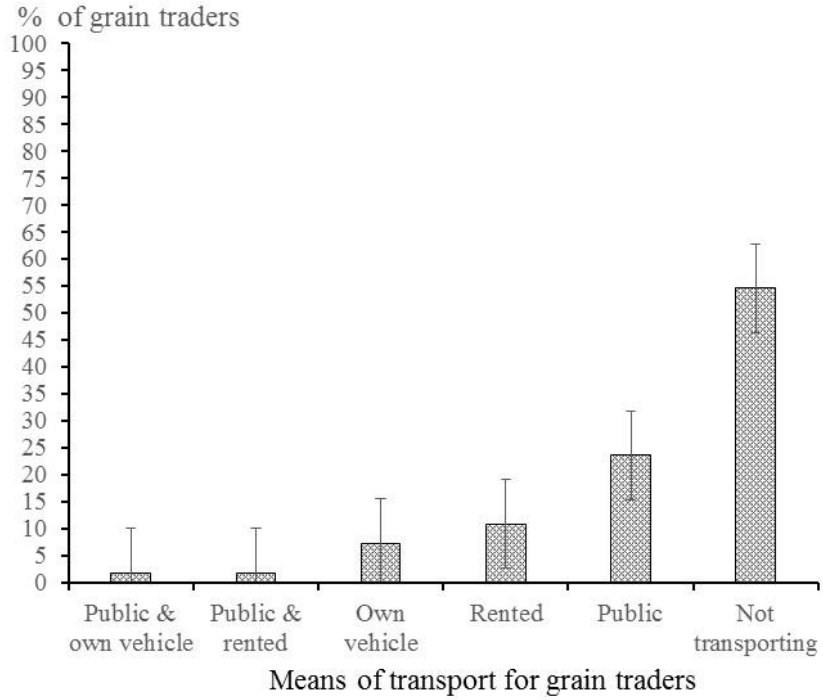


Figure 7.11

Percent of Grain Traders in Transportation Means

Results showed that, the highest percentage of traders had no transport means for both green gram and pigeon pea and that agreed with the study expectation. Due to general poor rural transport services and high costs in Kenya, the study expected that, the traders had minimal transportation of grains. According to literature, rural transport services referred to continuum of transport activities and operations that connected rural households and farms to market centres (Njenga, 2003). Therefore, based on the literature, the highest percentage of traders without transporting green gram and pigeon pea could be supported by poor rural transport services stemming from the low levels of motor vehicle ownership and poor transport infrastructure. Poor transport infrastructure could not attract vibrant and competitive transport operations.

7.3.8 Grain traders' storage practices

Figure 7.12 showed the traders' mean storage duration (days) for the green gram and pigeon pea grains. Storage duration was the number of days taken by the stock of green gram and pigeon pea while in store. Sometimes the traders could keep grains for a short and also for a long duration. Typically, the traders were found with specific grain stores while others using allocated spaces in

business shops. According to the results, both traders showed similarities in the mean storage days for the shortest and longest durations.

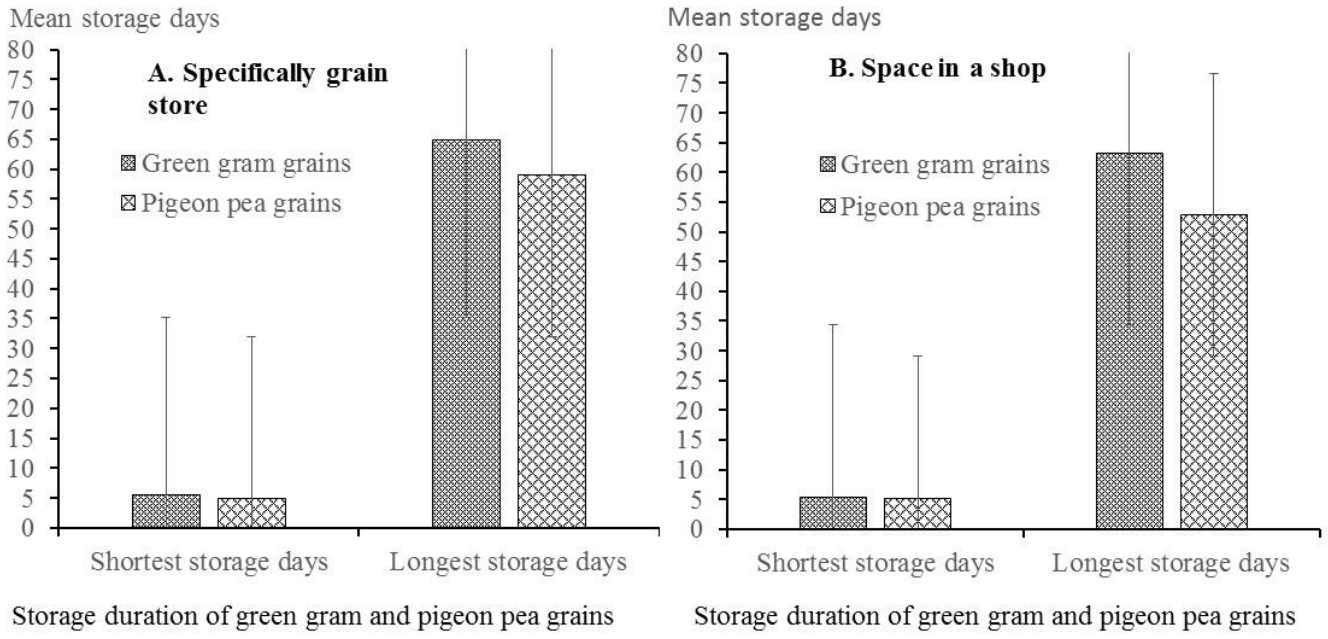


Figure 7.12

Mean Duration of Grain Storage

Traders with specifically grain store was an indicator of large scale grain stockists. Use of a space in the business shop could hold very bags of grains and therefore indicated small scale traders. For the case of traders with specifically grain store, the mean shortest and longest storage days for green gram grains were 5.44 and 64.88, respectively. Traders using spaces in their shops to stock grains of green gram had the mean shortest and longest storage days of 5.32 and 63.28, respectively. The mean shortest and longest storage days using specifically grain store for pigeon pea grains were 4.92 and 59.08, respectively. The traders found using spaces in their business shops stored pigeon pea grains within the mean shortest and longest days of 5.24 and 52.88, respectively.

The behaviours of grain traders in storage duration using specifically grain store and spaces in their shops were similar. Results implied that, the frequency of transactions were similar though the storage capacity varied. Many studies in the literature on the grain traders' access to the storage facilities in sub-Saharan countries, have reported that, storage facilities are still

inadequate in terms of availability, storage and premise space and location (Dessalegn et al., 1998). Insufficiency and improper storage facilities have been revealed in several studies in the literature at the levels of farmers, private and government (Alam et al., 2007).

Studies on trader frequency of transactions indicated that, the traders buy seasonal grains from the market when price is low, store these grains and then sell them in the market when price is comparatively high (Alam et al., 2007). According to Chowdhury (1993) and Jabbar (2016), the nature and extent of private food grain stocks depended on a range of factors relating to the structure of food grain production, consumption, marketed surplus, and pattern of marketing by producers and traders along the supply chain, and of the structure and conduct of food grain market. It has been noted that, the stocking and marketing behaviour of various types of traders as well as marketed surplus of producers and their marketing patterns influenced the flow of food grains and prices.

7.3.9 Rural financing institutions and the level of trader outreach

Figure 7.13 indicates the percentages of private grain traders outreached by different rural finance institutions. Results show that, most of the private grain traders are not outreached by the rural finance institutions (65.5%). According to the findings, the percentages of traders outreached by the rural finance institutions are; banks (12.7%), microfinance (8.2%), combinations of institutions (5.5%), grain suppliers (3.6%), merry-go-round (2.7%), table banking (0.9%) and friends (0.9%).

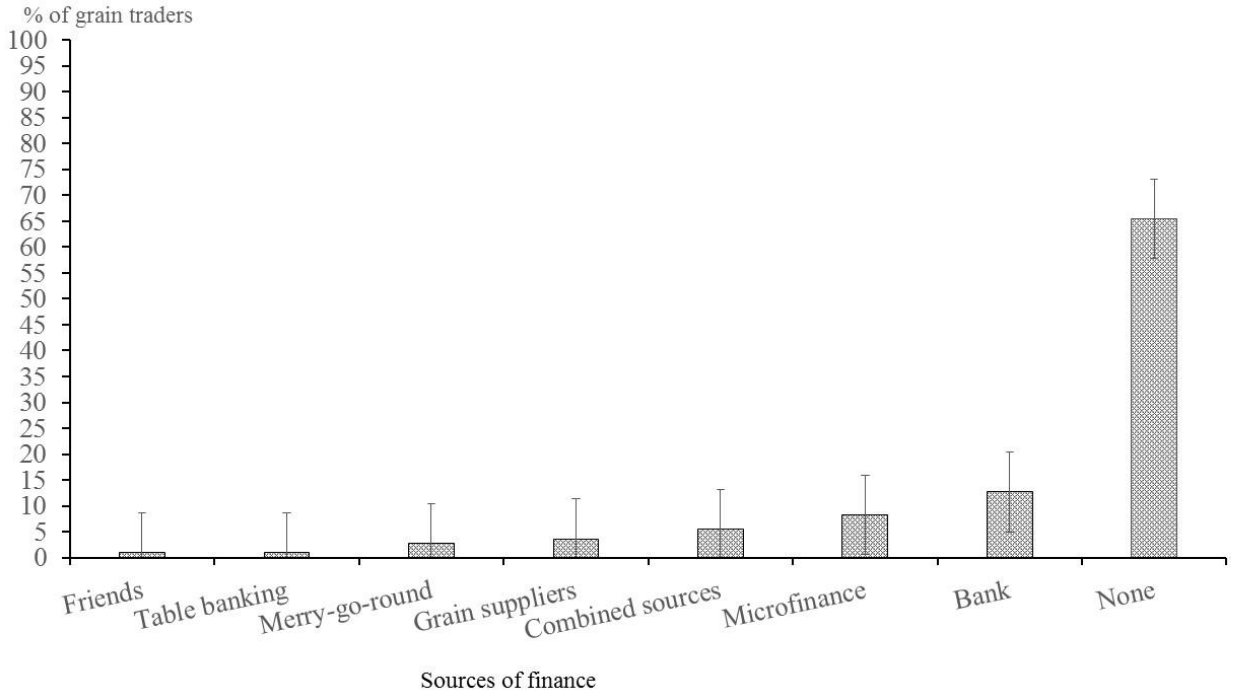


Figure 7.13

Percentage of Grain Traders Using Rural Financing Institutions

The study expected that, high percentage of private grain traders are not outreached by the rural finance institutions. Findings show that, the highest percentage of traders have no rural financial institutions. The finding agrees with the study expectation. According to literature on rural finance institutions, it has been shown that, in most developing economies, low access to formal credit persists and is a limiting factor in operation and business expansion (Dessalegn et al., 1998).

Durojaiye et al. (2014) examined the relationship between low access to formal credit and the trader size and argued that, the grain marketing requires considerable investment of fund in the area of bulk purchase, development of storage facilities and processing facilities. Lack of access to credit and inadequate fund to expand businesses often discourage prospective grain traders from buying their products in bulk. The inadequacy of fund prevents grain traders from expanding their business in order to reduce costs due to economies of scale.

According to Zeller (2001), the supply of formal rural and agricultural credit appears to have considerably declined due to structural adjustment programs. Despite structural adjustment

programs, commercial banks have not entered the rural and agricultural credit market on a substantial scale in most developing countries (Wenner, 2002). It has been assumed that, the commonly perceived decline of state-driven and formal credit is compensated for by an increase in informal credit granted by traders, agribusiness firms and informal savings and credit groups.

The study findings agree with the literature on the low outreach of rural finance institutions. There is low percentage of private traders reached by the formal and informal rural finance institutions. Though low percentages of grain traders, formal institutions through banks have higher percentages of traders than informal institutions.

7.3.10 Determinants of traders' performance in purchases of green gram and pigeon pea grains

It has been shown that social capital plays an important role in facilitating human interaction (Coleman, 1993; Granovetter, 1985; Putnam et al., 1993). The features of social capital are trust, norms, and networks that can improve the efficiency of society, according to Putnam et al., 1994). Many studies in the literature on social capital indicate that, social capital can lower transactions costs by reducing the costs in information and search and also increases trust (Fafchamps & Minten, 2001; Fafchamps, 2006; Fukuyama, 1995; Knack & Keefer, 1997; Woolcock & Narayan, 2000). According to Bigsten et al. (2000), trust helps in mitigating the abuse that may occur during the purchase and sale of commodities (non-delivery, late payment, deficient quality, incorrect quantity).

Results shown in Figure 7.14 indicated that, the mean of grain traders whom the trader could ask for a loan from was less than two traders (about 1.8 persons). Results showed that, traders had chosen to use brokers for both purchase and sale transactions with a mean of 2.9 and 3.3, respectively. According to the results, traders were also operating in other markets with a mean of 1.3. Buyers of green gram and pigeon pea are categorized into buyers within the same market and at distant markets. The mean number of buyers within the same market was indicated as 6.7 while the mean number of buyers at distant markets was 3.4.

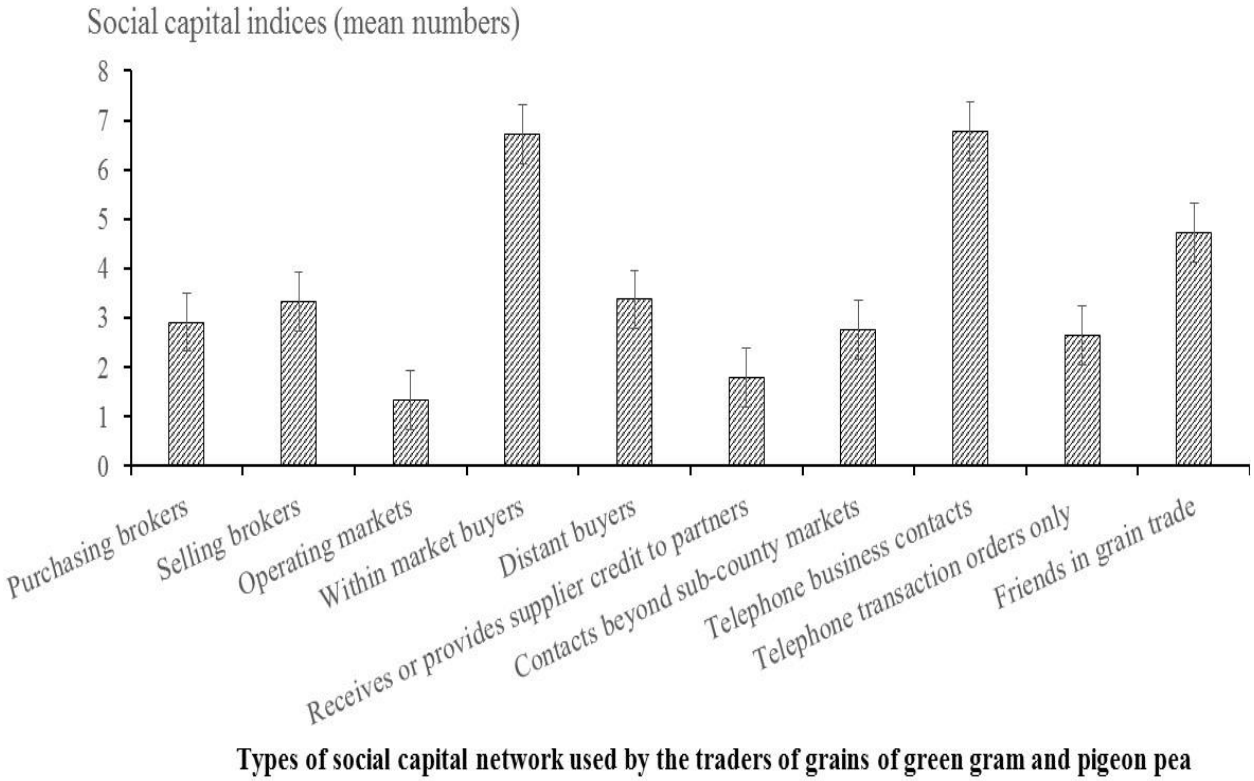


Figure 7.14

Number and Type of Relationships Used by Traders of Green Gram and Pigeon Pea Food Grains

Results indicated that, in their social capital, the traders had contacts beyond their sub-county markets which could be used to facilitate exchange of grains. The mean number of contacts beyond sub-county markets was 2.8. The traders were found having telephone contacts to facilitate the grain exchange (mean of 6.8). Also through the telephone, result show that, there was an exchange of grain. The mean number of buyers through the telephone is shown as 2.6. Friendship to the grain trader is part of human interaction in the structure of grain traders. Result shown that, the mean number of friends to the trader in the grain trade is 4.7.

The finding supports prior expectation that, traders' social capital is enhanced by the types of relationships, or the amount of trust, that traders enjoy with their regular partners to facilitate the exchange. The findings also supports the literature on the factors that enhance a trader's social capital. According to Gabre-Madhin (2001), the relationship factors that enhance a trader's social capital include; whether the trader's parents were involved in the grain business in the past,

whether family members are currently in the grain business, the number of languages the trader speaks, the number of regular partners the trader has, and the number of people the trader consults regularly. The trust factors are based on telephone conversation and supplier credit. Trader's social capital is enhanced if a trader is able to sell or purchase solely on the basis of a telephone conversation and if the trader receives or provides supplier credit to partners.

7.3.11 Empirical results of private traders' performance based on the volume of green gram purchase

Table 7.4 gives the multiple linear regression results. The model summary results showed the overall goodness of fit and F-tests. The overall goodness of fit of the regression model measured by the coefficient of determination and indicated by the adjusted R-squared (adj.R^2) was 0.9972. About 99.72 % of the variation in volume of purchase of green gram is explained by the model, that was, the variation in the traders' volume of purchase of green gram as independent variable is explained by the human, social and physical explanatory variables.

Table 7.4

Results of Multiple Linear Regression of Private Traders' Performance Based on the Volume of Green Gram Purchase

Model variables	Coefficients	Std. Err.	t	P>|t|	95% Conf. Interval	
Dependent Variable: Volume of green gram purchased (kgs)						
Independent Variables:						
(Constant)	-3951.398*	2366.817	-1.67	0.099	-8654.949	752.153
Trader's age	14.667	22.562	0.65	0.517	-30.171	59.505
Trader's gender	198.713	458.538	0.43	0.666	-712.534	1109.961
Trader's experience	11.788	32.153	0.37	0.715	-52.109	75.686
Social capital						
Trader's purchasing brokers	51.623	88.977	0.58	0.563	-125.199	228.445
Trader's selling brokers	-144.571*	75.197	-1.92	0.058	-294.009	4.868
Persons the trader could ask for loan from	-288.911**	143.096	-2.02	0.047	-573.284	-4.538
Local trader's clients in the same market	-26.678	46.630	-0.57	0.569	-119.345	65.989
Distant trader's clients outside market	-44.365	104.763	-0.42	0.673	-252.559	163.828
Trader's contacts in distant markets beyond the sub-county	285.884***	83.860	3.41	0.001	119.229	452.539
Trader's business contacts by telephone	-13.552	16.935	-0.80	0.426	-47.206	20.102
Trader's friends in grain trade	35.644	59.499	0.60	0.551	-82.598	153.886
Trader's regular buyers in the same markets	0.257	10.152	0.03	0.980	-19.918	20.432
Trader's regular distant buyers outside the market	-6.229	30.243	-0.21	0.837	-66.329	53.873
Trader's buyers with telephone orders only	-57.969	112.865	-0.51	0.609	-282.266	166.326
Physical capital						
Annual working capital	-0.002***	0.001	-3.56	0.001	-0.0025	-0.001

Storage capacity	-1.316	1.328	-0.99	0.324	-3.954	1.323
Markets in which trader operate	91.873	342.722	0.27	0.789	-589.215	772.960
Trader's volume of pigeon pea purchases	0.505***	0.056	9.02	0.000	0.394	0.617
Volumes of cowpea purchased	0.278***	0.103	2.71	0.008	0.074	0.482
Volumes of beans purchased	0.527***	0.046	11.35	0.000	0.435	0.619
Purchase market distances	675.636	448.629	1.51	0.136	-215.919	1567.192
Overall Model Fit						
Adj. R-squared	0.9972					
F-Statistic	1849.91***					

*, **, *** indicated 10%, 5%, 1% significance levels, respectively

The results indicates that, the F-test is highly significant (p = 0.0000). Therefore F test is suitable for the application of overall fit of the developed model. Hence the model is adequate for the explanation of the traders' variation in the volume purchased of green gram. As expected, the traders with a higher number of contacts in distant markets beyond the sub-county are significantly and positively associated with the increase in the volume of purchase of green gram. A one increase in the trader's number of contacts in distant markets beyond the sub-county, leads to 285.8838 kilograms increase in the volume of purchase of green gram. The result implies that the traders increased the volume of purchase of green gram because the contacts lead to potential markets with better price and demand. The finding is consistent with the literature that networking as one of the social capitals increases the performance of grain traders (Eleni, 2001; Fafchamps & Minten, 1999). Barr (2000) and Fafchamps and Minten (2002) argued that, firms with more social capital get more return from their labour and physical and human capital.

Multiple grains purchase is among the trading practices used by market actors. Results indicate that, when a trader increases pigeon pea purchase by a one kilogram, the volume of green gram purchase increases significantly by 0.5054047 kilograms. In accordance with expectations, the volume of purchase of pigeon pea is shown to have a strong positive effect on the volume of purchase of green gram. In every one kilogram purchase of pigeon pea grains, the trader purchases lower volume of green gram by about 50 %.

The volume of green gram grains purchased depended on the volumes of grains of other crops stocked together or in the portfolio of grains traded. For instance, results shown in Table 7.4 indicated that a one kilogram increase in the volume of purchase of cowpea, increased significantly the volume of purchase of green gram by 0.278153 kilograms (27.8 %). The findings were contrary to the study expectation. Due to limited resources during purchasing and competition, it was expected that, as the volume of green gram increased, there would be low purchases of other grains for instance cowpea.

The traders' volumes of beans purchased was another factor considered to influence the volumes of green grams purchased by traders. According to the results shown in Table 7.4, the relationship between the volumes of purchases of beans and green grams was positive and significant. As the trader increased the volumes of purchase of beans by one kilogram, the volume of purchase of green gram increased significantly by 0.5269458 kilograms. The trader's practice of purchasing beans lowers the volume of purchase of green gram by 52.7 %. In accordance with the study expectation, the volume of purchase of beans lowers the volume of purchase of green gram though positively.

Result in Table 7.4 showed negative and significant effect of increasing saler brokers on the volume of purchase of green gram. According to the finding, the traders with more saler brokers have lower volume of purchase of green gram by 144.5705 kilograms. This finding is contrary to expectation. It was expected that, the volume of purchase of green gram grains increases with the increase in the use of sales brokers. The finding is also contrary to the work by Rehima et al. (2017) which indicates that, the volume of purchase increases with the use of intermediaries at the time of sale because probably the intermediaries may identify potential markets and better prices. .

Increase in the number of persons the trader could a get loans, reduces significantly the trader's volume of purchase of green gram by 288.9108 kilograms. The finding is contrary to the expectation that traders with greater number of persons the traders may get loans could achieve greater volume of purchase than those traders with less number of persons that could advance loans or else equal. The finding was contrary to the work by Durojaiye et al. (2014) which indicated that, the grain traders with lack of access to credit and inadequate funds to expand businesses were often discouraged from prospective buying their products in bulk. In order to

reduce costs due to economies of scale, it has been indicated in the literature that, the grain traders with the inadequacy of funds are prevented from expanding their business.

The annual working capital reduces significantly the volume of purchase of green gram. Traders with higher annual working capital have lower volume of purchase of green gram than traders with less annual working capital. As the annual working capital increases, the traders reduce the volume of purchase of green gram by 0.0016032 kilogram (0.16 %). It was expected that, the traders with a higher annual working capital significantly and positively associated with higher volume of purchase than the traders with lower annual working capital.

This finding is inconsistent with earlier findings in the literature which indicate that, an increase in working capital leads to an increase in the volume of purchase (Rehima et al., 2017). According to Jabbar et al. (2006), larger working capital would normally be expected to permit larger volume of business and economy of scale.

7.3.12 Empirical results of private trader performance on pigeon pea volumes purchased

Table 7.5 showed the multiple regression results of traders' volume of purchase of pigeon pea. The coefficient of determination (Adj. R-squared) which measured the overall goodness of fit of the regression model was 0.9890 or 98.9 % of the variation in volume of purchase is explained by the explanatory variables. The analysis of variance indicated that F-Statistic (466.21) was highly significant at 1 % level. The F-test of overall significance indicates that, the stata multiple linear regression model provided a better fit to the data than the model with no explanatory variables.

Table 7.5

Results of Multiple Linear Regression of Private Trader Performance on Pigeon Pea Volume of Purchase

Model variables	Coefficients	Std. Err.	t	P>|t|	95% Conf. Interval	
Dependent Variable: Volume of pigeon pea purchased (kgs)						
Dependent Variable:						
(Constant)	1719.983	3291.526	0.52	0.603	-4821.234	8261.199
Trader's age	7.749698	31.00311	0.25	0.803	-53.86246	69.36186
Trader's gender	-597.8813	626.2312	-0.95	0.342	-1842.384	646.6217
Trader's experience	-3.243253	44.12429	-0.07	0.942	-90.931	84.44449
Trader's purchasing brokers	-18.92246	122.2306	-0.15	0.877	-261.8302	223.9853
Trader's selling brokers	119.9891	104.4817	1.15	0.254	-87.64639	327.6246
Persons the trader could ask for loan from	289.3956	198.3367	1.46	0.148	-104.7569	683.5482
Trader's local clients in the same market	-33.15103	63.96538	-0.52	0.606	-160.2688	93.96673
Trader's Distant clients outside market	86.97651	143.5085	0.61	0.546	-198.2165	372.1696
Trader's contacts in distant markets beyond the sub-county	-282.2822**	118.5984	-2.38	0.019	-517.9715	-46.59286
Trader's business contacts by telephone	27.34845	23.12389	1.18	0.240	-18.60543	73.30233
Trader's friends in grain trade	10.48653	81.75021	0.13	0.898	-151.9748	172.9479
Trader's regular buyers in the same markets	-10.26142	13.87831	-0.74	0.462	-37.84165	17.31881
Trader's regular distant buyers outside the market	43.9439	41.21675	1.07	0.289	-37.96573	125.8535
Trader's buyers with telephone orders only	95.58874	154.6693	0.62	0.538	-211.7841	402.9615
Physical capital						
Annual working capital	0.002247***	0.000615	3.65	0.000	0.0010248	0.003469

Storage capacity	-0.3888973	1.830427	-0.21	0.832	-4.026487	3.248692
Trading practices						
Markets in which trader operate	63.08032	470.1203	0.13	0.894	-871.1849	997.3456
Trader's volume of green gram purchases	0.9504035***	0.1053788	9.02	0.000	0.7409853	1.159822
Volume of cowpea purchases	-0.4266295***	0.1391979	-3.06	0.003	-0.7032561	-0.1500028
Volume of beans purchases	-0.1377607	0.0988455	-1.39	0.167	-0.3341954	0.0586739
Purchase market distances	-363.6719	621.8778	-0.58	0.560	-1599.523	872.1795
Overall Model Fit						
Adj. R-squared	0.9890					
F-Statistic	466.21***					

, * indicated 5%, 1% significance levels, respectively

As shown in Table 7.5, the volume of purchase of pigeon pea grains is negatively and significantly determined by the trader's contacts in the distant markets beyond the sub-county. The finding indicates that, the traders with higher contacts in the distant markets beyond the sub-county have lower volume of purchase of pigeon pea grains than the traders with less contacts. For each additional contact the trader has, the volume of purchase of pigeon pea decreases by 282.2822 kilograms.

The negative relationship between the trader's contacts in distant markets and the volume of purchase of pigeon pea was contrary to the expectation. This was probably because contacts did not necessarily translate to purchases and therefore the number of contacts in the distant markets beyond the sub-county could not improve access to market information. As argued by Rehima et al. (2017), market information is important in enhancing trader's performance.

As expected, the traders with a higher annual working capital are significantly ($p = 0.000$) and positively associated with higher volume of purchase of pigeon pea. An increase in annual working capital leads to an increase of 0.002247 kilograms (0.2247%) in the volume of purchase of pigeon pea. This finding on the positive influence of the working capital on the volume of purchase was consistent with the work by Fafchamps and Minten (1999), Fauzilah et al. (2012), Jabbar et al. (2008) and Wang et al. (2006). According to Rehima et al. (2017), the importance of financial capital to trader's business performance is generally accepted. Literature shows that,

considerable investment of fund is required in grain marketing in the area of bulk purchase (Durojaiye et al., 2014).

The volume of grains in the traders' portfolio and the competition in resources could influence the trader on the volume of purchase of pigeon peas. The purchase of green grams increased significantly the volume of pigeon peas at 1 %. The finding indicated that, when a trader increased the volume of purchase of green gram by one kilogram, the volume of purchase of pigeon pea increased by 0.95 kilograms, with all other variables being constant. The finding therefore means that, when a trader stocks green gram, the volume of purchase of pigeon pea is lower the volume of green gram by 5%. The finding is according to the study expectation. It was expected that, when a trader stocks both pigeon pea and green gram, the volume of purchase of pigeon pea is lower than the volume of green gram. Contrary to the expectation, the stocking of pigeon pea and cowpea grains was found with inverse relationship. Results in Table 7.5 indicated that, a one kilogram of purchase of cowpea, reduces significantly ($p = 0.003$) the volume of purchase of pigeon pea by 0.4266295 kilograms (42.7%). The finding indicated that, traders with high volume of purchase of cowpeas, had low volume of purchase of pigeon pea.

7.3.13 Empirical results of the effects of social capital on traders' performance on sales of green grams

The effects of social capital on the traders' sales of green gram were shown in Table 7.6. The coefficient of multiple determination as reflected in the adjusted R^2 was 0.3646. That implied that, about 36.46% of the variance in the sales of green gram was explained by the model (social capital variables).

Table 7.6

Results of Multiple Regression of Effect of Social Capital on Trader's Performance on Green Gram Sales

Social capital variables	Coeffients	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Dependent Variable: Volume of green gram sales (kgs)						
Independent Variables:						
(Constant)	-14093.2*	7566.055	-1.86	0.066	-29109.73	923.3209
Purchasing brokers	136.7479	1212.672	0.11	0.910	-2270.069	2543.565
Selling brokers	-585.1142	1036.306	-0.56	0.574	-2641.895	1471.667
Persons the trader could ask for loan from	137.6735	1854.04	0.07	0.941	-3542.082	3817.429
Markets in which the trader operates	4664.251	4408.098	1.06	0.293	-4084.603	13413.1
Regular buyers in trader's market	376.9554***	140.1022	2.69	0.008	98.89131	655.0196
Non-frequent local buyers in the trader's market	-1618.951***	609.2628	-2.66	0.009	-2828.169	-409.7327
Regular distant buyers	-652.2169	434.5595	-1.50	0.137	-1514.697	210.2635
Non-frequent distant buyers	6179.066***	1184.454	5.22	0.000	3828.253	8529.88
Distant markets trader has contacts beyond the sub-county	1006.798	1179.775	0.85	0.396	-1334.729	3348.325
Business contacts by telephone	-96.87983	236.8369	-0.41	0.683	-566.9356	373.1759
Friends in grain trade	-637.7928	804.0695	-0.79	0.430	-2233.648	958.0625
Buyers with telephone orders only	865.3367	1352.74	0.64	0.524	-1819.478	3550.151
Overall Model Fit						
R^2	0.4345					
Adj. (R^2)	0.3646					
F-ratio	6.21***					

*, *** indicated 10%, 1% significant levels, respectively

Results in Table 7.6 indicated that *F*-test was highly significant ($p = 0.066$). The significant *F*-test implies that, all of the model coefficients are not zero. This implied that the model with no variables and the model with all the variables were different. Therefore, the model was adequate.

Results showed that, among the 11 variables included in the multiple regression model, only three contribute significantly to the traders' sales. These variables were local buyers in the trader's market ($p = 0.009$), distant buyers outside trader's market ($p = 0.000$) and regular buyers in trader's market ($p = 0.008$). The traders with more numbers of non-frequent local buyers in the same market have significant reduction in the sales of green gram grains. An increase in the number of random local buyers in the trader's market, reduced the trader's sales of green gram by 1618.951 kilograms. This was because, the random local buyers were not reliable causing low transactions on sales.

The finding was contrary to the study expectation. There was also lack of agreement between the finding and the literature on the influence of social capital on the trader's sale performance. Fafchamps and Minten (2002) indicated that, the number of traders known by the trader increased the sales. This could be explained by the established trust customers are likely to buy on credit. There also networking as one of the social capitals which develops people's interaction and facilitates market transaction.

As expected, the traders with a higher regular buyers was found to have significant and positive influence ($p = 0.000$) on the sales of green gram An increase of one regular buyer would result in 376.9554 kilograms increase in the sales of green gram. This finding is consistent with literature on the contribution of social capital to the grain traders' performance. It has been found that social capital enables traders to reduce transaction costs, develops people's interaction and facilitates market transaction (Fafchamps & Minten, 1999; Rehima at al., 2017), play an important role in the resolution of dispute among traders (Fafchamps & Minten, 2001).

Networking is one of the social capitals which are determinants of the traders' performance. Building relationships and social networks may thus enable traders to economize on transaction costs even though they would probably fail to achieve the same level of aggregate efficiency as perfect markets. According to results shown in Table 7.6, the green gram buyers at distant markets affected significantly ($p = 0.000$) the traders' performance in sales. Results indicated that, an increase of a one distant buyer of green gram led to an increase of 6179.066 kilograms of sales. The increase in the sales justified that more distant buyers probably broadened the trader's

volume of sales of green gram. This finding was consistent with the study expectation. It was expected that, traders with access to distant buyers have higher volume of sales of green gram than the traders with less access to distant buyers. The finding is consistent with the work by Rehima et al. (2017) which indicated that, for the market integration, traders collected market information from distant market regularly. With the availability of market information, traders took rational decisions in the market situation where they operated.

7.3.14 Empirical results of the effects of social capital on traders' performance on sales of green grams

Results of the multiple regression analysis of the trader's volume of sales of pigeon pea were shown in Table 7.7. The overall goodness of fit of the regression model was measured using the coefficient of determination (adj. R^2). According to the results, the model for traders explained about 36.01% of variation in variable sales. Results in Table 7.7 indicated that F-test was highly significant at 1% level. Based on the significant F-test, the null hypothesis that, none of the explanatory variables contributed to the model was rejected.

Table 7.7

Results of Multiple Regression Model on Pigeon Pea Sales

Social capital variables	**Coefficients**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf. Interval]**	
Dependent Variable: Volume of pigeon pea sales						
Independent Variables:						
(Constant)	-9216.448*	5228.684	-1.76	0.081	-19593.94	1161.043
Purchasing brokers	-81.3945	838.0426	-0.10	0.923	-1744.677	1581.888
Selling brokers	-205.0091	716.1615	-0.29	0.775	-1626.392	1216.373
Persons the trader could ask for loan from	282.7819	1281.274	0.22	0.826	-2260.192	2825.755
Markets in which the trader operates	2905.308	3046.31	0.95	0.343	-3140.775	8951.391
Regular buyers in trader's market	258.9637***	96.82064	2.67	0.009	66.80152	451.1259
Non-frequent buyers within trader's market	-1104.172***	421.0441	-2.62	0.010	-1939.828	-268.5159
Regular distant buyers	-401.3703	300.3117	-1.34	0.185	-997.4058	194.6652
Non-frequent distant buyers	4230.762***	818.5424	5.17	0.000	2606.182	5855.342
Distant markets trader has contacts beyond the sub-county	668.0408	815.3088	0.82	0.415	-950.1216	2286.203
Business contacts by telephone	-70.55303	163.6712	-0.43	0.667	-395.3951	254.2891
Friends in grain trade	-432.2996	555.6694	-0.78	0.438	-1535.15	670.5504
Buyers with telephone orders only	464.8328	934.8399	0.50	0.620	-1390.566	2320.231
Overall Model Fit						
R^2	0.4305					
Adj. (R^2)	0.3601					
F-ratio	6.11***					

*, *** indicated 10%, 1% significant levels, respectively

Looking at the p-values of the t-test for each explanatory variable, there are three variables among the 12 variables in the model, significantly influencing the trader's volume of sales of pigeon pea. The significant variables are regular buyers in trader's market, non-frequent local buyers in the trader's market and non-frequent distant buyers.

Result of the effect of regular buyers on the trader' performance based on the sales of pigeon pea are shown in Table 7.7. An increase in the number of regular buyers influenced significantly and positively the sales of pigeon pea at 1 percent. An increase of a regular buyer, increases the volume of sales of pigeon pea by 258.9637 kilograms. The finding was consistent with the expectation that an increase in the number of regular customers within the same market, increases the volume of sales. This could be due to reduced search costs as indicated by Gabre-Madhin (2001a), McMillan and Woodruff (1998) and Minten and Kyle (1999). Literature on social capital indicates that, regular customers reduce search costs for clients. When traders create network of clients, they can easily exchange different information from one location to another location without a need to pay for information collection process (Coleman, 1988; Fafchamps & Minten, 1999a; Fafchamps & Minten, 2002; Grootaert, 1998; Lyon, 2000; Rauch & Casella, 1998; World Bank, 2002).

Contrary to the expectation, the traders with a higher number of non-frequent buyers within the same market are significantly and negatively associated with the volume of sales of pigeon pea. Result in Table 7.7 shows that, an increase in the number of non-frequent buyers within the trader's market, significantly ($p = 0.010$) reduces the traders' volume of sales of pigeon pea by 1104.172 kilograms. The finding indicates that, the relationship between the traders' and the non-frequent customers decreases the performance of grain traders in terms of sales of pigeon pea. This probably could be because the traders willingly sold above the market price to their random customers. Non-frequent customers probably have no networks with the traders. According to Fafchamps (2006), a network was described situations in which individual agents only trust a limited number of agents they know individually.

Expectedly the coefficient of non-frequent distant buyers was positive and significant at 1 percent. The results meant that, with the increase in non-frequent distant buyers, traders increased the sales of pigeon pea by 4230.762 kilograms. A possible explanation for this would be that non-frequent distant buyers enhanced a social capital through trust, networking and relationships. This finding supported the arguments in the literature on the social capital.

According to Fafchamps (1996), Fafchamps (1997) and Fafchamps and Minten (1999), trust capital enables customers to place and take orders and provide trade credit - all features of markets that are taken for granted and which are often absent from liberalized markets in poor countries. Trust capital facilitated the access of reliable information on technology and market opportunities by the traders and customers (Barr, 1998; Barr, 2000; Greif, 1993). According to Fafchamps and Minten (2002), relationships and social networks enable agents to economize on transactions costs.

7.3.15 Effect of social capital on trader's performance in the retail-farm gate margin in green gram and pigeon pea trading

Results of the effects of social capital on market margin of green gram are shown in Table 7.8. The proportion of the variation in the market margin was explained by the explanatory variables was 17.99%. The results indicate that F-test was significant at 1% level and therefore, the model was adequate in explaining the variation in the market margin.

Table 7.8

Effect of Social Capital on Trader's Performance in The Retail-Farm Gate Margin in Green Gram Trading

Model variables	Coeffients.	Std. Err.	t	P>|t|	95% Conf. Interval	
Dependent Variable: Green gram retail-farm gate margin						
Independent Variable:						
(Constant)	11.122***	1.779	6.25	0.000	7.589	14.654
Purchasing brokers	0.165	0.285	0.58	0.565	-0.401	0.731
Selling brokers	0.375	0.244	1.54	0.127	-0.108	0.859
Persons the trader could ask for loan from	0.788*	0.436	1.81	0.074	-0.078	1.653
Markets in which the trader operates	1.215	1.037	1.17	0.244	-0.842	3.273
Regular buyers in trader's market	0.012	0.033	0.38	0.708	-0.053	0.078
Non-frequent buyers in the trader's market	-0.037	0.143	-0.26	0.798	-0.321	0.248
Regular distant buyers	-0.037	0.102	-0.37	0.716	-0.240	0.166
Non-frequent distant buyers	-0.135	0.278	-0.48	0.630	-0.688	0.418
Distant markets trader has contacts beyond the sub-county	0.311	0.277	1.12	0.265	-0.239	0.862
Business contacts by telephone	0.040	0.056	0.72	0.473	-0.070	0.151
Friends in grain trade	0.034	0.189	0.18	0.857	-0.341	0.409
Buyers with only telephone orders	-0.913***	0.318	-2.87	0.005	-1.544	-0.281
Overall Model Fit						
R^2	0.270					
Adj (R^2)	0.179					

F-ratio	2.99***

*, *** indicated 10%, 1% significant levels, respectively

According to the results showed in Table 7.8, out of 12 explanatory variables, only two contributed significantly to the gross margins. The variable on the number of persons the trader could borrow a loan contributed to the model significantly and positively. Results indicate that, an increase in the number of persons the trader could borrow a loan, increases the unit of margin of green gram significantly at 10% (p = 0.074) by 0.788. Loans are used to increase the volume of stocks. The more the sales, the greater the possibility of breaking even. However, the positive relationship is contrary to the expectation. It was expected that, since loans provide working capital to the traders, the marketing margin is negatively affected. Rehima et al. (2017) which argued that, a trader may get more profit and may be more competitive in the grain market by frequently selling a large quantity of grain. To benefit from the quantity sold, the trader may sell at a low price instead of the increasing price. The finding is also contrary to the finding of Jabbar et al. (2008) which indicates that, a working capital negatively affected the livestock market margin per cattle.

Buyers with only telephone orders of green gram have decreasing effect on the unit margin. As the number of buyers with only telephone orders increased, significantly at 1% (p = 0.005) the units of margin decreased by 0.913. Expectedly, the numbers of buyers with only telephone orders reduces significantly the market margin of green gram. This is because of unreliability of such buyers in terms of commitment to acquire and pay for the stocks as well as the transaction cost in follow ups. The finding is consistent with the finding of Rehima et al. (2017) which shows that, traders who own mobile phones reduce marketing margin. Similarly the finding of Aker (2010) indicates that mobile phones are more useful in reducing price dispersion when agricultural markets are farther apart.

The effect of the factors of social capital on traders' performance in retail margins of pigeon peas was presented in Table 7.9. Results indicated that, the multiple correlation coefficient indicated by adjusted R squared was about 1.34%. This was a proportion of variance in retail margins that was explained by the predictors. Though the F-test was not significant, there were variables contributing to the model. These variable were persons the trader could ask for loan from (-0.576*), regular buyers in trader's market (0.044*) and buyers with only telephone orders (-0.438*)

Table 7.9

Effect of Social Capital on Trader's Performance in The Retail-Farm Gate Margin in Pigeon Pea Trading

Model variables	**Coefficients.**	**Std. Err.**	**t**	**P>|t|**	**95% Conf. Interval**	
Dependent Variable: Pigeon pea retail-farm gate margin						
Independent Variables:						
(Constant)	9.999***	1.406	7.11	0.000	7.209	12.789
Purchasing brokers	0.184	0.225	0.82	0.416	-0.263	0.631
Selling brokers	-0.007	0.193	-0.04	0.969	-0.389	0.375
Persons the trader could ask for loan from	-0.576*	0.345	-1.67	0.098	-1.259	0.108
Markets in which the trader operates	0.109	0.819	0.13	0.894	-1.517	1.735
Regular buyers in trader's market	0.044*	0.026	1.70	0.092	-0.007	0.096
Non-frequent local buyers in the trader's market	-0.074	0.113	-0.65	0.516	-0.299	0.151
Regular distant buyers	-0.086	0.081	-1.07	0.287	-0.247	0.074
Non-frequent distant buyers	-0.099	0.220	-0.45	0.651	-0.537	0.337
Distant markets trader has contacts beyond the sub-county	0.216	0.219	0.99	0.326	-0.219	0.651
Business contacts by telephone	-0.018	0.044	-0.41	0.686	-0.105	0.069
Friends in grain trade	0.176	0.149	1.18	0.240	-0.120	0.473
Buyers with only telephone orders	-0.438*	0.251	-1.74	0.085	-0.937	0.061
Overall Model Fit						
R^2	0.122					
Adj (R^2)	0.013					
F-ratio	1.12^{ns}					

Note: ^{ns}, *, *** none significant and significant at 10 % and 1 %, respectively

According to results in Table 7.9, the number of persons the pigeon pea trader could ask for a loan affected negatively the market margin. Significantly at 10% level (p = 0.098), the market margin decreased by 0.5760 units as the number of persons the trader could ask for a loan increased. The finding was consistent to the expectation. It was expected that, market margin is reduced by working capital accessed through loans. The finding supports the work by Rehima et al. (2017) which revealed that, working capital has a negative and significant effect on marketing margin. Similarly Jabbar et al. (2008) found that a working capital negatively affected the livestock market margin in per cattle.

The coefficient for the variable on the number of regular buyers in trader's market shown in Table 7.9 indicated an increasing magnitude of the market margin. An increase in the number of regular buyers in trader's market, increases the market margin by 0.0442479 units at 10% significance level (p = 0.092). The effect of regular buyers on the market margin was found contrary to the expectation. It was expected that as the number of regular buyers increases, the market margin decreases because with the high number of buyers, price risk traders may sell a large quantity of grain frequently at a low price instead of high price to benefit from the quantities. Similar arguments have been stated by Jabbar et al. (2008) and Rehima et al. (2017).

As expected, buyers with only telephone orders showed decreasing influence on the market margin. Results in Table 7.9 indicated that, an increase in the number of buyers with only telephone orders, decreases the market margin by 0.437722 units at significance level of 10% (p = 0.085). The finding was consistent with the previous literature on human capital which indicate that, the grain traders who own mobile phones have reduced marketing margin. According to Rehima et al. (2017), mobiles phones facilitate the diffusion of information in grain markets. Similarly the finding by Aker (2010) indicates that mobile phones reduce price dispersion in agricultural markets which are farther apart.

7.4 Conclusion and Recommendations

Low performance of grain traders is a source of poor transformation from subsistence to sub-commercial to commercial of green gram and pigeon pea. This evidence was based on the original data on grain traders in the study areas. The characterization of the grain traders, revealed that, male slightly dominated female in the grain trading business. The majority of the traders are in the middle age scale. Most of the traders have acquired formal education at college level. According to the annual volume purchased, traders mainly stocked maize, beans, green

gram, pigeon pea, cowpeas, sorghum, dolichos and millets in that order from the highest to the lowest percentage. Green gram and pigeon pea crops are less competitive to the maize and beans in terms of stocking volume. Most of traders started trading after market liberalization (2000s) with low percentage starting before liberalization (< 1980). The traders gave variuos reasons for starting their trading after market liberation as; there was existence of the market, the trade perceived profitability and the diversity of their business activities. Analysis of degrees of market competition indicates that, few individuals (traders) handled green gram and pigeon pea commodities. Few traders accounted for high volume of purchases of green gram and pigeon pea as indicated by high Gini Coefficients. The larger the value of the Gini Coefficient, the higher the concentration and more the likelihood that the market would be imperfectly competitive. Market reforms in Kenya facilitated Traders' entry into the markets. This was indicated by higher percentages of traders who entered the markets after market reforms than before and during reforms. The market reforms reduced the entry barriers to the markets. In a perfect market, there are no barriers to firms wishing to enter or leave the market. The pattern of the market entry and exits show likelihood of barriers. Before the trader entered the market, the response to market entry by other traders was high. At the time the trader was entering the market, the response to the other traders declined. After the trader's entry the response increased slightly. The market entry therefore, remained less competitive during the time of the trader's entry and after. Among the eight alternative chains, majority of traders had chosen the chain involving farmers, rural retailers and rural consumers/farmers. The chain was found ending in rural consumers. According to the consumers in the chain, the chain is not competitive in reaching urban or export consumers. Though the traders were found performing various marketing functions, some functions were carried out by few traders and not competitive. Majority of the traders were found performing the functions of assembling and selling to consumers through retail and micro-retailers. Quality control through verification and quality which could increase the value of green gram and pigeon pea was poorly performed by the traders, making the grains less competitive in the marketing channels. The trader's performance was measured using the volume of purchase, the volume of sale and marketing margins. The study found that, some factors of social capital, human capital, physical capital, trading practices and transaction costs influenced positively and negatively the volumes of purchases and sales and the market margins of green gram and pigeon pea. In terms of green gram volume of purchase, the social capital factors which influenced the trader's performance were; the trader's selling brokers, persons the trader could ask for a loan and the trader's contacts in distant

markets beyond the sub-county. A significant increase in the volume of purchase of green gram was found when a trader increased the contacts in distant markets beyond the sub-county. It therefore meant that, the traders with more contacts in distant markets beyond the sub-county would purchase higher volume of green gram than the traders with less contacts. Higher volume of purchase would lead to more share. This would lead to imperfect markets of green gram. The traders with reduced volume of purchase of green gram due to social capital had increased number of trader's selling brokers and persons the trader could ask for a loan. There was no facilitation of exchange by the selling brokers and the persons available to offer loans to the traders. Annual working capital is a physical capital and it was important in the running of the grain business. However, as a result, the annual working capital negatively affected the volume of purchase of green gram. This means that, increasing annual working capital does not improve the performance of traders of green gram. Trading practices which increased the volume of purchase of green gram of the traders were the trader's volume of pigeon pea purchases, the trader's volume of cowpea purchases and the trader's volume of beans purchases. Stocking pigeon pea, cowpea and beans increased the volume of purchase of green gram. Therefore, stocking pigeon pea, cowpea and beans influenced the trader's performance.

In terms of pigeon pea volume of purchase, the social capital factor which influenced significantly the trader's performance was the trader's contacts in distant markets beyond the sub-county. When the traders used the contacts in distant markets, the volume of purchase of pigeon pea decreased. The negative relationship meant that, though there was increased contacts, they were not important in facilitating the exchange of pigeon pea grains. Annual working capital was used by the traders to increase the volume of purchase of pigeon pea. This was shown by the relationship between the volume of purchase and the annual working capital. The annual working capital positively affected the volume of purchased grain of pigeon pea. Increasing annual working capital for the traders can be of great value in improving their performance in the volume purchased of pigeon pea. According to the trading practices used by the traders, the evidence indicated that, traders stocked pigeon pea grains together with other grains. Green gram grains were among the grains stocked by the traders. Purchasing green gram for the stock affected the volume of purchase of pigeon pea. As the trader increased the volume of purchase of green gram for the stock, there was an increase in the volume of purchase of pigeon pea. This relationship suggests that, green gram purchase is important to the pigeon pea purchase. According to the evidence, the practice of stocking cowpea reduced the volume of

purchase of pigeon pea. The evidence suggested that, the volume purchased of cowpea is more than the volume purchased of pigeon pea. The evidence also suggested the importance of traders' reduction of the volume of purchases of cowpea in order to enhance the market exchange of pigeon pea. The trader's performance related to the sales of green gram grains was significantly affected by the social capital factors. These factors were regular buyers within the trader's market, non-frequent local buyers in the trader's market and non-frequent distant buyers. As the traders use regular buyers within the trader's market and the non-frequent distant buyers there was an increase in the volume of sales of green gram. The trader's use of non-frequent local buyers within the trader's market reduced the volume of sales of green gram grains. The social capital factors which influenced the sales of pigeon pea were the regular buyers located in the trader's market, the non-frequent buyers within trader's market and the non-frequent distant buyers. The evidence suggested that, regular buyers located in the trader's market and the non-frequent distant buyers facilitated the increase in the sales of pigeon pea. As the traders use non-frequent buyers who are within trader's market, there was reduction in the volume of sales of pigeon pea.

The marketing margin calculated for each grain trader was the difference between the purchasing and selling prices. The levels of purchasing and selling prices determine the magnitude of the trader marketing margins. For instance, wider marketing margin indicates high selling price and low purchasing price to producers. This is an indicator of market failure due to many reasons. The evidence revealed the factors of social capital influencing the marketing margin of grain traders of green gram. The factors were the persons available to the trader for a loan and the buyers with only telephone orders. The trader's use of available persons to ask for a loan widened the marketing margin. Those green gram traders having buyers with only telephone orders, reduced their marketing margins. The relationship between the pigeon pea grain trader and the persons the traders could ask for loans, adversely affected the marketing margin. The traders were probably willing to reduce the selling price or pay better price for the pigeon pea purchase to the producers than the market price. Reducing selling price and increasing purchasing price of pigeon pea absorb the customers and producers objectives. The trader's use of regular buyers within the trader's market widened the marketing margin. During the trader's use of regular buyers within the trader's market, the traders willingly increase selling price to customers or pay better purchasing price to the producers than the market price. Therefore the widened marketing margin makes the market inefficient. Buyers with only telephone orders

lowered the marketing margins of traders of pigeon pea. As social capital buyers with only telephone orders increase social network for the traders and can be of great value in providing information on better prices and links of unknown buyers with unknown sellers. The use of telephone reduces transaction costs in terms of search costs. Following the findings on the barriers to market entry, the study suggested that, there is need to encourage various traders across the age categories to enter into green gram and pigeon pea grain trading. This is in respond to market reforms which reduced the entry barriers to the markets, existence of the market and the diversity of other business activities. Regarding the degrees of market competition, there is need to encourage grain traders to increase the volumes of purchases of green gram and pigeon pea grains, making many traders instead of few to account for high volumes. The distribution of the volumes of purchases of green gram and pigeon pea among many traders would reduce the Gini Coefficients and enhancing well-functioning of markets. In terms of market structure, the study suggested organization of traders into few competitive alternative chains. There is need for short chains but ending in urban and export markets. Research is recommended to generate information on the efficient marketing chain. For the trader's marketing functions, quality control through verification and quality could increase the value of green gram and pigeon pea, making the grains more competitive in the marketing channels. The marketing functions were found limited to assembling and selling, hence there is need to increase the value-added functions.

Various factors were recommended for improving the performance of traders in terms of the volumes purchased and sold of green gram and pigeon pea and the traders' marketing margins. The findings suggested factors related to social capital, human capital, physical capital, trading practices and transaction costs on trader's performance. The recommended social capital factors for improving trader's performance in terms of adding the volume of purchase of green gram were the trader's purchasing brokers, the trader's contacts in distant markets beyond the sub-county and the trader's friends in grain trade. Though not significant, the human capital factors with adding influence and recommended for improving the volume of purchase of green gram were the trader's age, the trader's gender and the trader's experience. The trading practices factors recommended for improving the volume of purchase of green gram were the markets in which trader operate, the trader's volume of pigeon pea purchases, the trader's volume of cowpea purchases and the trader's volume of beans purchases. The study suggested variuos factors for improving a trader's performance in the volume of purchase of pigeon pea. The social

capital factors recommended for increasing the volume of purchase of pigeon were the trader's selling brokers, the persons the trader could ask for loan from, the trader's distant clients outside market, the trader's business contacts by telephone, the trader's friends in grain trade, the trader's regular distant buyers outside the market and the trader's buyers with telephone orders only. The recommended factor of physical capital with adding influence to the volume of purchase of pigeon pea was the annual working capital. The study suggested access to credit to provide annual working capital through different means, for instance through micro finance institutes and banks. Other recommended factors for improving the volume of purchase of pigeon were related to the trading practices. These factors were the markets in which trader operated and the trader's volume of green gram purchases. Various factors of social capital were suggested for improving the trader's performance in the sales of green gram. These factors showed increasing coefficients. The factors were the purchasing brokers, the persons the trader could ask for a loan, the markets in which the trader operates, the regular buyers in trader's market, the non-frequent distant buyers, the distant markets trader has contacts beyond the sub-county and the buyers with telephone orders only. Hence, the traders could strengthen their trade relationship with their customers through the social capital as a strategy to create confidence among traders, help them to reduce transaction costs, solve financial problems and to create a competitive market. The social capital factors which were recommended for improving the trader's performance in the sales of pigeon pea were the persons the trader could ask for a loan, the markets in which the trader operates, the regular buyers in trader's market, the non-frequent distant buyers, the distant markets that the trader has contacts beyond the sub-county and the buyers with telephone orders only. These factors increase social network for the traders and enhances their access to markets. The network enables traders to relate to each other in a more trustworthy manner. The increase in the retail-farm-gate margins in the green gram trading has been supported by the social capital factors, such as the purchasing brokers, the selling brokers, the persons the trader could ask for loan from, the markets in which the trader operates, the regular buyers in trader's market, the distant markets trader has contacts beyond the sub-county, the business contacts by telephone and the business contacts by telephone. This factors could lead to excess profit. However, the study suggested the social capital factors for reducing retail-farm-gate margins in green gram trading. These factors are the non-frequent buyers in the trader's market, the regular distant buyers, the non-frequent distant buyers and the buyers with only telephone orders. The social capital factors which supported the increase in the retail-farm-gate margins in the pigeon pea trading were the purchasing brokers, the markets in which the

trader operates, the regular buyers in trader's market, the distant markets trader has contacts beyond the sub-county and the friends in grain trade. However, the social capital factors recommended for reducing the retail-farm-gate margins in pigeon pea trading are the selling brokers, the persons the trader could ask for a loan, the non-frequent local buyers in the trader's market, the regular distant buyers, the non-frequent distant buyers, the business contacts by telephone and the buyers with only telephone orders.

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CHAPTER EIGHT

GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

8.1 General Discussion

8.1.1 Levels and determinants of commercialization of joint and specific green gram and pigeon pea production among the smallholder farmers

This study conceptualized agricultural commercialization as the process of increasing the proportion of agricultural production that was sold by farmers. Results indicated that the smallholder farmers in the study area could be described as subsistence, semi and fully commercialized. The process was measured using household commercialization index (HCI). A value of zero signified that, the household was totally subsistence oriented. The closer the index was to 100, the higher the degree of commercialization. This index has been used in the past literature by Agwu et al. (2012) and Martey et al. (2012) and therefore, households fell under the categories of subsistence (0 – 30%), semi-commercial (31 – 50%) and fully commercial (51 – 100%).

Results of field data analysis revealed, that, the level of commercial transformation process of joint and specific green gram and pigeon pea food crops was low at subsistence in the study area. The proportion of production that was sold was low for the joint and crop-specific green gram and pigeon pea, leading to low HCI. However, some farmers had transformed from subsistence to semi-commercial to commercial. The transformation was based on joint and crop-specific green gram and pigeon pea production in agro-ecological zone lower midland four (AEZ LM 4) and agro-ecological zone lower midland five (AEZ LM 5). Based on crop-specific green gram production, farmers in AEZ LM 5 were more transformed into semi-commercial and fully commercial than the farmers in AEZ LM 4. Therefore, it would be faster to commercialize green gram crop-specific production in AEZ LM 5 than in AEZ LM 4. For the case of pigeon pea, it would be faster to commercial the specific food crop in AEZ LM 4 than in AEZ LM 5. Joint commercialization of green gram and pigeon pea would favour farmers in AEZ LM 5 than in AEZ LM 4. Therefore, commercializing green gram and pigeon pea jointly would favour famers in AEZ LM 5 than AEZ LM 4.

Other past studies have shown that, food crops have potential of being commercialized despite subsistence. A study done by Muhammad-Lawal et al. (2014), revealed that, the highest percentage of households were in full commercialization of food crops. Farmers in fully commercialization would mean producing crops mainly for the market for income generation. Those in subsistence scale would imply producing food crops mainly for consumption. In the moderate scale (semi-commercial) would mean producing both for consumption and for sale. A study done by Mazengia (2016) in Guangua district, North-western Ethiopia, on smallholders' commercialization of maize production indicated that, more maize production was utilized at home as food and as source of seed than taken to the market.

In a joint or household (total) commercialization of green gram and pigeon pea production, the main factors, which significantly reduced the amount sold were the types of commodities and production storage facility. In this case, the category of farmers growing pigeon pea tended towards subsistence level than the category of farmers growing green gram in the study area. This was explained by the level of production specialization in each crop. Farmers specialized more in green gram than pigeon pea food crops. As farmers specialized in green gram and pigeon pea production, the production was stored either in traditional granary or in living houses. The category of farmers found storing production in living houses tended towards subsistence level than the category of farmers using traditional granary. This behaviour could have influenced by the lower capacity of storage in living houses. Despite reduction in commercialization level towards subsistence, there were factors which significantly influenced the smallholders' production transformation towards semi-commercial and fully commercial. These factors were such as agro-ecological condition, total cropped land, market price per kilogram, use of improved seeds, total livestock holding and cropping intensity. All these factors influenced the joint or total commercialization by changing the conditions of supply for green gram and pigeon pea commodities.

In a crop-specific commercialization of green gram production, the significant factor which influenced farmers to reduce commercialization and remain at subsistence level was the household head years in school. Green gram production remained at subsistence in households where the heads had higher number of years than the households where the heads had lower number of years. This could be linked to decision of the more educated household head on production and market participation issues. Despite, green gram being in subsistence level in households where the heads had higher years in school, there were factors which significantly

enhanced green gram production from semi-commercial to fully commercial. These factors were such as agro-ecological condition, total cropped land, market price per kilogram and productivity of green gram. The link between agro-ecological condition and transformation of green gram into commercial was that, farmers in agro-ecological zone lower midland five had more production than farmers in agro-ecological zone lower midland four. The link between productivity and commercial transformation was through increased production which could increase marketed surplus. In regards to the commercial levels of crop-specific pigeon pea production, the transformation was significantly affected by the total land under crops and the sizes of family and household labour. Results of ordered logit regression model estimation indicated that, as the total land under crops increased, the production was reduced towards subsistence level. This could be linked to low proportion of land under pigeon pea cultivation in the study area. Despite the subsistence behaviour of farmers due to total land under crops, this study established that, there was commercial transformation of pigeon production due to the increase in the size of the family and household labor.

The established factors affecting the commercial levels of the household and crop-specific green gram and pigeon pea supported the findings in the past literature shown by many authors. For instance, according to von Braun et al. (1994) and Jaleta et al. (2009), some of the determinants of commercialization at the household level were such as agro-climatic conditions and risk, access to infrastructure and market, resource endowment, institutions, social and cultural factors affecting consumption preferences, production and market opportunities and constraints. A study by Chirwa and Matita (2012) found that, demographic and population change, urbanization, availability of new technologies, market creation and infrastructure, trade and macroeconomic policies determined commercialization of smallholder rice farmers. According to Jagwe and Ouma (2010), the factors which significantly affected the decision of the household to participate in the market were such as commodity price, availability of family labour and geographic location of the household. Additional factors were the availability of physical and market infrastructure, age of the household head, the available farm size to the household, positive attitude of the household head toward risk (Fredriksson et al., 2017), access to land and assets, use of technology and amount of rainfall (Olwande et al., 2015).

8.1.2 Productivity and commercial levels of green gram and pigeon pea production among smallholder farmers

Based on the computation of the crop-specific and household commercialization index (HCI), productivity played an important role as the denominator. Moreover, it has been argued in the past literature that, productivity increases production (Emran & Shilpi, 2012; Wickramasinghe & Weinberger, 2013). Results showed that, farmers in fully commercial level had the highest mean productivity of green gram. The lowest mean productivity of green gram was found with subsistence farmers. Different results were found in the productivity of pigeon pea in the commercial levels. Farmers in fully commercial level had the lowest mean productivity of pigeon pea. Semi-commercial level farmers had the highest mean productivity of pigeon pea. Subsistence farmers were slightly lower in the mean productivity of pigeon pea than the semi-commercial farmers.

Based on the resource base, as the sizes of farms increased, there was an increase in the productivity of green gram and pigeon pea food crops. The findings meant that, farmers with small farm sizes had lower productivity of green gram and pigeon and therefore low production leading to subsistence behaviour. Also production risk factors in terms of agro-ecological zones caused variations in productivity of green gram and pigeon pea among farmers. For instance, agro-ecological zones enhanced the mean productivity of green gram differently in the study area. Farmers in agro-ecological zone lower midland five (AEZ LM 5) had higher productivity of green gram than farmers in agro-ecological zone lower midland four (AEZ LM 4). For the case of pigeon pea, the highest productivity was found with the farmers in AEZ LM 4. These findings implied that farmers in AEZ LM 4 were more likely to increase pigeon pea productivity than farmers in AEZ LM 5. The possibility of increasing green gram productivity was higher in AEZ LM 5 than AEZ LM 4.

The role of agricultural commercialization for smallholders' productivity has been emphasized in the literature by many past authors. For instance, Strasberg et al. (1999) and Tirkaso (2013) found that, household agricultural commercialization, generally had a significant and positive effect on food crop fertilizer use and productivity in Kenya. A study by Ochieng et al. (2016), showed a positive effect of commercialization on improved seed varieties use and food crop yields. While commercial levels might explain the productivity variations among farmers, the observed differences due to agro-ecological zones supported other authors in the literature.

Based on the literature, for instance agro-ecological zones affected productivity of food crops through input use (Strasberg et al., 1999) and risk factors (Arias et al., 2013),

Multiple linear regression model estimated productivity differences among farmers of green gram and pigeon pea food crops. The model established significant factors for increasing green gram productivity such as education level of household head, use of improved seed, production specialization, commercialization and ox-cart ownership. The factors which were found useful in increasing pigeon pea productivity were gender of household head and use of improved seed. Various empirical studies pointed out that, productivity increase could be gained via intensified use of inputs. For instance Bekele et al. (2010) found that the use of inputs such as fertilizer, pesticides and seeds or by efficient reallocation of resources increased productivity.

8.1.3 Effects of productivity and output retention on size of marketed surplus of green gram and pigeon production among smallholder farmers

Marketed surplus was the amount of production of green gram and pigeon pea that had entered the market. According to multiple linear regression model, the factors which significantly increased the amount of green gram production sold were farm size, productivity of green gram, retention for seed and given away and production agro-ecological condition. Any effort to raise the amount of green gram production that had entered the market would consider these factors. The category of farmers which lacked market information had lower amount of green gram production marketed than the category of farmers which accessed the information. Therefore, improving the access to market information would enable farmers to increase green gram production entering the market. For the farmers to increase the amount of pigeon pea production marketed, there would be increased production retained for seed and higher market price of output. These factors significantly increased pigeon pea production that was marketed.

Past studies on the commercialization function indicated that, a higher marketed surplus would help farmers to participate in a high value markets to increase their level of income. According to Pradhan et al. (2010), the process of increasing the proportion of agricultural production that was sold by farmers would be referred as agricultural commercialization. Martey et al. (2012) indicated that, with increased marketed surplus, agricultural commercialization could occur. However, past studies on the marketed surplus function indicated various factors at the producer level which affected marketed surplus of various crops. According to Kaur and Gupta (2017), improvement in the crop yield would increase the level of production which in turn could

increase the extent of marketed surplus. Therefore, according to the literature, attempts to improve the yield of green gram and pigeon pea would increase the marketed surplus.

8.1.4 Assessing the factors affecting market performance in commercializing small farms focusing on green gram and pigeon production

This study examined the market performance as a function of concentration, market size, integration and institutional setting. Looking at the gender of grain traders, both males and females participated in the markets of green gram and pigeon pea. Women dominated in the grain markets at the age categories of less than 30 and 31-40 years. In the older age categories, men dominated in the grain markets. In terms of education, the highest percentage of traders had reached college level. Most of the traders had entered the grain markets after the market liberalization (2000s). The main commodities stocked by the grain traders in order of volume purchased from highest to the smallest were maize, beans, green gram, pigeon pea, cowpeas, sorghum, dolichos and millets. Market concentration reflected the degree of competition in the markets of green gram and pigeon pea. According to the results market concentration was high leading to imperfect type of competition. An increased market concentration represented a high level of lack of competition leading to few participants dominating the markets for green gram and pigeon pea purchases.

According to the multiple linear regression model, the factors which significantly reduced the volume of green gram purchased by traders were trader's selling brokers, persons the trader could ask for loan from and annual working capital. The factors which significantly increased the volume of green gram purchased were trader's contacts in distant markets beyond the sub-county, trader's volume of pigeon pea purchased, trader's volume of cowpea purchased and trader's volume of beans purchased. The factors which significantly influenced traders to reduce the volume of pigeon pea purchased were the trader's contacts in distant markets beyond the sub-county and trader's volume of cowpea purchased. The factors which showed significant increase in the volume of pigeon pea purchased were annual working capital and trader's volume of green gram purchased.

Past studies in the literature indicated that, market concentration measured the proportion of the total market share accounted for by the top largest firms in an industry and it is a function of the number of firms and their respective shares of the total production or sales. According to Margetts (2006), market concentration is an important determinant of conduct and performance

and therefore the type of competition. Arias et al. (2013) indicated that, low volumes transacted cause many local food markets to be volatile limiting the market's ability to modify demand and/or supply side shocks. Volatility can affect the level and riskiness of returns to the producer.

8.2 Conclusions

There were three types of farmers based on the household commercialization index (HCI). These types of farmers were subsistence, semi-commercial and fully commercial. Small farmers were reluctant to commercialize green gram and pigeon pea because they needed to be sure of their food security and therefore, subsistence-oriented production. Mainly subsistence-oriented production was contributed by low productivity leading to low production and therefore low marketed surplus. Focusing on the green gram and pigeon pea in the household commercial transformation process would mean increasing productivity and marketed surplus. The study established factors for raising productivity of green gram were the education level of household head, use of improved seed, green gram production specialization index and ownership of ox-cart. The factors for raising pigeon pea productivity were gender of household head and use of improved seed. Raising marketed surplus of green gram depended on productivity of green gram, retention for seed and given away and market price of output. The factors which showed increase in the marketed surplus of pigeon pea were retention for consumption, retention for seed and given away and market price of output. Raising of productivity and marketed surplus would depend on competitive structure of the market. This study established that, local green gram and pigeon pea production markets lacked competition as shown by the high degree of market concentration determined by the share of purchases. The grain traders of green gram and pigeon pea who had significantly increased the volume purchased were due to trader's contacts in distant markets beyond the sub-county, trader's volume of pigeon pea purchased, trader's volume of cowpea purchased and trader's volume of beans purchased. Grain traders of pigeon pea significantly increased the volume purchased due to the increase in annual working capital and trader's volume of green gram purchased. In terms of decrease in the sizes of grains purchased of green gram and pigeon pea, traders were influenced by various factors. For instance, traders reduced the volumes of green gram grains due to trader's selling brokers, persons the trader could ask for loan from and annual working capital. Volumes of pigeon pea grains purchased were reduced due to trader's contacts in distant markets beyond the sub-county, trader's volume of green gram purchased and trader's volume of cowpea purchased. It was therefore, reasonable to conclude at least that, lack of competition in the market of green gram

and pigeon pea grains could have indirectly influenced traders to reduce their purchasing sizes and, market integration. Reduced sizes purchased and market integration could lead to disincentives to small farmers and therefore lowering productivity and marketed surplus.

8.3 Recommendations

Policy recommendations were drawn from the results. Since small farmers were found in subsistence, semi-commercial and fully commercial levels of commercialization, a policy was recommended to reduce the disparities and facilitate smallholders' transformation from subsistence to more specialized and market-oriented systems. The established important pathways for increasing household commercialization index were raising productivity, marketed surplus and improving market performance. However, various policies were recommended to complement these effects focusing on green gram and pigeon pea production. For instance policies designed to increase small farm commercialization through productivity-enhancing technology packages. Research policies for generating improved varieties of green gram and pigeon pea and also institutional for enhancing extension programs were recommended. Productivity could also be enhanced through the policies designed to support extension programs in the promotion of use of pesticides and fungicides. Since market prices of green gram and pigeon pea outputs were found to be positively related to marketed surplus, a price policy was recommended to stimulate households to increase production and sell excess (surplus). Observations of grains traders' markets indicated higher concentration measures which represented higher levels of lack of competition for both green gram and pigeon pea production. The findings indicated that, few large traders dominated the markets and therefore a market improvement policy was recommended to increase investments by small traders to promote co-existence.

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1. APPENDICES

1. Appendix A

Questionnaires

A1. Questionnaire on household crop production systems survey

Section 01: Geographical Information

Q1. County Q2. District (sub-county) Q3. Location Q4. Sub-Location Q5. Village	_____ _____ _____ _____ _____	
Q6. Agro-ecological Zone *(1 = LM4; 0= LM5)* _____		
Q7. GPS coordinates (UTM):	S: _____ E: _____	
Q8. Altitude (m)	[__ __ __ • __]	

Section 02: Household Respondent and Type Ideal respondent: household head and/or spouse.

Main respondent: Q1. Sex (1=Male, 2=Female) [__ __] Q2. Age (in Years) [__ __] Q3. Educational level (completed years) [__ __]	
Q4. Is the respondent the head of the household? (*1=YES, 0=NO*) [__ __]	
Q5. If NO, what is the relationship of main respondent to household head? *(1=Spouse, 0=Child)*	[__ _]
Q6. Household type (1=Male headed, 0=Female headed)	[__ _]

Section 03: Demography

We would like to know about you and your household. Can you please tell us about all the members of your household currently living with you in this household, starting with the household head?

	Q1.Sex of household member *(1= Male; 0 = Female)*	Q2.Age of the household member (years)	Q3.Education (completed years of formal school)	Q4.Primary occupation of this person (1=farming, 2=trading, 3=employment, 4= Other (specify)_____
01	[__ __]	[__ __]	[__ __]	[__ __]
02	[__ __]	[__ __]	[__ __]	[__ __]
03	[__ __]	[__ __]	[__ __]	[__ __]
04	[__ __]	[__ __]	[__ __]	[__ __]
05	[__ __]	[__ __]	[__ __]	[__ __]
06	[__ __]	[__ __]	[__ __]	[__ __]
07	[__ __]	[__ __]	[__ __]	[__ __]
08	[__ __]	[__ __]	[__ __]	[__ __]
09	[__ __]	[__ __]	[__ __]	[__ __]
10	[__ __]	[__ __]	[__ __]	[__ __]
11	[__ __]	[__ __]	[__ __]	[__ __]
12	[__ __]	[__ __]	[__ __]	[__ __]
13	[__ __]	[__ __]	[__ __]	[__ __]
14	[__ __]	[__ __]	[__ __]	[__ __]

Section 04: Tenure & Land Use

Section 4.1: Land Tenure

In this section, we want to gather information about the land that the Household head or his/her spouse owns and/or uses.

	Land 1	Land 2	Land 3	Land 4	Land 5

Q1. How far from the homestead *(km)*?	[____]	[____]	[____]	[____]	[____]
Q2. Total farm size *(acres)*	[____]	[____]	[____]	[____]	[____]
Q3. Cropped farm size *(acres)*	[____]	[____]	[____]	[____]	[____]
Q4. Who owns the piece of land (1=family, 2=borrowed, 3=rented in)	[____]	[____]	[____]	[____]	[____]
Q5. If you own the piece of land, what is the tenure situation that you have over the piece of land? (1=holds a formal title, 2=no formal)	[____]	[____]	[____]	[____]	[____]
Q6. If rented in, what is the monthly rent (KES)?	[____]	[____]	[____]	[____]	[____]
Q7. For how long (years), have you been using this piece of land?	[____]	[____]	[____]	[____]	[____]
Q8. Have you ever used this land as collateral for obtaining a loan? *(1= YES, 0 = NO)*	[____]	[____]	[____]	[____]	[____]

Section 4.2: Crop Production Systems

We want to collect information on crop production systems used in your cropped pieces of lands.

Section 4.2.1: Information for October 2011 Short Rains Season

Crop production systems	Land 1	Land 2	Land 3	Land 4	Land 5
Dominant Crop					
Q1. Area under dominant crop (acres)	[____]	[____]	[____]	[____]	[____]
Q2. Name of crop	[____]	[____]	[____]	[____]	[____]
Q3. Name of variety	[____]	[____]	[____]	[____]	[____]
Q4. Quantity of seed planted	[____]	[____]	[____]	[____]	[____]
Q5. Units (kg, 2 kg packet, 2 kg Gorogoro, other specify_____	[____]	[____]	[____]	[____]	[____]
Q6. Source of seeds (1=own seed, 2=farmer/neighbour, 3=KARI,	[____]	[____]	[____]	[____]	[____]

4=stockist/agent, 5=NGO/CBO, 6=GoK, 7=other specify_____					
First Minor Crop					
Q7. Area under first minor crop (acres)	[____]	[____]	[____]	[____]	[____]
Q8. Name of crop	[____]	[____]	[____]	[____]	[____]
Q9. Name of variety	[____]	[____]	[____]	[____]	[____]
Q10. Quantity of seed planted	[____]	[____]	[____]	[____]	[____]
Q11. Units (kg, 2 kg packet, 2 kg Gorogoro, Other specify_____	[____]	[____]	[____]	[____]	[____]
Q12. Source of seeds (1=own seed, 2=farmer/neighbour, 3=KARI, 4=stockist/agent, 5=NGO/CBO, 6=GoK, 7=other specify_____	[____]	[____]	[____]	[____]	[____]
Second Minor Crop					
Q13. Area under second minor crop (acres)	[____]	[____]	[____]	[____]	[____]
Q14. Name of crop	[____]	[____]	[____]	[____]	[____]
Q15. Name of variety	[____]	[____]	[____]	[____]	[____]
Q16. Quantity of seed planted	[____]	[____]	[____]	[____]	[____]
Q17. Units (kg, 2 kg packet, 2 kg Gorogoro, other specify_____	[____]	[____]	[____]	[____]	[____]
Q18. Source of seeds (1=own seed, 2=farmer/neighbour, 3=KARI, 4=stockist/agent, 5=NGO/CBO, 6=GoK, 7=other specify_____	[____]	[____]	[____]	[____]	[____]
Third Minor Crop					
Q19. Area under second minor crop (acres)	[____]	[____]	[____]	[____]	[____]
Q20. Name of crop	[____]	[____]	[____]	[____]	[____]
Q21. Name of variety	[____]	[____]	[____]	[____]	[____]
Q22. Quantity of seed planted	[____]	[____]	[____]	[____]	[____]
Q23. Units (kg, 2 kg packet, 2 kg	[____]	[____]	[____]	[____]	[____]

Gorogoro, other specify_____					
Q24. Source of seeds (1=own seed, 2=farmer/neighbour, 3=KARI, 4=stockist/agent, 5=NGO/CBO, 6=GoK, 7=other specify_____	[____]	[____]	[____]	[____]	[____]
Animal Manure					
Q25. Quantity applied	[____]	[____]	[____]	[____]	[____]
Q26. Units ((10 kg bag, 25 kg bag, 50 kg bag, 90 kg bag, ox-cart, 2 kg Gorogoro, 7=other specify_____)	[____]	[____]	[____]	[____]	[____]
Chemical fertilizers					
Q27. Quantity applied at planting	[____]	[____]	[____]	[____]	[____]
Q28. Units (2 kg packet, 50 kg bag)	[____]	[____]	[____]	[____]	[____]
Q29. Quantity applied at top dressing	[____]	[____]	[____]	[____]	[____]
Q30. Units (2 kg packet, 50 kg bag)	[____]	[____]	[____]	[____]	[____]
Chemical pesticides					
Q31. Quantity applied	[____]	[____]	[____]	[____]	[____]
Q32. Units (100 milliliters, 200 milliliters)	[____]	[____]	[____]	[____]	[____]
Chemical fungicides					
Q33. Quantity applied	[____]	[____]	[____]	[____]	[____]
Q34. Units (100 milliliters, 200 milliliters)	[____]	[____]	[____]	[____]	[____]
Labour from household					
Ploughing:					
Q35. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q36. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q37. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Planting:					
Q38. Number of people from	[____]	[____]	[____]	[____]	[____]

household involved					
Q39.Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q40.Number of hours per day	[____]	[____]	[____]	[____]	[____]
Weeding					
Q41.Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q42. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q43. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Manure application					
Q44. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q45. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q46. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Fertilizer application					
Q47. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q48. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q49. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Pest control					
Q50. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q51. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q52. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Harvesting					
Q53. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q54. Number of days spent on this	[____]	[____]	[____]	[____]	[____]

activity					
Q55. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Hired labour					
Ploughing					
Q56. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q57. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q58. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q59. Amount paid per person per day in cash equivalent (Kes)	[____]	[____]	[____]	[____]	[____]
Planting					
Q60. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q61. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q62. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q63. Amount paid per person per day in cash equivalent (Kes)	[____]	[____]	[____]	[____]	[____]
Weeding					
Q64. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q65. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q66. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q67. Amount paid per person per day in cash equivalent (Kes)	[____]	[____]	[____]	[____]	[____]
Manure application					
Q68. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q69. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q70. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q71. Amount paid per person per day in cash equivalent (Kes)	[____]	[____]	[____]	[____]	[____]
Fertilizer application					

Q72. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q73. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q74. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q75. Amount paid per person per day in cash equivalent (Kes)	[____]	[____]	[____]	[____]	[____]
Pest control					
Q76. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q77. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q78. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q79. Amount paid per person per day in cash equivalent (Kes)	[____]	[____]	[____]	[____]	[____]
Harvesting					
Q80. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q81. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q82. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q83. Amount paid per person per day in cash equivalent (Kes)	[____]	[____]	[____]	[____]	[____]

Section 4.2.2: Information for April 2012 Long Rains Season

Crop production systems	Land 1	Land 2	Land 3	Land 4	Land 5
Dominant Crop					
Q1. Area under dominant crop (acres)	[____]	[____]	[____]	[____]	[____]
Q2. Name of crop	[____]	[____]	[____]	[____]	[____]
Q3. Name of variety	[____]	[____]	[____]	[____]	[____]
Q4. Quantity of seed planted	[____]	[____]	[____]	[____]	[____]
Q5. Units (kg, 2 kg packet, 2 kg Gorogoro, other specify_____	[____]	[____]	[____]	[____]	[____]

Q6. Source of seeds (1=own seed, 2=farmer/neighbour, 3=KARI, 4=stockist/agent, 5=NGO/CBO, 6=GoK, 7=other specify_____	[____]	[____]	[____]	[____]	[____]
First Minor Crop					
Q7. Area under first minor crop (acres)	[____]	[____]	[____]	[____]	[____]
Q8. Name of crop	[____]	[____]	[____]	[____]	[____]
Q9. Name of variety	[____]	[____]	[____]	[____]	[____]
Q10. Quantity of seed planted	[____]	[____]	[____]	[____]	[____]
Q11. Units (kg, 2 kg packet, 2 kg Gorogoro, Other specify_____	[____]	[____]	[____]	[____]	[____]
Q12. Source of seeds (1=own seed, 2=farmer/neighbour, 3=KARI, 4=stockist/agent, 5=NGO/CBO, 6=GoK, 7=other specify_____	[____]	[____]	[____]	[____]	[____]
Second Minor Crop					
Q13. Area under second minor crop (acres)	[____]	[____]	[____]	[____]	[____]
Q14. Name of crop	[____]	[____]	[____]	[____]	[____]
Q15. Name of variety	[____]	[____]	[____]	[____]	[____]
Q16. Quantity of seed planted	[____]	[____]	[____]	[____]	[____]
Q17. Units (kg, 2 kg packet, 2 kg Gorogoro, other specify_____	[____]	[____]	[____]	[____]	[____]
Q18. Source of seeds (1=own seed, 2=farmer/neighbour, 3=KARI, 4=stockist/agent, 5=NGO/CBO, 6=GoK, 7=other specify_____	[____]	[____]	[____]	[____]	[____]
Third Minor Crop					
Q19. Area under second minor crop (acres)	[____]	[____]	[____]	[____]	[____]
Q20. Name of crop	[____]	[____]	[____]	[____]	[____]
Q21. Name of variety	[____]	[____]	[____]	[____]	[____]

Q22. Quantity of seed planted	[____]	[____]	[____]	[____]	[____]
Q23. Units (kg, 2 kg packet, 2 kg Gorogoro, other specify_____	[____]	[____]	[____]	[____]	[____]
Q24. Source of seeds (1=own seed, 2=farmer/neighbour, 3=KARI, 4=stockist/agent, 5=NGO/CBO, 6=GoK, 7=other specify_____	[____]	[____]	[____]	[____]	[____]
Animal Manure					
Q25. Quantity applied	[____]	[____]	[____]	[____]	[____]
Q26. Units ((10 kg bag, 25 kg bag, 50 kg bag, 90 kg bag, ox-cart, 2 kg Gorogoro, 7=other specify_____)	[____]	[____]	[____]	[____]	[____]
Chemical fertilizers					
Q27. Quantity applied at planting	[____]	[____]	[____]	[____]	[____]
Q28. Units (2 kg packet, 50 kg bag)	[____]	[____]	[____]	[____]	[____]
Q29. Quantity applied at top dressing	[____]	[____]	[____]	[____]	[____]
Q30. Units (2 kg packet, 50 kg bag)	[____]	[____]	[____]	[____]	[____]
Chemical pesticides					
Q31. Quantity applied	[____]	[____]	[____]	[____]	[____]
Q32. Units (100 milliliters, 200 milliliters)	[____]	[____]	[____]	[____]	[____]
Chemical fungicides					
Q33. Quantity applied	[____]	[____]	[____]	[____]	[____]
Q34. Units (100 milliliters, 200 milliliters)	[____]	[____]	[____]	[____]	[____]
Labour from household					
Ploughing:					
Q35. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q36. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q37. Number of hours per day	[____]	[____]	[____]	[____]	[____]

Planting:					
Q38. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q39.Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q40.Number of hours per day	[____]	[____]	[____]	[____]	[____]
Weeding					
Q41.Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q42. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q43. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Manure application					
Q44. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q45. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q46. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Fertilizer application					
Q47. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q48. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q49. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Pest control					
Q50. Number of people from household involved	[____]	[____]	[____]	[____]	[____]
Q51. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q52. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Harvesting					
Q53. Number of people from	[____]	[____]	[____]	[____]	[____]

household involved					
Q54. Number of days spent on this activity	[____]	[____]	[____]	[____]	[____]
Q55. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Hired labour					
Ploughing					
Q56. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q57. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q58. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q59. Amount paid per person per day in cash equivalent (KES)	[____]	[____]	[____]	[____]	[____]
Planting					
Q60. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q61. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q62. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q63. Amount paid per person per day in cash equivalent (KES)	[____]	[____]	[____]	[____]	[____]
Weeding					
Q64. Number of people hired	[____]	[____]	[____]	[____]	[____]
Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q65. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q66. Amount paid per person per day in cash equivalent (KES)	[____]	[____]	[____]	[____]	[____]
Manure application					
Q67. Number of people hired	[____]	[____]	[____]	[____]	[____]
Q68. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]
Q69. Number of hours per day	[____]	[____]	[____]	[____]	[____]
Q70. Amount paid per person per day	[____]	[____]	[____]	[____]	[____]

in cash equivalent (KES)						
Fertilizer application						
Q71. Number of people hired	[____]	[____]	[____]	[____]	[____]	
Q72. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]	
Q73. Number of hours per day	[____]	[____]	[____]	[____]	[____]	
Q74. Amount paid per person per day in cash equivalent (KES)	[____]	[____]	[____]	[____]	[____]	
Pest control						
Q75. Number of people hired	[____]	[____]	[____]	[____]	[____]	
Q76. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]	
Q77. Number of hours per day	[____]	[____]	[____]	[____]	[____]	
Q78. Amount paid per person per day in cash equivalent (KES)	[____]	[____]	[____]	[____]	[____]	
Harvesting						
Q79. Number of people hired	[____]	[____]	[____]	[____]	[____]	
Q80. Number of days worked by the hired labour	[____]	[____]	[____]	[____]	[____]	
Q81. Number of hours per day	[____]	[____]	[____]	[____]	[____]	
Q82. Amount paid per person per day in cash equivalent (KES)	[____]	[____]	[____]	[____]	[____]	

Section 4.2.3: Main Constraints to Green gram and Pigeon pea production

For each season, identify and rank the four (4) most important constraints to production of green grams and pigeon peas?

		October 2011 Short Rains Season		April 2012 Long Rains Season	
	Q1. Constraint	Q2. Identify	Q3. Rank (use 1= Most	Q4. Identify	Q5. Rank (use 1= Most

		(*tick*)	important)	(*tick*)	important)
01	Inadequate rains	[____]	[____]	[____]	[____]
02	Late rains	[____]	[____]	[____]	[____]
03	Pests	[____]	[____]	[____]	[____]
04	Diseases	[____]	[____]	[____]	[____]
05	Low soil fertility	[____]	[____]	[____]	[____]
06	Late planting	[____]	[____]	[____]	[____]
07	Lack of labour	[____]	[____]	[____]	[____]
08	Poor seed quality	[____]	[____]	[____]	[____]
09	Lack of fertilizer application	[____]	[____]	[____]	[____]
10	Lack of manure application	[____]	[____]	[____]	[____]
11	Other specify_____	[____]	[____]	[____]	[____]

Section 5: Disposal of produce of Green gram and Pigeon pea in October 2011 long and April 2012 Short rains Seasons

	Green gram			Pigeon pea
Production Disposals	October 2011 Long rains season	April 2012 Short rains season	Total	April 2012 Short rains season
Q1. Quantity harvested (kgs)	[____]	[____]	[____]	[____]
Q2. Quantity Consumed in the Household (kgs)	[____]	[____]	[____]	[____]
Q3. Quantity sold (kgs)	[____]	[____]	[____]	[____]
Q4. Quantity lost at postharvest (kgs)	[____]	[____]	[____]	[____]
Q5. Quantity reimbursed (kgs)	[____]	[____]	[____]	[____]
Q6. Quantity given away as gifts/donations (kgs)	[____]	[____]	[____]	[____]
Q7. Quantity used to feed animals (kgs)	[____]	[____]	[____]	[____]
Q8. Quantity kept as seeds (kgs)	[____]	[____]	[____]	[____]
Q9. Farm gate price per unit (kes)	[____]	[____]	[____]	[____]
Q10. Market price per unit (kes)	[____]	[____]	[____]	[____]

Section 6: Environmental Elements

Section 6.1: Household Assets

Q1. Do you have storage structures in your homestead? (*1= YES, 0= NO*) [____]

Q2. What types of household assets do you own? (*fill the table below*)

	Q1. Household asset	Q2. Total Number
01	Cattle	[____]
02	Oxen	[____]
03	Ploughs	[____]
04	Ox/donkey carts	[____]
05	Sprayers	[____]
06	Wheel barrows	[____]
07	vehicles	[____]
08	Bicycles	[____]
09	Tractors	[____]
10	Radio	[____]
11	Mobile phones	[____]
12	Televisions	[____]

Section 6.2: Access to Information

Section 6.2.1: Source of Information

Where do farmers get their information about agricultural practices?

Q1. Practices		Q2. Sources of information (tick the sources of information that apply)		
01	Improved varieties of green gram and pigeon peas	[_]Did not get any information	[_]Barazas	[_]Newspaper
		[_]Government extension service	[_]Seed traders/Agrovets	[_]Radio
		[_]Farmer Coop or groups	[_]Neighbour/other farmers	[_]TV
		[_]NGOs	[_]Research Centre	[_]Cell phone
		[_]Field days	[_]School	

02	Field pest and disease control	[_]Did not get any information [_]Government extension service [_]Farmer Coop or groups [_]NGOs [_]Field days	[_]Barazas [_]Seed traders/Agrovets [_]Neighbour/other farmers [_]Research Centre [_]School	[_]Newspaper [_]Radio [_]TV [_]Cell phone
03	Agronomy of green grams and pigeon peas	[_]Did not get any information [_]Government extension service [_]Farmer Coop or groups [_]NGOs [_]Field days	[_]Barazas [_]Seed traders/Agrovets [_]Neighbour/other farmers [_]Research Centre [_]School	[_]Newspaper [_]Radio [_]TV [_]Cell phone
04	Storage of green grams and pigeon peas	[_]Did not get any information [_]Government extension service [_]Farmer Coop or groups [_]NGOs [_]Field days	[_]Barazas [_]Seed traders/Agrovets [_]Neighbour/other farmers [_]Research Centre [_]School	[_]Newspaper [_]Radio [_]TV [_]Cell phone
05	Market information	[_]Did not get any information [_]Government extension service [_]Farmer Coop or groups [_]NGOs [_]Field days	[_]Barazas [_]Seed traders/Agrovets [_]Neighbour/other farmers [_]Research Centre [_]School	[_]Newspaper [_]Radio [_]TV [_]Cell phone

Section 6.2.2: Quality of Information

Information about perception by farmers of quality of information received

	Q1. Source	Q2. Satisfaction level				
		Very satisfied	Satisfied	Dissatisfied	Very dissatisfied	Do not know
01	Government extension service	[__]	[__]	[__]	[__]	[__]
02	Farmer Coop or groups	[__]	[__]	[__]	[__]	[__]
03	NGOs	[__]	[__]	[__]	[__]	[__]
04	Field days	[__]	[__]	[__]	[__]	[__]
05	Barazas	[__]	[__]	[__]	[__]	[__]
06	Seed traders/agrovets	[__]	[__]	[__]	[__]	[__]
07	Neighbours/other farmers	[__]	[__]	[__]	[__]	[__]
08	Research Centre	[__]	[__]	[__]	[__]	[__]
09	School	[__]	[__]	[__]	[__]	[__]
10	Newspaper	[__]	[__]	[__]	[__]	[__]
11	Radio	[__]	[__]	[__]	[__]	[__]
12	TV	[__]	[__]	[__]	[__]	[__]
13	Cell phone	[__]	[__]	[__]	[__]	[__]

Section 6.3: Access to Credit and Rural Finance

Q1. Did you receive any cash (formal and informal) credit for OCTOBER 2011 and/or APRIL 2012 crop season for crop production? (*1=YES, 0=NO*) [____]

Q2. If No to Question 1, please give the main reason? (1= No need for credit, 2= Borrowing is risky, 3= interest rate is high, 4= Too much paper work, 5= Expected to be rejected, so did not try it, 6= I have no asset for collateral, 7= No money lenders in this area for this purpose, 8=

Lenders do not provide the amount needed, 9= No credit association available, 10= Other specify) [____][____][___]

Q3. If Yes to Question 1, please give the main details of the purposes? (1= Buy seeds, 2= Buy fertilizer, 3= Buy herbicides and pesticides, 4= Farm equipment/Implements, 5= Invest in transport (bicycle, etc), 6= Buy oxen for traction, 7= Buy other livestock, 8= Invest in irrigation, 9= Non-farm business or trade, 10= To pay land rent, 11= Buy food, 12= School fees, sheets and uniform) [____][____][____]

Q4. If Yes to Question 1, please give the main details in the table below:

Season	Source (Code A)	Amount (Kes)	What collateral was used, if any? (Code B)
October 2011 Short Rains Season	[____]	[____]	[____]
APRIL 2012 Long Rains Season	[____]	[____]	[____]
Code A		Code B	
Money lender Farmer group/coop Merry go round Microfinance Bank SACCO Relative Other specify_____		01.No collateral 02. Land 03. Livestock 04. Group Assurance 05 Other specify _____	

Section 6.4: Social Capital

Section 6.1.1: Membership in Farmer and Community groups

In this section, we want to collect information on groups that you are involved with, in the last 3 years

	Q1.Type of group	Tick
01	Produce marketing	[____]
02	Input access/marketing	[____]
03	Seed production	[____]
04	Farmer research group	[____]
05	Savings and credit	[____]
06	Tree planting and nurseries	[____]
07	Soil and water conservation	[____]
08	Input credit	[____]
09	Other specify_____	[____]

Section 6.4.2: Collective Action

Q1. In the last 12 months, did you participate in collective action? (*1=YES, 0=NO*)

Q2. If yes, how often? (1= once, 2= 2-6 times in total, 3= 7-11 times in total, 4= once a month, 5= once a week

Q3. If yes, what type of collective activity? [____]

Section 6.5: Access to Infrastructure and Service

Here, we want to learn about the access to infrastructure and services

	Q1. Infrastructure/service	Q2. Distance (km)	Q3. Usual means of transport (Code A)	Q4. Time (hours), dry season	Q5. Time (hours) rainy season
01	Local trading centre	[____]	[____]	[____]	[____]

02	Major trading centre	[____]	[____]	[____]	[____]
03	Agricultural offices	[____]	[____]	[____]	[____]
04	Nearest paved road	[____]	[____]	[____]	[____]

Code A: 1= Walking, 2= Bicycle, 3= Car, 4=Motorbike, 5= Matatu, 6= Combination of walking and public transport, 7= Other specify_____

A2. Questionnaire on traders

Section A: Market Functions and Institutions

A1. Name of the market _____A2. Sub-County: _____A3. Location:_____

A4. Business classification: Wholesaler [____]? or Retailer [____]? (Tick One Category)

A5. Number of traders in your business classification identified above in this market [_____]

A6. Number of brokers for purchasing green grams, cowpeas and pigeon peas in the market [_____]

A7. Number of brokers for selling green grams, cowpeas and pigeon peas in the market [_____]

A8. Trader (owner) Telephone number _____A9. Gender _____

A10. Age of the trader (Years) _____A11. Highest level of education (schooling of trader (years) 0= No formal education, 1=Primary, 2= Secondary, 3= Tertiary college, 4=University, 5=others (specify) __

A12. Marriage status of the trader? 1=single, 2=married, 3=divorced, 4=Widower, 5=widow, 6=other specify

A13. Name of the business manager _____Tel number _____A14. Gender _____

A15. What is your relationship with the owner of business (trader)? [_____] 1=No relationship

2=wife, 3=husband, 4=son, 5=daughter, 6=brother, 7=sister, 8=other (specify) _____

A16. Age of the respondent (Years) _____A17. Highest level of education (schooling of respondent) (years) 0= No formal education, 1=Primary, 2= Secondary, 3= Tertiary college, 4=University, 5=others (specify) __

A18. Where is the location of your business? 1= market centre, 2= outskirts of the market

A19. Currently, are you the sole owner of the business? 1=yes, 0=otherwise [_____]

A20. Are you the sole owner and the manager of the business? 1=yes, 0=otherwise [_____]

A20.1. if otherwise what types of business arrangement? 1=partnership, 2=family, 3=consumer corporative group, 4=registered company, 5=other (specify) _____

A21. Are you the owner but with other business? 1=yes, 0=otherwise [_____]

A22. Other occupation than grains trade? 1=yes, 0 = otherwise

A23. Market entrants and exits? (Fill the table below)

Entrant and Exits	Numbers
A23.1. Which year did you start your grains business- Business age/experience (years) - (years operating this business)? (State year)	
A23.2. How many grain traders entered the market in the SAME year with you?	
A23.3. How many grain traders entered the market before you?	
A23.4. How many grain traders entered the market after you?	
A23.5. How many grain traders who entered the market in the same year with you, have exited from the market?	
A23.6. How many grain traders who entered the market before you have exited from the market?	
A23.7. How many grain traders who entered the market after you have exited from the market?	

A24. What types of grains did you market in 2013? What fraction of your grain business (in terms of value, KES) does each of the following commodity represent?

Commodity name	1.Types of grains marketed 1=yes, 0=otherwise	2.In view of the TOTAL revenue generated, indicate the share of each commodity
A24.1 Green grams		
A24.2 Cowpeas		
A24.3 Pigeon peas		
A24.4 Beans		
A24.5 Dolichos		
A24.6 maize		
A24.7 sorghum		
A24.8 millets		

A25. How did you decide which commodity in the above table to market?

Commodity name	Decision on which commodity to market (Codes)
A25.1 Green gram	
A25.2 cowpeas	
A25.3 pigeon pea	
A25.4 beans	
A25.5 dolichos	
A25.6 maize	
A25.7 Sorghum	
A25.8 millets	
A25.9 others	

Codes: 1=produced within the location, 2= produced within the sub-county, 3= many distributors, 4=low purchasing price, 5=many consumers, 6=achieve expected selling price within short duration, 7= less storage costs, 8=few competitors in the market, 9=government incentives. 10=other (specify) ____

A26. Approximately, how many kilograms of green grams, cowpeas and pigeon peas you Purchased (stocked) in the year 2013 (concentration index).

Month 2013	1.Green gram		2. Cow pea (Kgs)		3. Pigeon pea (Kgs)	
	1.1 Volume of purchases (Kgs)	1.2 Total transactions (number of purchases)	2.1 Volume of purchases (Kgs)	2.2 Total transactions (number of purchases)	3.1 Volume of purchases (Kgs)	3.2 Total transactions (number of purchases)
1.Jan						
2.Feb						
3.March						
4.April						
5.May						
6.June						
7.July						

8.Aug						
9.Sept						
10.Oct						
11.Nov						
12.Dec						

A27. Approximately, how many kilograms of other grains you Purchased (stocked) in the year 2013 (concentration index).

Month 2013	1. Beans (Kgs)	2.Dolichos (Kgs)	3.Maize (Kgs)	4.Sorghum (Kgs)	5.Millets (Kgs)
1.Jan					
2.Feb					
3.March					
4.April					
5.May					
6.June					
7.July					
8.Aug					
9.Sept					
10.Oct					
11.Nov					
12.Dec					

A28. How much was your initial investment capital in grain business (KES) _____

A29. What determined your initial investment capital in the grain business? 1= Budget constraint, 2=No. of buyers, 3=barriers to entry, 4=uncertainty, 5=space, 6= competition, 7=lack of supplier, 8=lack of business skills, 9=other (specify) _____

A30.What is your total annual working capital (stocking and running capital) in the grain business (KES) _____

A31. Do you rent or have your own store (warehouse)? 1=rent, 0=have own store [_____]

A32. What type of store? 1=specialised store, 2=small space in the shop, 3=other (specify)_____ [_____]

A33. What is the capacity of your grain store _____ bags (90 kg bag)?

A34. Social capital of traders, 2013

Variable	Number
A34.1 Number of persons the trader could ask for loan from	
A34.2 Number of markets in which you operate	
A34.3 Number of local seller clients in this market	
A34.4 Number of distant seller clients outside this market	
A34.5 Number of distant markets with contacts beyond the sub county	
A34.6 Number of business contacts by telephone	
A34.7 Number of members of the family in grain trade	
A34.8 Number of friends in grain trade	
A34.9 Number of regular buyers in this market	
A34.10 Number of regular distant buyers (outside this market)	
A34.11 Number of buyers with telephone orders only	

A35. How long did you typically store (days between purchase and sale) your green grams, cowpeas and pigeon peas (January to December 2013)? What was the longest you stored the products?

Commodity	1.Average buying price per Kg before storage (KES) in 2013 (12 months)	2. Days of Shortest storage duration (days) in 2013	3. Price per kg after shortest storage duration	4. Days of the Longest storage duration (days) in 2013	5. Price per kg after Longest storage duration	6. Problems in longest Storage duration (codes)
A35.1 Green gram						

A35.2 Cow pea						
A35.3 Pigeon pea						

Codes: 1=inadequate space, 2= Losses due to storage pests, 3=high costs of storage pesticides, 4=Losses due to moisture, 5=competition from imports, 6=lack of price increase, 7=Theft, 8=Other (specify)_____

A36. What proportion of the rent paid is attributable to the grain stored? [_____]

A37. Apart from your core business what else do you undertake? (Use the Table below)

Inputs distribution	Production	Assembly	Transport	Storage	Grading	Distributing	Exporting
1[___]	2[____]	3[____]	4[_____]	5[___]	6[____]	7[_____]	8[_____]

A38. How did you transport your grains from source to the place of sale (wholesale or retail) from January to December 2013?

Commodity	Mode of transport				5.Distance in Kilometres
	1.Public means 1=yes, 0=otherwise	2.Own vehicle 1=yes, 0=otherwise	3.Rented vehicle 1=yes, 0=otherwise	4.Total transport costs (KES)	
A38.1Green gram	[_____]	[_____]	[_____]	[_____]	[_____]
A38.2Cowpea	[_____]	[_____]	[_____]	[_____]	[_____]
A38.3Pigeon pea	[_____]	[_____]	[_____]	[_____]	[_____]

A39. Have you been using a formal business plan for this business? (Tick one that applies) 1=Yes, 0=otherwise [_____].

A39.1 If yes, how has this business plan helped you in achieving your objectives? _____ 1. Access credit;

2. Access to technology; 3. Access to technical advice; 4. Improve Monitoring and Evaluation;

5. Increase profit 6. Others (specify)

A40. What was your total number of employees in the grains business here in the year 2013? Total employee _____ Adult men (>35 years) ____ Adult women (>35 years) _____ Male youth (18-35 years) _____ Female youth (18-35years) _____

A41. Do you face any constraints in accessing financial credit? 1=Yes [___] 0=otherwise [____].

A41.1 If yes, what is the main constraint faced in accessing credit? 1. Religious, 2.Gender/cultural, 3. Lack of collateral security, 4. High interest rates, 5. Lack of information, 6. Long processing period, 7. Other specify_____

A42. If credit is provided to <u>you</u> what are the frequency and terms of payment? (Fill the Table below)

Source (see codes)	Terms of payment						Frequency
	1.Maximum amount of money allowed to be borrowed for all grains	2.Maximum duration	3. Is Top up allowed? 1=yes,0=otherwise	4.Payment, 1=cash, 2=cheque,	5.Penalty for default	6.Collaterals 1=trader property, 2=shares, 3=relative, 4=another trader, 5=provincial administration	7.Number of instalments allowed
A42.1[__]							
A42.2[__]							
A42.3[__]							

A42.4[__]							
A42.5[__]							

Codes: Source: 1=Merry-go-round (RoSCAs) 2=Loan from the market Association, 3=loan from the area traders' union, 4=Loan from a bank; 5= Loan from Micro-finance, 6=Institutions; 7= Enterprise Development funds; 8= Co-operatives; 9. Grants from donors; 10= Friends, 11= Family, 12= Suppliers, 13=Other (Specify)_____

A43. What are the characteristics of the finance sourced? (Fill the Table below)

Source of loan (see codes)	1.Amount applied for bank loan (KES)	2.Amount of requested loan received (KES)	3.Purpose (see codes)	4.Adequacy 1=yes, 0=No.	5.Satisfaction with the financial institution (see codes)
A43.2.1[__]					
A43.2.2[__]					
A43.2.3[__]					
A43.2.4[__]					
A43.2.5[__]					

Codes:

Source: 1=Merry-go-round (RoSCAs) 2=Loan from the market Association, 3=loan from the area traders' union, 4=Loan from a bank; 5= Loan from Micro-finance, 6=Institutions; 7= Enterprise Development funds; 8= Co-operatives; 9. Grants from donors; 10= Friends, 11= Family, 12= Suppliers, 13=Other (Specify)_____

Purpose: 1. Business start-up capital; 2. Expansion; 3. Accounts Receivable; 4. Loan Refinancing; 5.Other (specify) _____

Satisfaction: 1. strongly unsatisfied; 2. Unsatisfied; 3. Neutral; 4. Satisfied 5. Strongly satisfied

A44. Traders' access to informal and supplier credit by region, 2013

Variable	Number
A44.1 Number of friends or family who were willing to give credit	
A44.2 Number of friends or family that gave credit	
A44.3 Number of friends or family to whom trader gave credit	

A44.4 Number of suppliers who were willing to give credit	
A44.5 Number of suppliers who gave credit	
A44.6 Number of buyers to whom trader gave credit	

A45. Have you insured your business? (Tick one that applies) 1=Yes [_]; 0=otherwise [_].

A45.1 If yes, fill the table below

Economic activity insured	Amount insured (KES)	Total annual amount Insured (KES)	3. frequency of payment: codes: 1=once, 2=regularly	4.Satisfaction (see codes)
A45.1.1 Inputs distribution				
A45.1.2 Production				
A45.1.3 Assembling				
A45.1.4 Transport				
A45.1.5 Storage				
A45.1.6 Grading				
A45.1.7 Distributing				
A45.1.8 Wholesaling				
A45.1.9 Retailing				
A45.1.10 Exporting				
A45.1.11 for all economic activities				

Codes for satisfaction:

1. Strongly unsatisfied; 2. Unsatisfied; 3. Neutral; 4. Satisfied 5. Strongly satisfied

A46. Do you belong to any trade association (institutional)? (Tick what applies): 1=Yes 0=otherwise.

A46.1. If yes, name THREE associations that are relevant to your business, membership status and services provided, satisfaction with the services provided? (*Provide information in the Table below*):

Association (Name)	1.Type of membership (Codes)	2.Services received (Codes)	3.Satisfaction level(see codes)
A46.1.1			

A46.1.2			
A46.1.3			

Services received codes: 1. monitoring of behaviour, 2=sanctioning of defection from cooperative endeavour, 3=Dispute resolution, 4= Infrastructure improvement, 5= Market management and security, 6=exchange of market information, 7=Quality improvement, 8=Social/religious welfare, 9=Credit facilitation, 10=Transport arrangements, 11=Training, 12=Supply control, 13=other (specify)

Type of membership Codes: 1=committee official, 2= member, 3=other (specify)

Satisfaction Level Codes: 1. strongly unsatisfied; 2. Unsatisfied; 3. Neutral; 4. Satisfied 5. Strongly Satisfied

A47. If the answer is otherwise in A46, what are the reasons for NOT being a member of the association? List three main ones

1._____

2._____

3._____

A48. Are you linked with other traders? 1=Yes; 0=otherwise. [____]

A48.1. If yes, which firm(s) or company (ies)? (Name two):

Name of the trader	Business activity (ies)
A48.1.1	A48.1.1.1
A48.1.2	A48.1.2.2

A49. What is the nature of the linkage? 1. franchise [using other entities'

brand names with permission and agreeing to maintain their standards; 2. Branch; 3.

Agency; 4. Advertisement, 5. Promotion, 6.Other (specify)._____

A50. For the amount of green grams, cowpeas and pigeon peas purchased, did you have contractual agreements with the producers/collectors and if so, what kind of agreements? (*Provide information in the Table below*):

Commodity	1.Contractual agreement/ arrangement 1=Formal, 2= Informal	2.With Whom was the contractual agreement (1=Individual farmer 2=Farmer Group 3=CBO 4=FBO 5 NGO 6=Other Specify)	3.Incidence of contracts not being honoured by you and the other party? 1=Yes, 0=No	4.Reason for not honouring contract (1=default on agreed prices, 2=Delays in payment 3=Delays in collection 4=poor quality 5= low quantities 6=Poor weather 7=underweight 8= Others Specify_____)	5.Suggestion for improvement
A50.1Green gram					
A50.2Cowpea					
A50.3Pigeon pea					

A51. For the amount of green grams, cowpeas and pigeon peas sold, did you have contractual agreements with the buyers and if so, what kind of agreements?

Commodity	1.Contractual agreement/ arrangement 1=Formal, 2= Informal	2.With Whom was the contractual agreement (1=Individual	3.Incidence of contracts not being honoured? 1=Yes,	4.Reason for not honouring contract (1=default on agreed prices, 2=Delays in payment 3=Delays	5.Suggestion for improvement

		buyer 2=wholesalers 3=Retailers 4=Institutions 5=Distributors 6=Other Specify)	0=No	in collection 4=poor quality 5= low quantities 6=Poor weather 7=underweight 8=Others Specify_____)	
A51.1Green grams					
A51.2Cow peas					
A51.3Pigeon peas					

A52. What are the institutions (rules) which promote exchange of ownership of goods in this market? (Fill the Table below)

Institutions (use codes)	1.Which ones promote exchange of ownership of goods in this market? 1=promote, 0=Not promote	2.Among the ones which promote exchange of ownership, which ones you like? and dislike? 1=like, 2=dislike
1=Shared values (respect, honour)	[_____]	[_____]
2=Contract	[_____]	[_____]
3=Enforcement mechanisms (legal system) –peer pressure, self censure	[_____]	[_____]
4=Commercial rules	[_____]	[_____]
5=Organization of wholesalers retailers and brokers (collusion, monopoly, integrity)	[_____]	[_____]
6=Co-operatives within the markets (cohesiveness, feeling togetherness)	[_____]	[_____]

7=Coordination (vertical supply arrangements),	[_____]	[_____]
8= Other (specify) _____	[_____]	[_____]

A53. What are the institutions to protect property and persons?

Institutions (use codes)	1. Which ones protect property and persons in this market? 1=protect, 0=Not protect	2. Among the ones which protect property and persons, which ones you like? and dislike? 1=like, 2=dislike
1=Perceived legitimacy (right to property and persons protection)	[_____]	[_____]
2=Religious-based norms	[_____]	[_____]
3=Traditional customs	[_____]	[_____]
4=Laws	[_____]	[_____]
5=other (specify)_____	[_____]	[_____]

Section B: Market Structure

B1.1. Which varieties of green gram, cow pea and pigeon pea did you purchased in the year 2013?

Aspects	Commodity varieties (Codes)								
	1.Green grams varieties			2.Cowpeas varieties			3.Pigeon peas varieties		
	1	2	3	1	2	3	1	2	3
B1.1.1 Variety (codes)									
B1.1.2 Origin (codes)									
B1.1.3 Quality (grade)-codes									

B1.1.4 Price (KES per kg)									
B1.1.5 Total volume bought (Kgs)									

Variety Codes: Green grams 1=Nylon, 2=uncle

Cowpeas: 1=K80, 2=M66, 3=KVU 27-1, 4=local

Pigeon peas: 1=Kat 60/8, 2=medium, 3=mbaazi 11, 4=local

Origin Codes: 1=Own farm, 2=Farmer group, 3=Direct from farmers within the location, 4=Direct from other farms in the locations within the sub county, 5=Assemblers, 6=another county (specify) _____ 7=from brokers/middlemen, 8=Wholesaler, 9=Distributors (truckers), 10=other (specify) _____

Quality (grade)-Codes: 1=weight (heavy, medium, light), 2=size (Small, Medium, Large), 3=No impurities, 4=No mixture, 5=Not damaged, 6=Taste (undecided, Not sweet, Moderately, Sweet, Very Sweet), 7=other (specify)_____

B1.2. How are the quality characteristics (product differentiation) of green gram, cow pea and pigeon pea grains? (Fill the Table below)

Commodity weight	Weight of varieties (grams)								Weight of grains with impurities (grams)
	Nylon	uncle	local						
B1.2.1 100 grain weight of green grams	[___]	[___]							[____]
	K80	M66	KVU 27-1	local					
B1.2.2 100 grain weight	[____	[____]	[___]	[__]	[__]	[_]	[__]	[__]	[____]

of cow peas	]								
	Kat 60/8	Mbaazi 1	Mbaazi 11	777	local				
B1.2.3 100 grain weight of pigeon peas	[___]	[____]	[___]	[__]	[__]	[_]	[__]	[__]	[____]

B1.3. what were the Quantities of green grams, cowpeas and pigeon peas sold during the year 2013:

Month	1.Green grams		2. Cow peas		3. Pigeon peas	
	1.1 Volume of sales (Kgs)	1.2 Total transactions (number of sales)	2.1 Volume of sales (Kgs)	2.2 Total transactions (number of sales)	3.1 Volume of sales (Kgs)	3.2 Total transactions (number of sales)
1.Jan						
2.Feb						
3.March						
4.April						
5.May						
6.June						
7.July						
8.Aug						
9.Sept						
10.Oct						
11.Nov						
12.Dec						

B1.4. Minimum amount of sales of green grams for the trader to remain in the market (not exit) – kgs [___]

B1.5.Minimum amount of sales of cowpeas for the trader to remain in the market (not exit) –kgs [__]

B1.6. Minimum amount of sales of pigeon peas for the trader to remain in the market (not exit) – kgs [__]

B1.7. How do you obtain the stock of green grams, cow peas and pigeon peas? who delivers? and who are the main buyers you sell to? (Fill the Table below).

Traded commodity	Three main sources of stock (codes) 1. Own farm 2. Farmer group 3. Direct from farmers within the location 4. Direct from other farms in the locations within the sub county 5. Assemblers 5. Another county (specify)_____ 6. From brokers/middlemen 7. Wholesaler 8. Distributors (truckers) 9. Other (specify)_____			*Main buyers of the* commodity [by volume]? (codes) 1= Rural wholesalers within the county (specify the market)_____ 2=Rural retailers within the county (specify the market)_____ 3= Broker/assemblers within the county (specify the market) _____ 4=Urban wholesalers (specify the Town)_____ 5=Institutions within the county (hospitals/schools) 6=Institutions outside the county (hospitals/schools) (specify the county)_____ 7=Individual consumers within the market 8=Individual consumers outside the market (Specify the locations)_____ 9=wholesalers within the market 10=retailers within the market 11=Exporters (specify the importing country)____ 12= Producer Marketing Group (PMG) 13=Other destinations (specify)_____		
	Source 1	Source 2	Source 3	buyer 1	buyer 2	buyer 3
B1.7.1 Green grams	source[__]	source[__]	source[__]	buyer[__] Distance [_____] Km	buyer[__] Distance [_____]	buyer[__] Distance [_____]
B1.7.2 Cowpeas	source[__]	source[__]	source[__]	buyer[__] Distance	buyer[__] Distance	buyer[__] Distance

				[_____] Km	[_____]	[_____]
B1.7.3 Pigeon peas	source[__]	source[__]	source[__]	buyer[__] Distance [_____] Km	buyer[__] Distance [_____]	buyer[__] Distance [_____]

B1.8. Traders' relations with brokers, in year 2013 (fill the table below)

Traders' relations with brokers in the year 2013	Tick below
1.Trader using brokers regularly	[_____]
2.Trader not able to operate without broker	[_____]
3.Trader working without a single broker	[_____]
4.Trader with kinship ties with broker	[_____]
5.Trader from same locality as broker	[_____]
	Fill number below
6.Number of Years with no relations with a broker	[_____]
7.Number of Transactions where broker gives sales advance or buyer credit	1.Number of all sales in 2013 (transactions) [_____] 2.Number of sales where broker gives advance [___]
8.Number of Local transactions where trader is present with broker	1.Number of all local transactions in 2013 [_____] 2.Number of local transactions where trader is present with broker [____]

9.Number of Distant transactions where trader is present with broker	1.Number of all distant transactions in 2013 [_____] 2. Number of distant transactions where trader is present with broker [____]

B1.9. Openness and conflict between brokers and traders, 2013 (fill the table below)

Openness and conflict between brokers and traders, 2013	Tick
1.Trader cross-checked information from broker	[_____]
2.Traders to whom broker reveals identity of trading partner	[_____]
3.Number of transactions in which traders know their trading partners	Number of transactions in which traders knew their trading partners [___]
5.Trader felt direct trading would cause conflict with broker	[_____]
6.Trader experienced conflict with broker (1=yes, 0=otherwise)	[_____]
7.Number of conflicts in the year 2013 with broker	[_____]
8.Trader for whom conflict was resolved through legal recourse	[_____]
9.Trader for whom conflict was resolved through mediation	[_____]
10. What does a broker do in grain business?	

B1.10. What are your reasons to work with a broker? (Circle the ones which apply)

1=Broker has better access to market information, 2=Broker acts as guarantor, 3=Broker has more contacts, 4=Broker identifies good quality, 5=I have no choice, 6=Broker gives business advice, 7=Less costly to work with broker, 8=other (specify)____

B1.11. What are your reasons not to work with a broker? (Circle the ones which apply)

1=I trade with partners whom I know well, 2=I know the market well enough, 3=Brokers cheat on prices, 4=I want to save commission fees, 5=I don't need a quick transaction, 6=Disagreement with broker, 7=other (specify)_____

B1.12. How can you distinguish green grams, cow peas and pigeon peas from this region from others from other regions?

Commodity	1.How can you distinguish the commodities (codes)	2.How can your customers tell the difference between local commodities and commodities coming from somewhere else (codes)
B1.12.1 Green grams		
B1.12.2 Cowpeas		
B1.12.3 Pigeon peas		

Codes: 1=Not Applicable, 2=colour, 3=weight, 4=size, 5=impurities, 6=mixture, 7=damaged, 8=Taste, 9=price differentials, 10=other (specify) _____

B1.13. Are there problems with the quality while buying green grams? 1=yes, 0=otherwise [__], cowpeas? 1=yes, 0=otherwise [___], pigeon pea, 1=yes, 0=otherwise [___]

B1.13.1. If yes, to B1.15, what was the approximate average amount of green grams, cowpeas and pigeon peas affected from January to December 2013?

Commodity	Approximate average amount affected			
	1.humidity	2.impurity	3.Damage (burnt, broken)	4.Mixing of varieties
B1.13.1.1 Green grams				
B1.13.1.2 Cowpeas				
B1.13.1.3 Pigeon peas				

B1.14. How many Wholesalers [_____], Retailers [_____] of green grams, cowpeas and pigeon peas are <u>located within the same line</u> with your business premise (<u>FILL</u> the trader responding to this question)

B1.15. Do you have plans to expand your business on green grams or cowpeas or pigeon peas?

Commodity	1.Current market place	1.1.Reasons for either yes or otherwise	2.Other market places	2.1 Reasons for either yes or otherwise:
B1.15.1Green grams	1=Yes [____] 0=otherwise [_____]	1._____ 2._____ 3._____	1=Yes [____] 0=otherwise [_____]	1._____ 2._____ 3._____
B1.15.2Cowpeas	1=Yes [____] 0=otherwise [_____]	1._____ 2._____ 3._____	1=Yes [____] 0=otherwise [_____]	1._____ 2._____ 3._____
B1.15.3Pigeon peas	1=Yes [____] 0=otherwise [_____]	1._____ 2._____ 3._____	1=Yes [____] 0=otherwise [_____]	1._____ 2._____ 3._____

B1.16. what three main support services do you receive from the National and/or County

Governments (government participation)?

List support services (Name)	1.Source of Service (see codes)	2.Level of Satisfaction (see codes)
B1.16.1		
B1.16.2		
B1.16.3		
B1.16.4		
B1.16.5		

Source of Service: 1=National 2= County

Satisfaction level:1. Strongly unsatisfied; 2. Unsatisfied; 3. Neutral; 4. Satisfied 5. Strongly satisfied

B1.17. what types of standards do you require while marketing green grams, cowpeas and pigeon peas? (Provide information in the Table below):

Commodity	Type of Standard (see codes)			Challenges in meeting the standards (codes)
	1	2	3	
B1.17.1Green grams				
B1.17.2Cow peas				
B1.17.3Pigeon peas				

Type of Standards: 1= Moisture; 2= Foreign matter; 3=Size; 4=Density; 5=Deformities; 6=Colour; 7=Texture; 8=Damage;9=Others

Standard challenges 1=Finance; 2=Equipment; 3=Cost; 4=Information; 5=Source of produce; 6=Producers awareness; 7=Consumer awareness; 8= Packaging; 9= Integrity issues

B1.18 What are the observed unethical trading practices? 1=Underweight grains, 2=Unfulfilled contracts, 3=Mis-labelling, 4=Over/under invoicing, 5=Counterfeits, 6=Unlawful discrimination, 7=Unfair competition, 8=misleading price information, 9=usurious practices (lending money at very high rates of interest), 10=other (specify)_____

B1.19. How many times from January to December 2013 were you visited by inspectors from the following regulators? and were you satisfied with their procedures and services?

Regulators	1.No. of inspections	2.Purpose of the inspection	3.Satisfaction level [See codes]
1.Weight and measures			
2.KEBS			
3.County Government			
4. Seed Companies			
5.KEPHIS			
6.PCPB			
9. KRA			
10.Others (Specify) [_____]			

Legend: KEBS = Kenya Bureau of Standards; KEPHIS = Kenya Plant Health and Inspectorate Services; PCPB = Pests Control Products Board;; KRA = Kenya Revenue Authority.

Codes for satisfaction level:1. Strongly unsatisfied; 2. Unsatisfied; 3. Neutral; 4. Satisfied 5. Strongly satisfied

B1.20. Do you demand any standards to be met by your suppliers? 1=Yes; 0=otherwise [_____]

B1.20.1. If yes, which ones? (Provide information in the Table below)

No.	Commodity	Standard 1	Standard 2	Standard 3
B1.20.1.1	Green grams			
B1.20.1.2	Cowpeas			
B1.20.1.3	Pigeon peas			

B1.21. Do your customers demand any standards to be met by you? 1=Yes; 0=otherwise. [_____]

B1.21.1. If yes, which standards you meet? (*Provide information in the Table below*):

No.	Commodity	Standard 1	Standard 2	Standard 3

B1.21.1.1	Green grams			
B1.21.1.2	Cowpeas			
B1.21.1.3	Pigeon peas			

B1.22. How would you characterize the green grams, cowpeas and pigeon peas market in this area in relation to competition?

Commodity	Characteristics of the market in the area (Codes)
B1.22.1 Green grams	
B1.22.2 Cowpeas	
B1.22.3 Pigeon peas	

Codes: 1=always a lot of competition among assemblers, 2=rarely competition among assemblers, 3=competition among assemblers varies according to supply, 4=always a lot of competition among wholesalers, 5=rarely competition among wholesalers, 6=competition among wholesalers varies according to supply, 7=always a lot of competition among retailers, 8=rarely competition among retailers, 9=competition among retailers varies according to supply.

B1.23. what distribution channels are used for the green grams, cowpeas and pigeon peas?

Commodity	1.Describe the specific market channels (Codes)	
B1.23.1 Green grams		
B1.23.2 Cowpeas		
B1.23.3 Pigeon peas		

Codes:

1	Small producer →	rural wholesalers →	Rural transporters →	Urban exporters →	Foreign market			
2	Small producer →	rural wholesalers →	Rural transporters →	Urban wholesalers →	Urban exporters →	Foreign market		
3	Small producer →	Rural assemblers →	Rural wholesalers →	Rural transporters →	Urban wholesalers →	Urban exporters →	Foreign market	
4	Small producer →	Rural assemblers →	Urban exporters →	Foreign market				
5	Small producer →	Rural assemblers →	Rural open-air retailers →	Rural consumers/small				

				producers				
6	Small producers →	Rural open-air retailers →	Rural consumers/small producers					
7	Small producers →	Rural consumers/small producers						
8	Small producer →	Rural assemblers →	Rural retailers shopkeepers →	Rural consumers/small producers				
9	Small producer →	Rural retail shopkeepers	Rural consumers/small producers					
10	Small producer →	Rural wholesalers →	Rural transporters →	Urban exporters →	Urban supermarket →	Urban consumers		
11	Small producer →	Rural assemblers →	Rural wholesalers →	Rural transporters →	Urban wholesalers →	Urban exporters →	Urban supermarket →	Urban consumers
12	Small producer →	Rural assemblers →	Urban wholesalers →	Urban exporters →	Urban supermarket →	Urban consumers		
13	Small producer →	Urban wholesalers →	Urban supermarket →	Urban consumers				
14	Small producer →	Rural assemblers →	Urban wholesalers →	Urban open air retailers →	Urban consumers			
15	Small producer →	Rural assemblers →	Urban wholesalers →	Urban retailers shopkeepers →	Urban consumers			
16	Small →	Rural →	Rural →	Rural →	Rural →	Rural		

	producer	assemblers	wholesalers	transporters	open-air retailers	consumers/small producers		

B2: Market Conduct

B2.1. List the languages you speak?
1)_____2)_____3)_____4)_____5)_____

B2.2. Which marketing strategy (ies) you use is (are) effective in increasing the sales more than the competitors? 1=lowering the price, 2= better quality, 3=storage, 4=promotion, 5=use of brokers, 6=many outlets in the same market, 7=other outlets in other markets, 8=other (specify)

B2.3. What was your search labour, measured by the number of persons employed by the trader to help in searching for buyers and sellers in the year 2013 (fill the table below)

	Number of traders consulted monthly	Number of employees engaged in searching for sellers	Wage for the seller searching employee (KES)	Number of employees engaged in searching for the buyers	Wage for the buyer searching employee (KES)
Year 2013					

B2.4. Number of persons responsible for purchasing and selling activities

	1.Number of persons responsible for purchasing activities	2.Number of persons responsible for selling activities
Year 2013		

B2.5. Have you ever had any business management training? 1=Yes 0=otherwise. [____]

B2.6. Which year was the most recent (state the year)_____

B2.7. Which organization? 1. Faith-based organization; 2.Public; 3. NGOs 4. Financial institutions 5. Others (specify) _____.

B2.7.1. If yes, what was the training in (Type) and for how long (Duration)?

Type of Training: 1=Business skills, 2=Management skills; 3=Governance; 4=Book keeping and Records; 5=Agribusiness and entrepreneurship; 6=Skills in value addition; 7=Climate change and adaptation 8=other capacity building skills (specify)_____

Duration: 1= less than a week; 2= more than a week; 3= more than a Month; 4= others (specify).

B2.8. Have your employees ever had any business management training? 1=Yes 0=otherwise [___]

B2.8.1. If yes, indicate main organization/source of training by ticking what applies? : 1.

Faith-based 2. Public 3. NGOs 4. Private 5. Others (specify) _____.

B2.9. what were the types of training received? 1. Business skills, 2=Management skills; 3=Governance; 4=Book keeping and Records; 5=Agribusiness and entrepreneurship; 6=Skills in value addition; 7=Climate change and adaptation 8=other capacity building skills (specify) _____

B2.10 what was your level of training satisfaction for the employees? 1. Strongly unsatisfied 2. Unsatisfied 3. Neutral; 4. Satisfied 5. Strongly satisfied

B2.11. how has the training helped improve your employees productivity? 1. Improved value addition; 2. Access capital/credit 3. Reduced losses; 4. Improved market Access/ share; 5. Other (specify)_____

B2.12. what are your main sources for weather/climate related information? 1. Traditional Indigenous Knowledge; 2. Radio; 3.Television; 4.Government Extension Officers; 5.Private Extension officers; 6. NGOs; 7. FBOs; 8.Meteorological Department; 9. Partners; 10.Internet; 11.Other specify_____

B2.13. If you were in grains business during the last famine, how did the experience change your business strategy? 1=acquired store, 2=developed supply chain, 3=keen on weather information, 4=withhold sales, 5=other (specify) _____

B2.14. Do you add value (sorting and grading, packaging, storing) to green grams, cowpeas and pigeon peas which you are selling? 1=Yes; 0=otherwise. [_____]

B2.14.1. If yes, fill in the Table below. How much did it cost you to add value from January to December 2013?

Commodity	Type of Value addition (see codes)	Value added Quantities (Kgs) in the year 2013	Total cost of value addition (KES) in the year 2013
B2.14.1.1 Green grams			
B2.14.1.2 Cowpeas			
B2.14.1.3 Pigeon peas			

VA Codes: 1. Sorting 2. Cleaning; 3. Grading; 4.) Packaging; 5=Storage; 6. Transportation; 7. Drying;

8. Other (specify _____

B2.15. how much did you sell the value added (VA) grains in the year 2013? (Provide information in the Table below):

Commodity	1.Average price per Kg for grains before Value Addition (KES) in the year 2013	2.Average price of Value Added grains per Kg (KES) in the year 2013
B2.15.1 Green grams		
B2.15.2Cow peas		
B2.15.3Pigeon peas		

B2.16. What are your main constraints in your day-to-day buying and selling activities of green grams, cowpeas and pigeon pea grains?

Commodity	Three main problems encountered (Codes)
B2.16.1 Green grams	
B2.16.2 Cowpeas	
B2.16.3 Pigeon peas	

Codes: 1=Limited funds , 2= Seasonality, 3= Low production, 4=Poor transport facilities, 5=Lack of customers, 6=Unfavourable market location, 7=Low selling prices, 8= Unpredictable market conditions, 9=Bad debtors, 10= Low consumers' income, 11= Price fluctuation, 12=High purchase prices, 13=storage costs, 14=storage losses, 15=taxes, 16=Transport costs, 17=High permit costs; 18=Insecurity; 19=Harassment by authorities; 20=Credit Constraints; 21=lack of market information; 22= High competition between Traders, 23=price undercut, 24=lack of business skills, 25=collusion, 26=poor market integration, 27= Untrusted sources (Thief), 28=others (specify) _____

B2.17. Do you use Information Communication Technology (ICT)? (Tick which applies):1=Yes 0=otherwise

B2.17.1. If Yes, Which ones? 1. Mobile telephony; 2. facebook and twitter 3. you-tube; 4. Skype; 5. Email; 6. Personalized website; 7. Print media; 8. Other web-based media; 9. Radio; 10. TV; 11. Others (specify)_____

B2.18. Which of these ICT do the other traders in this area use most frequently? (List three main ones

using the codes in B2.21.1): 1 [_____] 2 [_____] 3 [_____]

B2.19. What are three most important uses of the ICT? 1_____2_____3_____

B2.20. what constraints associated with the use of ICT do you face?

1._____2._____3._____4._____

B2.21 Name three main market/industry emerging trends that you think will shape the future direction

of marketing green grams, cowpeas and pigeon peas:

1. _____

2. _____

3. _____

B2.22.What are the three important options that you apply when your supplies are disrupted/threatened

by climate related changes? 1. Close shop 2. Shift to other available commodities 3. Increase storage capacity 4. Look for supply elsewhere 5. Seek Government support 6. Rationing sales 7. Increase prices 8. Others (Specify)___

B3: Market Performance

B3.1. Estimates of physical marketing costs. What were the components and marketing costs? Costs incurred by the Trader in the year 2013

Marketing functions	1.Green grams	2.Cowpeas	3.Pigeon peas	4.Total

	Average costs for 12 months (KES)			
1.Transport costs				
2.Storage cost including chemicals				
3.Wages of employees	Total No. of employees [_____] Total wage cost[_____]			
4.Cost of packaging materials (sacking)				
5.Operating cost of machinery and equipment				
6.value of grain losses				
7.Expenses on sorting and grading				
8.Inspection fees				
9.Levies (cess)				
10. Road stops costs				
11.Interests on loans				
12. Electricity cost				
13. Insurance premium				
14. Rent for business premises				
15. Permit and licenses				

C: Pricing Efficiency

C1. Price discovery for <u>sales</u> and <u>purchases</u>

How frequent do you change prices?	Sales (Tick)	Purchases (Tick)	Reasons for changing sales prices	Reasons for changing purchases prices
1.Daily	[_____]	[_____]		
2.Weekly	[_____]	[_____]		
3.Every three months	[_____]	[_____]		

4.Every four months	[_____]	[_____]		
5.Every six months	[_____]	[_____]		
6.Annually	[_____]	[_____]		

C2. What do you base the selling and purchases prices of green grams, cowpeas and pigeon peas?

Commodity	How do you decide sales price (codes)	What is the degree of personal contact among the market (codes)	How do you decide purchase price (codes)	What is the degree of personal contact among the market (codes)
C2.1.Green grams				
C2.2.Cow peas				
C2.3.Pigeon peas				

Sales and purchase (Codes): 1=price offered by buyer, 2=expected profit, 3=costs of investment, 4=other (specify) _____

Degrees of contact (Codes): 1=working together with other traders (collusion), 2=bids, 3=contracts, 4=government control, 5=other (specify)_____

C3. Are there formal or informal Producer Marketing Groups (PMG) of green grams, cowpeas and pigeon peas around your market, that affect bargaining power? 1=yes, 0=otherwise [_____]

C3.1. If yes to C3. Indicate their functions in the Table below

Commodity	Functions of producer marketing groups (Codes)
C3.1.1.Green grams	
C3.1.2.Cowpeas	
C3.1.3.Pigeon peas	

Codes: 1=Inputs distribution, 2=production, 3=assembly, 4=transport, 5=storage, 6=grading, 7=distributing, 8=wholesaling, 9=retailing, 10=exporting, 11=importing, 12=Negotiation, 13. Price discovery, 14=other (specify)____

C4. How do you find out about prices? 1. Mobile telephony; 2. Facebook and twitter 3. You-tube; 4. Skype; 5. Email; 6. Personalized website; 7. Print media; 8. Other web-based media; 9. Radio; 10. TV; 11. Others (specify) _____

C5. Does the physical location of the market (in relation to the population of producers and road infrastructure) affect selling prices and marketing arrangements (spatial advantage)? 1=yes [___], 0=Otherwise [____]

C6. What prices did you pay while purchasing from the producer (farmer) or Assembler (intermediaries) during each month of the year 2013 for average quality of green grams, cow peas and pigeon peas

Month 2013	1.Green gram (KES per Kg)		2.Cowpea (KES per Kg)		3.Pigeon pea (KES per Kg)	
	1.1.producer	1.2.Assembler	2.1.producer	2.2.Assembler	3.1.producer	3.2.Assembler
February-March						
June-August						

2. Appendix B

Data analysis outputs

Table B1.

Factors Influencing Household Commercialization Level of Pooled Green Gram and Pigeon Pea Food Crops

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
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Iteration 0:   log likelihood = -374.91509
Iteration 1:   log likelihood = -324.45377
Iteration 2:   log likelihood = -309.65937
Iteration 3:   log likelihood = -307.00926
Iteration 4:   log likelihood = -306.99929
Iteration 5:   log likelihood = -306.99929

Ordered logistic regression                     Number of obs   =        682
                                                LR chi2(12)     =     135.83
                                                Prob > chi2     =     0.0000
Log likelihood = -306.99929                     Pseudo R2       =     0.1811
```

Subsistencelevels	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Croptype	-.6258558	.2434731	-2.57	0.010	-1.103054	-.1486572
AEZ	1.169921	.2586575	4.52	0.000	.6629622	1.676881
Totalcroppedland	.0674328	.0247314	2.73	0.006	.0189602	.1159054
Familysize	-.073068	.1342079	-0.54	0.586	-.3361107	.1899747
Householdlaborsize	.0820509	.1722281	0.48	0.634	-.25551	.4196118
Storageofproduce	-.4681082	.2397587	-1.95	0.051	-.9380266	.0018102
Unitprice	.0403466	.005205	7.75	0.000	.0301451	.0505481
UseImprovedSeeds	.8668198	.3799137	2.28	0.023	.1222026	1.611437
Totallivestockunit	.0425098	.0256653	1.66	0.098	-.0077933	.092813
GGCroppingIntensity	.1894772	.1080335	1.75	0.079	-.0222646	.4012189
Agehouseholdhead	.0072603	.0091457	0.79	0.427	-.0106649	.0251855
Educationhouseholdhead	.0216434	.0314142	0.69	0.491	-.0399273	.0832141
/cut1	7.280889	1.413913			4.509671	10.05211
/cut2	7.869389	1.419553			5.087117	10.65166

Table B2.

Factors Influencing Crop-Specific Green Gram Commercialization Level

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   12.0   Copyright 1985-2011 StataCorp LP
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Iteration 0:   log likelihood = -214.64583
Iteration 1:   log likelihood = -125.25691
Iteration 2:   log likelihood = -110.21326
Iteration 3:   log likelihood = -108.13224
Iteration 4:   log likelihood = -108.11513
Iteration 5:   log likelihood = -108.11512

Ordered logistic regression                     Number of obs   =        341
                                                LR chi2(12)     =     213.06
                                                Prob > chi2     =     0.0000
Log likelihood = -108.11512                     Pseudo R2       =     0.4963
```

var1_Householdlevels_GG	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
var2_AEZ_LM4_LM5	2.39356	.5588802	4.28	0.000	1.298175	3.488945
var3_Totalcroppedland	.1177709	.0469313	2.51	0.012	.0257872	.2097546
var4_Familysize	.0327525	.2209315	0.15	0.882	-.4002653	.4657704
var5_Householdlaboursize	-.0319097	.2873398	-0.11	0.912	-.5950853	.5312659
var6_Storageofproduce	-.4920395	.4222088	-1.17	0.244	-1.319553	.3354746
var7_Unitprice	.0323599	.0082751	3.91	0.000	.0161409	.0485788
var8_Useimprovedseeds	.8965218	.6635934	1.35	0.177	-.4040974	2.197141
var9_Totallivestockunit	.0084729	.0808442	0.10	0.917	-.1499788	.1669245
var10_GGcroppingintensity	-.1482836	.2885511	-0.51	0.607	-.7138334	.4172661
var11_Agehouseholdhead	-.0162949	.0163953	-0.99	0.320	-.0484291	.0158392
var12_Educationhouseholdhead	-.1010804	.0575414	-1.76	0.079	-.2138594	.0116987
var13_GGproductivity	.0229884	.003692	6.23	0.000	.0157522	.0302246
/cut1	12.72184	2.899827			7.03828	18.40539
/cut2	13.68173	2.927228			7.944465	19.41899

Table B3.

Factors Affecting the Smallholder's Pigeon Pea Crop Specific Level of Commercialization

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   12.0   Copyright 1985-2011 StataCorp LP
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teration 0:   log likelihood = -153.39412
teration 1:   log likelihood = -145.84987
teration 2:   log likelihood = -143.17931
teration 3:   log likelihood =  -143.1571
teration 4:   log likelihood = -143.15699
teration 5:   log likelihood = -143.15699

rdered logistic regression                      Number of obs   =        341
                                                LR chi2(12)     =      20.47
                                                Prob > chi2     =     0.0586
og likelihood = -143.15699                      Pseudo R2       =     0.0667
```

var1_Householdlevels_PP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
var2_AEZ_LM4_LM5	-.3025149	.3784174	-0.80	0.424	-1.044199	.4391695
var3_Totalcroppedland	-.0035388	.0538266	-0.07	0.948	-.1090371	.1019594
var4_Familysize	.008195	.2042778	0.04	0.968	-.3921821	.408572
var5_Householdlaboursize	.0211577	.2577673	0.08	0.935	-.484057	.5263725
var6_Storageofproduce	-.8219269	.3659208	-2.25	0.025	-1.539118	-.1047354
var7_Unitprice_PP	.0293598	.0089644	3.28	0.001	.0117899	.0469297
var8_Useimprovedseeds	.1221839	.6579927	0.19	0.853	-1.167458	1.411826
var9_Totallivestockunit	.0517683	.0395456	1.31	0.191	-.0257397	.1292764
var10_PPcroppingintensity	.2365053	.1592987	1.48	0.138	-.0757143	.548725
var11_Agehouseholdhead	.0167018	.0133108	1.25	0.210	-.0093868	.0427905
ar12_Educationhouseholdhead	.0716458	.0468595	1.53	0.126	-.0201972	.1634888
var13_PP_productivity	-.002496	.0028517	-0.88	0.381	-.0080852	.0030933
/cut1	2.35486	1.844963			-1.261201	5.970921
/cut2	3.032365	1.848939			-.5914893	6.65622

Table B4.

Factors Affecting Productivity of Green Gram

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.661[a]	.437	.419	86.44052

a. Predictors: (Constant), Agroecologicalzones, CROPPINGINTENSITY, Improvedseed, Education, Manureuse, Oxcart, TotalCroppedland, Gender, Knapsacksprayer, Livestock, Householdlevels_GG

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1997979.708	11	181634.519	24.309	.000[b]
	Residual	2570355.311	344	7471.963		
	Total	4568335.019	355			

a. Dependent Variable: GG_ANNUALTOTALGGProduction

b. Predictors: (Constant), Agroecologicalzones, CROPPINGINTENSITY, Improvedseed, Education, Manureuse, Oxcart, TotalCroppedland, Gender, Knapsacksprayer, Livestock, Householdlevels_GG

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-143.096	45.006		-3.180	.002
	Householdlevels_GG	88.120	7.106	.575	12.400	.000
	Education	2.281	1.142	.086	1.998	.047
	Gender	-15.621	10.109	-.067	-1.545	.123
	Manureuse	-11.869	9.633	-.051	-1.232	.219
	Improvedseed	38.124	18.618	.084	2.048	.041
	Oxcart	26.924	13.114	.095	2.053	.041
	Knapsacksprayer	-11.035	10.989	-.045	-1.004	.316
	Livestock	1.794	1.407	.058	1.275	.203
	TotalCroppedland	.936	1.365	.031	.685	.494
	CROPPINGINTENSITY	15.240	7.526	.083	2.025	.044
	Agroecologicalzones	11.794	10.233	.052	1.153	.250

Table B5.

Factors Affecting Productivity of Pigeon Pea

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.279[a]	.078	.048	2.12916

a. Predictors: (Constant), CROPPINGINTENSITY, Ownedox_cart, Useofmanure, UseofPPimprovedseed, Education, Householdlevels_PP, TotalCroppedland, LM, HouseholdheadGender, Sprayer, TOTALANIMALS

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	132.432	11	12.039	2.656	.003[b]
	Residual	1573.067	347	4.533		
	Total	1705.499	358			

a. Dependent Variable: LNYIELD

b. Predictors: (Constant), CROPPINGINTENSITY, Ownedox_cart, Useofmanure, UseofPPimprovedseed, Education, Householdlevels_PP, TotalCroppedland, LM, HouseholdheadGender, Sprayer, TOTALANIMALS

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.751	1.115		5.157	.000
	Householdlevels_PP	-.287	.214	-.070	-1.340	.181
	LM	-.833	.229	-.191	-3.646	.000
	Education	-.014	.028	-.027	-.493	.623
	HouseholdheadGender	.017	.249	.004	.067	.947
	Useofmanure	.221	.242	.050	.914	.361
	UseofPPimprovedseed	.879	.453	.101	1.941	.053
	Ownedox_cart	-.385	.319	-.071	-1.208	.228
	Sprayer	.160	.269	.034	.596	.552
	TOTALANIMALS	-.015	.048	-.018	-.312	.755
	TotalCroppedland	-.174	.090	-.102	-1.930	.054
	CROPPINGINTENSITY	.139	.250	.029	.556	.579

Table B6.

Determinants of Traders' Performance in Purchases of Green Gram Grains

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   12.0   Copyright 1985-2011 StataCorp LP
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Source	SS	df	MS	Number of obs =	110
				F(21, 88) =	1849.91
Model	1.6693e+11	21	7.9489e+09	Prob > F =	0.0000
Residual	378128088	88	4296910.09	R-squared =	0.9977
				Adj R-squared =	0.9972
Total	1.6731e+11	109	1.5349e+09	Root MSE =	2072.9

GGPURCHASES	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AgeTrader	14.66714	22.56237	0.65	0.517	-30.17082	59.5051
Gender	198.7134	458.5377	0.43	0.666	-712.534	1109.961
MarketRegion	675.6362	448.6289	1.51	0.136	-215.9194	1567.192
BUSINESSEXPERIENCE	11.78843	32.15328	0.37	0.715	-52.10945	75.68631
PPPURCHASES	.5054047	.0560383	9.02	0.000	.3940405	.616769
CPTOTALPURCHASES	.278153	.1025889	2.71	0.008	.0742791	.4820269
BEANSTOTALPURCHASES	.5269458	.0464223	11.35	0.000	.4346911	.6192004
AnnualWorkCapital	-.0016032	.0004499	-3.56	0.001	-.0024973	-.0007091
StoreCapacity	-1.315603	1.327762	-0.99	0.324	-3.954251	1.323045
Number_brokersPurchasing	51.62297	88.9766	0.58	0.563	-125.1993	228.4453
A7NbrokersSell	-144.5705	75.19724	-1.92	0.058	-294.0092	4.868264
A341loan	-288.9108	143.0958	-2.02	0.047	-573.2836	-4.537921
A342NMktOperate	91.87255	342.7218	0.27	0.789	-589.2151	772.9602
A343NlocalSeller	-26.67754	46.63009	-0.57	0.569	-119.345	65.98997
A344NDistantSeller	-44.36531	104.7625	-0.42	0.673	-252.5587	163.8281
A345NDistantMkt	285.8838	83.86031	3.41	0.001	119.2291	452.5386
A346NBusinessContacts	-13.55199	16.93466	-0.80	0.426	-47.20607	20.10209
A348NFriends	35.64394	59.49923	0.60	0.551	-82.59828	153.8862
A349NRegularBuyersMkt	.2568441	10.15186	0.03	0.980	-19.91784	20.43153
3410NRegularDistantBuyers	-6.228521	30.24278	-0.21	0.837	-66.32969	53.87264
A3411NBuyersTel	-57.96965	112.8653	-0.51	0.609	-282.2657	166.3263
_cons	-3951.398	2366.817	-1.67	0.099	-8654.949	752.1534

Table B7.

Determinants of Traders' Performance in Purchases of Pigeon Pea Grains

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
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Source	SS	df	MS		
Model	7.9110e+10	21	3.7671e+09	Number of obs =	110
Residual	711062346	88	8080253.93	F(21, 88) =	466.21
				Prob > F =	0.0000
				R-squared =	0.9911
				Adj R-squared =	0.9890
Total	7.9821e+10	109	732300777	Root MSE =	2842.6

PPPURCHASES	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AgeTrader	7.749698	31.00311	0.25	0.803	-53.86246	69.36186
Gender	-597.8813	626.2312	-0.95	0.342	-1842.384	646.6217
MarketRegion	-363.6719	621.8778	-0.58	0.560	-1599.523	872.1795
BUSINESSEXPERIENCE	-3.243253	44.12429	-0.07	0.942	-90.931	84.44449
GGPURCHASES	.9504035	.1053788	9.02	0.000	.7409853	1.159822
CPTOTALPURCHASES	-.4266295	.1391979	-3.06	0.003	-.7032561	-.1500028
BEANSTOTALPURCHASES	-.1377607	.0988455	-1.39	0.167	-.3341954	.0586739
AnnualWorkCapital	.002247	.000615	3.65	0.000	.0010248	.0034691
StoreCapacity	-.3888973	1.830427	-0.21	0.832	-4.026487	3.248692
Number_brokersPurchasing	-18.92246	122.2306	-0.15	0.877	-261.8302	223.9853
A7NbrokersSell	119.9891	104.4817	1.15	0.254	-87.64639	327.6246
A341NTLoan	289.3956	198.3367	1.46	0.148	-104.7569	683.5482
A342NMktOperate	63.08032	470.1203	0.13	0.894	-871.1849	997.3456
A343NlocalSeller	-33.15103	63.96538	-0.52	0.606	-160.2688	93.96673
A344NDistantSeller	86.97651	143.5085	0.61	0.546	-198.2165	372.1696
A345NDistantMkt	-282.2822	118.5984	-2.38	0.019	-517.9715	-46.59286
A346NBusinessContacts	27.34845	23.12389	1.18	0.240	-18.60543	73.30233
A348NFriends	10.48653	81.75021	0.13	0.898	-151.9748	172.9479
A349NRegularBuyersMkt	-10.26142	13.87831	-0.74	0.462	-37.84165	17.31881
A3410NRegularDistantBuyers	43.9439	41.21675	1.07	0.289	-37.96573	125.8535
A3411NBuyersTel	95.58874	154.6693	0.62	0.538	-211.7841	402.9615
_cons	1719.983	3291.526	0.52	0.603	-4821.234	8261.199

Table B8.

Influence of Social Capital on Trader's Performance in the Retail-Farm Gate Margin in Green Gram Pea Trading

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
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```

Source	SS	df	MS
Model	1937.22209	12	161.435174
Residual	5233.33245	97	53.951881
Total	7170.55455	109	65.7849041

Number of obs	110
F(12, 97)	2.99
Prob > F	0.0014
R-squared	0.2702
Adj R-squared	0.1799
Root MSE	7.3452

var1MARGIN	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
var2A6NbrokersPur	.1648885	.285217	0.58	0.565	-.4011882	.7309652
var3A7NbrokersSell	.3753882	.2437363	1.54	0.127	-.1083609	.8591374
var4A341NTLoan	.7879387	.4360649	1.81	0.074	-.0775294	1.653407
var5A342NMktOperate	1.21501	1.036772	1.17	0.244	-.8426955	3.272716
var6A343NlocalSeller	-.0367904	.1432969	-0.26	0.798	-.3211951	.2476143
var7A344NDistantSeller	-.1347157	.2785803	-0.48	0.630	-.6876205	.4181891
var8A345NDistantMkt	.3110617	.2774798	1.12	0.265	-.2396589	.8617824
var9A346NBusinessContacts	.0401601	.0557034	0.72	0.473	-.0703957	.1507159
var10A348NFriends	.0342562	.1891149	0.18	0.857	-.3410845	.4095969
var11A349NRegularBuyersMkt	.0123939	.0329517	0.38	0.708	-.053006	.0777938
var12A3410NRegularDistantBuyers	-.0373122	.1022072	-0.37	0.716	-.2401652	.1655407
var13A3411NBuyersTel	-.9127215	.3181607	-2.87	0.005	-1.544182	-.2812607
_cons	11.12179	1.779515	6.25	0.000	7.589942	14.65363

Table B9.

Influence of Social Capital on Trader's performance in the retail-farm gate margin in pigeon pea trading

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
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Source	SS	df	MS
Model	453.814152	12	37.817846
Residual	3266.37676	97	33.6739872
Total	3720.19091	109	34.1301918

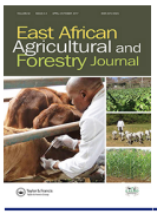
Number of obs	110
F(12, 97)	1.12
Prob > F	0.3508
R-squared	0.1220
Adj R-squared	0.0134
Root MSE	5.8029

var1MARGIN	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
var2A6NbrokersPur	.1842363	.2253302	0.82	0.416	-.2629817	.6314543
var3A7NbrokersSell	-.0073871	.1925592	-0.04	0.969	-.3895637	.3747896
var4A341NTLoan	-.5760093	.3445047	-1.67	0.098	-1.259756	.1077372
var5A342NMktOperate	.1090894	.8190819	0.13	0.894	-1.516562	1.73474
var6A343NlocalSeller	-.0738178	.113209	-0.65	0.516	-.2985063	.1508706
var7A344NDistantSeller	-.0998852	.220087	-0.45	0.651	-.536697	.3369266
var8A345NDistantMkt	.2162948	.2192176	0.99	0.326	-.2187914	.651381
var9A346NBusinessContacts	-.0178299	.0440074	-0.41	0.686	-.1051723	.0695126
var10A348NFriends	.1764997	.1494066	1.18	0.240	-.120031	.4730304
var11A349NRegularBuyersMkt	.0442479	.0260328	1.70	0.092	-.0074201	.0959158
var12A3410NRegularDistantBuyers	-.0864435	.0807468	-1.07	0.287	-.2467036	.0738166
var13A3411NBuyersTel	-.437722	.2513567	-1.74	0.085	-.9365954	.0611515
_cons	9.999078	1.405872	7.11	0.000	7.208812	12.78934

3. Appendix C

Publications

C1. Yields of green grams and pigeon peas under smallholder conditions in Machakos County, Kenya



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Yields of Green Grams and Pigeonpeas under Smallholder Conditions in Machakos County, Kenya

John Mulwa Wambua, Margaret Ngigi & Muhammad Lutta

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Yields of Green Grams and Pigeonpeas under Smallholder Conditions in Machakos County, Kenya

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ABSTRACT

Green grams and pigeonpeas have multiple benefits to the rural poor as food security, fodder for livestock and fuel for small-scale farmers, despite low smallholder yields in Kenya. However, little is known about the factors between different farmers that influence the yields of green grams and pigeonpeas. The objectives of this study therefore were to describe and compare how the groups of farmers in agro-ecological zones (AEZs) LM 4 and LM 5 differ by their yields of green grams and pigeonpeas and to estimate the parameters of the variables which explain the yields. Data collection was through a well-structured questionnaire, administered to 364 respondents, selected through a multi-stage sampling technique. Each AEZ had an equal sample size (182 respondents). One-way analysis of variance (ANOVA) and multiple linear regression were used during data analysis. The ANOVA results showed that the mean of the green gram yields in AEZs LM 4 and LM 5 was 19.90 and 173.67 kg ha^{-1} while the mean of the pigeonpea yields was 109.26 and 34.01 kg ha^{-1}, respectively. The multiple linear regression model results showed that the green gram yields were positively related to the use of improved seed ($p = 0.001$), cultivated farm sizes ($p = 0.011$), green gram crop intensity ($p = 0.005$), oxcart ($p = 0.003$) and agro-ecological zone ($p = 0.000$). The farmer differences in the use of improved seed were found to be significantly and positively related to the yields of pigeonpeas ($p = 0.057$), while the sizes of the cultivated farms ($p = 0.057$) and the agro-ecological zones ($p = 0.000$) showed inverse relationships (IRs). Based on the given research evidence, it was therefore concluded that the groups of farmers in AEZs LM 4 and LM 5 have different yields of green grams and pigeonpeas and there are factor gaps in productivity.

KEYWORDS

Green grams; smallholder conditions; pigeonpeas; yields

C2. Assessment of differences in small farmer uses of produce and determinants of marketed surplus of green grams and pigeon peas in semi-arid Machakos County, Kenya

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Assessment of Differences in Small Farmer Uses of Produce and Determinants of Marketed Surplus of Green Grams and Pigeon Peas in Semi-arid Machakos County, Kenya

John Mulwa Wambua, Margaret Ngigi & Lutta Muhammad

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ABSTRACT

Small farmers in semi-arid areas of eastern Kenya produce green grams and pigeon peas for both subsistence and income. Because of this, it was important for a detailed investigation on the difficulty of raising marketed surplus (produce) of green grams and pigeon peas. The literature with respect to how small farmers differed in the uses of the produce and the determinants of marketed surplus is sparse. The objectives of the study therefore were to assess the differences in farm retention (for self-consumption, seed and payments in kind) and marketed surplus and to determine the factors affecting marketed surplus. Survey research design was selected for making the observations. Sampling of the households was done using a multistage technique. There were 364 households selected in two agro-ecological zones, each with 182 respondents. Data collection was done using a well-structured questionnaire. Data analysis was done using the IBM SPSS Statistics 21. One-way analysis of variance results indicated that farmers of green grams and pigeon peas differed significantly in the produce consumed, marketed and used as seed and in-kind transactions. Green grams farmers differed significantly at $F_{(3, 1\,452)} = 11.420$, $p = 0.000$, whereas pigeon peas small farmers at $F_{(3, 1\,452)} = 21.680$, $p = 0.000$. Multiple linear regression analysis results showed factors influencing farmers in marketed produce of green grams as area cultivated, yield and region of production at $p = 0.01$. Seeds and in-kind transactions showed positive effect at $p = 0.05$, whereas access to market information at $p = 0.1$. The factors influencing farmers on marketed production of pigeon peas were seeds and in-kind transactions and the price of output ($p = 0.01$). The study concluded that the design of policy interventions therefore needed to take account of small farmer variations and the factors influencing the marketed production of green grams and pigeon peas.

KEYWORDS

area cultivated; in-kind transactions; marketed produce; price of output; region of production; seed retention; yield

C3.Functional diversity and performance of direct marketing outlets for smallholder farmers of green gram and pigeon pea commodities in Machakos County, Kenya

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Functional Diversity and Performance of Direct Marketing Outlets for Smallholder Farmers of Green Gram and Pigeon Pea Commodities in Machakos County, Kenya

John Mulwa Wambua, Margaret Ngigi & Lutta Muhammad

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Functional Diversity and Performance of Direct Marketing Outlets for Smallholder Farmers of Green Gram and Pigeon Pea Commodities in Machakos County, Kenya

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ABSTRACT

The smallholder direct marketing outlets (private grain traders) serve the smallholder farmers poorly in the rural areas of Kenya, making local markets thin and less competitive. The purpose of this study is to evaluate the diversity and the determinant factors influencing the private grain traders' performance based on the volumes transacted of green gram and pigeon pea commodities. A multistage stratified random sampling procedure was employed for this study to obtain relevant information on the grain traders in Mwala and Yatta subcounties. One hundred and ten (110) grain traders were sampled in Mwala (38) and Yatta (72) subcounties. Descriptive statistics and a multiple linear regression were used during analysis. The descriptive statistics indicated that the grain traders were diverse in terms of age with majority being 31 to 40 years old, gender in trading found mainly males (54.5%), trader education status with the majority having college education (58.2%), access to credit with large group of traders not accessing (65.5%) and the distribution of the volume purchased of green gram and pigeon peas grain, which indicated high market concentration and the trader inequality. Our model for the trader purchases of green gram and pigeon pea grain was correctly described by the multiple linear regression model. The results obtained from the ANOVA indicated that the overall regression is significant, $F_{(16,\ 93)} = 2\ 632.316$, $p < 0.000$ for the green gram purchases and $F_{(16,\ 93)} = 660.542$, $p < 0.01$ for the pigeon peas purchases. Grain markets for the green gram and pigeon pea functions poorly, because few traders dominate the markets with high shares in the volumes purchased. Few traders are likely to offer low prices to the smallholder farmers of green gram and pigeon pea. There is a possibility of collusion in the market, owing

KEYWORDS

multiple linear regression; multistage stratified random sampling; Mwala; private grain traders; trader education status; unequal market shares; Yatta

4. Appendix D

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